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UPPER TANA NATURAL RESOURCES MANAGEMENT PROJECT (UTaNRMP)

SOCIAL ECONOMIC AND ECOLOGICAL IMPACT STUDY OF WILDLIFE BARRIER IN MT. KENYA ECOSYSTEM, THUCHI -THINGITHU RIVERS IN THARAKA NITHI AND MERU COUNTIES

FINAL REPORT - JUNE 2019

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ACRONYMS

BCR	Benefit-Cost Ratio
CBO	Community Based Organization
CEO	Chief Executive Officer
CFA	Community Forest Association
CIG	Common Interest Group
DBH	Diameter at Breast Height
EIA	Environmental Impact Assessment
ERR	Economic Rate of Return
FGD	Focused Group Discussion
GIS	Geographic Information System
GOK	Government of Kenya
GPS	Geographic Positioning System
Ha	Hectares
HH	Household
HWC	Human Wildlife Conflicts
IFAD	International Fund for Agricultural Development
KFS	Kenya Forest Service
KII	Key Informant Interview
Km	Kilometre
KWS	Kenya Wildlife Service
LPG	Liquified Petroleum Gas
LULUC	Land Use and Land Cover
MA	Management Agreement
MKEPP	Mount Kenya East Pilot Project
Mt	Mountain
NDVI	Normalized Vegetation Index
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
NPV	Net Present Value
PPP	Public Private Partnership
RABA	Rapid Agro-Biodiversity Appraisal
SCMP	Sub Catchment Management Plan
SCP	Semi-Automatic Classification
ToR	Terms of Reference
UTaNRMP	Upper Tana Natural Resources Management Project
WRA	Water Resources Authority
WRUA	Water Resources Users Association

EXECUTIVE SUMMARY

1. Introduction

The Upper Tana Natural Resources Management Project (UTaNRMP) is an eight-year project (2012-2020) funded by Government of Kenya, International Fund for Agricultural Development (IFAD), Spanish Trust Fund and the Local community. The goal of the project is to "*contribute to reduction of rural poverty in the Upper Tana river catchment*". This goal is pursued via two development objectives which reflect the poverty-environment nexus namely (i) increased sustainable food production and incomes for poor rural households living in the project area; and (ii) sustainable management of natural resources for provision of environmental services. The thrust of the project is to empower people to undertake community natural resources management.

The project is in its seventh year, and among the interventions it has undertaken is the erection of a 60 km solar powered wildlife control fence from Thuchi River in Tharaka Nithi County to River Thingithu in Meru County. The solar wildlife control fence was undertaken by the Upper Tana Natural Resources Management Project in collaboration with other stakeholders mainly Kenya Wildlife Service (KWS), Kenya Forest Service (KFS), Rhino Ark Foundation and Mt. Kenya Trust between 2014 and 2016. The fence design was also changed from a 6-strand wildlife control fence to a detailed/ comprehensive control fence with 8 strands and a tight lock at the bottom implying higher construction cost but increased effectiveness.

This study was commissioned to assess the 60 km wildlife control fence of Mt Kenya Ecosystem in Tharaka Nithi and Meru Counties (Thuchi River to Thingithu River), focusing on social economic and ecological impacts and comparing the situation before and after the fence.

Objectives of the study were:

a) To carry out a social-economic and ecological impacts assessment of the fenced area;
b) To provide a detailed comparative economic, social and ecological impacts assessment between the fenced and un-fenced areas of the Mt Kenya ecosystem - both to the ecosystem and the livelihoods of the neighbouring communities to guide future interventions/investments; and
c) To provide an ecological trend of changes as a result of the wildlife control fence.

2. Approach and Methodology

Overall, the study used a participatory approach which involved all stakeholders from project staff; county and national government staff and beneficiary communities, all geared to fully respond to the scope of work and activities given in the terms of reference. The consultants' team maintained consultative discussions with the client over the entire period of the assignment.

The methodology consisted of a reconnaissance survey; literature review of documents and preparation of data collection instruments; field study for key informant interviews, focused group discussions, and household surveys; transect walks; and remote sensing and GIS for land cover changes.

The survey started with collection of secondary data and preparation of data collection instruments, namely: - a household questionnaire, key informant interview guide, focused group discussion guide, and a transect line observation guide. The project areas were then mapped and delineated. Sampling of households (HH) was then undertaken using stratified random sampling using ArcGIS with an overall sample size of 495 households taken around Chuka, Chogoria and Ruthumbi forests (60 Kms of fenced areas); Lower Imenti forest (15 kms of non-fenced sample was purposively selected in proximity with project sites for contrafactual control and comparisons with fenced areas); and Lower Imenti forest (6-strand fence – also selected purposively). A total of 32 transects (inside Chuka, Chogoria and Ruthumbi forest) measuring one kilometre each were taken wherein 313 quadrants sites were taken and field measurements and observations recorded. All data collected was then analyzed and draft report prepared. The draft report was presented to the client and thereafter presented in a Stakeholders'' Validation Workshop. All client and stakeholder views were then incorporated into the final report.

3. Study Findings

3.1 Ecological Impacts

Impacts on Land Cover: The study findings indicate change occurred in natural forest cover which showed a positive change of 186.7 ha (0.68% increase from 48.72%) due to regeneration, and enrichment planting; forest plantation declined by 9% due to harvesting; while grassland declined by 62% due to regeneration. Annual cropland (maize, bananas, vegetables) increased by 12% 2,044 ha), whereas perennial crops such as tea and coffee farms declined by 7% (584 ha). This can be attributed to the trend of farmers reverting to annual crops for subsistence and sale, owing to the security being provided by the presence of the electric fence, a fact which was confirmed during the household interviews. Additionally, the decline can be attributed to intercropping of annual crops such as maize on neglected coffee farms, where the dominant pixel picked is annual crop as noted in the study area.

Impacts on Biodiversity Conservation: On the whole, transect observations undertaken in the outer 5 km block near the fence indicated lots of regeneration. Indeed, most of the initial quadrant plots taken during the transects indicate lots of saplings and young trees with small diameters at breast height (DBH). More mature trees are seen as one goes inside the forest, with the last quadrants showing more mature trees than saplings. Regeneration is therefore quite evident especially in the areas near the fence with the main species being *Makaranga kilimandscharica* (Mukaragati) at 19%; 18% for *Strombosia scheffleri* (Muthiringo); 10% for *Rauwolfia caffra* (Mwerere); 9% for *Xymalos monospora* (Mwako) and *Syzygium guineense* (Muriru); 8% for *Bridelia micrantha* (Mukwethe); 7% for *Podocarpus falcatus* (Podo); 5% Trichilia emetica (mutugati) while the combination of other species (over 50) made up the other 16%. On average, the number of saplings per hectare were about 2,301, with a high of over 3,000 per hectare in Chogoria and a low of 432 in the fenced areas of Lower Imenti Forest. This is an indicator that most forest degradation was human induced on the forest edges which were now healing due to the presence of the fence that also controls entry into the forest.

Impacts on Climate Change: The fence has been shown to have spurred regeneration and stopped forest degradation on the forest edges which are now healing. In terms of climate change, the improved forest ecosystem improves its capacity as a carbon sink with about 17 tonnes of carbon being sequestered per hectare per year. As the impact is higher on the forest edges, it can therefore be assumed that about 25% of the healing/growth in the 300Km belt (60 km x 5 km outer forest block most affected) can be attirbuted solely to the fence. This translates to 75,000 ha, with a total of 129,133 tonnes of carbon dioxide sank attributed to the fence.

Water Quantity and Quality: FGDs with WRUAs indicated that the fence had improved water quantity and quality as there was less interference with water flow from water intakes especially by people who may have entered the forest illegally; incidences of pipe breakages have reduced and hence water rationing are also minimal. Rivers between Thuchi and Thingithu (inclusive of the two) have seen significant increased water flows between December 2015 and December 2018 according to data from UTaNRMP, with an average increase of 1.34 cubic metres per second from 3.83 cubic metres per second recorded before the fence, to 5.17 cubic metres per second after, an increase of 35%.

Effects on Forest Fires: While major fire incidences in the 3 forest stations are not common, it is noteworthy that there have been no incidences of fires reported since the fence was erected.

3.2 Socio-economic Impacts

Impacts on Crops Diversification: Crops destruction had led to farmers leaving their farms farrow or planting crops with less potential to wildlife damage as a way of the community avoiding losses occasioned by wildlife incursions on farmlands. The field study established that the proportion of

farmers cropping increased by 5% from 89.5% to 94.6% as a result of putting up the wildlife control fence. As earlier mentioned, annual cropland (maize, bananas, vegetables) increased by 12% (2,044 ha), whereas perennial crops such as tea and coffee farms declined mainly due to farmers reverting to annual crops for subsistence and sale, owing to the security provided by the solar powered electric fence. Farmers have diversified by introducing crops that could not be grown near the forest due to wildlife damage like bananas, vegetables and horticultural crops (onions, cabbages, tomatoes, kales, and French beans). The communities have also adopted new technologies especially irrigation which has gone up by 8.9% from 59.1% to the current 68% after the fence was erected. Farmers in the fenced areas also invested more in farm inputs (fertilizers and improved seeds), spending 96% more than those in non-fenced areas as they try to boost their productivity (an average Kshs 1,783 compared to the non-fenced areas with an average Kshs 910).

Impacts on Food Security: Food security has been enhanced through increased area under cropland, higher productivity, improved food access, and crops diversification, leading to better nutrition for the areas. Irrigation has also enhanced food security by ensuring all year-round food production, resulting to more food on the table. According to the study, there was also an increase in the proportion of households who engaged in crop production from 89.5% to 94.6% before and after the fence respectively, indicating increased engagement in farming. Irrigating Households increased from 59.1% to the current 68% after fencing. The percentage of those who keep livestock increased marginally by 3% from 82.2% to 85.1% while those of poultry also increased by 8% from 58.4% to 66% of the respondents. Farm crops were also the main source of income in the fenced areas at 92%, compared to 80% in the non-fenced areas and 85% in the 6-strand fenced areas. Crop damage by wildlife also reduced by 99% further improving food security.

Impacts on Human-wildlife Conflicts: This was the main objective of erection of the widlife barrier. Past problem animals consisted of mainly elephants, buffaloes, leopards, hyenas, monkeys, and small burrowing animals like hedgehogs. According to records from KWS, the fence has been effective in reducing human-wildlife conflict incidences by 97%. (from an average of 117 incidences per annum (between 2004 – 2014) to an average of three incidences per annum after the fence (2016-2018). This is compared to 95% human wildlife conflicts reported in the non-fenced areas of Lower Imenti, and 50% conflicts in the 6-strand fenced areas of Lower Imenti. The human deaths in fenced areas dropped from an average of one annually (between 2007 – 2014) to zero, human injury from one annually to zero, while livestock predation (sheep, goats, and cows) by leopards, lions, and hyenas dropped by 80% from an aveerage of about 10 per annum before the fence to 2 cases annually after the fence.

The total cost from human death, human injury, damage to property and crops stood at Kshs 67 million (2004-2014) translating to Kshs 6.7 million annually before the fence, to Ksh 246,500 (2015-2018) which translated to Kshs 61,625 annually, representing 99% reduction.

Before the fence, 78.4% the respondents watched over their crops at night, and 65.3% made fire to deter animals from invading their farms - these figures have now reduced to zero. The implication on these social methods of protection from wildlife was that they led to inadequate sleep in most days (94.4% of respondents), less productivity during the day (61.7%), night separation from spouse and children (30.7%) and matrimonial rights were impacted negatively (17.8%), sometimes leading to divorce. Community members interviewed during FGDs in Chuka, Chogoria, Ruthumbi and Lower Imenti indicated that the erection of the fence has greatly positively impacted on family union, as spouses can spend time with family, and men no longer have excuses for spending the night outside their homes, sometimes in pretext of guarding crops from wildlife. 97% of the respondents indicated an improvement in security from animal attacks following the fence being erected with resultant peace among the populace. 73.6% of the respondents indicated that the fence was either effective or very effective in curbing human wildlife conflict.

Impacts on Incomes and Livelihood Improvement: In the fenced area of Thuchi to Thingithu, the study indicated that household income levels increased from an average Kshs 45,000 to Kshs 125,604 per annum an income increase of 179%. This is compared to Kshs. 79,610 in the unfenced area, indicating that income on fenced areas of Thuchi-Thingithu are better off by Kshs 45,994 per household per year, a 58% difference. The highest average household incomes levels were in Ruthumbi at Kshs 162,604 per annum. Those living below the poverty line were about 11% of household respondents in the fenced areas as compared to 64% of respondents in Lower Imenti (non-fenced) areas. 73% of respondents in the fenced areas now claimed to be having savings mainly from farm produce sales, unlike in the past when they did not have anything set aside for a rainy day. This can be attributed to increased incomes and livelihoods. The mean saving per household year in the fenced area of Thuchi-Thingithu was Kshs 26,516 per annum. Improved incomes are also seen between the assets owned in fenced and non-fenced areas, with those in the fenced areas being more endowed. Notably, there were more households using Liquefied Petroleum Gas (LPG) for cooking in the fenced areas (36%) as compared to the non-fenced areas (19%).

Impacts on Relationships between communities and agencies mandated to manage ecosystem: The results from the study indicate that the relationship between forest neighbouring communities and the government agencies, namely KWS and KFS, has improved significantly after the fence was erected. Findings reveal varying levels of trust between community members and different institutions that are actively involved in forest management and conservation. Overall the relationship is positive and complementary across the study area. It has also solved boundary disputes and conflicts between KFS and forest adjacent communities since the beacons of the forest are now all in place. Other impacts include non-interference with rangers' schedules as compared to before where they could cancel their duties to respond to other alerts related to forest and communities e.g. human wildlife conflicts

Impacts on Human Wildlife Conflict Management Costs: The erection of wildlife barrier has reduced costs of responding to Human wildlife incidences for both KFS and KWS from Kshs. 4,531,500 between 2004 and 2014 (annual cost of Kshs 453,150 million) to Kshs 103,900 between 2015 and 2018 (Annual cost of Kshs 25,975) reflecting a 94% cost reduction. However, predation of livestock by leopards who jump over the fence has continued to be a challenge.

Impacts on Revenue Collection: There is increase in revenue collection at the forest stations due to reduced number of gate entry permits to access community resources inside the fenced area. In Chuka for example, revenue from grass cut and carry grew by 645% after the fencing.

Impacts on Land Value: The value of the land appreciated upon fencing with an average appreciation of 86% from an average of Kshs 917,000 per acre to Kshs 1,703,421 per acre. This is a capital gain on land to the community around fenced Mt. Kenya forest ecosystem.

Impacts on Community Health: 88.8% of the household respondents indicated an improvement in human health as a result of the fence. The improvement in human health may be due to reduction in risks arising from wildlife attacks, reduced exposure to unfavourable weather conditions when guarding against wild animals, food security and availability of variety of food crops thus improving human nutrition.

Impacts on Education: The education environment has also improved with 91.6% of respondents reporting that children go to school in peace. Another 65.3% said that children could now play freely, while 51.3% reported that children can read in peace. Another 43.6% said that children can now concentrate on their homework. As a result of these factors, 48.2% of the respondents felt that education performance had improved because of wildlife control fence. This is as compared to the non-fenced area where human wildlife conflicts resulted in lack of children safety 88.2%, poor school attendance 70.0%; poor performance in school 47.3%; and interrupted study 31.8%.

Impacts on Tourism: Tourism was only measurable at the Chogoria Forest Station as it was the only one among the fence stations with a gate to the National Park. Revenues increased by 41% from an annual average Kshs 730,000 before the fence to an annual average Kshs 1,026,000 after the fence was erected. The number of visitors also increased from 444 to 526 before and after the fence respectively, an18% increase. Revenues however dropped by 10% in 2017, mainly as a result of the political environment in the run-up to the election. The change in revenues is due to reduced illegal access to the park for mountain climbing and other tourism activities. Average duration before and after the fence was 4 days, as most visitors are mountain climbers.

Impacts on Forest Encroachment and Illegal Activities: Reports from all the areas visited indicated that the fence had effectively managed to reduce human encroachment into the forest land as well as drastically reduce any illegal activities such as logging, poaching and general

biodiversity destruction. In Ruthumbi forest station, it was reported that illegal logging had dropped from 13 cases per month (before fence) to 1-2 cases in a month (after fence) representing 84.6% reduction since the fence was erected.

Impacts on Fuelwood and Household Energy: The fence has negatively affected the source of firewood for the community, which used to rely mainly on the forest for their firewood needs. Among the factors mentioned are the increased distance travelled to get firewood (32.4%), increased time spent in fetching firewood (20.9%), and increased cost of firewood (27.2%). The study area has no history of charcoal production but it is good to note that there were no reported cases of charcoal production in the forest since the erection of the fence. The fence has also helped persons climb the energy ladder, with the fenced areas having more households (36%) using LPG for cooking as compared to the non-fenced areas (19%).

Impacts on Livestock husbandry: The percentage of households with grazing portions on farm increased from 72% to 75% after fencing while those in the non-fenced areas stood at 37%. Those with fodder on-farm increased from 86% to 91%. In terms of fodder, there was a general increase in land allocated to fodder with those between 0.5 – 1 acres of fodder area increasing from 9% to 15% after the fencing. Overall, the area for grazing within the farms reduced by 9% after fencing from an average of 0.35 acres to 0.32 acres while that of land under fodder increased by 81% from an average of 0.43 acres to 0.78 acres. There has also been an increase in zero grazing after the fencing (from 52.3% to 73.2% of the respondents), and a reduction of grazing in the forest areas (from 27.8% to 3.3% of the respondents). The number of households cutting and carrying grass from the forest increased from 13.1% to 22.1% while those purchasing fodder increased from 3.3% to 11.0%. Free grazing reduced from 27% to 20% due to reduced access to the forest vide the fence, and the requirement to pay for any cattle and sheep entering. This subsequently led to the increased proportion of farmers who moved to zero grazing and also increased fodder areas on-farm. Effects on livestock husbandry after fencing includes reduced access to pasture inside the forest (47.1%), reduced livestock diseases (30.0%) and reduced access to water for livestock (13.1%).

Cost Benefit Analysis:

Total Benefits

Benefits	**Value (Kshs. Mn)**
Domestic water	161.7
Water for Irrigation	110.0
Water for Livestock	35.8
Reduced soil erosion	301.4
Carbon sequestration	45.2
Tourism	1.2
Timber and Non-timber forest products	3.5
Total	**658.8**

Total Costs:

Costs	**Baseline costs (Kshs. Mn)**
Fence	162.5
Maintenance	3.7
Management	1.9
Biomass loss	4.3
HWC costs	0.1
Forgone agriculture	4.3
Non-resident cultivation	6.1
Charcoal	6.3
Total	**189.2**

The benefits and costs estimated from the project are used to estimate the cost-benefit ratio. Calculation of the CBA considers rates of discount of 5% and 7% respectively for 25 years in calculating the values of benefits and costs. Two scenarios are presented. The first scenario (actual case) considers the actual costs and benefits assuming that they remain the same over the 25 years. In the second scenario (future benefits), it is assumed that benefits increase annually by 3% while costs (other than those for fence construction and biomass) increase annually at the rate of 2%. The costs of fence construction and biomass loss are one-off costs and hence are accounted for once. From this, estimates of Economic Rate of Return (ERR), Benefit-Cost Ratio (BCR), Net Present Value (NPV) and Incremental benefits that accrue to the fence adjacent community are calculated.

CBA scenarios

Discount Rate	ERR	BCR	NPV (mi)	Total Benefits (mi)	Total Costs (mi)	Incremental benefits (mi)
Actual case						
5%	22. 86	19.69	9,438.99	17,128.80	749.20	16,379.60
7%	22.86	18.51	7,885.94	17,128.80	749.20	16,379.60
Future benefits						
5%	27.58	23.39	13,027.42	25,398.74	921.03	24,477.72
7%	27.58	21.81	10,570.51	25,398.74	921.03	24,477.72

The results show that the NPV is positive and is higher at lower discount rate (5%) in both scenarios. For instance, for the actual case, the NPV at 5% and 7% discount rates are Kshs. 9.4 billion and Kshs. 7.9 billion respectively. The NPV is higher in scenario two where future benefits and costs are assumed to change. The incremental benefit is also higher in the case of future benefits irrespective of the discount rate used, with about 49% more. The BCR are higher than 1 in both scenarios, implying that the electric fence was beneficial to the community adjacent to the fence. This means that conservation of the Mt. Kenya forest ecosystem is beneficial and that investments are justified. The ERR are higher than 10%, showing that the benefits of the electric fence are higher than the costs.

Sustainability: The fence is only as good as its maintenance. Wildlife fences have in the past failed due to lack of maintenance including in the control area of Lower Imenti forest. While it might not be a challenge at the moment, the issue of sustainability is important especially if the current maintenance arrangements lapse. Indeed, key to the success of the fence project so far is the initial community mobilization and involvement in the fence erection and maintenance. However, to ensure that the fence is regularly monitored and maintained, a Fence Trust Fund has been recommended.

Study Conclusions: Overall the study concludes that the social benefits from the fence outweigh the negative impacts from the construction of the fence. Discussions with community members further indicated that the fenced areas were experiencing improved food security, resulting from reduced crop damage by wildlife and consequently increased food crops production, increased food varieties with the increased growing of maize, beans, bananas, vegetables, fruits, arrowroots and sugarcane among others. This was reported to have improved feeding at the household level and incomes through the sale of surplus harvests. Reports from community members further indicated that land had increased in value in the fenced areas because people could now farm in peace. Some people who had previously abandoned their farms due to the elephant attacks had since resettled and were farming. To the forest managers, identification of forest beacons and erection of the fence had not only made forest management easier but it had literally enabled more controlled access to the forest which had, in turn, tamed illegal activities. In addition, relationships

between the community members and KWS, and KFS has overall improved given the reduced conflict incidences. Improved relationships at the household level were also reported as men spent more time at home with their spouses and children. In the unfenced areas, wildlife continued to cause a challenge to the community through the frequent raiding of crops by elephants. Men stayed outside at night, children and women experienced disrupted sleep and immense discomfort on the thought that their parents were out all night. The main crops in these areas were limited to cash crops which immensely affected food security.

Ecologically, the fence has seen positive trends and negated the earlier fears of habitat fragmentation and wildlife restrictions with subsequent trampling by large animals leading to negative impacts on the ecosystem.

This report presents a strong social case for the wildlife control fence based on the findings and responses from the stakeholders interviewed. Economically, the cost-benefit analysis shows that the investments are justified with the ERR higher than 10% showing that the benefits are higher than the costs.

Recommendations:

- The wildlife control fence is a worthy investment and should be extended to other areas especially in the Lower Imenti forest where incidences of human-wildlife conflicts are currently high.
- For sustainability, the fence maintenance should continue to use local communities and engage them.
- The innovative PPP model should be considered as a good strategy towards ensuring that the whole ecosystem is fully fenced but with corridors to enable wildlife move to other ecosystems.
- Community forums to discuss emerging issues on the fence should be put in place to mitigate any challenges arising on the fence and its maintenance.
- For sustainability, it is recommended that a Trust Fund, similar to the one in the Aberdares, be established to take care of the fence maintenance.

1. INTRODUCTION

1.1 Project Background

The Upper Tana Natural Resources Management Project is an eight-year project (2012-2020) funded by Government of Kenya, International Fund for Agricultural Development (IFAD), Spanish Trust Fund and the Local community. The goal of the project is to "*contribute to reduction of rural poverty in the Upper Tana river catchment*". This goal is pursued via two development objectives which reflect the poverty-environment nexus namely (i) increased sustainable food production and incomes for poor rural households living in the project area; and (ii) sustainable management of natural resources for provision of environmental services. The thrust of the project is to empower the people to undertake community natural resources management.

The rationale for UTaNRMP is based on the nexus between rural poverty and ecosystem health in a densely populated and environmentally fragile watershed of critical national and global significance. High prevalence of rural poverty contributes to environmental degradation which in turn reduces sustainable livelihood opportunities as well as creating negative environmental externalities including forest degradation, human-wildlife conflict, and reduced availability and quality of water to downstream users.

The project area is the Upper Tana catchment which covers an area of 17,420 km^2 and includes 24 river basins and the tributaries of four river basins under the Mount Kenya East pilot Project for Natural Resources Management (MKEPP) that drain into the Tana River. The area covers the six counties of Murang'a, Nyeri, Kirinyaga, Embu, Tharaka-Nithi and Meru and is home to 5.2 million people. The project primarily focuses on community natural resources management. The project has four components, each of which has a specific planned outcome as shown in Table 1.1 below.

Table 1.1: Components of UTANRMP

Component	Outcome
a) Community Empowerment	• Rural communities empowered for sustainable management of natural resources
b) Sustainable Rural Livelihoods	• Natural resource-based rural livelihoods sustainably improved
c) Sustainable Water and Natural Resource Management	• Land, water and forest resources sustainably managed for the benefit of the local people and the wider community
d) Project Management and Coordination	• Project effectively and efficiently managed

Under the Sustainable Water and Natural Resources Management Component, a wildlife control fence measuring 60 Km and running from River Thuchi in Tharaka Nithi to River Thingithu in Meru (Figure 1.1) has been completed. The fence was constructed between 2014 – 2016 and took only 2 years from the anticipated 6 years. This was made possible through a Management Agreement (MA) signed between UTaNRMP/Rhino Ark Foundation/Mt Kenya Trust, Kenya Wildlife Service and Kenya Forest Service (see institutional roles in Table 1.1 below). At the project's design stage (2011), UTaNRMP was to fund the construction of 60Km of a 6-strand wildlife control fence. However, KWS changed the design to a detailed/ comprehensive wildlife control fence with 8 strands and a tight-lock at the bottom. The change implied a higher construction cost which could have reduced the distance covered but the Management Agreement which specified roles and responsibilities of each of the partners mitigated this shortcoming and 60Km of a comprehensive fence was delivered.

In the preparatory phase before the fence was erected, UTaNRMP and the other partners undertook community mobilization to ensure concurrence on the fence's alignment, and also informing the communities on the Management Agreement, and their role in the erection and maintenance of the fence. This has so far ensured that the fence is well management and maintained.

1.2 Objectives of the Assignment

The Terms of Reference gave 3 main objectives, namely:

a) To carry out a social-economic and ecological impacts assessment of the fenced area (Thuchi river in Tharaka Nithi County to Thingithu River in Meru County (a distance of approximately 60Km) to guide the management of the Mt Kenya ecosystem and the wildlife control fence;
b) To provide a detailed comparative economic, social and ecological impacts assessment between the fenced and un-fenced areas of the Mt Kenya ecosystem-both to the ecosystem and the livelihoods of the neighbouring communities to guide future interventions/investments; and
c) To provide an ecological trend of changes as a result of the wildlife control fence.

Table 1.2: Costed Institutional Roles and Responsibilities as per the Management Agreement

PARTIES' CONTRIBUTIONS		
PARTY	**DESCRIPTION**	**AMOUNT (Kshs)**
UTaNRMP	MATERIALS	112,408,800.00
	Add 5% Contingencies	5,620,440.00
	TOTAL	**118,029,240.00**
RHINO ARK	LABOUR AND SUPERVISION	13,093,333.00
	CAMPING EQUIPMENTS	1,853,000.00
	TOOLS	915,700.00
	TRANSPORT	7,967,800.00
	MISC	2,104,500.00
	SUB TOTAL	**25,934,333.00**
	Add 5% Contingencies	1,296,717.00
	TOTAL	**27,231,050,00**
MKT	LABOUR AND SUPERVISION	2,666,667.00
	Add 5% Contingencies	133,333.00
	TOTAL	**2,800,000.00**
KWS	CIVIL STRUCTURE (Energizer Houses & Roads)	23,700,000.00
	TOTAL	**23,700,000.00**
KFS	Installation of access gates within the forest reserve as per the project design estimates. - currently estimated at 85,000 for each gate-About 12 gates are estimated to be installed	**1,000,000**
	GRAND TOTAL	**172,760,290.00**

NB: *The actual construction cost was Kshs 162.5 million*

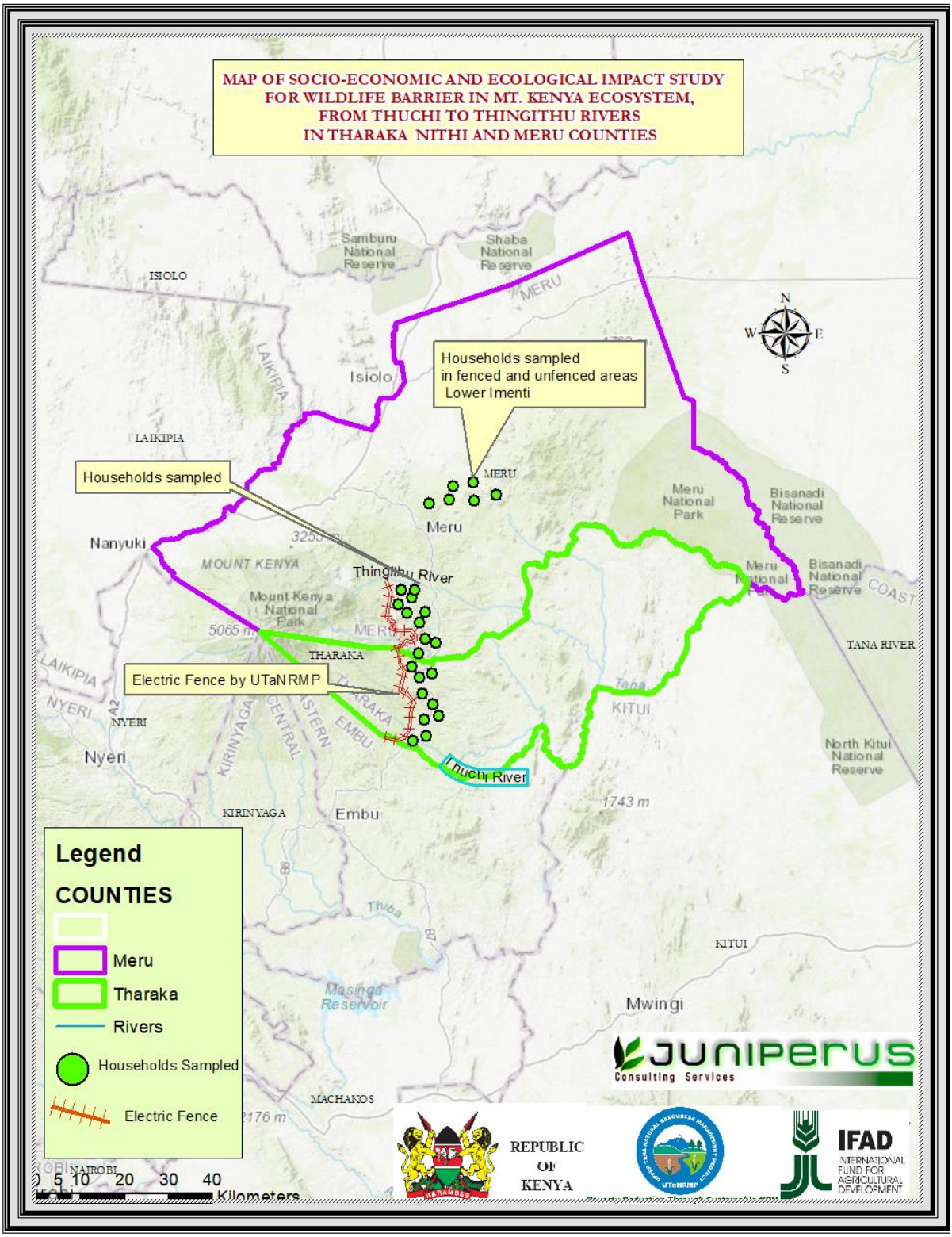


Figure 1.1: Map of Project Area

1.3 Specific Tasks

The ToR listed 15 specific objectives/tasks to be undertaken during the assignment. These were:

I. Assessing the land use/land cover changes brought about by the wildlife control fence from 2014 to 2018 along from Thuchi River to Thingithu River (distance of approximately 60KM) in both the forest areas and the farmlands;
II. Assessing the effects/impacts of the wildlife control fence on biodiversity conservation-flora and fauna e.g. improved cover, forest healing and regeneration;
III. Assessing the effects/impacts of the wildlife control fence on crop diversification in the farmlands;
IV. Assessing the effect/impacts of the wildlife control fence on food security. This looked at production levels in the farmlands and new technologies in place (specifically, uptake of new farming technologies);
V. Assessing the effects/impacts of the wildlife control fence on the human /wildlife conflicts-frequency/intensity, main damage, types of animals involved in the past and if there are still some problem animals;
VI. To assess the effect of the wildlife control fence on the relationship of forest neighbouring communities and the government agencies mandated to Manage the Ecosystem (Kenya Wildlife Service (KWS), Kenya Forest Service (KFS) and the Community Forest Associations (CFA);
VII. To assess the effect/impact of the wildlife control fence on revenue generation to the government agencies and the CFA;
VIII. To assess the effect/impacts of the wildlife control fence on ecosystem management costs- in terms of time, equipment and money, and establish its benefits for institutions;
IX. To assess the effect/impact of the wildlife control fence on land value, household cohesiveness, education, security;
X. To assess the effects/impacts of the wildlife control fence on human encroachment into the forest, charcoal production, grazing, logging, forest produce poaching, animal poaching;
XI. To assess the effect of the wildlife control fence on forest fires- causes, frequency and intensity;
XII. To assess the effect/impact of the wildlife control fence on tourism-in terms of numbers, income and duration;
XIII. To perform a social economic analysis for the wildlife control fence including cost-benefit analysis;
XIV. Compare (i) to (xiii) above to the areas that are yet to be fenced in Mt. Kenya and those with other types of fences (6-strand); and
XV. Give recommendations on institutional framework to sustain the fence.

1.4 Study Area

The study covered the 60 Km covered by the wildlife control fence within the forest and the adjacent land area to a maximum of 10 kilometres from the wildlife barrier. The area traverses the forest stations of Chuka, Chogoria in Tharaka Nithi County, and Ruthumbi in Meru County.

Additionally, the study had proposed to cover the areas immediately after the fence coverage for the non-fenced area, an area falling under Meru forest station. However, when undertaking the field visits, it was discovered that this area had already been fenced. As a result, the Lower Imenti forest was chosen for the non-fenced area. Additionally, the same station, Lower Imenti was chosen as a control area for comparison purposes with other types of fences as sections of the forest station have a 6-strand fence. The fenced and non-fenced areas of Mt. Kenya are as shown below:

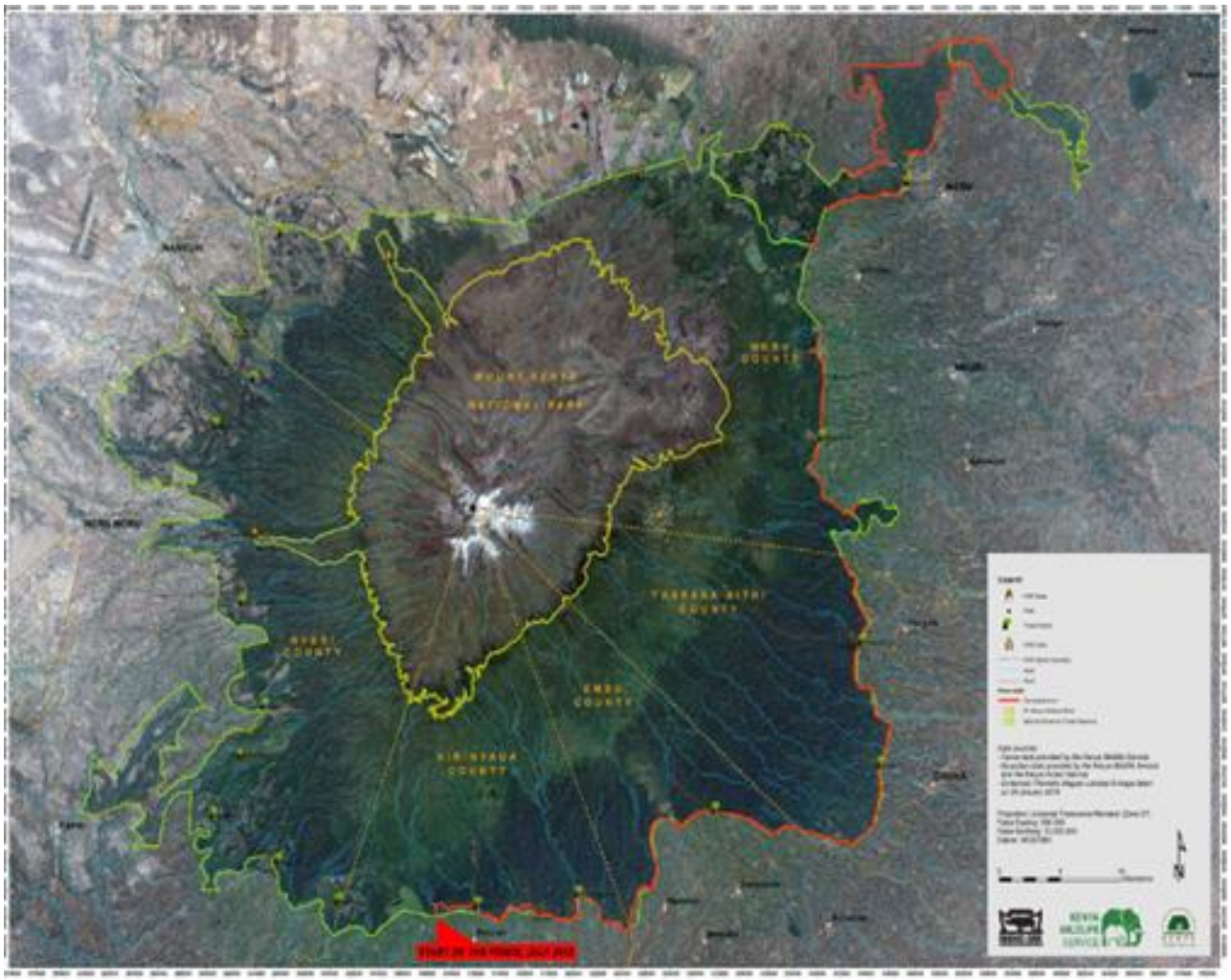


Figure 1.2: Map of Fenced Areas in Mt. Kenya

1.5 Justification of the Study

This study was important to inform if erection of the 60Km wildlife control fence had positive ecological, social and economic impacts; and whether the erected wildlife barrier was efficient in managing human wildlife conflicts and/or had contributed to livelihoods improvement. This is because the debate on wildlife control fences is a controversial one especially among conservationists with some in support and others strongly against. Those who support fencing do so especially because of the great impact on the livelihoods of park/forest adjacent communities, and also with regards to improving conservation and protection of keystone species.

Those against see fences as impediments to animals moving across landscapes and generally limiting animal movements, and also fragmenting ecosystems. Both the potential positive and negative impacts had been highlighted in the Environmental Impact Assessment (EIA) study for the Mt Kenya fence done in 2009.

The environmental, social and economic assessment of the fencing of the Aberdare Conservation Area, undertaken in 2011, had similar objectives and justification to this study namely, informing the key stakeholders of the impact of the fences both positive, negative and unintended, to the communities and ecosystem. Further the study aimed to determine whether fencing was an appropriate management tool for protected areas that can be replicated in the other water towers in Kenya, and other parts of the world where competing demands exist between conservation and human pressures.

2. APPROACH AND METHODOLOGY

2.1 General Approach

Generally, the study used a participatory approach which involved all stakeholders from project staff; county and national government staff and beneficiary communities. The approach and methodology aimed to fully responding to the terms of reference and thus meet the key three objectives of carrying out a social-economic and ecological impacts assessment of the fenced area; providing a detailed comparative assessment between the fenced and un-fenced areas of the Mt Kenya ecosystem plus the comparative analysis between the areas fenced using the comprehensive 8-strand and 6 strand fences; and providing an ecological trend of changes as a result of the wildlife control fence. It also aimed to meet all the 15 specific objectives listed in the ToR.

Two modes of comparisons were used, namely "before and after" and "with and without." The "before and after" compared current information on the fencing project area with information from before project intervention to measure the changes that took place. The "with and without" approach compared information on households sampled in the project area with those households outside the fenced area that did not take part in project interventions (a "control group").

In order to achieve the study objectives, triangulation of methods and approaches was used, applying both qualitative and quantitative techniques. The following data collection tools and techniques were used:

i. Reconnaissance Field visit
ii. Literature review/desk study
iii. Focus group discussions (FGD)
iv. Key informant interviews (KII)
v. Transect Lines (structured direct measurements and observations)
vi. Household Surveys
vii. Remote sensing and GIS

2.2 Discussions with the client

The study team maintained consultative discussions with the client over the entire study period. Initially, the consultants held discussions with the client on their interpretation of the ToR, the objective, scope and criteria of the assessment, and any issues raised in the inception report. The client and the consultant agreed on the field visits itinerary and informed the relevant field officers accordingly.

2.3 Delineation of Main Study Area

The main study area was between Thuchi and Thingithu Rivers where the 60Km wildlife control fence had been constructed. The main study area was delineated as shown below in Figure 2.1 where a buffer zone was created from the fence into the community land and into the forest as the area of interest for the ecological and socio-economic study. The buffer zone was used to create shape files which was also used to overlay satellite imageries.

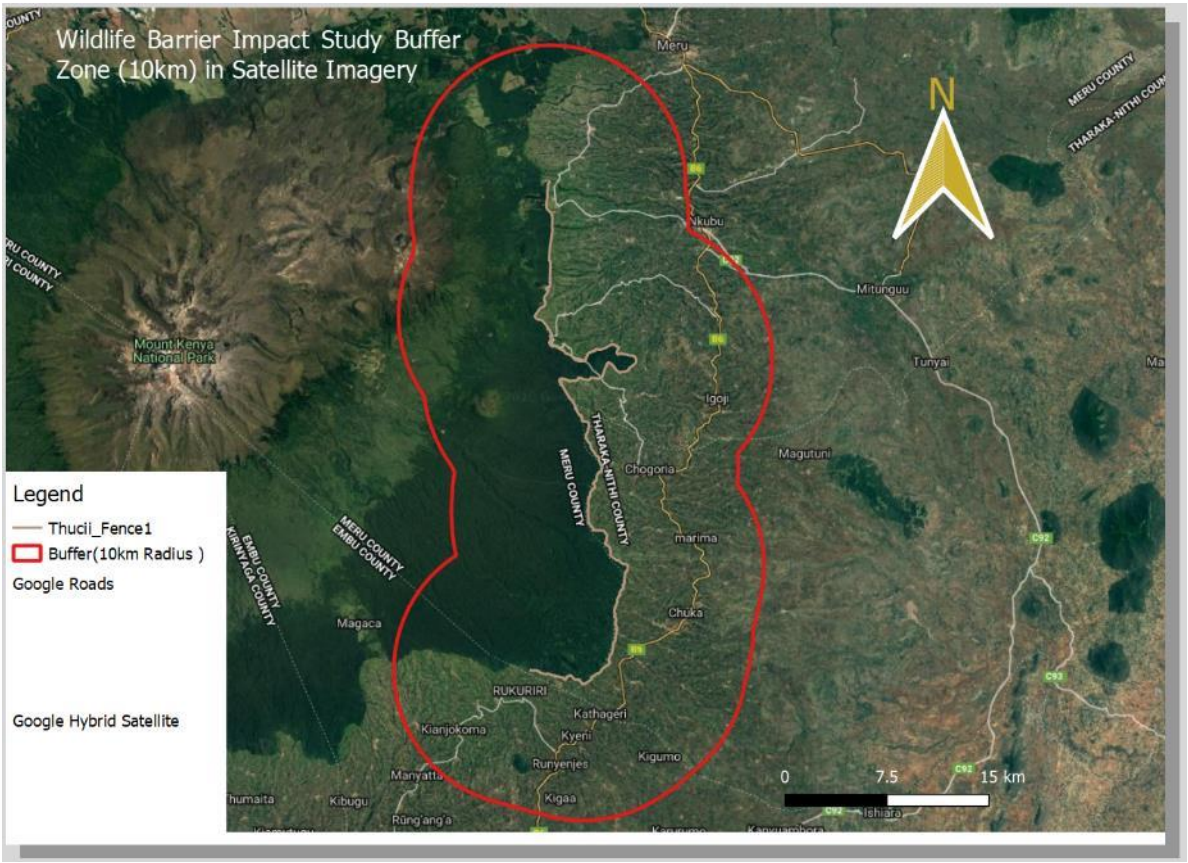


Figure 2.1: Main 10km Buffer Zone for Fence Social economic and Ecological Study

It should be appreciated that for comparison reasons, the study also covered sections of Lower Imenti forest where there were sections which were unfenced, and sections which were fenced using the 6-strand wildlife control fence.

2.4 Collection of Secondary Data and Literature Review

This involved desk and literature review of documents received from the client and other publicly available data and literature. The literature review also included the analysis of Landsat imagery for the project area and the larger Mt. Kenya Ecosystem. Among the key documents reviewed were:

I. Environmental impact assessment study report for the erection of wildlife barriers around Mt. Kenya (2009);
II. Environmental, social and economic assessment of the fencing of the Aberdare Conservation Area (2011)
III. Fence design;
IV. Draft handbook on management of electric fences (2014);
V. Management agreement between UTaNRMP, KWS, KFS, Rhino Ark Charitable Trust, Mt. Kenya Trust and the respective CFAs (2014).
VI. The Wildlife Conservation and Management Act 2016
VII. The Forest conservation and Management Act 2016
VIII. The Environment Coordination and Management Act Cap 387 (2015)
IX. The Un convention on Migratory Species (Bonn Convention - 1979)

Findings from literature review include:

- Under the Management Agreement, UTaNRMP was responsible for procuring/paying for all the fencing materials; KWS was responsible for constructing the energizer houses and the main gates plus ensuring the fence security and maintenance; Rhino Ark was constructing the fence and the main gates; Mt. Kenya Trust was responsible for paying a maximum amount of KShs 2.8 million towards transport costs, site meetings costs, staff allowances, daily costs for operating the equipment, casual employment costs for the building of 10 kilometres of the fence in Chogoria area; and the respective CFAs through their chairpersons were to be members of the of the fence construction committees in respective forest stations.
- The cost of the fence was broken down into: Construction materials Kshs. 121 million; Community sensitization Kshs. 4.5 million; Construction costs by Rhino Ark/Mt Kenya Trust Kshs. 30 million; Community contribution was Kshs 7 million for clearing and fencing labour. Total cost was Kshs 162.5 million.
- Fence management/maintenance is undertaken by community members employed by KWS for every 8 kms of fence for purposes of manning the fence, solar panels, and energizers. The employed community members are supported by KWS rangers. In each energizer house, KWS puts up a structure that can accommodate two rangers.
- The number of households in the area were 34,740 by 2016 with current number approximated at 37,390 HH in year 2019 at an average growth of 2.5% as per average annual population growth.

Some highlights of Mt. Kenya Fence EIA Report 2009;
The Environmental Impact Assessment (EIA) report for the Mt. Kenya fence by Kamfor Company Limited (April 2009) had highlighted some of the potential positive and negative impacts of the fence and these will be confirmed in this study. The potential positive impacts highlighted that are relevant to this study, and which were actually found to have occurred included:

a. Reduced human-wildlife conflicts;
b. Increased conservation within the forest;
c. Increased agricultural productivity and food security;
d. Better watershed protection;
e. Improved security;
f. Improved social order;
g. Improved health and reduced cases of pulmonary diseases; and
h. Social-economic impacts: peace, less damage to property and infrastructure; better relations between forest neighbouring communities and KWS/KFS

The relevant potential negative impacts highlighted by the EIA included:

a. Loss of vegetation from clearing of vegetation for fence alignment;
b. Soil erosion from loss of vegetation, compaction and machines/vehicles during construction;
c. Restriction of wildlife movement by fence resulting in trampling, habitat destruction, overgrazing, increased populations;
d. Limited access to the forest due to gates; and
e. Possible increased accidents from electric fence;

Most of these impacts were short-term during the construction phase, while some like trampling and habitat destruction did not occur.

Under the "No Project" option in the analysis of alternatives, the EIA report highlighted what would happen if no wildlife barrier was put in place. The issues highlighted, and which are still found happening in the non-fenced areas included:

a) Continued Destruction of Crops by animals;
b) Food insecurity because of destruction of food crops by animals
c) Economic losses from destruction of forest plantations;
d) Loss of revenue by KFS from firewood collection, fodder collection, and grazing, and of course from illegal logging quantify this perceived loss.
e) Negative impacts on human health due to long stays in the cold to protect crops and to scare wildlife at night resulting to pneumonia, flu and common colds;

f) Disruption of social order with communities being awake at night to protect crops and sleeping during the day;
g) Loss of Productivity arising from the disruption of social order and poor health results in reduced community productivity especially with regard to agriculture; which the main economic activity;
h) Poor performance by children in schools as they miss school due to fatigue from lack of sleep, or because of insecurity brought about by wildlife;
i) Insecurity, both real and perceived, e.g. fear of walking at night and early morning after a night of terror;
j) Destruction of infrastructure e.g. water pipes;
k) Poverty arising from the human wildlife conflicts, poor agricultural production, food insecurity; and disruption of social order.
l) Poor community relationship with institutions dealing with wildlife (KWS) and the forest (KFS):

Wildlife control Fences in Kenya; the Aberdares social economic and ecological study report: Several wildlife barriers have been put up and tried in Kenya, and even in the Mt. Kenya ecosystem. These are of various types and include electric fences (starting from 2 strands); and game moats. The efficacy and impact of such fences has not been well documented, other than in the Aberdares, where a similar study like this has been undertaken.

In a nutshell, the Aberdares report highlighted positive attributes to the fencing project to include among others: a 20.6% increase in forest cover; a decrease of the open areas (which include grassland and farmland) by about 54% signifying ecosystem recovery which is attributable to the fence; an overall increase of the area under plantation forests by 47% between 2000 and 2010; continuing ecological succession in areas that were earlier disturbed by human activities; significant reduction of incidences of human-wildlife conflicts involving large mammals; improved food security and household incomes; improved security including that of children; improved land values; and enhanced agro-forestry activities in community land amongst others.

To Fence or not to Fence Debate: There is often a temptation to put up elephant fences anywhere where human-elephant conflict is deemed to be severe. But fences are not appropriate for all situations. There should be sufficient and reliable prior information on the damage caused by wild animals and especially elephants to justify both the considerable expense of constructing a fence and the commitment to continual maintenance that any fence requires. Carefully planning the layout and design of fences, for example, is especially important for non-target species . The local ecology and movement pattern of elephants must be reasonably well known since disregarding established movement routes may put a fence under such severe challenge that the maintenance demand cannot be met. Commercial fencing contractors or people with relevant experience should always be consulted when erecting wildlife fencing. As a general rule for

fencing, the smaller the project the less it costs and the better it works. An encircling fence layout is best since it avoids 'funneling' elephants around the open end of a fence. Enormously expensive fencing projects have failed completely against elephants by disregarding the simple observation that elephants encountering a fence will often merely walk along it until they reach the end. This of course exacerbates problems for people who live near the end.

As a problem elephants appear not to be 'deflected' from their target, the only option is to identify that target and keep them out. Thus a small, encircling fence around a valuable resource (e.g. an irrigated field, a water point or a food storage facility) has the best chance of success both in terms of reduced elephant damage and overall costeffectiveness. Electric fencing technology is simple and definitely deters elephants - if it is continuously kept under good management. Fences need electrification in most savanna elephant ranges or where crop raiders are determined and persistent. Fences may not need electrification as much in the forest elephant range where elephants appear not to be so persistent at crop raiding.

A study in Gabon demonstrated clear deterrence of forest elephant crop raiding using single strand non-electrified fencing to encircle small plots of cultivation in the rainforest. The expectation is that a fence will eliminate elephant problems. This is not always true in practice. Some elephants that are 'habitual fence breakers' do exist and these may need to be removed or eliminated if they can be individually identified.

Fence maintenance: Maintenance is the number one challenge with any type of wildlife fencing. A fence is only as good as its maintenance, which has to be continual and meticulous. Collective maintenance of an electric fence by a rural community has often failed because it involves a long chain of responsibility, which easily collapses at the weakest link. Even in countries where wildlife management schemes operate at a local level, the results of electric fencing projects have often been disappointing for reasons almost always attributable to maintenance deficiencies. This is an institutional problem not a technological one, so with improved discipline it can be rectified. The most serious maintenance problems with electric fences are nearly always associated with the power supply, vandalism and theft of components (particularly solar panels, energizers and wire) which are extremely common in community managed fences. Not only does this deactivate the fence but frequently creates the knock-on effect of the maintenance demand thereby outstripping its budget, leading to total collapse of the project.

Keeping vigorous growth of vegetation clear of a fence line in the growing season is a perennial challenge that characterizes the management of electric fences. Vegetation contact causes power leakages and overgrowth conceals the fence from being an obvious barrier to elephants. Constant high voltages (> 5Kv) in electric fences will deter most elephants but low voltage, a frequent manifestation of poor maintenance, may merely irritate a determined elephant that may then destroy a section of the fence. Because each electric fence energizer powers several

kilometers of fencing, disruption of the power supply at one point inactivates a long section of fence. If power is not restored promptly the adverse conditioning associated with the barrier is lost, and long sections of the conflict boundary quickly become porous to elephants. An evaluation of several years' usage of anti-elephant fencing under various management regimes in Zimbabwe is particularly informative. In that country the models for constructing elephant fences are (in order of size of project)- **Source: IUCN African Elephant Specialist Group www.iucn.org/afesg**

Human Wildlife Conflicts in Kenya: Conflicts between people and wildlife rank amongst the main threats to conservation in Africa. In Kenya, for instance, with much of the wildlife living outside protected areas, one of the real challenges to conservation is how to enhance and sustain coexistence between people and wild animals. It is undoubtedly evident that the expansion of the human society has forced people to infringe on wildlife habitats and convert land to other uses incompatible with wildlife.

Human-wildlife conflicts negatively impact on the humans and wildlife alike. An understanding of how the people and conservation agents deal with the problem of wild animals is critical in evolving and establishing sustainable conservation systems. Several research findings suggest the need to address the issue of human-wildlife conflict in the context of sustainable conservation practice through a combination of indigenous and conventional rationales to demonstrate that wildlife can co-exist with people.

The Kenya Wildlife Service (KWS, 1995) considers human-wildlife conflicts to include the contentions relating to destruction, loss of life and property, and interference with rights of individuals or groups attributable directly or indirectly to wild animals. The increase in human population has resulted to encroachment into more marginal lands inhabited by wildlife, leading to fragmentation and conversion of land, for instance, to settled agriculture and other uses incompatible with wildlife. These, as Kangwana (1993), Conover (2002) and Okello et al., (2003) argue does not only escalate conflicts between the people, wildlife, and the authorities responsible for the conservation of wildlife, but also pose a real challenge to sustainable wildlife conservation practice. In Kenya, for instance, where much of the wildlife live outside designated protected areas, Western (1995) observes that the people who live in these areas depend more on natural resources and find it difficult to tolerate wild animals in their lands when they consider them a threat to their lives and livelihoods.

The main wildlife problems in the Kenyan rangelands are crop damage, competition for water and grazing, livestock predation, increased risk of some livestock diseases, various inconveniences such as when protecting crops, and even human fatalities (*KWS, 1992; Norton-Griffiths, 1996; Campbell et al., 2000; Muruthi, 2005*). Problem animals in Mt. Kenya ecosytem are mainly elephants, buffalos, monkeys, baboons, porcupines, hyenas and leopards. Elephants

are considered to be the most problematic animals. They are involved in : consumption and destruction of many food and cash crops; damage to property; damage to infrastructure; water supply and fences; injury and killing of livestock; injury and death of humans.

Monkeys and baboons are the most identified crop-raiding animals. Traits enabling the primates to exploit a wide range of agricultural landscape include: complex social organization structures; being highly omnivorous and terrestrial, and the ability to exploit arboreal habitats. Porcupines are also problematic to communities living next to Mt. Kenya Ecosystem. They are difficult to control because of their high intrinsic rates of growth, hence highly resilient to disturbance and are nocturnal in character. Additionally, wildlife and forest conservation strategies restrict the peoples' access to and use of the natural resources. Where such conflicts compromise the people's livelihoods, and solutions to conflicts are not adequate, it reduces and erodes their local support for conservation efforts (Mulholland and Eagles, 2002). The wild animals, many of which are already threatened or endangered are often killed in retaliation or to prevent future conflict.
It is important to note that Human-wildlife conflict is also a land-use problem, and is due to incompatibile land use types and interest of sharing a common boundary such as state owned national reserve adjacent to privately owned farmlands and settlements. Conflicts also arise from differing behaviour, goals, value needs, expectations, and ideologies between parties (Omondi, 1994). Kelso (1962) notes that land use conflicts occur because land resources are limited while wants are limitless. The increasing competition for use of scarce land has resulted in conflict management becoming a major issue. Effective conflict management requires adequate understanding of conflict history, causes and how it affects the parties involved. IUCN/SSC African Specialist Group defines human-elephant conflict as "any human-elephant interaction, which results in negative effects on human-social, economic or cultural life, on elephant conservation or on the environment".

Human Wildlfe Conflicts in Mt. Kenya Ecosystem: Within Mt. Kenya Ecosystem conflicts can be grouped as direct and indirect. The direct conflicts involves human deaths or injuries, killing of livestock and wildlife, destruction of property such as crops, stores, houses, infrastructure facilities, spread of diseases, especially East Coast Fever through wildlife-livestock interaction, deforestation, and competition for essential resources such as water, tree, grass and salt licks. The indirect conflict arises when there is disruption of socio-economic activities such as school attendance, lack of sleep, noise, insecurity, and fear of leaving the boma early or coming back too late. Human wildlife conflict in Mt. Kenya Ecosystem is also as a result of encroachment of communities on former wildlife areas, blocking of wildlife corridors, and increase in animal population

Fencing is one of the most commonly used conservation tools in the world. Fences can however, have long-term consequences for animals by blocking wildlife migratory routes, disrupting gene transfer through mating and altering population dynamics. The possible costs to animals due to

changed behavior are unclear but cost benefits to stakeholders are subtantially huge in terms of increased food security, peace of mind, less disturbance, more sleep, more concentaration in schools etc. Fencing may lead to overgrazing and habitat destruction due to limited amounts of resources such as wetlands, flood plains and conservanies if these are fenced outside. EIA studies must ensure such areas are within reach by wildlife to ensure that conflicts are not shifted to unfenced areas of the ecosytem. The benefits of electrical fencing are undeniable, but decisions to fence or not to fence, type and design of fence as well as maintenance costs and roles of stakeholders must be informed by integrated environmental impact assessment studies. There is no doubt that ractical mitigation of human-wildlife conflict is critical to the success of coexistence between people and conservation in Mt Kenya Ecosysytem and generally in Kenya.

In the past several mechanisms and strategies have been initiated in an effort to reduce and manage human-wildlife conflicts and provide long-term solutions to the prevalent resource use conflicts around and within the ecosytem. However, there has been an increase in the human-wildlife interface problem, with serious consequences for sustainable conservation practice. Concurrently, the traditional strategies for resolving these conflicts that have existed in Kenya have gradually eroded. In the Mt kenya ecosystem, various efforts have been made to try and mitigate the human-wildlife conflicts, and such efforts have included creation of barriers to stop animals from going into people's farms, scaring of animals back into the forests when they invade, relocation of animals to different parks especially where the problem is that of over-population, and in certain instances, killing of problem animals. Efforts to mitigate human wildlife conflicts have involved local communities, KWS, KFS, and various donors especially the Bill Woodley Trust and Action Aid. Various temporary barriers were put up in an ad hoc manner and their effectiveness has been varied from one area to another. The fragmented approach to construction of wildlife barriers has on the whole not fully solved the human/wildlife conflicts while at the same time creating other incidental challenges.

Compensation: The Wildlife Conservation and Management (Amendment), 2016, establishes compensation for personal injury or death or damage to property. The responsibilty for compensation is vested in the County Compensation Committee. Compensation as regard to human death is Kshs 5 million and in case of injury, a maximum of Kshs 2 million depending on extent of injury

2.5 Reconnaissance Field Visits

These were undertaken to meet the key stakeholders and make arrangements for mobilization of the fence adjacent communities in stakeholder meetings. The number and venues of the meeting were also agreed. Logistics to recruit local enumerators were also put in place. The visits also aided in identification of local community structures relevant to the study, and identification of the contact persons for the CFAs/WRUAs.

2.6 Sampling

2.6.1 Households Sample

Household Sample Size: For the household survey, sampling covered (as population), all households within 10 km of the fence in the project area. To determine the overall sample size for the household survey, the formula used was Cochran's (1963) for large populations, incorporating "power" in sample size calculations.

$$n_0 = \frac{(Z_{(\frac{1}{2})\alpha} + Z_{(1-\frac{1}{2}\beta)})^2 p(1-p)}{d^2} = \frac{(1.96+1.64)^2(0.5)(0.5)}{0.1^2} = 311$$

Where $Z_{(\frac{1}{2})\alpha}$ and $Z_{(1-\frac{1}{2}\beta)}$ are the critical values of the standard normal distribution for type 1 error and type 2 errors respectively. For the proposed study, the critical values used were at 5% level for type 1 error and 95% for the power (type 2 error). A conservative value of 50% (i.e. p=0.5) of households, whose livelihoods improved as stated above in the first questions was used for sample size needed was assumed. A margin of error at 5% (i.e. d=0.1) was used in the calculation resulting to an estimated sample size of n_0 =311 households. The project area has an estimated beneficiary population size of households is 34,720. Therefore, the project area final sample size using finite population correction in n

$$n = \frac{n_0 N}{n_0 + (N-1)} = \frac{311\ X\ 34{,}720}{311 + (34{,}720 - 1)} = 308.2$$

Adding 10% to account for attrition, a total sample size of 331 households for the fenced project area was derived which was then divided among the three strata/forest stations of Chuka, Chogoria, and Ruthumbi based on the distance of fence in each forest station as given below in Table 2.1.

The non-project forest purposively selected strata in proximity with the project sites for contrafactual control for comparison was originally planned for Meru forest station which falls immediately after Ruthumbi station and has similar climatic, and socio-economic attributes to the other 3 forest stations but was presumed non-fenced. However, on reaching the ground for field work, Meru forest was replaced by Lower Imenti forest as most sections which had been presumed non-fenced were found to be already covered by a comprehensive fence. Lower Imenti Forest station had both unfenced area and fenced area using the 6-strand fence. For the non-fence area, a section of about 15 Kms was taken, and using the same ratio, we added another household sample size of 82 Households for this stratum to take care of unfenced area. Additionally, in order to verify whether the number of the fencing strands is significant, an extra forest stratum still within Lower Imenti Forest, measuring about 15 Kms, which had been fenced using 6-strands was added as strand level control, with 82 samples also taken. The Lower Imenti

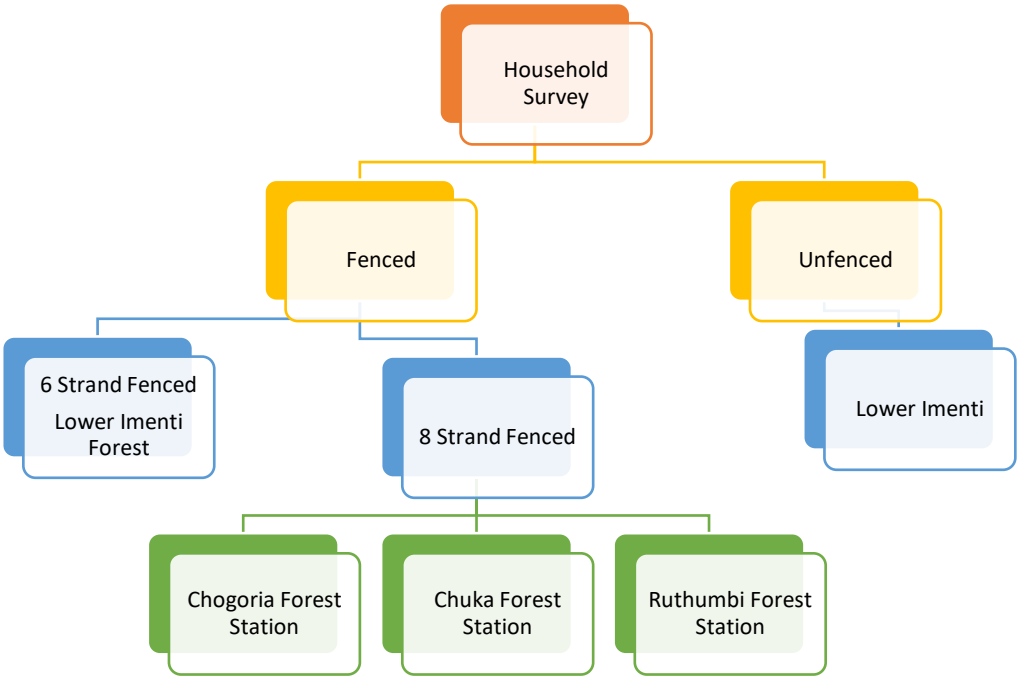
forest station thus had two strata (one fenced and one fenced with 6-strands) and a total HH size of 164 HH as shown in Table 2.1.

Table 2.1: Sample Size

Forest Station Stratum	Length of Fence in Station (Kms)	Percentage of sample size	Number of Households
Chuka	20 kms	0.33	109
Chogoria	15 Kms	0.25	82
Ruthumbi	25Kms	0.42	139
Sub-Total			**331**
Lower Imenti Station (none fenced)	15 Kms		82
Lower Imenti (fenced with 6-strand)	15 Kms		82
Total Sample Size			**495**

Household Survey: The household survey was carried out among the communities residing adjacent to the wildlife fencing control area (project area) and the community residing in the non-project area. A three-stage sampling scheme was used.

The first stage was purposive sampling, where selection was on the basis of project area or non-project area. The project area was then split into strata consisting of three adjacent forest stations, namely Chuka Forest and Chogoria Forest in Tharaka Nithi County and Ruthumbi Forest in Meru County. In order to verify whether the size of the fencing strand is significant, an extra forest stratum, namely, Lower Imenti Forest in Meru County was added as strand level control for both non-fenced areas and for comparison with a 6-strand fence.



The third stage was household selection. The number of households in each stratum were proportional to the strata size. As there was no sampling frame in the strata level, households were selected by stratified random samplings using ArcGIS, where the area of the forest station (10 Kms from fence) was mapped and a random tool used to allocate the sampling sites (the tool gave GPS coordinates for each HH site). Where the site did not fall on a HH, the nearest HH from the allocated site was selected. For replacement, where there was no one in the select household, the HH nearest on the right was selected as replacement. As the impacts of the comprehensive fence were anticipated to be higher nearer the fence, we allocated more sites (70%) near the forest boundary as shown in Fig. 2.2. The households sampled are as shown in GPS points in Figures 2.3, 2.4 and 2.5 below.

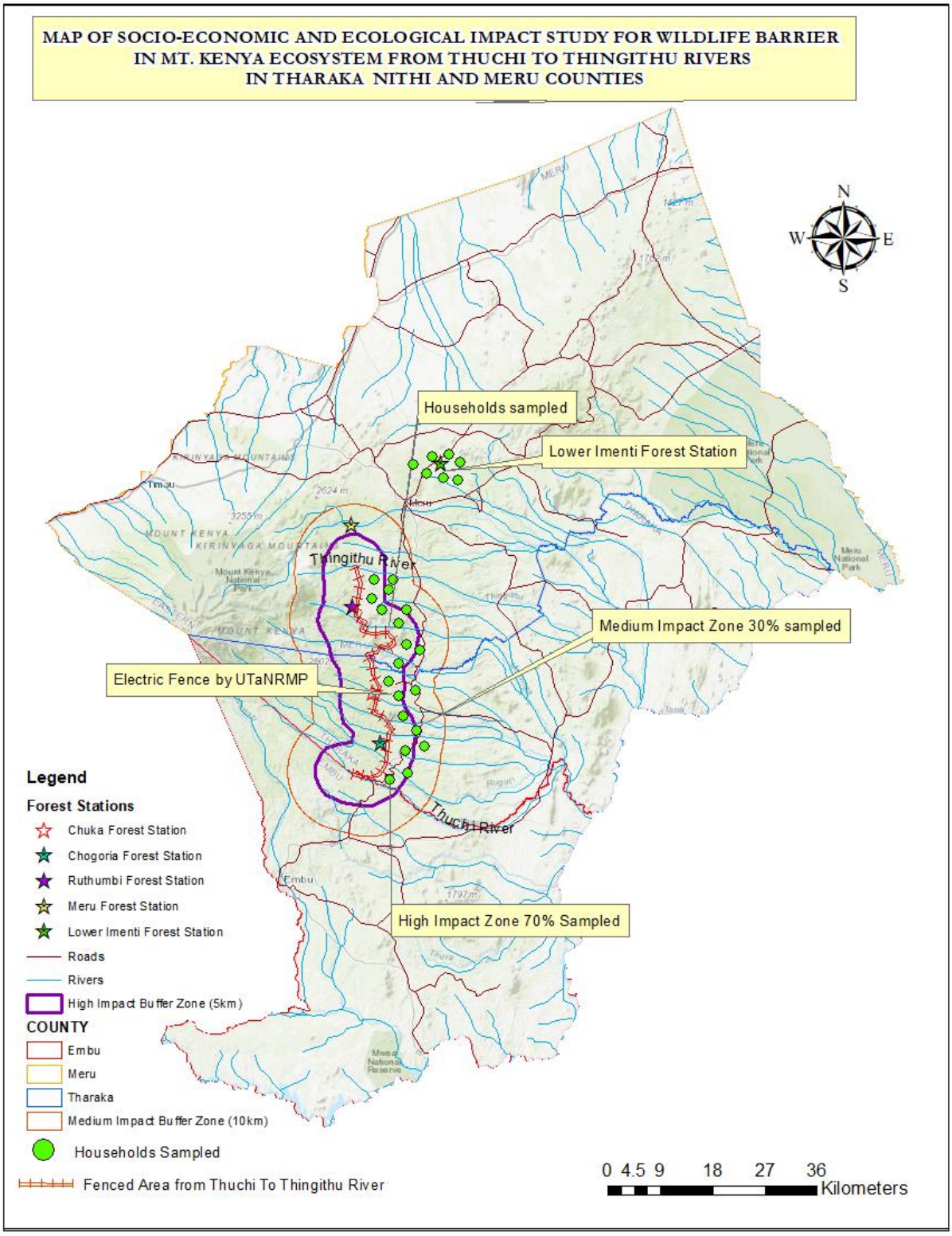


Figure 2.2: Selection of HH samples

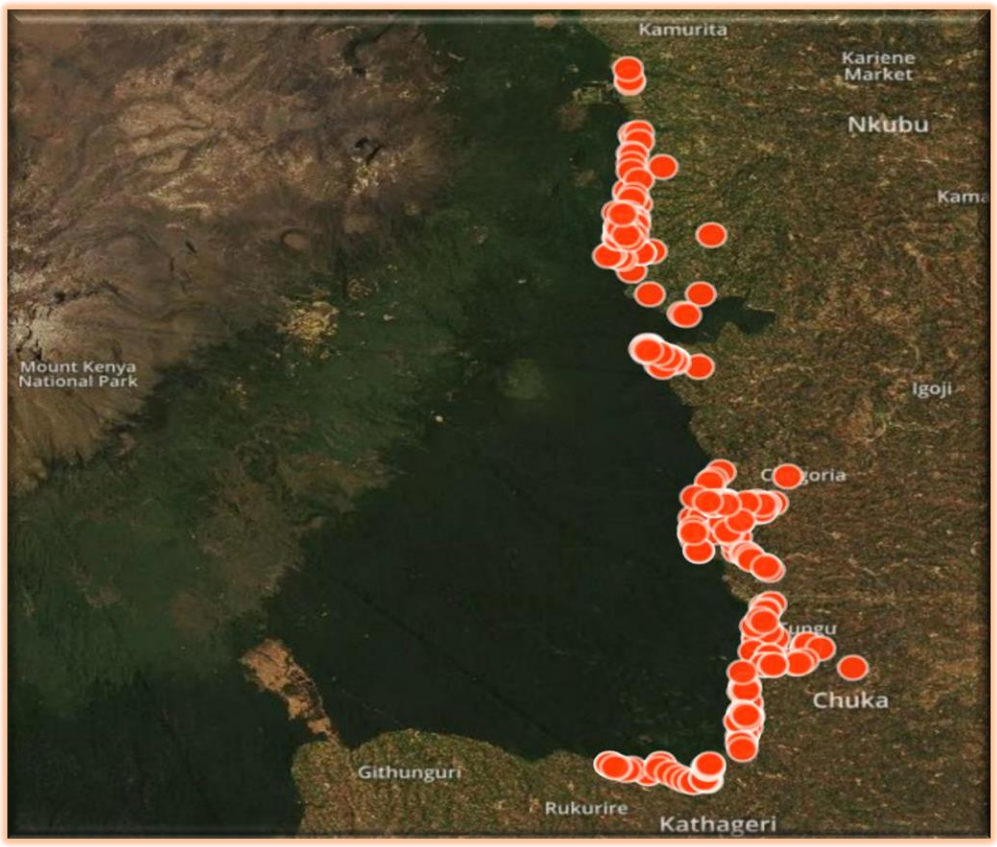


Figure 2.3: Household Samples in Chuka, Chogoria and Ruthumbi

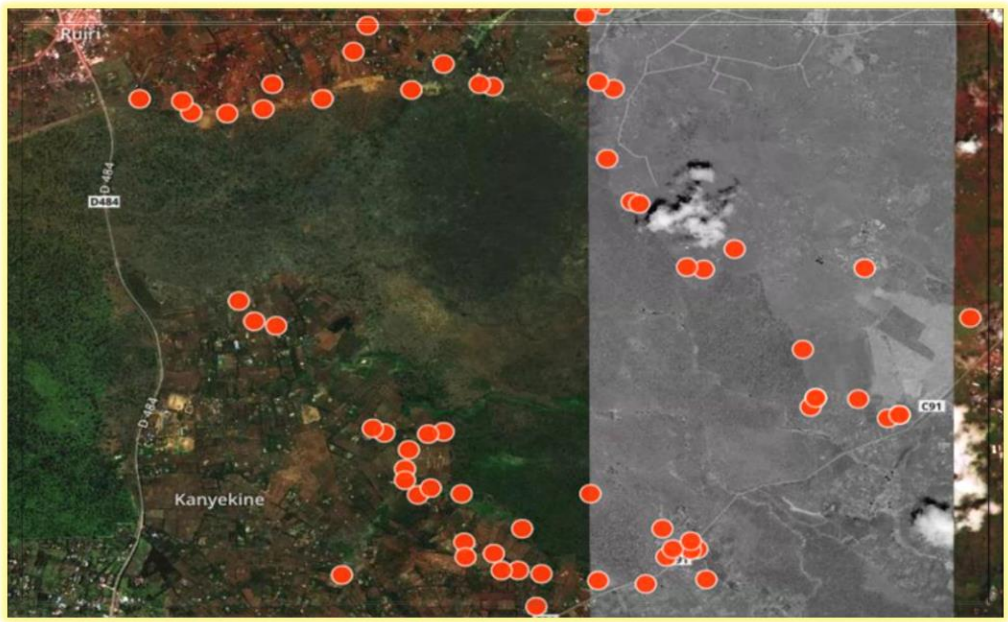


Figure 2.4: Household Samples in 6-strand Fenced Area in Lower Imenti

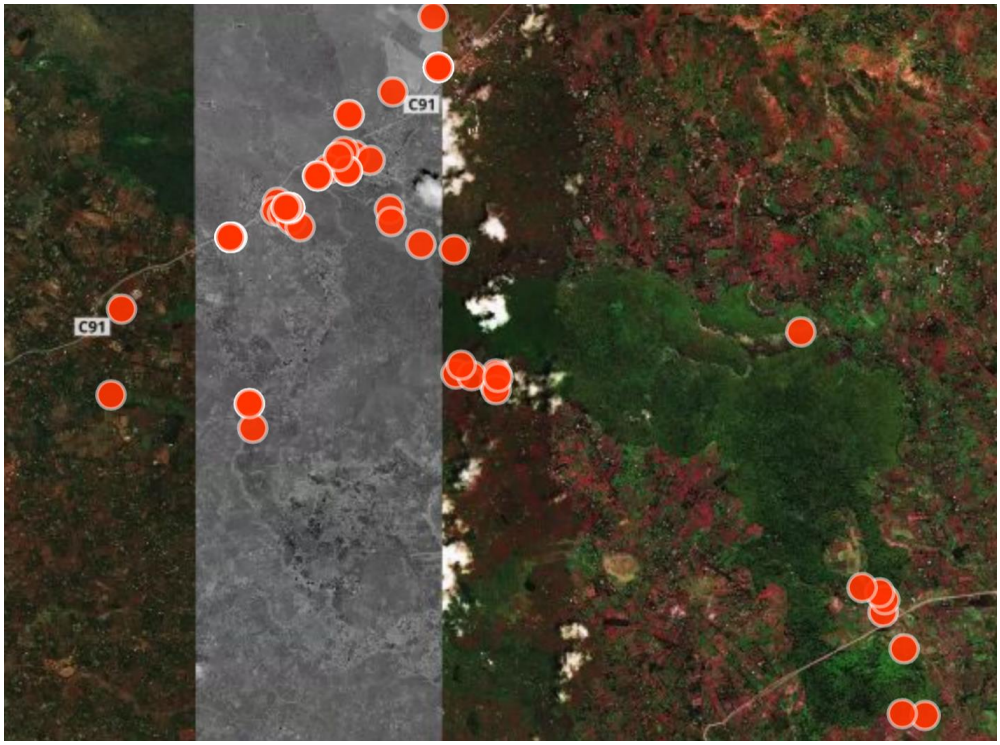


Figure 2.5: Household Samples in Unfenced Areas in Lower Imenti

2.6.2 Key Informant Sample

For the majority of key informants, the sampling was purposive and targeted all the key stakeholders who could provide key information regarding the socio-economic and ecological impacts of the wildlife barrier as shown in Table 2.2 below.

For some institutions like schools, the criteria for selection was the proximity to the forest station offices. Here we selected the nearest primary and secondary school near the forest station offices in each of the forest stations.

For water companies, the criteria for selection was the size of Water Company (in terms of number of connections). For each of the three forest stations, the three largest water companies which have easements were selected based on interviews with the forest managers.

For businesses, selection was random around the largest of the towns/market centres that fall within the 10 km buffer in each of the forest stations. These were Chuka, Chogoria and Marimba. For each town, the team established the 'centre' of the town and from there, one team moved to the North and the other to the South. Each team selected the first establishment encountered in each category for the interview. Where an establishment was selected e.g. a restaurant was closed or unwilling to participate, the next establishment in the category encountered was

selected for the interview. For Chiefs/assistant chiefs, the two locations nearest the forest station office were selected. For each forest station, we interviewed 3 chiefs or their assistants.

Table 2.2: Key Informants Targeted

Stakeholder institution	Targeted individuals/officers	Key Information
• UTaNRMP	i. Project Coordinator; ii. Land and Environment Coordinator, iii. Community Empowerment Coordinator, iv. Monitoring and Evaluation Officer, v. Knowledge Management and Learning Officer.	i. Participatory fencing process and costs ii. Key impacts observed socio-economically and ecologically iii. Unintended impacts and lessons learnt
• Rhino Ark Foundation (RA)	i. Chief Executive Officer ii. Fencing Project Manager	i. Fencing costs ii. Impacts of different fence designs iii. Unintended impacts and lessons learnt iv. Experiences from other fencing projects v. Fence sustainability strategies
• Kenya Forest Service	i. Ecosystem Conservators in Meru and Tharaka Nithi, ii. Forest managers in the forest stations- Chuka, Chogoria, Ruthumbi	i. Changes in management costs and revenues ii. Relationship with CFA members before and after the fence iii. Change in levels of illegal activities before and after the fence iv. Fire incidences before and after v. Arrests – before and after vi. Key ecological changes observed after fencing vii. Unintended impacts and lessons learnt iii. Trees planted within forest station and community in fence period
• Kenya Wildlife Service	i. Wardens in Chogoria and Meru, Senior Warden Mt Kenya National Park, ii. Asst. Director-Mountain Region; iii. Research Scientists at Kingongo iv. Fencing Technical Manager-KWS	i. Human- wildlife incidences ii. Relationship with Communities before and after fence iii. Transfer of h/w conflicts in non-fenced area iv. Impacts of different types of fences v. Unintended impacts and lessons learnt
• Water companies/projects: The three largest (in terms of persons served) around each of the three forest stations	Managers	i. Incidences of pipes breakage/water disruption before and after fence ii. Repair costs before and after fence
• CFA and WRUA committees	Chairman or secretary of CFAs/WRUAs: i. CFAs: Chuka, Chogoria, Ruthumbi, Meru, Lower Imenti ii. WRUAs: Upper sections Thuchi, Tungu, North and south Maara, Mutonga, Kithinu, Thingithu, Mariara, Kathita	i. Situation before and after the fence ii. Community contribution to fence construction iii. CFA and WRUA institutional benefits from fence – revenues, employment, involvement in conservation, water availability, water infrastructure maintenance
• Ministry of Interior and coordination	Chiefs/assistant chiefs neighbouring the forest station –	i. Community cohesion including household conflict before and after fence

Stakeholder institution	Targeted individuals/officers	Key Information
	i. Chuka: Kiangondu and Mugwe locations ii. Chogoria: Chogoria and Murugi locations iii. Ruthumbi: Ntima and Kinoru iv. Meru: Municipality v. Lower Imenti: Ngine location	ii. Education standard before and after fence iii. Illegal forest activities before and after fence iv. General security issues before and after the fence v. Land values
• Business owners in townships/markets within 10Km from Forest boundary	i. Hoteliers, timber yards, charcoal sheds	i. What has changed since the wildlife control fence was constructed in terms of availability of firewood, charcoal, and forest products; food products
• School heads	i. Head teachers ii. Pupils/students whose homes are adjacent to the forest	i. Level and attendance of school by pupils before and after fence ii. School performance before and after fence

2.6.3 FGDs Sample

The forest adjacent communities were also consulted through the Focus Group Discussions (FGDs) technique. Using the forest stations (Chuka, Chogoria, Ruthumbi, and Lower Imenti) as the main sampling strata, the team undertook FGDs with four categories of community members as agreed with the client. These were Focal Development Area Committees, Community Forest Associations, Water Resources Users Associations and school-going children.

After the initial FGDs comprising of the community institutions, the combined community groups were then divided again in terms of age and gender to form new FGDs which included: adult males; adult females; male youth; and female youth. The FGDs were to assist in probing for gender and age specific issues among the larger community. The new FGD groups were also undertaken because power relations limit active participation of some members in an FGD and thus the need to separate the groups. Children FGDs were undertaken in primary and secondary schools within the target areas using child friendly methods, on the impact of the fence from the perspective of children. Overall, 45 FGDs were convened across the study area of five strata falling within four forest stations (Lower Imenti had two strata for non-fenced and 6-strand). Table 2.3 below summarizes the number of FGDs undertaken per each forest station stratum.

Table 2.3: Target FGDs in each Forest station coverage

Area	Category of respondents	Number of FGDs	Number of participants
Per Forest station	CFA Representatives	1	8 -12
	WRUA Representatives	1	8 -12
	FDA Committee	1	8 -12
	Adult Male	1	8 - 12
	Adult Female	1	8 -12
	Male Youth	1	8 -12
	Female Youth	1	8 -12
	Children in schools	2	8 - 12
Total		**9**	**108**

2.6.4 Transect Samples

To triangulate the results of the remote sensing, the 10 Kms buffer area in each forest station were sampled using transects. The Quick Biodiversity Assessment Guideline for Rapid Agro-Biodiversity Appraisal (RABA) (Kuncoro, 2006) was used and combined both stratified (per forest station) and systematic sampling (distances between line transects).

Each forest station was divided into 5 Km blocks of sampling units/strata. Those with a 25 Kms length like Ruthumbi had 10 blocks while those with 15 Km length had 6 blocks. As in the HH survey, more line transects were undertaken on the outer 5 Kms radius block near the fence as opposed to the inner block as more impact with regards to change and human activity was envisaged in these blocks. For each 5 Km block, we therefore undertook one transect for the inner 5km buffer zones and 2 transects in the outer block near the fence. For the non-fenced and 6-strand fence, we took 2 'control' transects each for comparisons.

<table>
<tr><td rowspan="3">10 Kms buffer</td><td>5 Kms radius</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5 Kms radius</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">5 Kms
60 Kilometre fence line</td><td>5 Kms</td><td>5 Kms</td><td>5 kms</td><td>5 kms</td></tr>
</table>

The first transect was randomly selected near the southern end of the forest station (within the first kilometre). Thereafter for the outer zone, the distance between transects was 2.5 kilometres which for the inner zone, the distance between transects will be 5 kilometres. The transects were first drawn on the forest station map with the help of the forest managers, before being actualized in the field. This ensured that selected areas could be walked through. The transects run parallel to the fence alignment.

Systematic sampling: Each transect was 1 Km long with recordings done at intervals of 100metres. For areas with trees, a square 8m x 8m sample plot was made at the 100m interval and a record of all trees (and their phenology e.g. if fruiting or flowering) in the sample plot recorded by their local or scientific names and diameter at breast height measurements made. Where only saplings existed, a square 4m x 4m sample plot was made and names and number of saplings recorded. Where a plant (tree and sapling) could not be identified positively, a specimen was collected for later identification.

In each of the transects, the frequency, diversity, and density of species was determined. Additionally, the primary and pioneer species were determined and the forest classified as primary, secondary or regenerating. The transects were also mapped on maps and GPS coordinates for future monitoring.

A total of 313 quadrants were recorded with Ruthumbi 118, Chuka 92, Chogoria 65, and Lower Imenti fenced area 19 and unfenced area 19 as shown in Table 3.2. The information recorded in every quadrant include the type of vegetation, status, other biodiversity observations, GPS coordinates, and photo (s). The information was collected using Kobo kit and submitted via mobile phones. The sampled points are as seen in Figure 2.6 below.

Table 2.4: Transect Walks Frequencies

Value	Frequency	Percentage
Ruthumbi	118	37.70%
Chuka	92	29.39%
Chogoria	65	20.77%
Lower Imenti (Fenced)	19	6.07%
Lower Imenti (Unfenced)	19	6.07%
	313	100.00%

2.7 Inception Report

An inception report was prepared before the start of the actual field data collection process. This was presented to the Project Coordination Team (PCT) in a meeting for discussion and agreement. All issues raised in the workshop were incorporated in the actual field data collection and a revised Inception report prepared

2.8 Field Visits

Field visits were undertaken between 13th to 25th May 2019 for the FGDs, ground-truthing and undertaking line transects, and HH questionnaire administration.

For HH questionnaire administration, the consultant recruited and trained local enumerators on 13th May 2019 after which they undertook a pre-test. A total of 16 enumerators (3 - 4 for each of the 4 selected forest station areas) with each undertaking 5 questionnaires per day as shown in Table 2.4 below. For the different strata, the enumerators took about 7-9 days to finish data collection. The consultants supervised the field data collection.

Table 2.5: Enumerators

Forest Station	Number of Households	Number of Enumerators	Number of Enumeration days
Chuka	109	3	8
Chogoria	82	3	6
Ruthumbi	139	4	7
Lower Imenti (non-fenced)	82	3	6
Lower Imenti (6-strand fenced)	82	3	6
Total Number	**495**	**16**	

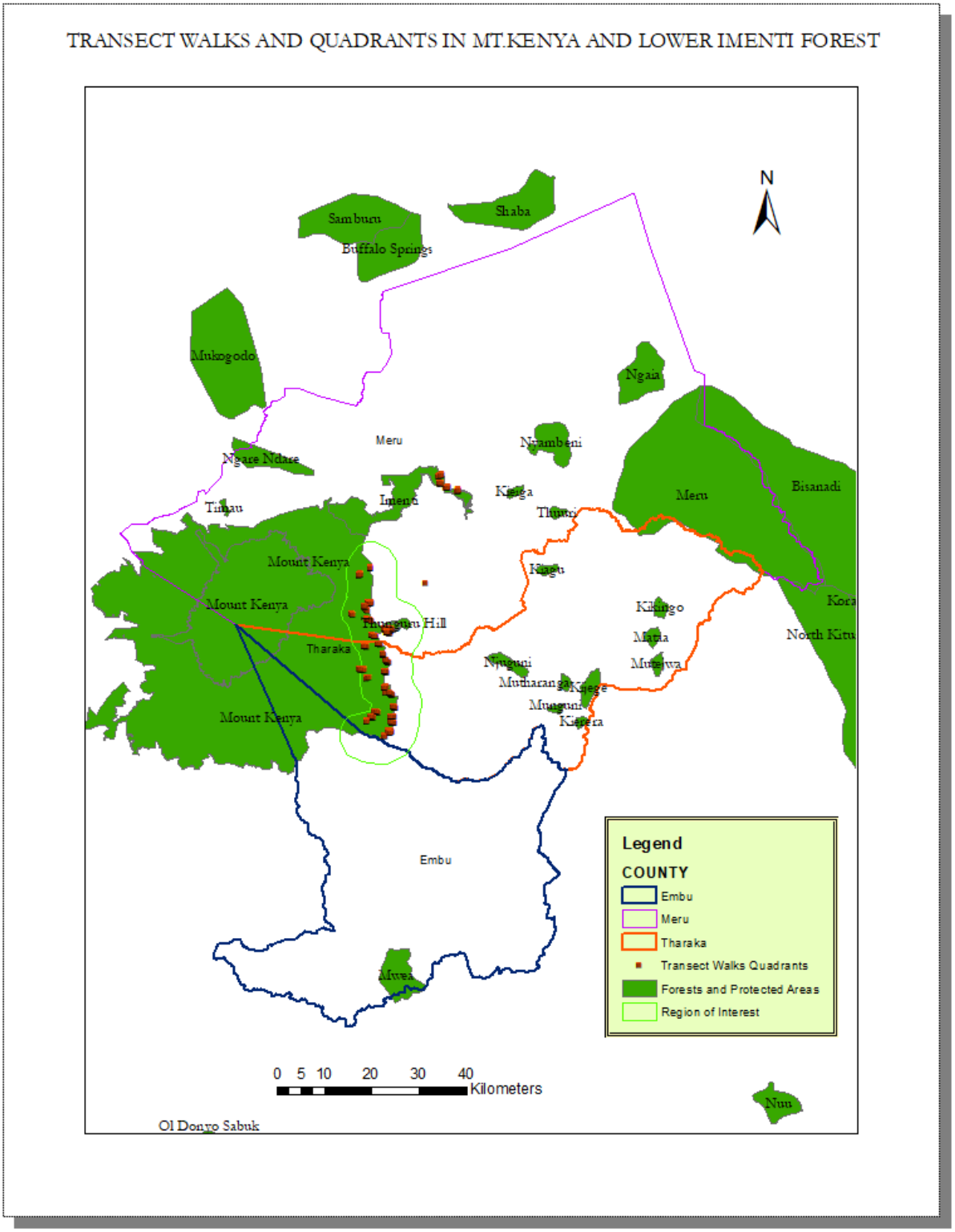


Figure 2.6: Transect Walk Quadrants

2.9 Data Collection and Analysis for the Key Areas

2.9.1 Ecological Issues, Land use and Cover Change

Land cover change assessment was undertaken using Landsat 8, Sentinel and Normalized Vegetation Index Imageries. The imageries for Landsat 8 were obtained from USGS https://earthexplorer.usgs.gov/ and Sentinel from https://cidportal.jrc.ec.europa.eu/forobs/sentinel.py, https://scihub.copernicus.eu/dhus/#/home and NDVI satellite imagery from University of Natural Sciences in Austria(http://ivfl-info.boku.ac.at/satellite-data-processing/dataprocess-global). The images were selected based on standard acquisition criteria through creation of Region of Interest, which then selects the Path and the Row for the Imagery to be obtained. The Landsat images selected were for the dry months of January 2014 and 2019 due to vegetation phenology whereby different vegetation may give similar reflectance values during early stages of growth during the rainy season. In addition, high altitude areas have tendency to have cloudy imageries, but we selected imageries with less than 10% cloud cover, and where not feasible, we undertook image masking and atmospheric correction in QGIS 3.2.6, and ArcGIS 10.4. The specifications for Landsat imagery are shown in Table 2.6

Table 2.6: Landsat Images Specifications

Year	Scenes	Path	Row	Resolution	UTM Zone	Centre Lat.	Centre Long	ULCorner Lat	UL Corner Long	UR Corner Lat.	UR Corner Long.
2014	5	168	60	Multispectral 30m	37	0°00'00.32"N	37°23'45.64"E	1°02'41.82"N	1°02'41.82"N	1°02'41.82"N	38°24'55.66"E
2019	5	168	60	Multispectral 30m	37	0°00'00.32"N	37°23'45.64"E	1°02'41.82"N	1°02'41.82"N	1°02'41.82"N	38°24'55.66"E

Upon acquiring satellite imageries composite imageries were created using Bands 1-9 for land cover and Bands 8 and 4 for NDVI floats. Image classification involved pre-classification, classification and post classification. Pre-classification involved software selection where ArcGIS 10.4, QGIS 3.26, ENVI 5.1 and ERDAs 2014 were selected. Classification schemes were also considered at this stage, where cropland, forest, woodland, grassland and riverine vegetations were considered on community land. In the forest, Natural forest, Bamboo, Moorland, Plantation, water body and Grassland were considered. An average of 500 training sites (verification sites) were created and 100 were selected for ground truthing. Those in the forest were further triangulated with 313 quadrants for transect walks captured using Kobo kit and uploaded on satellite imageries with photos. A new classification scheme with a signature file, was therefore developed based on ground truthing, which captured Natural forest, Plantation, Grassland, Annual cropland, Perennial cropland, Built-up area and Other lands which include bare land, and roads, shrubland and waterbody. The classification was done in ArcGIS 10.4, using Maximum likelihood. An accuracy test was undertaken using ENVI 5.1 with an overall accuracy of 98% and Kappa Coefficient of 0.9, whereas User and Producer (Software) Accuracy ranged from 97%-99. Land

cover change differentiation was undertaken using Landsat 8 imageries for 2014 and 2019. For NDVI Near Infrared and Red were used to create floats and were differentiated in spatial analyst tool box, using map algebra, raster calculator.

Baseline conditions were determined from secondary sources especially literature and key informant interviews. The baseline conditions were compared to the current conditions to determine the changes that have occurred since completion of the fence construction. Key aspects covered under this section included flora, fauna, human-wildlife conflicts, access to biological resources, and any changes in revenue collection.

2.9.2 Socio-economic Issues

This covered among others, socio-economic impacts like improved security, food security, livelihood improvement, stakeholders' perception of the fence, community perceptions towards ecosystem managers (KWS and KFS); incidences of human wildlife conflicts, land values in the area adjacent to the fence, cost of managing human wildlife conflicts, fence and ecosystem management issues and stakeholder inputs to future management of the fence and the ecosystem.

The socio-economic impacts which the study focused on included but were not limited to: -

- Impact on food security
- Impact on crops diversification
- reduced food gap and poverty amongst targeted households
- Reduction of human-wildlife conflicts:
- Illegal removal/taking of forest products and poaching
- Encroachment on the forest reserve
- Land values appreciation/depreciation.
- Gate placements and impact on communities
- Time spent/saved on guarding crops
- Wood fuel prices – increase or decrease
- Impact on reduction in grazing pressure in forest reserve.
- Sources of building materials
- Cost benefit analysis

The cost-benefit analysis was undertaken for the study as a standard method used for evaluating interventions and projects. This enabled the consultant to capture the monetary gains and losses resulting from the project. The objective was to compare the present value of a stream of benefits to a stream of costs. Discounting was used to calculate the present value of future costs and benefits.

Evaluation of the fence project involved consideration of benefits accruing against the costs. This was done by using four different ratios: The Expected Rate of Return (ERR), the Net Present Value (NPV), the Incremental Benefits, and the Benefit-Cost Ration (BCR). The EER gave the interest rate at which benefits are equal to costs, thus measuring the extent to which total benefits cover total costs. It was calculated by taking the ratio of total benefit to total cost of the fence over the life of the fence. Total benefit and total cost were the sum of benefits and costs respectively over the life of the fence. The NPV gave a parameter that reduces a stream of discounted benefits and costs to a single number. It measured the net worth of the project, such that the higher the value of NPV, the better the project. NPV was calculated by taking the difference between the present (discounted) value of benefits against present (discounted) value of costs over the life of the fence. BCR gave the overall monetary value of the fence project. It was calculated by taking the ratio of discounted benefits against discounted costs. The higher the BCR the better the project. The Incremental benefits was calculated by taking the difference between total benefits and total costs.

The impact of the project was established by comparing the period before and after construction of the fence. The approach involved establishing any change and the extent of the changes for fenced and unfenced area, so as to establish the actual impact of the fence on the community in general and the economy of the people around the fenced and non-fenced areas. This was by considering the before-and-after outcomes/impacts for the community around the fenced area and before-and-after outcomes/impacts for the community around the unfenced area.

2.10 Draft report writing

The Consultant prepared a draft report on the Fence Socio-economic and Ecological study. This was shared and presented to the client and comments incorporated before sharing with other stakeholders at a validation organized by the client.

2.11 Stakeholders validation workshop

The draft report including its findings and recommendations was presented in a stakeholders' validation workshop held on was held on 26th June 2019 at Kaguru Agricultural Training Centre in Nkubu, Meru County. Here, the Consultant received further comments and inputs from the stakeholders. After the validation workshop, the stakeholder views were incorporated in the final report. Proceedings of the workshop were also prepared and submitted to the client as part of the final deliverables

2.12 GIS map

GPS coordinates of all transects, and the community stakeholder meetings and sampled households were taken during the field visit. These were then be down-loaded and all the sampled sites geo-referenced. A map was then prepared of all project sites visited. A live Map data in CSV was also provided where information on all households interviewed can be accessed.

2.13 Final report

All comments received from the client and stakeholders were incorporated in the final report which was then submitted to the client in six hard copies and six CDs. Additionally, a map in both hard and soft copies plus the Validation Workshop Proceedings were also submitted.

3. STUDY FINDINGS

3.1 Ecological Impacts

This section highlights the ecological impacts associated with the erection of the wildlife control fence. The key ecological impacts detected include changes in land cover, impacts on forest cover and biodiversity conservation, impacts on climate change, and impacts on water quality and quantity. The ecological impacts were mainly derived from Landsat imageries and the transects established in the forest within the 60Km Thuchi to Thingithu wildlife control fence area. Some information was also from literature review such as water quality and quantity.

3.1.1 Land Cover Change Detection

Change detection uses remotely sensed imagery, acquired on at least two dates during the same season, to identify change that might have occurred in the interval between the two dates. The selected period for change detection in Mt. Kenya Ecosystem (Thuchi to Thingithu Rivers) was January 2014 and January 2019. Land cover change assessment was undertaken using composite imageries for the different years, which were created separately using 9 bands as bands 10-11 in Landsat are thermal and used for atmospheric change detection. Training sites used in pre-classification were corrected during ground truthing where pre-classified areas were corrected to reflect the actual cases. For instance, there was a lot of nappier grass growing on farmland, and when cut it reflects as grassland, Shrubland on the Nithi Valley reflects as woodlands. The information for ground truthing was captured using Trimble GPS with image capture capability on North/South of training sites. After ground truthing, the corrected training sites (figure 3.1) were reclassified, and correct signature file created, which was used for classification using Maximum Likelihood in ArcGIS 10.4, and similar tests were undertaken in ENVI 5.1 using Parallel Piped and Maximum Likelihood Image Classification techniques. An accuracy test was undertaken using ENVI 5.1 using confusion matrix and maximum likelihood which had overall accuracy of 98% and Kappa Coefficient of 0.9, whereas User and Producer (Software) Accuracy ranged from 97%-99%.

Figure 3.1: Sentinel 3 imagery (2019) 10m resolution used for training sites

3.1.2 Change Differentiation

Land Cover classification sets (Figures 3.2 & 3.3) were differentiated using ArcGIS 10.4 using the Raster calculator under the Spatial Analyst Toolbox. In order to obtain land cover change, the number of pixels per classification in the attribute tables were then multiplied by 30m x 30m which is the value for each pixel count. The area obtained per class were then converted into Hectares as shown in Table 3.1.

Table 3.1: Land Cover 2019 and 2014

Land Cover Class	Area in Ha 2019	% Cover 2019	Area in (Ha) 2014	% Cover 2014	Change in Ha 2014-2019	% Cover Change
Natural Forest	27,748.38	48.72	27,561.66	48.41	186.72	0.68%
Forest Plantation	172.21	0.30	189.78	0.33	-17.57	-9.26%
Grassland	549.27	0.96	1,465.78	2.57	-916.51	-62.53%
Shrubland	2,428.38	4.26	2,762.34	4.85	-333.96	-12.09%
Annual Cropland	18,159.79	31.88	16,115.07	28.30	2,044.72	12.69%
Perennial Cropland	7,635.56	13.41	8,219.85	14.44	-584.29	-7.11%
Water Body	4.83	0.01	5.02	0.01	-0.19	-3.78%
Build-up Area/Other lands	256.50	0.45	618.90	1.09	-362.40	-58.56%
Total	56,954.92	100	56,938.41	100.00	16.51	0.03%

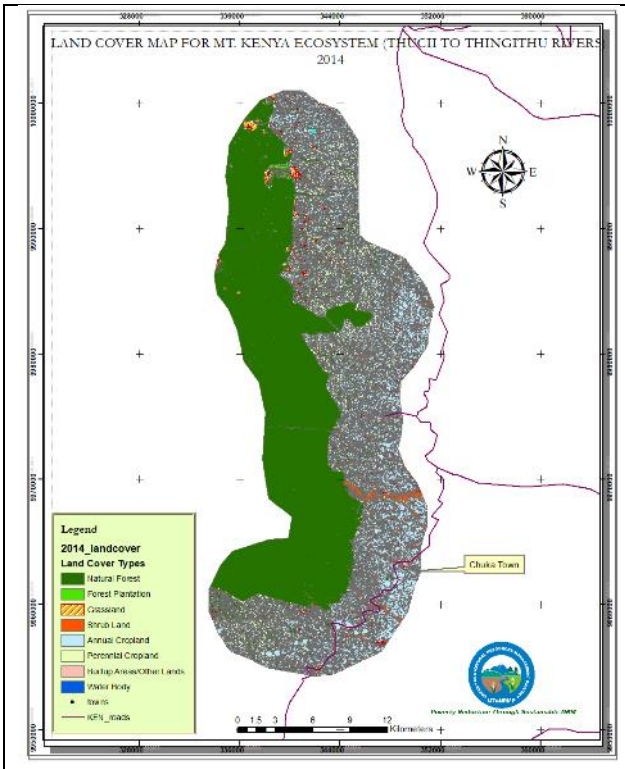


Figure 3.2: Land Cover Map 2014

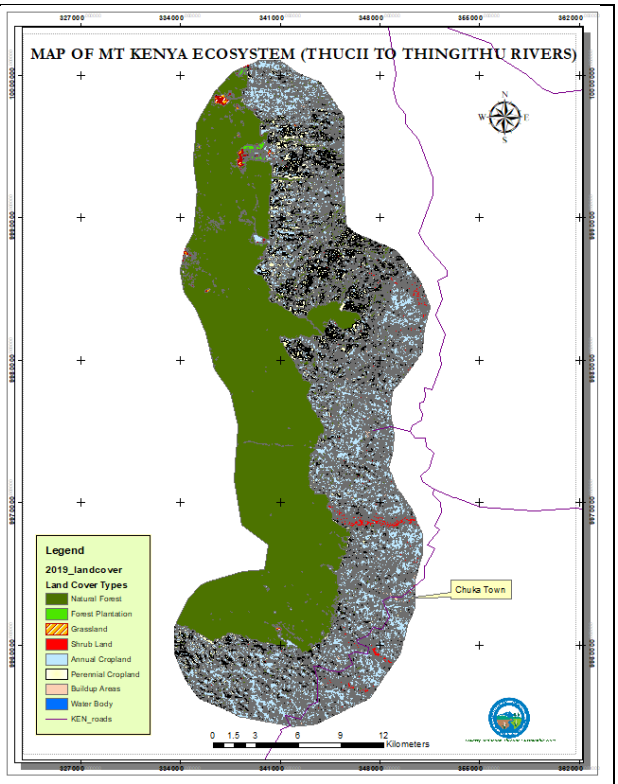


Figure 3.3: Land Cover Map 2019

3.1.3 Change in Land cover

Forest: The study findings indicate change occurred in natural forest cover which showed a positive change of 186.7 ha (0.68% increase) due to regeneration, and enrichment planting whereas forest plantation declined by 9% due to harvesting. This is supported by Normalized Vegetation Index (NDVI) along the fence showing an increased change in pixel values of between -0.3 to 0.24 as shown in Figure 3.4. NDVI which is calculated as Near Infrared-Red/Near Infrared+Red is classified as 0 to 1 which indicates vegetation health and 0 to -1 vegetation deterioration. The change variation of 0.2 to 0.3 is normally associated with shrubs and plants regeneration which means that most of the visible light was used for product biomass and giving a positive vegetation anomaly. This is an important change variation as natural forest takes 10-15 years to show significant change, and the first four years are usually critical for growth. The green areas in Figures 3.5, 3.6 & 3.7 represents vegetated areas with stronger near-infrared reflectance, and yellow area medium whereas red shows areas that have less to no vegetation or areas that have been cleared. Mature trees often have an index of 0.6-1 which are differentiated by high chlorophyll content, such areas have plants with good condition, high leaf biomass, canopy closure, and vegetation with high chlorophyll content. The areas of change are shown in Figures 3.8 & 3.9.

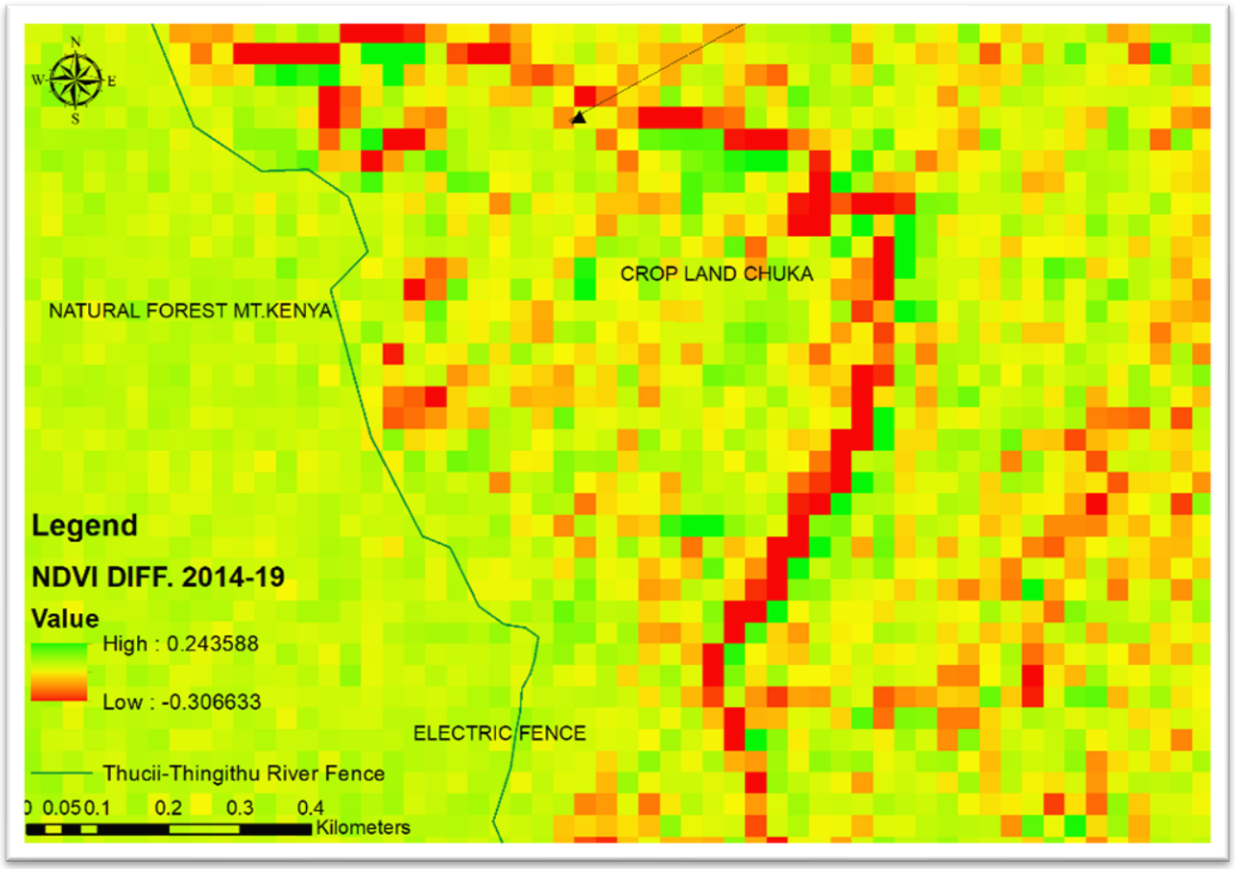


Figure 3.4: NDVI Difference imagery

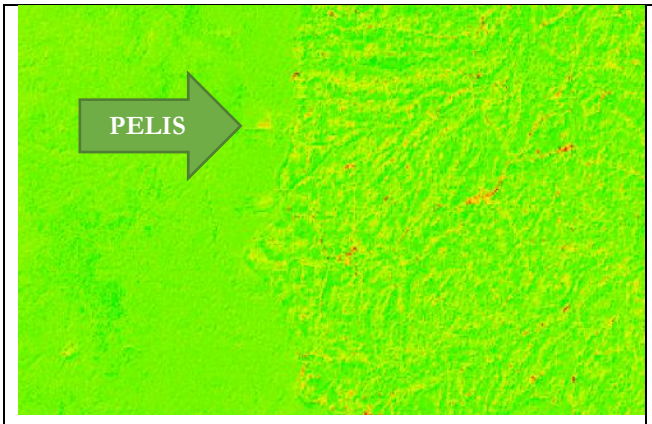


Figure 3.5: NDVI Imagery of Ruthumbi area 2014

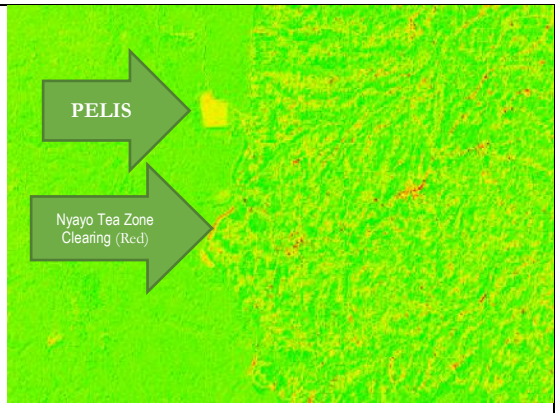


Figure 3.6: NDVI Imagery of Ruthumbi area 2019

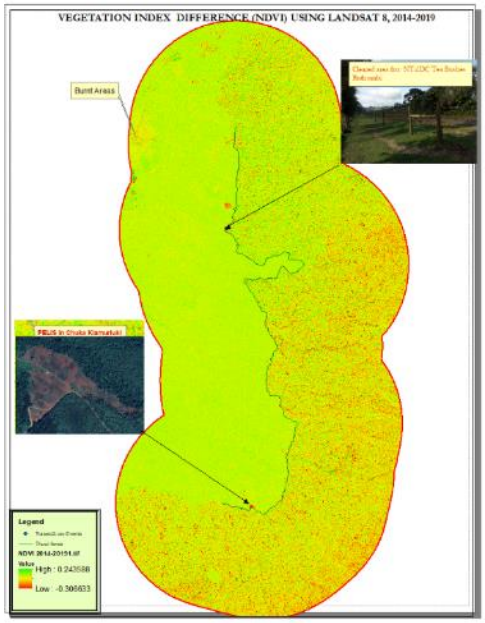


Figure 3.7: NDVI Imagery with Pictorial overlay of Chuka and Ruthumbi Forest Station

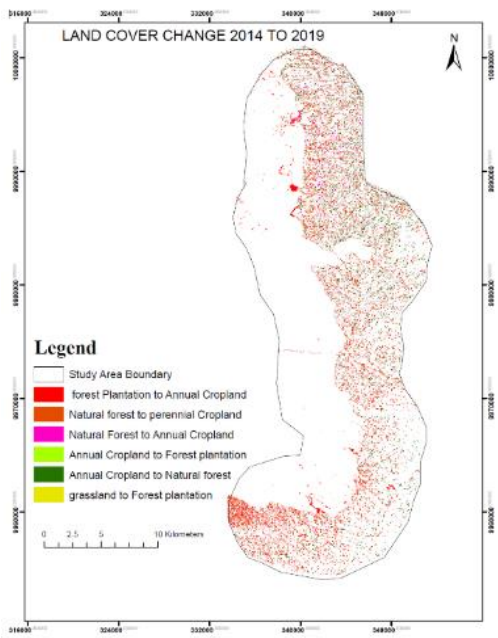


Figure 3.8: Areas of Change

Impacts on Grassland: This declined by 62% as shown in Table 3.1 and in Figures 3.8 and 3.9 which shows areas of change. The decrease in grassland in the forest area can be attributed to regeneration, while in the farmlands, the decline can be attributed to conversion of annual croplands as farmers took up farming as a result of the wildlife fence.

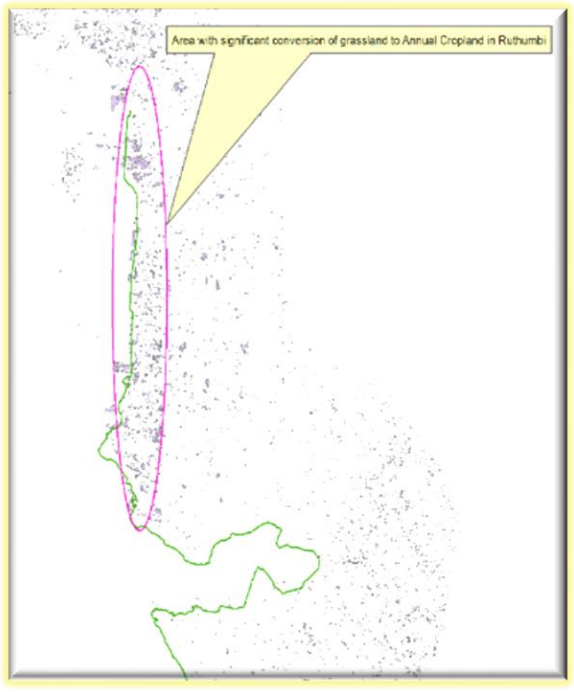


Figure 3.9: Area with significant grassland to crop land change

Figure 3.10: Built-up/Other lands to Cropland

Impacts on Annual Cropland: Annual cropland (Maize, Bananas, vegetables/horticultural crops) increased by 12% (2,044 ha), whereas perennial crops such as Tea and Coffee farms declined by 7% (584 ha). The decline can be attributed to intercropping of annual crops such as maize on neglected coffee farms, where a dominant pixel picked is annual crop as noted in the study area. In addition, it can also be attributed to the trend of farmers reverting to annual crops for subsistence and sale, owing to the security of the electric fence as shown in Plates 3.1 & 3.2 and Figure 3.11. This aspect is also in agreement with the household study which shows farmers cropping increase from 75.9% to 91.4% due to security. During ground truthing it was evident that farmers are now planting crops such as bananas, vegetables, maize which they would not before the erection of the fence.

Photo 3.1: Maize crop in Ruthumbi next to the Fence

Photo 3.2: Young Banana Farm near the fence in Kiamuriuki in Chuka

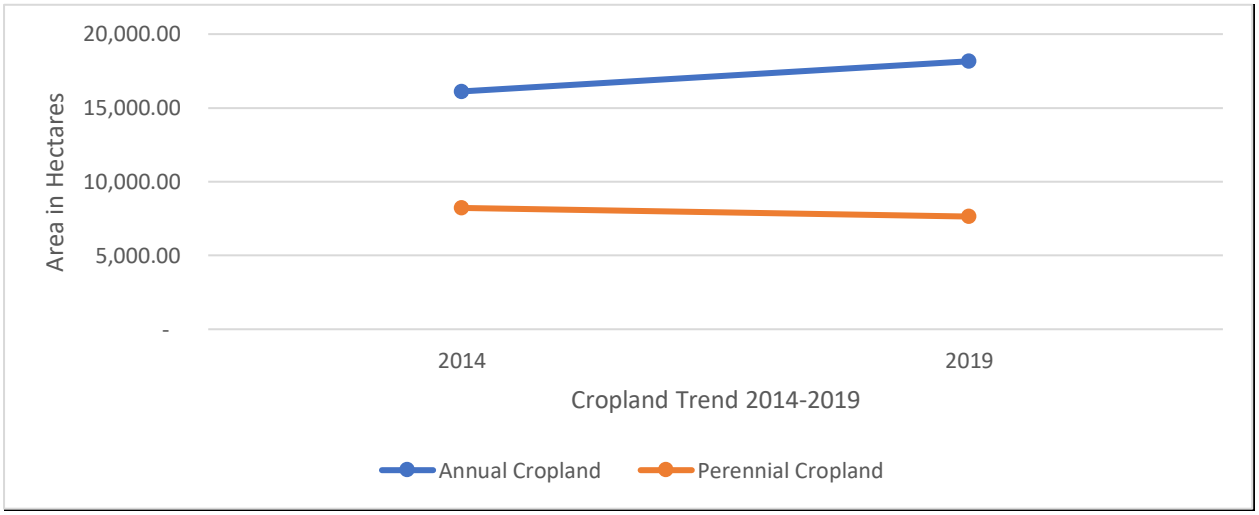


Figure 3.11: Cropland Trend 2014-2019

Impacts on Built up area and other lands: The build-up area and other lands which comprises bare lands has declined due to conversion to croplands as shown in Figure 3.10 above. The areas of change were significantly pronounced around urban centres and sparsely distributed

along the fence. This include areas such as road reserves that are reclaimed by community members for cropping activities, as well as tree planting.

3.1.4 Fence Impacts on Forest Cover and Biodiversity Conservation

The three forest stations of Chuka, Chogoria and Ruthumbi are part of 2000 square kilometres of forest surrounding Mt. Kenya which was gazetted as Mt. Kenya Forest Reserve in 1932. In 2000, through a government notice, the entire Mt. Kenya Forest Reserve was gazetted as a National Reserve under the management of KWS but the earlier Forest Reserve status was not revoked. This implies that the Forest Reserve/National Reserve is legally managed jointly by KWS and KFS. (Mt. Kenya Ecosystem Management Plan 2010-2020); The reserve is a complex harbouring not only the animals, plant, air, water but also micro-organisms which depend on one another for completion of the forest succession system in ecology. If one part is altered or destroyed then the whole vital ecosystem will be destroyed. The three forest stations are on the eastern *(*windward) and hence receive heavier rainfall unlike the western (leeward) side. This means that the area has the potential to experience fast regeneration of flora.

An ecological look on the area just after the electrified fence inside the forest shows that there has been past degradation with differences noted between the first 5 km block near the fences (marked blue), and the second 5 km block further in (marked green).

In the inner 5 km block, the forest is mainly intact saved for indications of once a time, selective huge tree harvesting of *Vitex and Ocotea spp*. (learnt it was during “Onyango” time - he was the First Kenyan Chief Conservator of Forests) but most of these areas have since healed.

On the whole, transect observations undertaken in the outer 5 km block near the fence indicated lots of regeneration. Regeneration is therefore quite evident especially in the areas near the fence with the main species being *Makaranga kilimandscharica* (Mukaragati) at 19%; 18% for *Strombosia scheffleri* (Muthiringo); 10% for *Rauwolfia caffra* (Mwerere); 9% for *Xymalos monospora* (Mwako) and *Syzygium guineense* (Muriru); 8% for *Bridelia micrantha* (Mukwethe); 7% for *Podocarpus falcatus* (Podo); 5% Trichilia emetica (mutugati) while the combination of other species (over 50) made up the other 16% as shown in Table 3.4 below. Indeed, most of the initial quadrant plots taken during the transects indicate lots of saplings and young trees with small diameters at breast height (DBH). More mature trees are seen as one goes inside with the last quadrants showing more mature trees than saplings. Regeneration is therefore quite evident

especially in the areas near the fence. FGDs with WRUAs and CFAs also indicated that the continued regeneration and improved ground cover is important as it reduces cases of landslides in the forest especially around Ruthumbi.

Table 3.2: Species Showing Most Regeneration

Biological Name	Local Name	Regeneration (%)
Makaranga kilimandscharica	Mukaragati	19.21
Strombosia scheffleri	Muthiringo	17.77
Xymalos monospora	Mwako	9.71
Syzygium guineense	Muriru	8.61
Rauwolfia caffra	Mwerere	8.61
Bridelia micrantha	Mukwethe	7.51
Podocarpus falcatus	Podo	7.28
Trichilia emetica	Mutugati	4.86
Others combined		16.45
Total		100

Overall, observations made during the transects show the sampled areas had Indigenous high forest 50.6% that is intact with close canopy cover. Regeneration was also recorded at 16.1% of observations made especially in Transect 10, 1, 5, 6 and 1, and in terms of quadrants this was noted in Q1 near the fence and Q2, Q3, Q4, and Q5, i.e. 200-500 meters from the fence as shown in Table 3.4. Regeneration was noted more in Ruthumbi, Chuka and Chogoria as shown in Figure 3.12. Notable too is that there was improved tree density in Lower Imenti unfenced area owing to rehabilitation activities and efforts by KFS, various partners and Community Forest Association. Elephants however also account for some tree's destruction especially along their known migration routes and dispersal areas. Elephant's destruction includes ripping-off of tree bark or uprooting of trees them in search of nutrients.

Table 3.3: Observations on Trees and Vegetation Status

Value	Frequency	Percentage
Indigenous (High Forest Intact)	167	50.6%
Regeneration	53	16.1%
Mature	48	14.5%
Normal forest	24	7.3%
Plantation	14	4.2%
Cultivated land	9	2.7%
Degraded	8	2.4%
Grassland	6	1.8%
Bare land	1	0.3%
	330	100.00%

Table 3.4: Observation of Trees Segregated by Quadrants

observation/Quadrant	10	8	1	6	9	2,3,4,5
Indigenous (High Forest Intact)	20	17	14	19	19	78
Regeneration	6	5	8	2	4	28
Mature	6	5	4	6	5	22
Normal forest	0	2	4	3	2	13
Plantation	2	2	1	1	2	6
Cultivated land	1	1	1	1	1	4
Degraded	0	1	1	2	0	4
Grassland	0	1	0	1	1	3
Bare land	0	0	1	0	0	0

Photo 3.3: **Transect 8 QD2 (200 metres from fence) Ruthumbi, Regeneration Coordinates UTM -0.15817 37.58897**

Photo 3.4: Transect 2, QD2 Enrichment Planting Chogoria Coordinates UTM: 0.24078 37.59252

Photo 3.5: Transect 8 QD 10 Eucalyptus Plantation Chuka
Coordinates UTM -0.32556 37.59987

Photo 3.6: Transect 5, QD 10 DBH measurements in Chuka,
Coordinates UTM-0.351061 37.59673

Discussions with stakeholders indicated that the forest ecosystem was healing with much vegetation starting to regenerate in areas which had previously been used as paths and routes to access the forest. Associated with this was the regeneration and thriving of species that were previously under risk of damages from illegal or uncontrolled activities.

Chuka Forest station: The regeneration in Chuka Forest station showed more saplings in the initial quadrants and more mature trees as one went further in to the forest. Compared to other stations, there were less trees per quadrant and the species mix was also lower. There were also sections with *Lantana camara* and other forms of climbers encountered in the transects. There were also many animal types encountered during the transects. These included elephants, monkeys and did diks. Other fauna observed were birds, butterflies, and insects (Table 3.6 & Appendix VI).

Chogoria Forest Station: As indicated in Appendix VI, Chogoria also indicated the same trend of regeneration as Chuka with a better species mix of about 5 different species and more trees, averaging 10 and going up to 20 per quadrant. The transects in the outer 5 km block were predominantly saplings indicating good regeneration.

Fauna was also plenty in the station with elephants, antelopes, gazelle, monkeys, snakes, birds and ants encountered (or evidence of their being there) during the transects.

Ruthumbi Forest Station: This also showed sign of regeneration with initial quadrants having more saplings and mature trees seen as one went into the forest. The number of trees per quadrant were also fewer, averaging about 5 and the species mix was also lower having 1-2

species. There are more open spaces in the forest compared to the other forest stations. Animal species including elephants, birds, and ants were also encountered during the transects (Table 3.6 & Appendix VI).

Lower Imenti Forest station (Fenced): The fenced areas (6 strand) within the forest station have lots of *Lantana Camara* which is an invasive species. Therein however are lots of saplings which are not able to grow into trees as they are suppressed by the lantana. Fauna was also seen in the form of elephants, and lots of birds.

Lower Imenti – non fenced: The non-fenced areas in the forest station have been rehabilitated by the community forest association and are better than the fenced in areas. This is because the rehabilitation focused on the areas outside. With the lantana removed, there was also a lot of regeneration and tree planting. There were fewer large animals but other fauna in the form of birds and monkeys were encountered.

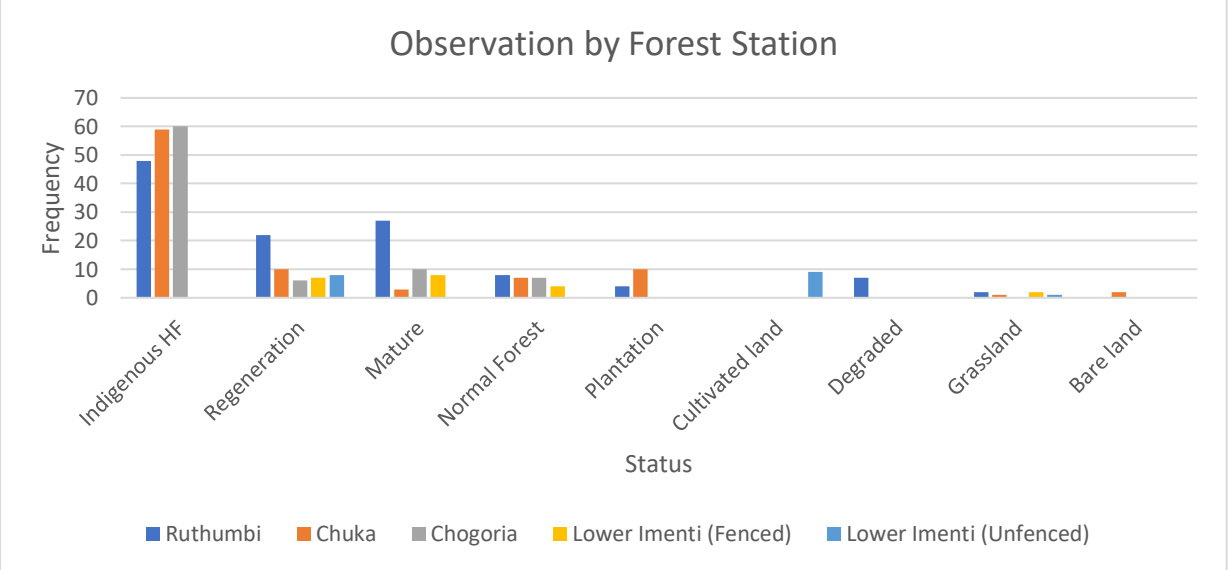


Figure 3.12: Observation on trees by Forest Station

Table 3.5: Observation of trees segregated by Quadrants

Forest Station	No. of trees	No of Transects	No. of trees per Transect	No. of trees per Quadrant	Quadrants per Ha	Saplings per Ha	Species mix per Quadrant
Chogoria	1,115.00	9	124	12	278	3,444	4
Chuka	672.00	12	75	8	278	2,076	3
Ruthumbi	448.00	15	50	5	278	1,384	3
Average	745	12	83	8	278	2,301	3
Lower Imenti	140.00	4	16	2	278	432.44	2

Table 3.6: Fauna Observation of Trees Segregated by Transects

FOREST STATION	TRANSECT NO.	SPECIES LOCAL NAME
Chogoria	T1	Birds (sighted); Elephant droppings
Chogoria	T2	Birds (heard);
Chogoria	T3	Elephants (tracks); birds (heard); snake (skin seen)
Chogoria	T4	Birds (heard and seen); Dik dik (droppings) elephant (droppings)
Chogoria	T5	Elephants; Columbus monkey; Gazelle (all sighted)
Chogoria	T6	Antelope
Chogoria	T7	Elephant
Chogoria	T8	Kwaare' (sighted)
Chogoria	T9	Monkey; hornbill (all sighted)
Chuka	T1	Elephant (tracks)
Chuka	T2	Birds (sighted and heard); Chameleon (sighted); dik dik (heard); Elephants (droppings)
Chuka	T3	Elephants (droppings); Birds and crickets (heard)
Chuka	T4	Elephants (droppings); Birds (heard and sighted); Monkeys (sighted); butterflies (sighted); Mongoose (sighted)
Chuka	T5	Bees (sighted); elephants (droppings)
Chuka	T6	Elephants (droppings); bees and snails (sighted)
Chuka	T7	Millipedes (sighted); elephants (droppings)
Chuka	T8	Birds (droppings and feathers\); Butterflies (sighted); Praying mantis (sighted); Grasshoppers and other insects (sighted); snail (sighted); frog (sighted)
Chuka	T9	Birds (sighted)
Chuka	T10	Elephant (droppings); bees and birds (sighted); mice (sighted)
Chuka	T11	Elephant (droppings); bees and birds (sighted);
Chuka	T12	Elephant (droppings); bees and birds (sighted);
Lower Imenti	T1	Hornbills, Hawks, squirrel and birds (all sighted)
Lower Imenti	T2	Gazelle (tracks); birds (heard)
Lower Imenti	T3	Birds (heard); Gazelle (tracks); Elephants (tracks)
Lower Imenti	T4	Antibear (sighted); birds (heard)
Ruthumbi	T1	Birds
Ruthumbi	T2	Columbus monkey
Ruthumbi	T3	Birds
Ruthumbi	T4	Elephants; Columbus & Sykes monkey; birds – all sighted
Ruthumbi	T5	Birds; Columbus monkeys
Ruthumbi	T6	Birds
Ruthumbi	T7	Elephant (droppings); birds – heard and sighted
Ruthumbi	T8	Birds; Columbus monkey (all sighted)
Ruthumbi	T9	Birds
Ruthumbi	T10	Birds
Ruthumbi	T11	Birds; Sykes monkeys (sighted)
Ruthumbi	T12	Elephant (droppings)
Ruthumbi	T13	Birds
Ruthumbi	T14	Birds
Ruthumbi	T15	Elephants (fresh droppings)' birds (heard)

3.1.5 Fence Impacts on Climate Change

In terms of climate change, improved forest ecosystem also means the fence has helped improve carbon sink through regeneration. According to the Centre for Urban Forest Research, (a branch of the U.S. Forest Service,) one tree sequesters about 40 Kgs (88 pounds) of carbon per annum with growing trees being better at sequestration than mature trees with each tree being adequate to serve 4 human beings. In the project area, the initial 5Km belt (from the fenceline) showed lots of regeneration with an average 8 trees per quadrant equivalent of 6,904 tree saplings per hectare for the fenced area compared to 432 tree saplings in the in unfenced areas. However, only about 33% of the trees are expeced to grow to maturity to give a stocking of about 600 trees per ha. Further, the healing of the forest can be attirbuted to about 25% of the 30,000 ha block (60Km of 5km block).

This translates to 17 tonnes of carbon sequestered per hectara per year. Considering the 7,500 ha (25% of block) attributed to the fence, this translates to 129,133 tonnes of carbon sequestered per year.

Table 3.7: Amount of Carbon Sequestration Attributed to Fencing

Forest Station	No. of trees per quadrant	No of trees per ha	Tonnes of carbon sequestered per year/ha
Chogoria	12	644.22	25.77
Chuka	8	388.27	15.53
Ruthumbi	5	258.84	10.35
Average	***8***	***430***	***17.22***
Lower Imenti	1.56	23	1.08

3.1.6 Impact of Fence on Water Quality and Quantity

Further, forest-adjacent communities' most important benefit is the water supply. This benefit is comprehensively enjoyed through piped water connection from the forest as reported by 92% of the household respondents, rivers (6%) and springs (2%) [Figure 3.13]. In the Lower Imenti fenced areas, water is sourced from the rivers (47.2%) and piped connection (36%). In the unfenced areas of Lower Imenti, water is sourced from piped connection (77.9%), river (20%) and rain water harvesting (18.9%).

After the erection of the fence, water supply has been affected both positively and negatively. Positively, 43% of household acknowledge there is improved water supply as wild animals are not trampling on water pipes within the community. On the negative, 45% (out of the 6% of respondents who source their water from rivers), lament on the increase in distance covered to

a water source as they have to access the rivers in the forest area through the forest gates. For example, women groups in Ruiri (Lower Imenti) indicated since the fence was erected, they have to walk longer distances posing a challenge for women and children who are tasked with the responsibility of water sourcing for the households.

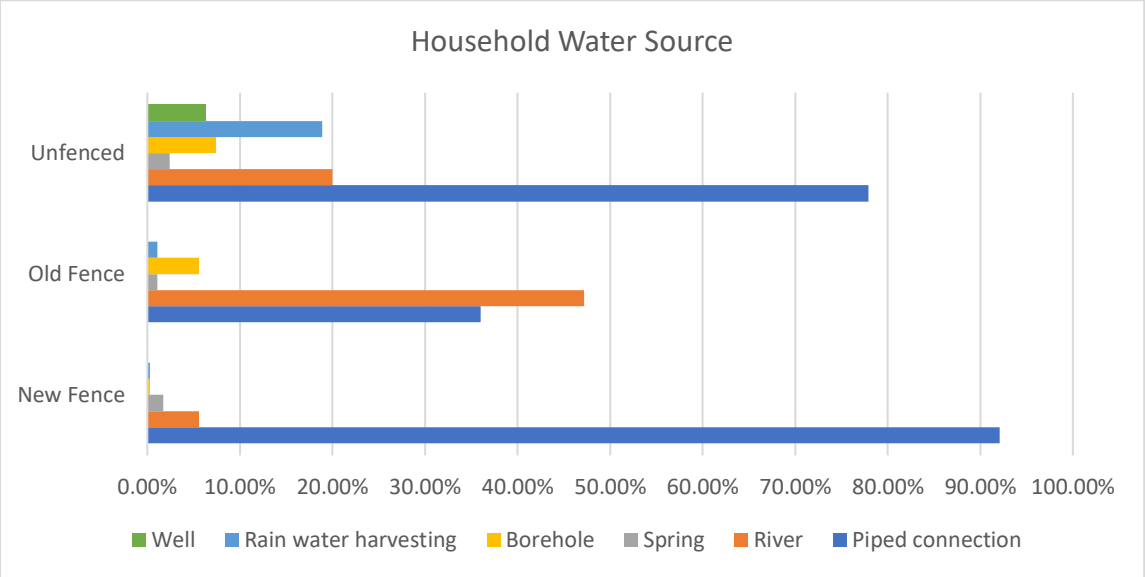


Figure 3.13: Household Water Sources

FGDs with WRUAs indicated that the fence had improved water quantity and quality as there was less interference with water flow from water intakes; incidences of pipe breakages were minimal hence water conflicts were also minimal; and water quality has improved, as there is less competition for water points in the forest, and less incidences of pollution have been reported. Sediment flow from road runoffs has also gone down due to grazing control and less livestock paths in the forests. Ground cover was forming on some of the degraded forest access roads earlier used by livestock and regeneration of trees which is good for catchment conservation, and has improved water quantity and adequate rainfall.

Rivers between Thuchi and Thingithu (inclusive of the two) have also seen significant increased flows between December 2016 and December 2018, with an average increase of 1.34 cubic metres per second from 3.83 cubic metres per second recorded before the fence, to 5.17 cubic metres per second after, an increase of 35%.

Table 3.8: River Flows between December 2015 and December 2018

River	Year 2015 (cumecs)	Year 2016 (Cumecs)	Year 2018 (Cumecs)	Change between years 2016 – 2018 (Cumecs)
Thuchi	0.862	1.93	5.92	3.99
Thuchi	1.14	2.39	4.47	2.08
Ruguti	1.46	4.29	5	0.71
Naka	0.097	0.095	0.229	0.134
Nithi	1.35	7.59	7.014	-0.576
Maara South	0.587	0.95	8	7.05
Maara South	0.813	3.98	2.37	-1.61
Maara North	0.188	0.87	2.46	1.59
Maara North	0.895	3.79	3.57	-0.22
Iraru	0.951	4.46	8.51	4.05
Thingithu	0.441	4	8.6	4.6
Thingithu	0.282	5.84	1.73	-4.11
Thingithu	0.193	7.34	9.35	2.01
Ruguti	1.183	3.67	7.2	3.53
Naka	0.0483	0.26	0.23	-0.03
Iraru	1.63	9.84	8.02	-1.82
Average	**0.757519**	**3.830938**	**5.167063**	**1.336125**

Source: UTaNRMP

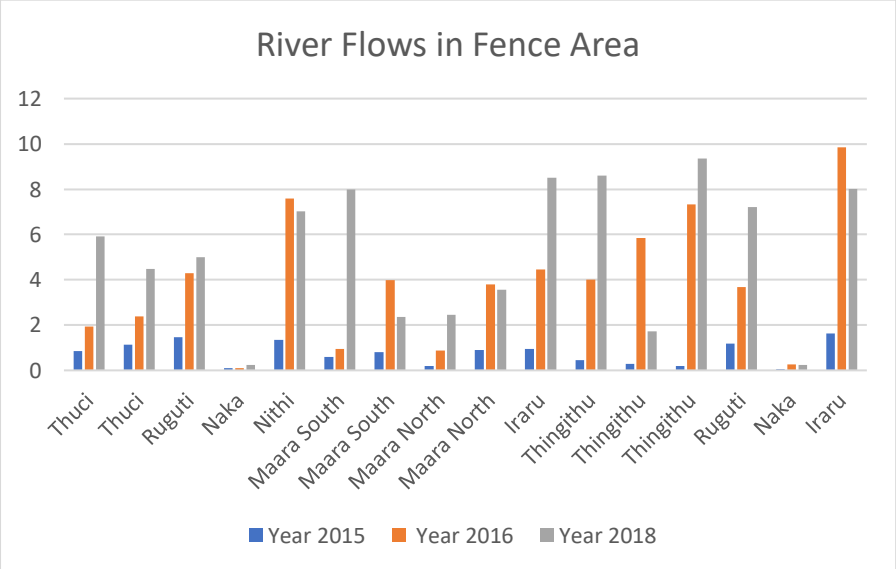


Figure 3.14: River flows in Fenced Area

3.2 Socio-Economic Impacts

This section highlights the socio-economic impacts associated with the fence since its erection between 2014 and 2016. The key impacts detected include those on food diversification in the farmlands; impacts on food security; impacts on human wildlife incidences and costs of managing conflicts; impacts on human deaths, injury, property and crop damage; impacts on incomes and livelihood improvements; impacts on relationships between communities and institutions mandated to manage the ecosystem; impacts on land values; impacts on health; impacts on education; impacts on protected area management; impacts on encroachment and illegal poaching; impacts on sources of fuelwood energy; impacts on tourism; impacts on forest fires; and impacts on livestock husbandry. The section also includes a cost-benefit analysis of the fence.

3.2.1 Fence Impacts on Crop Production and Diversification in the Farmlands

One of the adverse impacts of human wildlife conflicts (HWC) is crops damage. This makes farmers to either plant crops that have less damage or they actually stop farming to avoid un-necessary losses occasioned by wildlife destruction. Among the benefits of the electric fence in the study area is the protection against destruction of crops by wildlife which has led to diversification of the crops being cultivated. The field study established that the proportion of farmers cropping increased by 5% from 89.5% to 94.6% as a result of putting up the wildlife control fence. This is shown in table 3.9 below.

Table 3.9: Area under Crop Production Before and After Fencing

Farm size (acres)	Crop area before fencing	Crop area after fencing
	Percent of respondents	Percent of respondents
<0.5	47.5	39.9
0.5-1	21.1	28.7
1-2	11.6	16.8
3-4	6.3	6.6
5-6	0.7	1.3
6-7	0.7	0.3
7-8	0.3	--
8-9	0.3	--
9-10	--	0.3
Above 10	0.7	0.3
None	10.6	5.6
Total	100.0	100.0

Overall, land under crops per household increased by an average 27%, increasing from an average of 0.75 acres to an average 0.95 acres. With regards to crops diversification, the study findings show an increase in the number of households engaged in the growing of new crops after the fence as seen in table 3.10.

Moreover, as shown in section 3.1.1 (Table 3.1 above), annual cropland (maize, bananas, vegetables) increased by 12% (2,044 ha), whereas perennial crops such as Tea and Coffee farms declined by 7% (584 ha). This was attributed to the trend of farmers reverting to annual crops for subsistence and sale, and intercropping within perennial crops owing to the security of the electric fence, a fact which was confirmed during the field study.

Table 3.10: Percentage households growing additional crops after the fencing

Crops Grown in Fenced Areas	Percentage change in number of respondent households
Maize	19%
Beans	138%
Bananas	20%
Tea	-33%
Potatoes	250%
Arrowroots	200%
Cabbages	50%
Cassava	300%
Sweet potatoes	200%
Yams	200%
Onions	0%
Pineapples	0%
Sukumawiki	0%
Sugarcane	100%
Pumpkin	100%
Gorjet	100%
Miraa	100%
Nappier grass	100%
Spinach	100%
Tomatoes	100%

A comparison of overall farm sizes in the fenced and unfenced area shows no wide variation in farm sizes. The proportion of land holding is determined by among other factors, land availability in the area and the population density as shown in Table 3.11.

Table 3.11: Farm Area Currently Under Crops

Cropping area in acres	Fenced Area - Comprehensive fence	Unfenced Area
	Total	**Total**
	% of respondents	**% of respondents**
None	**6**	**1**
<0.5	**40**	**45**
0.5-1	**29**	**24**
1-2	**17**	**17**
3-4	**7**	**12**
5 and above	**2**	**2**

Farmers are also engaged in growing diverse crops like cabbages and tomatoes which were introduced in the area after the fence and were hitherto not grown. The production levels of other crops like maize, beans, and bananas has also gone up as shown in Table 3.12.

Table 3.12: Average production levels in a ¼ of an acre before and after the fence

Crop	Average Production before the fence on a ¼ of an acre	Average Production after the fence on a ¼ of an acre
Maize	10 -15 kgs	300 kgs
Beans	10 -15 kgs	20 – 30kgs
Bananas	1 bunch	20 bunches
Arrowroots	5kgs	100kgs
Cabbages	-	600 heads
Tomatoes	-	200kgs

While some communities have not introduced any new crops - they still plant the same crops as they did before without the fear of attack by wildlife. Fencing has enabled farmers to start growing crops that they were either not grown or the unit area of production was too low due to wildlife damage as some of them are favourite foods for elephants. Before fencing, farmers were mainly planting tea and coffee which are unpalatable to wildlife. The communities have also adapted new technologies especially irrigation which has gone up from 59.1% r to the current 68% of the household respondents after the fence was erected. Farmers in the fenced areas also invested more in farm inputs (fertilizers and improved seeds), spending 96% more than those in non-fenced areas as they try to boost their productivity (an average Kshs 1,783 per household per year compared to the non-fenced areas with an average Kshs 910).

3.2.2 Impacts on Food Security

Before the fence, incidences of crop destruction led to reduced food security, given that the quantity and variety of food available to the people were limited. This was because people living adjacent and close to the forest greatly reduced the range of crops and economic activities, they could engage in.

Food security has been enhanced through improved land areas for crop production, increased productivity, improved food access, and crops diversification, leading to better nutrition for the areas. The area of land allocated for cropping increased after fencing compared to the period before as shown in table 3.9 above. This generally shows that the community increased the cropland sizes after fencing as a way of expanding crop production. There was also an increase in persons engaged in food crops production from 89.5% to 94.6% meaning more persons were now growing their own crops leading to better food access. The households are therefore able to increase on crop production and address food insecurity issues.

The percentage of household respondents doing irrigation increased from 59.1% to the current 68% after fencing. This has enhanced food security by ensuring all year-round food production, resulting to more food on the table. Overhead irrigation was the major type of irrigation practiced by the farmers as reported by 79.6% of the respondents with drip irrigation following at 13.1%. On average respondents pay Kshs.360 per month for irrigation water, with the maximum amount paid by the households being Kshs. 2,625 per month. Vegetables were the main crops grown under irrigation, i.e. kale (*sukuma wiki*), snow peas, potatoes while some farmers also planted maize under irrigation.

The community also engaged in poultry and livestock keeping. The percentage of those who keep livestock and poultry increased marginally by 3% (82.2% to 85.1%) and 8% (58.4% to 66%) respectively on average as shown in Table 3.13. Additionally, after the fencing, farmers do not lose an average Kshs 91,775 per annum which respondent households estimated as losses occasioned from crop damage as a result of human wildlife conflicts.

Table 3.13: Proportion Irrigating, Keeping Livestock and Poultry: Before and After Fencing

Activity	Percentage of respondents (%) Before Fence	Percentage of respondents (%) After Fence
Household respondents undertaking irrigation	59.1	68.0
Household repondents keeping livestock-Cows, sheep, goats	82.1	85.1
Houswehold repondents keeping poultry	58.4	66.0

3.2.3 Impacts on Overall Human Wildlife Incidences

General Situation before fencing: Prior to the erection of the fence, human-wildlife conflicts posed both direct and indirect impacts on the community members living adjacent and near to the forest. Directly, invasion of the settlements by wildlife led to the destruction of crops and other property including, but not limited to livestock, and infrastructure. Discussions with community members through the focused group discussions indicated that people, especially men, lost much of their sleep chasing away wildlife, particularly elephants. Wildlife was equally at risk of attacks, some fatal, from the agitated villagers.

In addition, community members faced other social problems, including women and children feeling neglected by their fathers who hardly spent time at home during the night. Children felt insecure, while women accused their husbands of neglecting them. Community cohesion was at risk as community members further from the forest line accused those next to the forest of not doing enough to contain wildlife inside the forest. Children were at risk of wildlife attacks on their way to and from school. They would leave home late to allow time for elephants to retreat into the forest.

The feeding patterns among these groups of people had also been affected, due to reduced quantity and variety of food they grew. Granted, while guarding community from wildlife is largely a man's affair, households for single women and those headed by women actually did perform the role. Ideally the expectation is that each household is expected to be represented in the operation. This forces single women often accompanied by the bigger children to join men from the other households to chase away wildlife and prevent damage to their crops. This of course meant that younger children were left alone in the house, which subjected them to psychological distress. While men can take time off to rest later in the day, women usually by virtue of their roles in the community often lack time to rest as they have in addition to guarding their farms perform other household duties as well.

Coping mechanisms before the fence: Prior to the erection of the fence, community members had various ways and means for protecting themselves and properties from wildlife. In this regard, 81.8% of the respondents made noise with *debes* and *sufurias* to scare the animals. About 78.4% of the respondents watched over crops at night and 65.3% made fire as shown in Fig. 3.15. The implication on these social methods of protection from wildlife was that they lead to inadequate sleep on most nights (94.4% of HH respondents), less productivity during the day (61.7% of HH respondents), night separation from spouse and children (30.7% of HH respondents) and matrimonial rights were impacted negatively (17.8% of HH respondents), sometimes leading to divorce as shown in Fig. 3.16.

According to the data, protection of property was skewed towards a communal arrangement where people mutually agreed to help each other to protect their property and therefore rarely were payments made towards protection. The initiative also included widows and people with disability. For the few who paid watchmen, the mean expenditure was Kshs 2,154.00 per month, with expenditure ranging from Kshs 200 to Kshs 24,000.

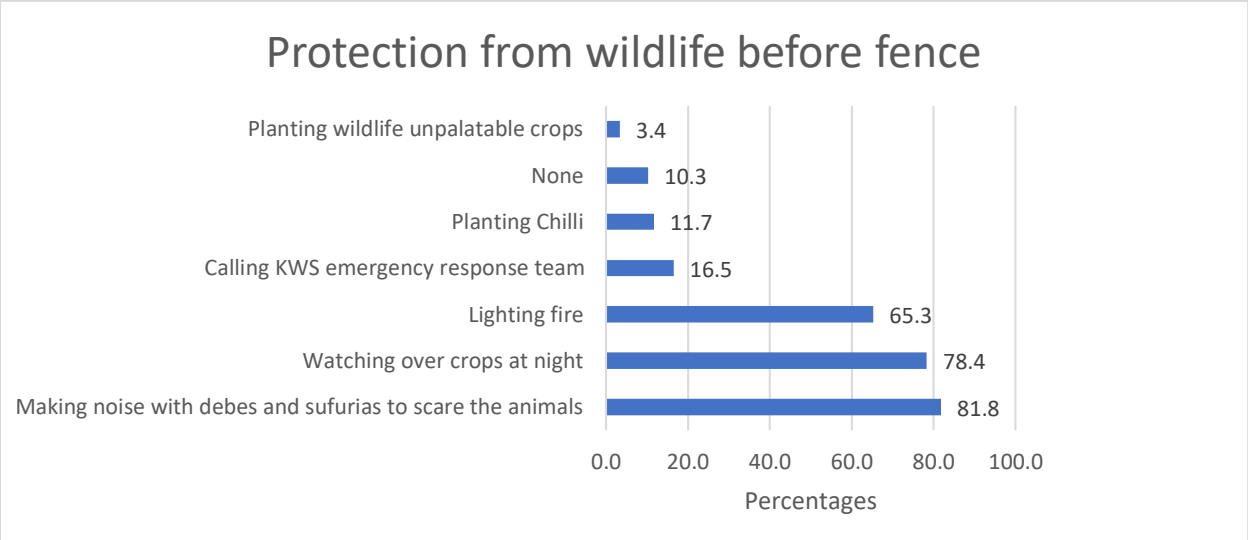


Figure 3.15: Coping Mechanism before fence

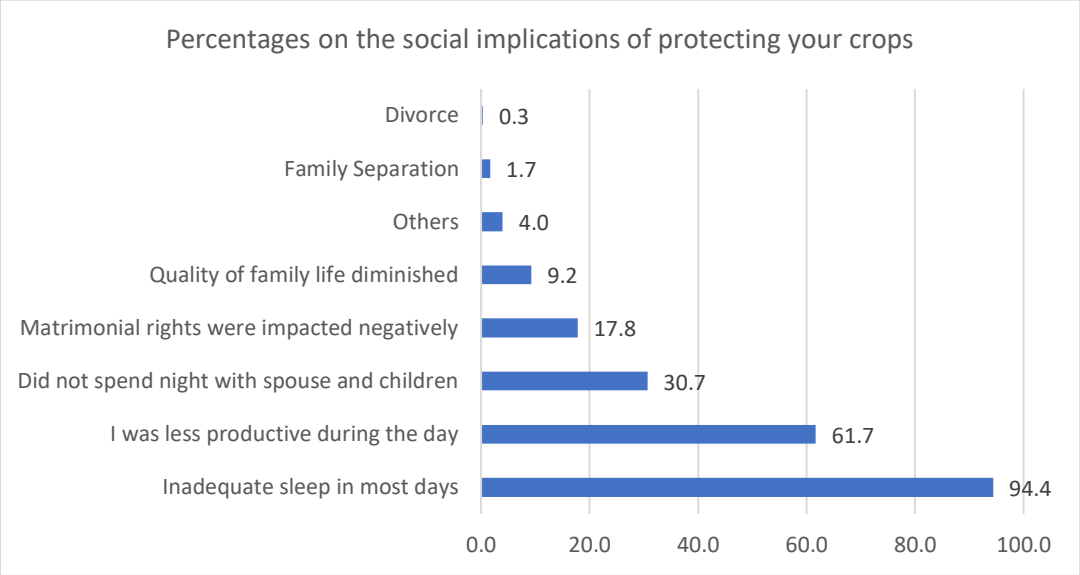


Figure 3.16: Percentages on the social implications of protecting farm crops

Current situation in fenced areas: Discussions with community members both at household and focused group discussin levels in the fenced areas however indicated that the above were things of the past and families enjoyed more peaceful nights. Those interviewed during FGDs in Chuka, Chogoria, Ruthumbi and Lower Imenti indicated that the erection of the fence has greatly positively impacted on family union, as parents can spend time with family, and men are no longer accused of spending the night outside their homes in pretext of guarding crops from wildlife. Overall, a drastic reduction in the number of human-wildlife incidences was reported across all the fenced areas. This corroborated project reports which showed drops in the number of human-wildlife incidences. This was evidenced by the reduced human-wildlife conflicts incidences by 97% (from an average of 117 per annum (between 2004 – 2014) to an average 3 per annum (2015-2018) after the fence (Table 3.14). A thematic analysis of the responses had the farmers hugely recording a positive improvement in their agricultural production levels after the fencing.

Table 3.14: Summary of incidences and associated costs

Year	Count of Type of conflict	Sum of Estimated cost (human/Property/crops) Kshs.	Sum of Estimated cost (man-days) Kshs.	Sum of Estimated cost (Fuel) Kshs.	Sum of Total cost Kshs.
2004	56	72000	138600	59000	269600
2005	210	10305285	819500	277000	11401785
2006	224	17268990	744700	208000	18221690
2007	47	1333625	148500	45000	1527125
2009	133	7394900	290400	133000	7818300
2010	117	2395745	270600	117000	2783345
2011	164	9898150	374000	164000	10436150
2012	177	6167540	391600	177000	6736140
2013	33	11776400	99000	33000	11908400
2014	13	443400	28600	13000	485000
Sub-Total	**1174**	**67,056,035**	**3,305,500**	**1,226,000**	**71,587,535**
2015	2	46500	4400	2000	52900
2016	4	24000	16500	4000	44500
2017	1	24000	3300	1000	28300
2018 to date	5	152000	62700	10,000	224700
Sub-Total	**12**	**246,500**	**86,900**	**17,000**	**350,400**
Grand Total	**1186**	**67,302,535**	**3,392,400**	**1,243,000**	**71,937,935**

Source: KWS/KFS

Comparison with non-fenced areas: On the contrary, the situation was very different in the unfenced areas based on discussions with community members in these areas. In Mbeu, Lower Imenti for example, the invasion of farms by elephants was nearly a daily occurrence. Findings from household surveys with community members in the unfenced areas show that a majority of the respondents (92%), reported that most people lacked adequate sleep with most of the time in the night being utilised to guard crops, livestock and households. Another 65% reported that they were unproductive during the day while half or 49% indicated that they were not spending enough time at night with their spouses and children. Slightly more than half the respondents (52%) indicated that there was not enough time to fulfil the partner's conjugal rights, while 42% said that in general, the quality of family life had diminished, with about 4% indicating that some families had even separated as a result. These findings are seen in the figure 3.17 below.

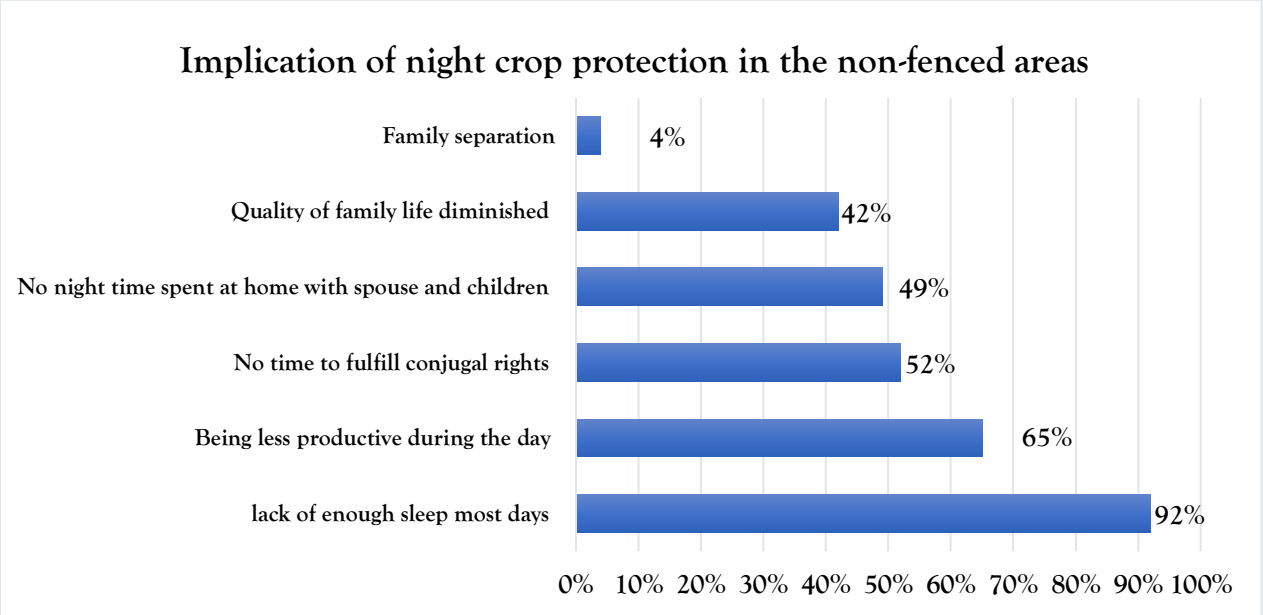


Figure 3.17: Impacts of night protection on Households

Discussions with community members in focussed group discussions confirmed these findings. They observed that often times, the KWS officers were slow to respond which forced community members to struggle to keep the animals at bay. They noted that to them, KWS was not doing enough to keep the animals away from their farms. However, some had suffered losses, following fatal attacks of their livestock by predator animals. In the unfenced areas, the average time spent on guarding crops is 18 hours a week. In non-fenced areas of the forest, 95% of respondents attest to human-wildlife conflict and only 5% experience peace between them and wild animals as seen in the figure 3.18 below.

Comparison with 6-strand fenced area: In other parts such as Ruiri, constant low current flows on the erected 6-strand fence resulted in elephants moving out of the fenced area into the settled areas, leading to renewed human-wildlife conflicts. In all areas, but mostly around Chogoria, monkeys and baboons still remained a menace for community members.

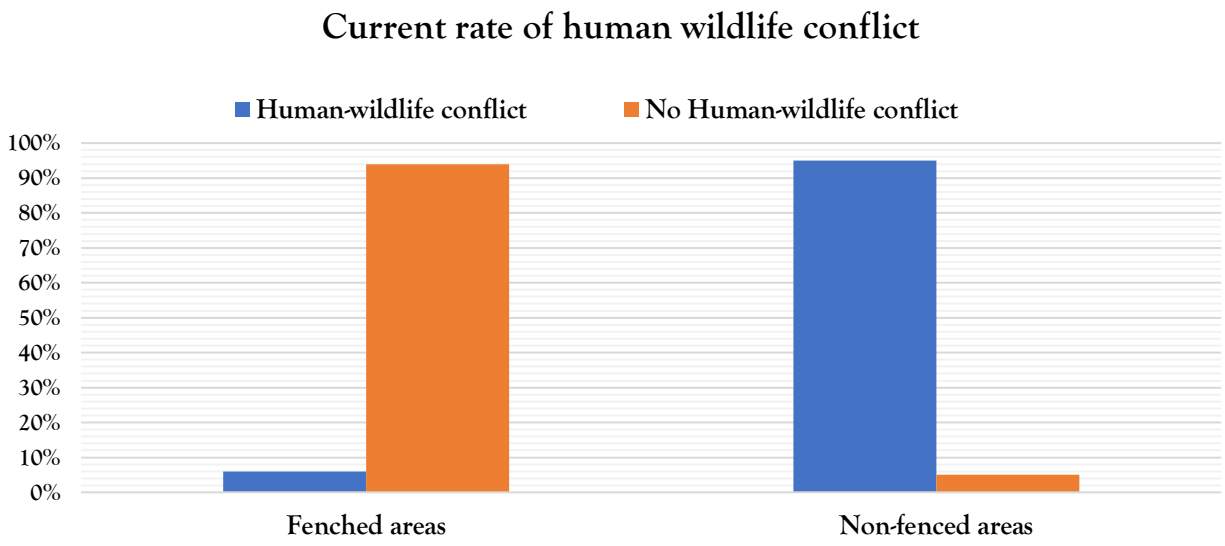
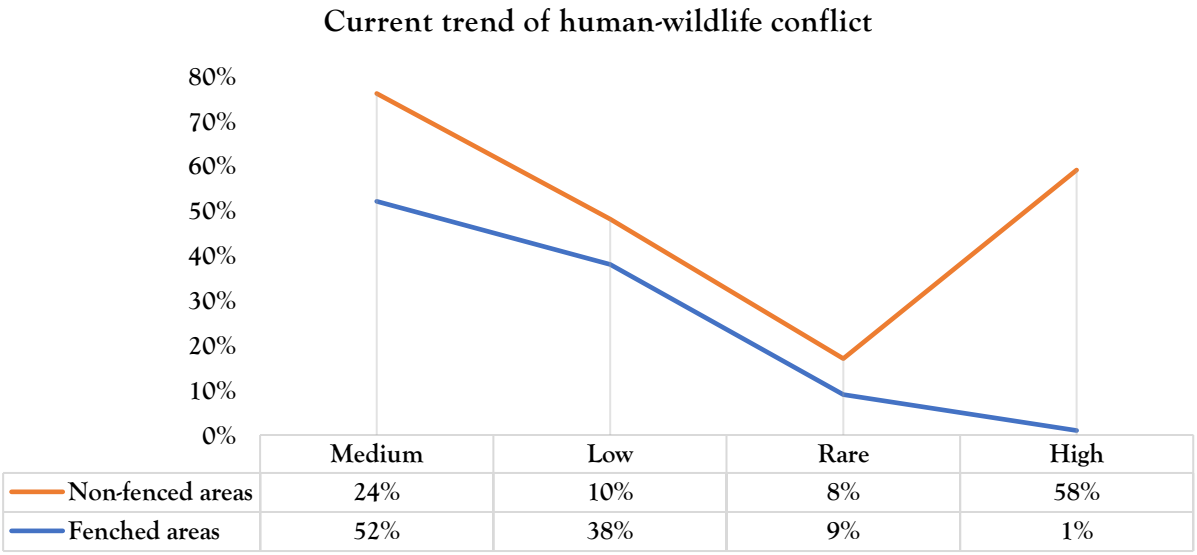


Figure 3.18: Current Human Wildlife Conflicts

Overall, it is evident that human-wildlife conflict has greatly reduced within the Mt. Kenya forest region especially in the fenced areas as shown in Figure 3.19 below. This has improved the livelihoods of the neighbouring communities through increased crop production.

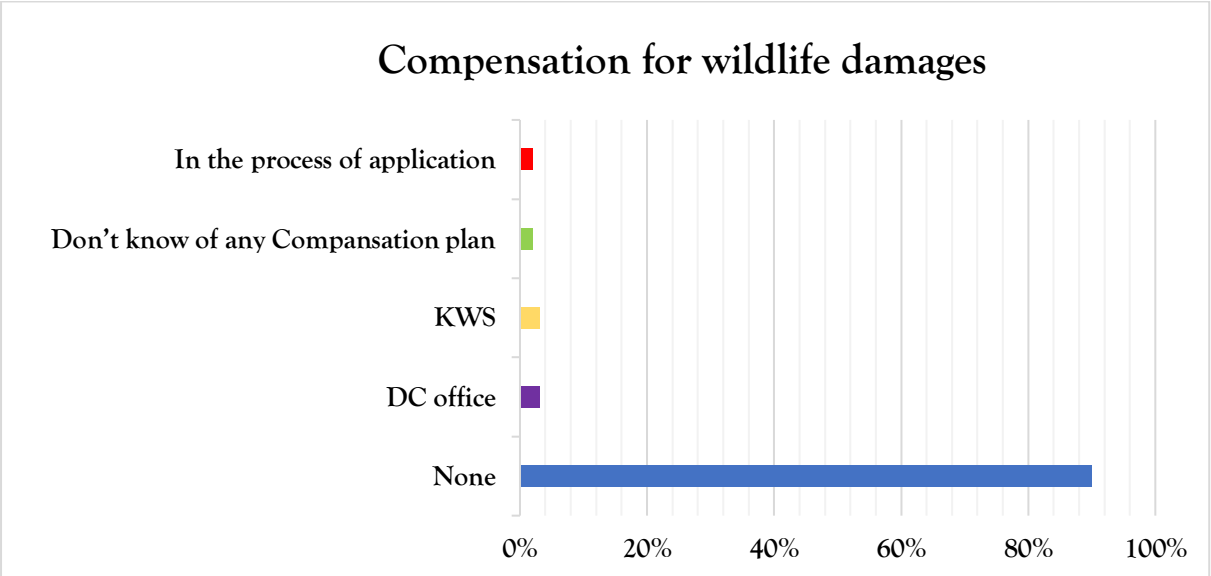


	Medium	Low	Rare	High
Non-fenced areas	24%	10%	8%	58%
Fenched areas	52%	38%	9%	1%

Figure 3.19: Trend of human Wildlife conflicts in Fenced and Unfenced Areas

Interviews and discussions with stockholders involved in the fencing of the forest, the local community, KFS, KWS, Rhino Ark and local administration, indicated that forest adjacent community incur costs related to wildlife damages, but there is no clear compensation plan in place to lessen the burden of property damage. 90% of all respondents who applied for compensation had not received anything. This has raised concerns among community members who feel at a loss because they are restricted to using the forest resources, yet

wildlife destroys their property and no compensation is received. This is seen in the figure 3.20 below



Figures 3.20: Compensation for Wildlife Damage

3.2.4 Impact on Human Deaths, Injury, Property and Crop Damage

The objective of erection of the widlife barrier was to reduce human wildlife conflicts and according to records from KWS, the fence has been effective in reducing human-wildlife conflicts. The human deaths in fenced areas dropped from an average of one annually (between 2007 – 2014) to zero, human injury from one annually to zero, while livestock predation (sheep, goats, and cows) by leopards, lions, and hyenas dropped by 80% from an aveerage of about 10 per annum before the fence to 2 cases annually after the fence shown in Table 3. 15. The toal costs associated with human death, human injury, damage to property and crops went down from Kshs 67 million (2004-2014) translating to Kshs 6.7 million annually before the fence, to Ksh 246,500 (2015-2018) which translated to Kshs 61,625 annually representing a 99% reduction.

The main problem animal prior to the fence was elephants and leopards. The current problem animals are leopards and monkeys which scale nearby trees and jump to the community farmlands. Overall people were more relaxed in the fenced areas, with reduced risks of attacks or stress resulting from invasion of wildlife. This is for example seen in Kiamuriuki in Photos 3.7 & 3.8).

Table 3.15: Sum of Estimated Costs of Human-Wildlife Conflict on Humans, Property and Crops

Sum of Estimated cost (human/Property/crops)						
Row Labels	Crop Damage (Kshs)	human death (Kshs)	human injury (Kshs)	Predation (Kshs)	property damage	Grand Total (Kshs)
2004	72,000					72,000
2005	10,157,285			148000		10,305,285
2006	17,268,990					17,268,990
2007	1,333,625				0	1,333,625
2009	2,330,900	5000000		64000		7,394,900
2010	2,291,745			104000		2,395,745
2011	2,210,150	5000000	2500000	188000		9,898,150
2012	3,515,540		2500000	152000		6,167,540
2013	1,140,400		10500000	136000		11,776,400
2014	443,400					443,400
Sub-Total						**67,056,035**
2015	46,500					46,500
2016	0			24000		24,000
2017				24000		24,000
2018 to date				152000		152,000
Sub-total						**246,500**
Grand Total	**40,810,535**	**10,000,000**	**15,500,000**	**840,000**	**0**	**67,302,535**

Source: KWS

Photo 3.7 Community members relaxing with their backs to the fence in Kiamuriuki

Photo 3.8 Enhanced food security in Kiamuriuki as farmers can now sell surplus Bananas to buyers

3.2.5 Impact on Security from Animal Attacks and Social Order

The wildlife fence (Thuchi-Thingithu) has led to increase in security and social order around the area. From the study findings, 97.5% of the respondents reported an improvement in general security following the fence being erected. This means substantial peace (from human wildlife conflicts) to the population as the risks arising from wildlife attacks has drastically reduced. Similar sentiments were echoed by teachers who reported that children from the forest adjacent areas arrived in school earlier than they used to do before the fence was erected. One teacher noted; *"Before the fence, they had to wait until the elephants retreated to the forest. Many also had to be accompanied by adults. But these days there is no danger*'. 73.6% of the respondents indicated that the fence was either effective or very effective in curbing human wildlife conflict.

Table 3.16: Impact of the fence on Security

	Total
	%
Improved Security	97.5%
Deteriorated security	0.8%
No effect on Security	1.7%
Total	100%

Overall, with the fencing, social order has stabilized within these communities as there is increased disposable income for development and enough time spent on income-generating activities as opposed to spending time and money on guarding farms and repairing or replacing damaged properties from wild animal attacks.

3.2.6 Impact on Incomes and Livelihood Improvement

In the fenced area of Thuchi to Thingithu, household income levels increased from an average Kshs 45,000 to Kshs 125,604 per annum an income increase of 179%. This is compared to Kshs. 79,610 in the unfenced area, indicating that income on fenced areas is better by Kshs 45,994 per household per year, a 58% difference. The highest inomes levels were in Ruthumbi at Kshs 162,604 per annum. The respondents living below the poverty line were about 11% in the fenced areas as compared to 64% of respondents in Lower Imenti (non-fenced) areas. 73% of respondents in the fenced areas now claimed to be having savings, unlike in the past when they did not have anything set aside for a rainy day. This can be attributed to increased incomes and livelihoods. The mean saving per household year in the fenced area was Kshs 26,516 per annum. Improved incomes are also seen between the assets owned in fenced and non-fenced areas, with those in the fenced areas being more endowed. Notably, there were more households

using Liquefied Petroleum Gas (LPG) for cooking in the fenced areas (36%) as compared to the non-fenced areas (19%).

Table 3.17: Income levels in fenced areas by foress station, gender and age group

Forest Station	Average per HH Income (Kshs) per annum)	Percentage living below poverty line
Chogoria	112,423	30
Chuka	100,700	37
Ruthumbi	162,695	17
Average Fenced areas	***125,604***	***11***
Lower Imenti (Unfenced Area)	79,610	64
Fenced Areas – Average HH incomes		
Men Headed Households	*137,989*	21
Women headed households	*107,094*	38
Fenced Areas (Age Groups)		
below 30	70,000	30
30-40	82,507	35
41-50	126,667	32
51-60	119,916	23
61-70	219,305	17
0ver 70	157,553	30

3.2.7 Impacts on Community Relationships with Institutions Mandated with Management of the Ecosystem

The existence of the fence has improved relationship of forest neighbouring communities and the Government agencies mandated to manage the ecosystem namely KWS and KFS. This improved relationship has further enhanced the management of the ecosystem. The study established that the forest, across all the stations visited, was managed through collaborative efforts amongst stakeholders drawn from government, communities (namely CFAs), and non-governmental organizations.

Findings further revealed varying levels of trust between community members and government institutions notable KWS and KFS. Overall the relationship is positive and complementary across the study area which is part of the larger Mt Kenya Forest Ecosystem. However, improvement in community participation is required. On the whole, the relationship between KWS, KFS, and CFAs has improved since the erection of wildlife control fence/barrier. The community perception of these institutions has improved, and community members are working together with them in supporting conservation and fence maintenance activities, and providing crucial information which is key to intelligence gathering and surveillance according to KWS Wardens.

It was reported by the Forest Manager Chogoria, that prior to the fence, one community member was reported to have protested to the him about the perennial attacks from wildlife by saying; *'We have resulted to come and just stay at the market place as our land is no longer of any value to us'*. Another, community member in Ruthumbi was reported to have similarly told the forester there that; *'I am willing to give you my land for free. I no longer have any use for it'*

Provision of employment for community members in fence erection and maintenance has also contributed towards improved relations between communities and KWS. The employment of local communities created a sense of ownership of the fence construction process and the fence upon completion, A participant in an FGD in Chuka for example noted; *"we cannot allow anyone to touch this fence. Playing with this fence is like playing with our lives"*

This notwithstanding, a majority of household respondents (72%) indicated that they were not directly involved in erecting of the fence while only 28% indicated that they were. This was perhaps as a result of the fact that the involvement of community members in the fence construction was mainly through the CFAs. The study sample, on the other hand, targeted the larger community.

Of the 28% involved in fence construction, 78% participated in community mobilization, 31% clearing of the fence-line vegetation and 18% on construction work. Further, only 13% of household respondents acknowledged involvement in its management while 87% are not taking part in the fence management. While this was a concern to community members, especially those settled adjacent to the fence, consultations with stakeholders indicated that a few community members were employed to manage the fence. Discussion in FGDs indicated that local people were mainly involved in clearing the fencing routes and attending meetings. A participant in an FGD in Ruiri reported; *'Yes members of the CFA were involved in digging the holes during the construction of the fence. People from the various places along the fence had specific areas that had been allocate to them'*

Findings from various FGDs within the study area indicated that the following challenges still constrained the relationship between the KWS, KFS and the community members adjacent to the forest: -

i. Inadequacy of forest access gates;
ii. Strict restriction and closure of firewood collection;
iii. Livestock grazing and fodder collection within the forest; and
iv. Restricted access to water points.

While community members were aware that these some of these restrictions were as a result of the government moratorium, the coincidence between the erection of the fence and the moratorium was likely to erode the community positive attitude towards the fence, if the moratorium continues for longer. CFA members and other community members met feared that this could lead to vandalism, which could, in turn, trigger a return of illegal forest activities and a return on human-wildlife conflicts. One community member reported; '*We are aware that the fence may have nothing to do with the ban. But the problem is that with time, people will not see the difference and some may begin to damage the fence to find easy entry. We need to get together as a community and find ways to make sure that this does not happen'*

The erection of the fence was reported to have increased costs of firewood in urban centers and costs of food by 20% in hotels in Chogoria, and Ruthumbi (up to a 10 km stretch) to factor in the increased cost of buying firewood, occasioned by reduced supply. On the positive however, it was reported that the moratorium had encouraged people to plant trees on their farmlands which will potentially provide them with firewood in the years to come. This was a positive contribution to the ecosystem.

This notwithstanding, both community members and the government officers were generally comfortable with the coordination and cooperation they had between themselves. In Lower Imenti however, there was a need to support improved relations between the KWS officers and the local community, especially around Ruiri area. Community members in this area lamented that KWS was always too harsh with community members.

From the study findings, all the respondents had full information about the electric fence before installation. Main sources of the information were from community sensitization and stakeholders' meetings which were held across the villages by KFS, KWS and CFAs.

Positive unintended impacts include enhanced local tourism as elephants come to feed close to the fence from where children and community members from areas further from the forest go to watch them. Additionally, community members through CFA are able to undertake Plantation Establishment Livelihood Improvement Scheme in areas where applicable. However, due to reduction on human interference in Ruthumbi, the number of antelopes had increased and was consequently causing damage to Cypress plantations in the forest.

3.2.8 Impact of Fence on Cost of Human Wildlife Conflict Operations

The erection of wildlife barrier has reduced costs of responding to Human wildlife incidences (cost of mandays anf fuel) from an annual average of Kshs. 453,150 before the fence (data from 2004 to 2014) to Kshs.25,975 annually after the fence (from 2015 to 2018) representing a 94.3% reduction. The information is as shown in Tables 3.18 and 3.19 below.

Table 3.18: Summary of Estimated Costs (Kshs) in Terms of Mandays Spent

Year	Crop Damage	Human Death	Human Injury	Human Threat	Predation	Property Damage	Grand Total
2004	132,000.00			6,600.00			138,600.00
2005	809,600.00				9,900.00		819,500.00
2006	734,800.00			9,900.00			744,700.00
2007	139,700.00			8,800.00		-	148,500.00
2009	270,600.00	2,200.00		13,200.00	4,400.00		290,400.00
2010	262,900.00			2,200.00	5,500.00		270,600.00
2011	346,500.00	2,200.00	2,200.00	8,800.00	14,300.00		374,000.00
2012	382,800.00		2,200.00		6,600.00		391,600.00
2013	81,400.00		8,800.00		8,800.00		99,000.00
2014	28,600.00						28,600.00
2015	4,400.00						4,400.00
2016	13,200.00				3,300.00		16,500.00
2017					3,300.00		3,300.00
2018 to date					5,500.00		5,500.00

Source: KWS

Table 3.19: Summary of Estimated Fuel Costs (Kshs)

Year	Crop Damage	Human Death	Human Injury	Human Threat	Predation	Property Damage	Grand Total
2004	56,000.00			3,000.00			59,000.00
2005	274,000.00				3,000.00		277,000.00
2006	206,000.00			2,000.00			208,000.00
2007	43,000.00			2,000.00			45,000.00
2009	124,000.00	1,000.00		6,000.00	2,000.00		133,000.00
2010	113,000.00			1,000.00	3,000.00		117,000.00
2011	153,000.00	1,000.00	1,000.00	3,000.00	6,000.00		164,000.00
2012	173,000.00		1,000.00		3,000.00		177,000.00
2013	25,000.00		4,000.00		4,000.00		33,000.00
2014	13,000.00						13,000.00
2015	2,000.00						2,000.00
2016	3,000.00				1,000.00		4,000.00
2017					1,000.00		1,000.00
2018 to date					10,000.00		10,000.00

For water companies, maintenance costs have also gone down. Before the fence was erected, elephants would destroy pipes during their incursions to farmlands. Reduced pipe breakages also mean better and reliable water access to households. There are also less costs for water treatment as there is reduced turbidity. For Muthambi 4K water project in Tharaka Nithi for example, there would be about five incidences annually before the fence, each costing Kshs 65,000 with total cost before the fence being Kshs 325,000. Incidences have now gone to zero thus the only costs incurred are for water treatment (about Kshs 10,000) per month. For Magumoini water project, also in Tharaka Nithi, elephant damage to water infrastructure repair costs were approximately Kshs 174,000 per annum before the fence, with an average of five incidences annually, which has now been reduced to zero after the fence. The water intakes and treatment are more secure due to controlled access through designated gates.

3.2.9 Impacts on Revenue Generation to the Government Agencies

In terms of actual numbers, management savings have been substantial, but his has not been matched in terms of revenues. Overall, incomes in the 3 forest stations reduced slightly by 3% from Kshs 1,403,598 to Kshs 1,351,931 mainly because of the decreased revenue in Ruthumbi due to the moratorium as shown in table 3.20 below. Revenues however increased in the other stations of Chogoria and Chuka.

Table 3.20: Revenue Collection Per Forest Station

Forest Station	Chogoria	Chuka	Ruthumbi	Lower Imenti
Year	Kshs	Kshs	Kshs	Kshs
2014		104,600	1,478,998	
2015	60,200	143,650	7,997,585	474,500
2016	60,200	176,350	2,550,600	1,511,460
Average before fencing	**60,200**	**141,533**	**4,009,061**	**992,980**
2017	386,700	328,750	1,070,600	922,660
2018	1,018,600	121,950	2,915,244	311,510
Average after fencing	**702,650**	**225,350**	**1,992,922**	**617,085**
Change in Average	642,450	83,817	(2,016,139)	(375,895)
% Change	1,067	59	(50)	(38)

In Chuka, KFS has benefitted from revenue collection through permits and licenses i.e. in firewood collection, and grass cutting. For example, grass revenues grew from an average Kshs 18,200 before the fence to Kshs117,750 after, an increase of 645%, while firewood revenue declined by 27% from Kshs 123,333 to Kshs 89, 600.

3.2.10 Impact on Land Values

The wildlife control fence has also led to changes in land value in areas bordering Mt. Kenya forest. According to the study data, the value of the land appreciated upon fencing. The mean price of land per acre in the area before the fence was erected was Kshs. 917,000 and after fencing rose to an average of Kshs. 1,703,421, a price appreciation of 86%. This is a capital gain on land to the community around Mt. Kenya forest.

A comparison of the value of land in the fenced and unfenced area shows that an acre of land in the unfenced area is averagely Kshs. 1,269,114, showing the value of land in the fenced area is higher by about 34% compared to the unfenced area. It should however be noted that the unfenced area is near Meru Town which automatically fetches a higher price for land due to the demand to build urban homes.

Table 3.21: Price of One acre of Land before and after fencing, Kenya Shillings

Area	Before Fencing (average price-ksh/Acre	After Fencing (average price – ksh/acre)
Fenced area-Thuchi-Thingithu section	917,000	1,703,421
Unfenced area-Lower Imenti	1,269,114	-

3.2.11 Impact on Health

Overall, human health has also improved following the wildlife fence with 88.8% of the respondents reporting reduced incidences of diseases and an improvement in human health as a result of improved feeding habits. The improvement in human health may be due to reduction in risks arising from wildlife attacks, reduced exposure to unfavourable weather conditions when guarding against wild animals at night, food security enhancement and availability of variety of food crops thus improving human nutrition.

Children in both primary and secondary schools indicated that there was an improved availability of food at home including on variety of food. This was as a result of reduced crop damage by the wildlife. One of the pupils in an FGD in Ruthumbi noted*; "There is enough food for all of us now at home. Every one eats until they get satisfied'* When asked how the situation was before the fence, the child had this to say; "*that time (before the fence), most of the food used to be damaged by the elephants, very little could be harvested and my parents could not afford to buy enough food all the time*'.

3.2.12 Impacts on Education

The education environment has also improved with 91.6% of respondents reporting that children go to school in peace. Another 65.3% said that children could play freely, while half or 51.3% reported that children can now read in peace. Another 43.6% said that children can now concentrate on their homework.

As a result of these factors, 48.2% of the respondents felt that education performance had improved because of the wildlife control fence. This was largely based on their observations from the performance of their children in school examinations and continuous assessment tests, which they attributed to early reporting to school which allowed children to revise, (51.5%), ability to concentrate on their homework (40.6%) rather than helping to guard farms from wildlife, and that they are also able to enjoy their play time (74.7%) without fear of attack from wild animals. On the contrary, respondents in unfenced areas cited lack of safety for school children (73.7%), poor school attendance (65.2%), poor school performance (44.1%) and interrupted studies as reported by 29.6% of the respondents.

Children in primary schools were more concerned about their security to and from school when they spoke about the impact of the fence on their education as compared to their counterparts in secondary schools. This was affirmed in all the 4[1] primary schools that children were consulted. According to the children, the fence has reduced their frequency of missing school, it had enabled them arrive early and at times leave schools late, which overall enabled them to cover the syllabus earlier than they used to previously. This was echoed by the teachers who reported overall there was better attendance and earlier arrivals by the children from the fenced areas. Children in Kiamitongu Primary further observed that prior to the fence elephants would stroll to the school which caused fear and disruption of lessons. These sentiments were also echoed by the secondary school students met in the 4[2] secondary schools.

3.2.13 Impact on Protected Area Management

The erection of wildlife barrier has enhanced security enforcement and reduced cases of intrusion into protected area. Intruders are now restricted to using specific areas or routes and it is now easy to monitor and nab them. Incidences of poaching in areas such as Chogoria have gone down, as formerly, wildpigs were alledged to be delicacies in the area. During one of the FGDs, mention of bush-meat elicited smiles and memories of the days that were, as the catch

[1] Children across the fenced areas were consulted in Kiamuriuki Primary in Chuka, Gitare primary in Chogoria, Iramebene Primary in Ruthumbi and Kiamitongu Primary in Ruirii Lower Imenti

[2] Kiamuriuki Secondary in Chuka, Mutindwa Secondary in Chogoria, Mutunguru Secondary in Ruthumbi and Kiamitongu Secondary in Lower Imenti.

was always shared with neighbours despite the risks of disease outbreaks from consuming the un-inspected game meat. The fence has also improved wildlife habitat, promoted ecosystem healing through regeneration of vegetation in the forest, improved water recharge in the catchment area, ehanced forest cover thus improving forest ecosystem services, reduced illegal cases of logging and charcoal production.

Other impacts include non-interference with rangers' schedules as compared to before the fence construction where they could cancel their duties to respond to other alerts related to forest illegal incursions and human wildlife conflicts. It has also solved boundary disputes and conflicts between KFS and forest adjacent communities since the beacons of the forest are now all in place. It has also promoted protection and conservation of the forest due to controlled access points.

3.2.14 Fence Impacts on Encroachment and Illegal Poaching

Reports from all the areas visited indicated that the fence had effectively managed to control any human encroachment into the forest land as well as drastically reduced any illegal activities such as logging, poaching and general biodiversity destruction. Discussions with the forest officers indicated that for most of them, and for the first time, they were able to identify each and every beacon, which implies that the construction of the fence did for the first time settle any disputes on where the boundary fence was.

In addition, the fence was reported to have reduced points of access which made it easier for the authorities to more effectively control access into the forest. Given that the fence was a comprehensive 8 strand with a tight lock at the bottom, it implies that there are no gaps in between which animals and humans can gain entry other than through the provided gates. This has however not gone entirely well with some community members, who reported that the access gates were presently too far apart for most of them. Even with controlled access, the access gates were according to them far.

From a conservation perspective, one positive aspect however with the controlled access was the fact that illegal access had immensely been minimized. Discussions with community members in Chogoria, for example, indicated that overall people who previously earned from illegal activities in the forest no longer had an opportunity to access the forest. In Ruthumbi, it was reported that illegal logging had dropped from around 13 cases per month to 1-2 cases in a month, representing a reduction of 85%. The majority of the cases involved men compared to women. The women always sought out permits from the KFS office.

3.2.15 Impact of fence on Forest Fires

While major fire incidences in the 3 forest stations are not common, it is noteworthy that there have been no incidences of fires reported since the fence was erected.

3.2.16 Impact on Sources of Fuelwood Energy

The wildlife fence has barred human encroachment into Mt. Kenya forest. With the fence, access to the forest has to be authorized and only through designated gates where entry is registered.

The fence has negatively affected the source of firewood for the community, which used to rely mainly on the forest for their firewood needs. Among the factors mentioned are the increased distance travelled to get firewood reported by 62.5%, increased cost of firewood reported by 62.7%, and increased time spent in fetching firewood reported by 41.5%. The others factor was increased cost of charcoal (20.6%).

This means that in terms of sourcing for firewood, the fence has made it costly and reduced accessibility for the community members, despite firewood being the main source of cooking energy. This has meant that the source of firewood has changed, with 75.2% of the respondents who use firewood currently sourcing firewood from their own farm, while 42.8% purchase it from the market. However, 9% of the respondents still source firewood from the forest. This is seen in Table 3.22 below.

The fence has thus effectively increased the community's own initiative to plant more trees. The fence has also helped persons climb the energy ladder, with the fenced areas having more households (36%) using LPG for cooking as compared to the non-fenced areas (19%).

Table 3.22: Main Firewood Source Currently

Firewood source	% of respondents
Own farm	75.26%
Forest	9.18%
Purchase from market	42.86%
Bushes (Riverine, Roadside)	9.18%

The leading expenditure on sources of energy was firewood with an average expenditure of Kshs. 2,221 per month, followed by agricultural wastes at Kshs. 2,288 per month, and charcoal at Kshs. 1,403 per month. The expenditure on energy sources per household varies highly across the sources.

Table 3.23: Average Monthly Expenditure on Sources of Energy (Kshs)

	Mean Expenditure by Respondents in Fenced Areas (Kshs)	Mean Expenditure by Respondents in Un-Fenced Areas (Kshs)
Firewood	2,221	956
Charcoal	1,403	583
Agricultural Wastes	2,288	3,314
Biogas	1,000	1,413
LPG (Gas)	1,337	1,114
Electricity	624	694
Briquettes		167
Kerosene	1,025	666

The mean monthly expenditures on sources of energy vary when a comparison is made between the fenced and unfenced area. Expenditures on firewood, charcoal, and LPG (Gas) are higher for households in the fenced area while expenditures on biogas and agricultural waste are higher for households in unfenced areas.

The fence restricts access to the forest and hence use of forest products. Due to this, the cost of firewood and charcoal tend to be high in the fenced area due to restriction on access and the fact that when access is allowed through designated gates, the households have to pay for collection of forest products such as firewood. One thing to note is that briquettes was reported to be used only in the unfenced area.

3.2.17 Impacts on Livestock Husbandry

The percentage of households with grazing portions on farm increased from 72% to 75% after fencing while those in the non-fenced areas stood at 37%. However, the area allocated for grazing reduced slightly by 9% after fencing from an average of 0.35 acres to 0.32 acres per household while that of land under fodder increased by 81% from an average of 0.43 acres to 0.78 acres. Those with fodder on-farm increased from 86% to 91%.

There has also been an increase in zero grazing after the fencing (from 52.3% to 73.2%), and a reduction of grazing in the forest areas (from 27.8% to 3.3%). Cut and Carry of grass in the forest also increased from 13.1% to 22.1% after fencing, while purchase of fodder increased from 3.3% to 11% of the respondents. Other impacts of the fence on livestock husbandry included increased reliance on pasture outside the forest as stated by 28.3% of respondents, reduced access to pasture inside the forest (48.9%), reduced livestock diseases (31.3%) and reduced access to water for livestock (13.1%) as shown in Table 3.24.

Table 3.24: Effect of the Fence on Livestock Husbandry

fence effect on grazing	% of respondents
Increased reliance on pasture outside the forest	**28.32%**
Reduced access to pasture inside the forest	**48.98%**
Reduced livestock diseases	**31.38%**
Reduced access to water for livestock	**13.01%**
No noted effect	**20.15%**

Animal diseases reduced significantly as reported by respondents with the disease incidents reducing from 730 to 430 before and after the fence respectively. Reduction in disease incidence was recorded for East Coast Fever, red water, foot and mouth disease, anthrax, nagana and tsetse fly related diseases which are passed on from wildlife to livestock.

A comparison of disease incidence in the fenced and unfenced areas was also done. Findings show significant reductions in incidence of livestock diseases in the fenced areas as shown in table 3.25 below. The difference in percentage incidences between the unfenced and before-fence can be attributed to the slightly warmer conditions in Lower Imenti which from example explains the higher rate in TBD in the non-fenced area as the disease is exacerbated by warmth and humidity. The same applies for East Cost fever whose epidemiology is impacted by the agro-ecological zones.

Table 3.25: Percentage Incidence of Livestock Diseases in Fenced (Before and After) and Unfenced areas

	Fenced areas		Unfenced areas
Type animal diseases	**Before fence**	**After fence**	**at Present**
East coast fever	72%	43%	54%
Red water	9%	1%	19%
Anthrax	48%	39%	31%
Foot and Mouth Disease	54%	24%	42%
Nagana	47%	31%	42%
TBD	1%	0%	18%
Tsetse fly related diseases	39%	5%	37%

3.2.18 Impact on Tourism

Tourism was only measurable at the Chogoria Forest Station as it is the only one among the fence stations with a gate to the National Park. Revenues increased 37% after the fence was erected from an annual average of Kshs 895,000 (2011-2014) to Kshs 1,230,500 (2015-2018). The number of visitors also increased from 444 to 526 before and after the fence respectively, an 18% increase. Revenues however dropped by 10% in 2017, mainly as a result of the political environment in the run-up to the election. Thereafter, the revenues have been on the rise. The impact of the fence on tourism can be attributed to reduced numbers of illegal entries points

around the forest station for mountain climbing and other tourism activities. This can also be attributed to improved security which has spurred interest to Chogoria Gate which provides spectacular sceneries for mountain climbers. Average duration before and after the fence was 4 days.

Table 3.26: Revenue Collection from Chogoria Gate

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019- Upto June
Income in Kshs	1,046,000	785,000	900,000	849,000	961,000	1,415,000	1,210,000	1,336,000	1,430,000
% Change		-25%	15%	-6%	13%	47%	-14%	10%	7%

3.2.19 Cost-Benefit Analysis

In establishing the economic effects of the fence, a benefit-cost analysis (BCA) approach was used. The benefits arising from the fence and the related costs were considered so as to come up with an estimate of the net benefit value. The costs and benefits were analysed based on data and calculations from the study, interviews with stakeholders and existing literature.

The benefits are identified following the Protected Area Benefit Assessment Tool (PA – BAT) developed by World Wide Fund for Nature (WWF), which identified a range of benefits in a protected area (Dudley and Stolton, 2009). While a number of benefits are listed in the tool, the study identified and considered benefits which are relevant for its purpose.

The natural ecosystem provides a number of benefits, both physical products and services, and these may be direct or indirect. The benefits are either based on use of ecosystem products which gives value or benefits derived from existence of the natural ecosystem which is the non-use benefit. The physical products and services include edible plants and animals, medicinal products, timber and non-timber forest products, cultural/aesthetic services, recreation, purification of air/water, biodiversity conservation, and carbon sequestration (IUCN/Nature Conservancy/WB, 2004).

In carrying out cost-benefit analysis (CBA) of conservation, the consultant focused on how the net benefits of the natural ecosystem change in response to the intervention (that is, erecting an electric fence) which alters the ecosystem conditions. Thus, the concern is about changes in flows of costs and benefits arising from the intervention by weighing the gross increase in ecosystem benefits to the opportunity cost of foregone ecosystem benefits and the cost of conservation measures (IUCN/Nature Conservancy/WB, 2004).

The perimeter of the entire Mt Kenya forest ecosystem is about 497 km. Calculation of the benefits and costs attributed to the 60 km electric fence was done by apportioning the values to the region and population served, instead of getting the value of the entire ecosystem. The proportion fenced through with support from UTaNRMP is about 12.1% of the entire Mt. Kenya ecosystem. The number of households in the fenced area is approximated at 37,390 households as per 2019. Using an average household size of 5, the population in the fenced area is approximately 186,950 people. This scenario assumed that the whole Mt. Kenya ecosystem is homogeneous.

Economic Valuation of Benefits

Valuation of the benefits from the 60km fence considered what accrues to the community as a result of having the fence in place. The benefits considered included

- Watershed conservation (Overall catchment protection, Water supply, Energy supply, Irrigation);
- Benefits to forest margin households/communities
- Tourism and recreation benefits
- Crops and livestock saved
- Soil erosion arrest
- Non-Timber Forest products
- Carbon sequestration

Estimates of benefits of forested areas

Economic value estimates for Mt. Kenya forest has been given as USD 20.4 million per annum while the benefit to forest-adjacent households was estimated at USD 212/HH/year (Emerton et al. 1998; Aberdare Fence Assessment Report, 2011). These are values of the entire Mt. Kenya ecosystem before the fence was constructed and may have changed over time due to changes in the ecosystem. In estimating the benefits of the fence, these values are not used and focus is on the fenced area only and not the entire ecosystem.

Water Use Benefits

Water from the natural ecosystem can be used either for domestic consumption, livestock, crop water, irrigation, and hydropower generation. The benefits for water are not restricted to the community around the ecosystem but are felt by other areas as well as at the national level. Calculation of benefits to water is based on water use charges for domestic and livestock water and financial costs for irrigation, and large-scale commercial water for urban areas (Aberdare Fence Assessment Report, 2011).

(a) Domestic Water Consumption

The domestic water demand (both rural and urban) accounted for 1,186 million M^3 /year (approx. 3.3 million M^3/day) in 2010 as indicated in Table 3.36 (The National Water Master Plan 2030). This gives about 36.9% of the total estimated demand of 3,218 million M^3/year (approx. 8.8 million M^3/day). The population of the counties served by the fence (i.e. Meru and Tharaka Nithi) in the Mt. Kenya region was estimated at 2.1 million in 2018 (CIDP 2018 – 2022 for Meru and Tharaka Nithi), with an average annual growth rate of 2.5% the population in 2019 is estimated at 2.2 million.

The population in the fenced area is 186,950. From the field survey, the main source of water for households in the fenced area is piped connection at 92.1%, meaning a population of 172,181 have access to piped water, 5.6% (10,469) are served by rivers while the remaining are served from other sources. Assuming the population, other than those with piped water, are served by the river (i.e. 14,769 people), then at an average consumption rate of 53 litres/ca/day for domestic consumption (WASREB 2019), the total supply is 285,706.3 M^3 for river water use with a value of Kshs. 142,853 (at an abstraction cost of Kshs.0.5/m^3). Mt. Kenya region is served by the Tana Water Services Board (TWSB) which has registered seven Water Service Providers (WSPs) (Table 3.27). The WSPs served a population of 460,779 in Meru and Tharaka Nithi counties in 2017/18 providing 7.339 million M^3 (WASREB, 2019).

Table 3.27: Water Service Providers under Tana Water Services Board (TWSB)

County	Utility	Population in service area	Population served	Water produced in m3 (000)	Domestic + Kiosks billed volume in m3 (000)	Billed volume in m3 (000)
Meru	Imetha	159,548	112,873	1,564	632	790
	Meru	148,292	96,070	2,768	2,341	2,341
	Tuuru	339,381	92,325	1,717	307	373
	Kathita Kiirua	33,729	27,493	708	408	485
Tharaka Nithi	Nithi	89,200	87,699	1,599	729	911
	Murugi Mugumango	35,959	22,017	2,455	1,244	1,771
	Muthambi 4K	24,541	22,302	1,046	508	668

Source: WASREB 2019

The average water tariff for Meru and Tharaka Nithi counties in 2017/18 was Kshs.48.5/M^3 and the average per capita consumption is 53 litres/ca/day. With a population of 172,181 along the fence line having access to piped water, the water supplied by the WSPs is valued at Kshs. 161,545,810. The total annual benefit is Kshs. 161.7 million per year.

(b) Water for Irrigation

The proportion of respondents from the field survey who reported to be practicing irrigation increased from 59.1% to the current 68% after fencing, and they pay an average of Kshs. 360 per month for irrigation water. That means the number of households practicing irrigation increased from 22,097 before fencing to 25,452 after fencing. With an average amount they pay of Kshs. 360 per month, the total cost of irrigation for the fenced area is Kshs. 110 million per year.

(c) Water for Livestock

The percentage of those who keep livestock increased marginally by 3% (from 82.2% to 85.1% - from 249HH to 258HH) on average, however, the fence reduced access to water for livestock as indicated by 13.1% of the households surveyed.

To estimate water for livestock for the fenced area, we use the proportion of national water for livestock to that for domestic use of 22% as at 2010 calculated from the National Water Master Plan 2030. From the estimated annual domestic water use of Kshs. 161.7 million, annual water for livestock is estimated at Kshs. 35.8 million.

Soil Erosion Control Benefits

Forest ecosystem plays a major role in controlling soil erosion. Calculation of soil erosion in the fenced area of the reserve is based on vegetation in the fenced area and also uses estimates of soil saved (MT/ha/year) from the Aberdare Assessment Report 2011 as a benchmark. It is assumed that agricultural activity leads to maximum soil erosion and thus no saving on soil. As per the Aberdare Assessment Report 2011, plantations are treated as woodlots. The total soil saved was estimated at 1,004,559 MT/year (Table 3.28), giving a value of soil saved of Kshs. 301.4 million (at royalty of Kshs. 300/MT - Aberdare Assessment Report 2011).

Table 3.28: Calculation of Soil Saved by Forest type

Type of Activity (ha)	Ruthumbi FS	Chuka FS	Chogoria FS	Total area (ha)	Soil saved (MT/ha/year)	Total soil saved
Indigenous forest	6,557.3	17,700.0	11,300.0	35,557.3	19.05	677,367
Bushland	395.0	1,700.0	600.0	2,695.0	18.20	49,049
Plantations	242.7	192.0	-	434.7	15.32	6,660
Grassland	3,009.0	500.0	1,700.0	5,209.0	18.20	94,804
Bamboo	2,301.0	3,400.0	2,400.0	8,101.0	19.15	155,134
Nyayo Tea Zone	1,260.0	-	-	1,260.0	17.10	21,546
Total	**13,765**	**23,492**	**16,000**	**53,257**		**1,004,559**

Note: The soil saved (MT/ha/year) are based on estimates of Aberdare Assessment Report. Data on forest coverage was from respective Forest Stations

Carbon Sequestration Benefits

In section 3.8.1 on the impact of fencing on project area management, it is assumed that only 33% of the trees will grow to maturity giving a stock of 600 trees/ha and that healing is attributed to 7,500 ha (25% of the 30,000 ha of the fenced area). Thus, carbon sequestration has been estimated at 129,133 metric tonnes. At a price of US$ 3.50 and an average exchange rate of US$ 1 to Kshs. 100, the value of carbon sequestration is Kshs. 45,196,666 per year (i.e. Kshs. 45.2 million/year).

Tourism and Ecotourism Benefits

Tourism is a major sector in the country. Tourism earnings increased from Kshs. 119.9 billion in 2017 to Kshs. 157.4 billion in 2018 (Economic Survey, 2018). Mt. Kenya National Park is a major tourist attraction in the country, with the study area having a great eco-tourism potential due to the presence of salt licks, fishing and cultural sites, scenic beauty and water resources. The number of visitors to Mt. Kenya National Park increased from 20,200 to 25,900 from year 2014. to year 2018 (Economic Survey, 2018).

To estimate the earnings from tourism in the fenced area of the reserve, we consider the revenue collected by KWS from the fenced part of the reserve, that is, at Chogoria gate. Revenue collection has been consistently increasing since 2014 when construction of the fence commenced, except for 2017 when the political climate affected tourism, from Kshs. 849,000 to Kshs. 1,336,000 in 2018 giving an average revenue collection of Kshs. 1,154,200 per year.

Timber and Non-Timber Forest Products (NTFP)

Households living near the forest depend on forest products which they collect directly from the forest. With the fence being in place, the households have to pass through designated access points (gates) to access the non-timber forest products. The gates are meant to allow for controlled access to the forest. Collection of non-timber products is charged depending on the product the household collects. The rates are Kshs.50/25kg for grass, Kshs.100/month for fuel wood collection and Kshs.50/month for each cattle head grazing. Levies on non-timber forest products are collected by KFS at the forest stations. To estimate the value of non-timber forest products in the fenced area, we use the annual revenues collected by Chogoria and Chuka forest stations (Tables 3.29). The total revenue collected since 2016 was Kshs. 1.8 million, giving an average annual revenue of Kshs. 591,653 per year, compared to Kshs 124,125.

Table 3.29: Revenue collections by Forest Stations

Forest Station	2014	2015	2016	2017	2018
Chogoria			60,200	386,700	1,018,600
Chuka	104,600	143,650	36,166	181,636	91,656
Total	**104,600**	**143,650**	**96,366**	**568,336**	**1,110,256**

Source: KFS, Chogoria and Chuka Forest Stations

Within the covered study area, timber is harvested only within the area covered by Ruthumbi forest station. To estimate the value of timber harvested within the 60km stretch of the fenced area, we use the revenue from timber and poles reported by Ruthumbi forest station (Table 3.30). The total revenue collected from timber and poles from 2014 to 2018 is Kshs. 14.3 million, giving an annual average revenue of Kshs. 2.9 million.

Table 3.30: Timber/poles revenue collection at Ruthumbi forest station

	2014	2015	2016	2017	2018
Timber	1,316,200	5,311,947	4,165,556	951,806	1,781,178
Poles	0	500,000	0	316,812	0
Total	**1,316,200**	**5,811,947**	**4,165,556**	**1,268,618**	**1,781,178**

Source: KFS, Ruthumbi Forest Station

The benefit from timber and non-timber forest products is therefore given by the revenue collected in both cases. From the analysis above, timber and non-timber forest products generate an average revenue of Kshs. 3.5 million/year.

Valuation of Costs

The costs that are associated with the wildlife control fence are;

(i) The cost of fence construction
(ii) Fence maintenance costs
(iii) Biomass loss
(iv) Human-wildlife compensation costs
(v) Opportunity costs foregone by the community e.g. agricultural land forgone, non-resident cultivation, illegal logging, livestock grazing etc

(a) Fence construction costs

A solar powered electric fence was constructed in the 60 km stretch. Electric fence has high initial costs of establishment and also require regular monitoring, despite its effectiveness in controlling wildlife movement and hence human-wildlife conflicts. Fence designs vary and can be two-strand fences which only control elephants while allowing all other animals to pass through; four strands; six strand and eight strand fences, with different efficacy in terms of mitigating human-wildlife

conflicts. From the environmental impact assessment report of Mt. Kenya electric fence, the two strand fences are very common in the Mt. Kenya region.

The Mt. Kenya electric fence is a comprehensive eight-strand fence that controls both large and small animals, and human movement in and out of the forest reserve. The costs of putting up a comprehensive and a non-comprehensive fence vary. The actual cost incurred in constructing the comprehensive fence include construction materials Kshs. 121 million, community sensitization Kshs. 4.5 million, and construction by Rhino Ark Kshs. 30 million based on data obtained from UTaNRMP. Community contribution was Kshs 7 million for clearing and fencing labour. This gives a total of Kshs. 162.5 million, meaning an average of Kshs.2.71 million per kilometre for the 60 km stretch. However, this does not include the in-kind contribution of the community in clearing the fencing area. The EIA report had estimated an average cost per kilometre of Kshs.1.5 million, implying cost escalation of about Kshs.1.1 million per kilometre due to the change of the fence design.

The cost of constructing a non-comprehensive fence covering a stretch of 60 km is estimated at Kshs. 1.5 million per kilometre, giving a total cost of Kshs. 90 million. This means the change in fence design led to an increase in the cost of constructing the solar powered electric fence by Kshs. 72.5 million.

(b) Fence management and maintenance cost

KWS has employed someone after every 8 km to man the fence, solar panels, and energizers. Fence monitoring is done on a daily basis with regards to measuring voltage, monitoring for broken or fallen posts and wires and to ensure that the fence is not vandalized. This gives a total of 8 personnel manning the fence. The average salary of a fence attendant ranges from Kshs. 20,000 to Kshs. 25,000 per month[3]. Assuming an average monthly salary of Kshs. 20,000 for a ranger, this amounts to Kshs. 160,000 per month or Kshs. 1,920,000 per year. For the three years, the maintenance costs are about 11 million giving annual maintenance cost of Kshs.3.7 million.

(c) Biomass loss

Construction of the fence was to involve clearing of 10 meters of vegetation to allow for fence construction, which could have resulted in an area of 600,000 metre square (equivalent to 60 hectare) being cleared. However, to minimize felling of mature trees, the fence was aligned to follow places with no mature trees. Due to this, we assume that only 15% of land vegetation was cleared giving an area of 90,000 meters square (equivalent to 9 hectare). Using an estimated value of biomass of an average Kshs. 480,000 per hectare, this gives a total value of Kshs. 4.32 million.

[3] This is as per information obtained from KWS senior warden- Mt Kenya National Park.

(d) Human-wildlife Conflicts costs

The number of human wildlife conflicts (HWC) were higher before the fence than after the fence. Most of the conflicts reported are crop damage, predation, human injury and human health. Between 2004 to 2014, a total of 1174 cases were reported mainly by elephants, velvet monkeys, and baboons. The cases reported after fencing are mainly crop damage and predation, but with only 12 incidences being reported between 2015 and 2018. The total cost of HWC from 2004 to 2014 was Kshs. 71.1 million giving an average cost of Kshs. 7.1 million per year. After fencing, the total cost of HWC from 2015 to 2018 was Kshs. 350,400 giving an average cost of Kshs. 87,600 annually. The figures translate to a reduction of compensation costs by 99.9% per year after the fence was constructed.

(e). Opportunity costs foregone

The opportunity costs account for the forgone benefit to the community from construction of the fence. This is derived from the community restricted access to the forest with the fence in place, thus inability to benefit from firewood, illegal logging, charcoal production, livestock grazing, and other benefits such as potential agricultural land not farmed, medicinal resources and the intrinsic value arising from the forest.

Agricultural land forgone

The agricultural land forgone is estimated from the part of reserve that is covered by the fence and is suitable for agriculture. From the transect walks (Table 3.5), land under forest plantation is estimated at 172.21ha. Assuming 20% of the forest land has agricultural production potential, then it can be considered as an opportunity cost. Using returns of the *shamba system* of Kshs. 124,141/ha (Aberdare Assessment Report 2011), the forgone value is Kshs. 4.28 million for the fenced area per year.

Non-resident cultivation

Non-resident cultivation enables farmers to work on plots in the forest for a given period while tending seedlings as a way of establishing exotic tree plantations. Restriction in access to forest means non-resident cultivation cannot take place, hence the benefits that could have accrued from this are considered as costs. The Task Force Report on Forest Resources Management and Logging Activities in Kenya (MEF, 2018) established that it costs KFS approximately Kshs. 50,000 to establish one hectare of forest, but through Plantation Establishment for Livelihoods Improvement Scheme (PELIS) it costs approximately Kshs. 15,000/ha[4] to establish one hectare of forest, implying a saving of Kshs.35,000/ha. In addition to the saving in forest establishment, there is a gained annual rent of Kshs. 400/ha. From the established forest plantation of 172.21ha, the savings were Kshs. 6,027,000 and rents of Kshs. 68,880 giving a total of Kshs. 6.1 million for the fenced area.

[4] MEF (2018), Task Force Report on Forest Resources Management and Logging Activities in Kenya, page 64.

Charcoal production

The fence has restricted free access to the forest by the community, hence inability to fetch firewood from the forest. This means that access to charcoal by those in the fenced area depends on their ability to pay. Due to this, the inability to access free charcoal from the forest is considered as an opportunity cost. From the field survey, 1% of the households in the fenced area reported that they use firewood, and the average expenditure reported was Kshs. 1,404 per month. The households in the fenced area therefore spend about Kshs. 6.3 million annually.

The total benefits and costs are presented in Tables 3.31 and Tables 3.32 below:

Table 3.31: Summary of Benefits

Benefits	**Value (Kshs. Mn)**
Domestic water	161.7
Water for Irrigation	110.0
Water for Livestock	35.8
Reduced soil erosion	301.4
Carbon sequestration	45.2
Tourism	1.2
Timber and Non-timber forest products	3.5
Total	**658.8**

Table 3.32: Summary of Costs

Costs	**Baseline costs (Kshs. Mn)**
Fence	162.5
Maintenance	3.7
Management	1.9
Biomass loss	4.3
HWC compensation cost	0.1
Forgone agriculture	4.3
Non-resident cultivation	6.1
Charcoal	6.3
Total	**189.32**

The benefits and costs estimated from the project are used to estimate the cost-benefit ratio. Calculation of the CBA considers rates of discount of 5% and 7% respectively for 25 years in

calculating the values of benefits and costs. Two scenarios are presented. The first scenario (actual case) considers the actual costs and benefits assuming that they remain the same over the 25 years. In the second scenario (future benefits), it is assumed that benefits increase annually by 3% while costs (other than those for fence construction and biomass) increase annually at the rate of 2%. The costs of fence construction and biomass loss are one-off costs and hence are accounted for once. From this, estimates of Economic Rate of Return (ERR), Benefit-Cost Ratio (BCR), Net Present Value (NPV) and Incremental benefits that accrue to the fence adjacent community are calculated.

Table 3.33: CBA scenarios

Discount Rate	ERR	BCR	NPV (mi)	Total Benefits (mi)	Total Costs (mi)	Incremental benefits (mi)
Actual case						
5%	22. 86	19.69	9,438.99	17,128.80	749.20	16,379.60
7%	22.86	18.51	7,885.94	17,128.80	749.20	16,379.60
Future benefits						
5%	27.58	23.39	13,027.42	25,398.74	921.03	24,477.72
7%	27.58	21.81	10,570.51	25,398.74	921.03	24,477.72

The results show that the NPV is higher at lower discount rate (5%) in both scenarios. For instance, for the actual case, the NPV at 5% and 7% discount rates are Kshs. 9.4 billion and Kshs. 7.9 billion respectively. The NPV is higher in scenario two where future benefits and costs are assumed to change. The incremental benefit is also higher in the case of future benefits irrespective of the discount rate used, with about 49% more. The BCR are higher than 1 in both scenarios, implying that the electric fence was beneficial to the community adjacent to the fence. This means that conservation of the Mt. Kenya forest ecosystem is beneficial and that investments are justified. The ERR are higher than 10%, showing that the benefits of the electric fence are higher than its costs.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The **innovative public private partnership (PPP**) between Rhino Ark, Mount Kenya Trust, KWS, UTaNRMP and communities has shown that PPP's are possible even in the realm of natural resources management. The partnership ensured that the fence was delivered within two years (as compared to six). The fence was also constructed and delivered despite the change in design (which was more costly), and the total distance covered through this successful partnership.

Land cover and biodiversity conservation: The fence has contributed to positive land cover change in terms of increased natural forest cover and regeneration in the forest areas. Further, as an unintended impact and due to the limited access to the forest, the fence has impacted on increased fodder and tree growing on-farm. Regeneration was quite evident especially in the areas near the fence also indicating that forest degradation was human induced on the forest edges which were now healing due to the presence of the fence that controls entry into the forest. The improved forest ecosystem also means the fence has helped improve carbon sink through regeneration. The fence has also improved wildlife habitat, improved recharge in the catchment area with rivers showing improved flows of 35%, ehanced forest cover thus improving forest ecosystem services, reduced incidences of forest fire, and reduced cases of illegal logging.

Crops diversification and Food Security: The fence has improved agricultural production both in terms of percentage of farmers cropping, increased land put under agriculture, and production per unit area. This has all contributed to crops food security and crops diversification with farmers now introducing new crops like bananas, vegetables and horticultural crops (onions, cabbages, tomatoes, kales, and French beans). The communities have also adapted new technologies especially irrigation and further invested in farm inputs.

Human Wildlife Conflicts and Livelihood improvement: The fence has been effective in bringing down losses from human deaths, human injury, damage to property and crops by 99% with human injuries and deaths being reduced to zero. Social order hads been restored and livelihoods improved with incomes rising from an average Kshs 45,000 to Kshs 125,604 per annum. Those living below the poverty line were about 11% of respondents in the fenced areas as compared to 64% respondents in Lower Imenti (non-fenced) areas. 73% of respondents in the fenced areas were now saving some monies in the bank (average Kshs 26,000), unlike in the past when they were not. The erection of wildlife barrier has reduced costs of responding to human wildlife incidences by 97.2%. As a result, the welfare of communities previously affected by this conflict changed for the better, with no sleep disruptions, reduced crop damages,

increased crop diversity and food security, improved incomes, improved security especially for school going children and overall reduced costs of wildlife management by the government. To the community, movement out of poverty among the community members who had previously been at the mercy of wildlife was beckoning.

Land value: The fence has impacted positively on land values with an appreciation of 86% from an average Kshs 917,000 per acre to an average of Kshs 1,703,421 per acre.

Social Impacts: The fence has improved security from animal attacks, improved human health from reduced exposure to the elements and improved nutrition; and also improved the education environment and school's performance as children are now able to go to school and study.

Encroachment and illegal activities: The fence had effectively managed to reduce human encroachment into the forest land as well as drastically reduce any illegal activities such as logging, poaching and general biodiversity destruction. The erection of wildlife barrier has enhanced security enforcement and reduced cases of intrusion into protected area. Intruders are now restricted to using specific areas or routes and it is now easy to monitor/nab them.

A fence is only as good as its maintenance. The fence has so far been well maintained with technicians every 8 Kms. This is a key lesson especailly in Lower Imenti where for some years, the fence had been left unattended and human wildife conflicts were again expereinced. Maintenance has to be continual and meticulous.

Overall the study concludes that the social benefits from the fence outweigh the negative impacts from the construction of the fence. This report presents a strong socio-economic case for the fence based on the findings and responses from the stakeholders interviewed. Indeed, the cost benefit analysis shows that the fence investments are justified as the ERR is higher than 10%, showing that the benefits of the electric fence are higher than its costs.

4.2 Recommendations

I. The wildlife control fence is a worthy investment and should be extended to other areas especially in the Lower Imenti forest where incidences of human wildlife conflict are currently quite high. The fence has proved to not only alleviate poverty but also improve conservation.

II. For sustainability, the fence maintenance should continue to use local communities and engage them. There is also need to create a trust fund for fence maintenance which will complement available resources.

III. The innovative PPP model should be considered as a good strategy towards ensuring that the whole ecosystem is fully fenced but with corridors to enable wildlife move to other ecosystems.

IV. While the fence erection involved community consultations, and participation, no forums exist for the community to report on emerging issues e.g. maintenance and number/distance to gates. Community forums to discuss emerging issues should thus be introduced to give room for community members to share their different experiences with the fence this far. Post fence community social dialogues will facilitate open discussions that could promote community led fence sustainability mechanisms.

V. Compensation after incidences of human-wildlife conflicts is a contentious issue especially in non-fenced areas and it should be addressed especially with regards to crop damage which is rarely compensated.

VI. There should be more efforts with regards to agro-forestry to reduce over-reliance on forests especially for firewood. This will reduce agency/community tensions in the event of moratoriums as is currently the case.

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APPENDICES

APPENDIX 1: KEY INFORMANT INTERVIEW GUIDE

UTaNRMP Staff (Project Coordinator, Land and Environment and Community Empowerment Coordinator)

1. What role did UTaNRMP play in the fencing process?
2. What role did you play in the construction/erection of the fence in question?
3. Could you briefly explain the fencing process?
    a. Who else was involved and in what roles?
    b. How were community members involved and how satisfied are you with their involvement?
    c. What were costs and who bore the costs?
4. What do you consider to be the most significant ecological impact of the fence and why?
    a. What are changes in vegetation degradation? (cultivation, livestock grazing, wood harvesting, forest fires, settlements,
    b. Changes in habitat structure
    c. Reported changes in wildlife movements/ migratory routes
    d. Reported changes in wildlife populations
    e. Impact and changes in wildlife habitat use and breeding sites
    f. Impact on wildlife behaviour
5. What do you consider to be the most significant social impact of the fence and why?
6. What do you consider to be the most significant economic impact of the fence and why?
7. Overall what has been the impact of the fence of land conservation
8. What would you consider to be the unintended results of this fence positive and negative?
9. What worked well in the fencing process that significantly contributed to the successful completion?
    a. What did not work well?
10. What lessons can be carried on to future similar interventions?
11. What sustainability strategies have been put in place to ensure the benefits from the fence are sustained?

UTaNRMP Staff (Project Coordinator, Community Empowerment Coordinator)

1. What role did you play in the construction/erection of the fence in question?
2. Could you briefly explain the fencing process?
    a. Who else was involved and in what roles?
    b. How were community members organised and involved in the process?
    c. Were all categories of community members involved ***(probe for, adult male and female, youth male and female, children (boys and girls), people with special needs, community committees and representatives)***
3. How the community contribution was organised and to what extent were the different categories of community members able to make their contributions?
4. What worked well in the community involvement approaches and why?
    a. What did not work well?
    b. What lessons could be borrowed in future interventions with respect to community involvement?

5. What do you consider to be the most significant social impacts of the fence and why?
6. What do you consider to be the most significant economic impacts of the fence and why?
7. In what ways has the fence contributed to community empowerment?
8. What would you consider to be the unintended results of this fence positive and negative?
9. What worked well in the fencing process that significantly contributed to the successful completion?
    a. What did not work well?
10. What lessons can be carried on to future similar interventions?
11. What sustainability strategies have been put in place to ensure the benefits from the fence are sustained?

Kenya Forest Service (Ecosystem Conservator and Forest Managers)

1. For how long have you worked with KFS?
2. What role did KFS play in the fencing process?
3. Could you briefly explain how the fencing process was?
    a. Who else was involved and in what roles?
    b. How were community members involved and how satisfied are you with their involvement?
    c. What were costs and who bore these costs?
4. How has this fence impacted on the management of the forest?
    a. What changes has KFS witnessed in management costs and revenues? ***(Please elaborate (estimate costs, revenues, now and before the fence)***
5. How do you compare the extent of illegal activities now and before the fence was erected? (***Please elaborate)***
6. What has been the impact of the fence on forest fires when you compare now and the period before the fence?
7. What has been the impact of the fence on illegal activities?

Average monthly arrests	**Total**	**Male**	**Female**	**Offence**
Before the fence				
After the fence				

8. To what extent has the fence reduced illegal activities in this area?
9. How would you compare the efficacy of the comprehensive fence as compared to other fence designs: (probe for 6 strand fence and other fence designs in other areas of the ecosystem)?
10. In what ways has this fence impacted on the relationship between CFA members and KFS?
11. What are the main ecological changes that can be attributed to the fence?
12. What are some of the social changes that can be attributed to the fence?
13. What are some of the economic changes that can be attributed to the fence?
14. Are there any unintended impacts- Both positive and negative?
15. How many trees were planted during the fencing period and after the fence was erected?
16. What sustainability strategies have been put in place to ensure the benefits from the fence are sustained?

Kenya Wildlife Service (Wardens and Senior Warden)

1) For how long have you worked with KFS?
2) What role did KFS play in the fencing process?
3) Could you briefly explain how the fencing process was?
    a. Who else was involved and in what roles?
    b. How were community members involved and how satisfied are you with their involvement?
    c. What were costs and who bore these costs?
4) How has this fence impacted on the management of the wildlife?
    a. Are there changes that have been observed in relation to human – wildlife conflicts?

Average monthly incidences reported	**Total**
Before the fence	
After the fence	

5) How has the fence impacted on the relationship between KWS and the community members in this area?
    a. Do we still have human/wildlife incidences after the fence was erected?
    b. Which are the problematic animals?
    c. What would be done to prevent these conflicts?
6) Has the fence had any impact on poaching? Please explain?
7) Is the fence likely to have transferred the human wildlife conflicts to other non-fenced areas? If so to which areas?
8) How would you compare the efficacy of the comprehensive fence as compared to other fence designs: (probe for 6 strand fence and other fence designs in other areas of the ecosystem)?
9) What are the main ecological changes that can be attributed to the fence?
10) What are some of the social changes that can be attributed to the fence?
11) What are some of the economic changes that can be attributed to the fence?
12) Are there any unintended impacts- Both positive and negative?
13) What sustainability strategies have been put in place to ensure the benefits from the fence are sustained?

Rhino Ark Foundation (CEO/Fence Manager)

1) What in your view was the main prompt that occasioned the erection of this fence?
    a. Why this particular section of the forest?
2) What were the costs of putting up this fence?
    a. Do you consider this to have been value for money? Does the benefit outweigh the cost? Please explain
    b. How do the unit costs compare with other fences that you have put up? Please give examples
    c. What are the other opportunity costs of putting up this fence?
3) What was the justification for this design of a fence? Was it the most effective and why? What is its added value?
    a. Are there other designs that would have cost less? If yes what is the distinct advantage of this design?
    b. How does this design compare with other designs from other fencing projects? Please give examples?

4) What do you consider to be the most important impacts of this fence?
    a. Ecological impacts
    b. Social impacts
    c. Economic impacts
5) What would you consider to be the unintended impacts of this fence- Both positive and negative?
6) What worked well in this fencing process, that could be replicated in other projects and why?
    a. What did not work well and why?
7) What lessons could inform other future and similar projects?
8) What sustainability strategies have been put in place to ensure the benefits from the fence are sustained?

Chiefs/Assistant chiefs

1) For how long have you been a chief in this location?
2) How was the situation of human- wildlife conflict before this fence?
    a. How has this changed since the fence was erected?
3) How would you explain the relationship between community members and within households before the fence was erected?
    a. How have this changed since the erection of the fence?
4) Do you think the fence has affected the education standards in this area in any way?
5) What was the extent of illegal forest activities before the fence?
    a. How has this changed since the fence?

Average monthly Illegal forest activities reported to chief	**Total**	**Male**	**Female**
Before the fence			
After the fence			

6) Has the fence had any impacts on general community security? Please explain
7) Have there been any changes in the value of land that can be attributed to the fence?
    a. What do you think led to these changes?

Price of an acre of land before the fence	**Price of an acre of land after the fence**

Water companies or projects

1) Are you aware of the Wildlife Control fence erected recently?
2) Of what benefits would such a fence to the Water Company or project?
3) What changes might the water company/project have experienced following the erection of this fence?
    a. Any changes to incidences of pipes breakage or water disruption since the fence.

Average Quarterly incidences before the fence	**Average Quarterly incidences before the fence**

    b. Any changes in the costs of repairs occasioned by the breakages

Average Quarterly costs before the fence	**Average Quarterly costs before the fence**

Business Owners/ Timber and firewood traders

1) How is the availability of charcoal, firewood/ timber or wood products in this area?
2) What do you rely on for your cooking energy?
    a. If wood hat is the source of the wood
3) Are you aware of the wildlife control fence that was recently erected in this area?
4) Do you think such a fence has any impact on your business? Please explain
5) What has changed since the fence was erected?
    a. Probe for availability of firewood, charcoal, and forest products food products
6) Overall do you think the fence has a positive or negative impact to businesses in this area? Please explain your response.

CFAs/WRUA chairman/secretary

1) For how long have you been resident in this area?
2) How was the situation of human- wildlife conflict before this fence?
    a. How has this changed since the fence was erected?
3) How would you explain the relationship between community members and within households before the fence was erected?
    a. How have this changed since the erection of the fence?
4) Do you think the fence has affected the education standards in this area in any way?
5) What was the extent of illegal forest activities before the fence?
    a. How has this changed since the fence?

Average monthly Illegal forest activities	**Total**	**Male**	**Female**	**Main offences**
Before the fence				
After the fence				

6) Has the fence had any impacts on general community security? Please explain
7) Has the fence had any impact on conservation activities" which ones and how?
8) Have there been any changes in the value of land that can be attributed to the fence?
    a. What do you think led to these changes?

Price of an acre of land before the fence	**Price of an acre of land after the fence**

School heads/ teachers

1) What is the total population of your school?
    a. Number of girls, number of boys?
2) What proportion of the students come from the forest area?
3) Are you aware of the wildlife control fence that was recently erected in this area?
4) In what ways might this fence have affected this school?
    a. Any changes in enrolment
    b. Any changes in absenteeism
    c. Any changes in time children get to school
    d. Any changes in safety of children
    e. Any changes in school attacks by wildlife?
    f. Any changes in health of children?
    g. Any changes in concentration of children?
5) Have we had incidences where children were attached by wildlife en-route to or from school?

Estimated attacks by wildlife each term before fence	Estimated attacks by wildlife each term before fence

6) What do you consider to be the most important impact of the fence to this school?

APPENDIX 11: FOCUSED GROUPS DISCUSSION INTERVIEW GUIDE

Community Groups (CFA, WRUAS, FDAs

INTRODUCTION

Good morning/ afternoon my name is ..... and I am here with my colleague …… We are from Juniperus Consulting Compnay. We are currently carrying out a wildlife control fence social economic and ecological study in Mt. Kenya ecosystem (Thuchi River to Thingithu River). We are talking to different groups and associations as well as community members on what you know and understand to be the impact of wildlife control fence to the community. All information that you give us will be kept confidential and you will not be identified personally in any reports resulting from this research. Your participation in this study is completely voluntary and you may refrain from answering any questions and end the survey at any point in time. It will take an approximately I hour to complete this discussion.

Do you consent to participating in this discussion?

Name of participant	M/F	YES	NO	Reasons for Non-Consent

Notes

- **If a participant refuses to consent, record their main reason for refusal and allow them to leave the group**
- **Never force anyone to participate in the FGD**

1. When was this association formed? Year
2. What is the total membership?

Total members	Male members	Female members	People with special needs	Youth members

3. What are the objectives of this association?
4. What is the type of interaction, role or relationship of this committee and the erected fence?
5. When was the fence put up in your area? State the year_____

6. What was the general situation in the area before the fence was put up?
7. What were the social problems experienced before the fence?
8. What economic costs did community members incur before the fence?
9. How was this committee involved in the fence erection?
    a. How were community members involved in the fence erection?
    b. How much was the community contribution and how was this managed?
10. How is this committee involved in the fence management?
    a. How is the community involved in fence management?
11. How would you compare the working relationship between the community and key organizations like KFS and KWS before and after the fence was put up?

View	**No of participants who say this**	**Reasons why they say this**
Relationship has improved		
Relationship has remained the same		
Relationship has worsened		

12. Of what benefit is this fence to this committee?
13. What is the impact of the fence on human-wildlife conflicts in the area?
    a. What was the number of conflicts before the fence?
    b. Which were the problem animals?
    c. What about now? Are there still problem animals? Which ones
14. Overall has this fence brought a negative or positive impact to incomes of community members

Impact of fence on incomes	No of participants who say so	Reasons for their response/ **What are the impacts**?
Positive impact		
No impact at all		
Negative Impact		

15. How has the fence impacted on the people living with disability and the very elderly?
16. What new crops have the local communities started growing since the fence was put up?
17. Are there any new technologies that the communities have embraced since the fence?
18. Is the area food secure?

	No of participants saying so	**Reasons for this response**
Food secure		
Food insecure		

a. What was the situation before?

19. What is the overall impact of the fence on livestock husbandry in the area?

Impact	No of participants saying so	Reasons for this response
Positive impact		
No impact at all		
Negative Impact		

a. How had the fence impacted on access to grazing fields and water for livestock keepers?
b. Are communities introducing new livestock breeds?

20. What is the overall impact of the fence on firewood and other energy access of households?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

21. What is the overall impact of the fence on water access by households?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

22. Is there improved agro-forestry activities on-farm?

	Number of participants who say so	Reasons for their response
Yes		
No		

23. What is the impact of fence on security?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

24. What is the impact of the fence on Health of community members? Social cohesion? Education?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		

No impact
Negative

25. What is the impact of fence on Social cohesion? Education?

Impact	No of participants saying so	Reasons for this response
Positive		
No impact		
Negative		

26. What is the impact of fence on Education?

Impact	No of participants saying so	Reasons for this response
Positive		
No impact		
Negative		

27. Do you think the fence transferred the problem of human-wildlife conflicts elsewhere?

	No of participants saying so	Reasons for response
Yes		
No		

28. What social problems have been resolved or reduced by the fence?
    a. Are marriages more stable?
    b. What about community cohesion
29. Has the fence led to any positive unintended impacts? Please explain
    a. Has the fence led to any negative unintended impacts? Please explain

For non-fenced areas:

1. When was this association formed? Year
2. What is the total membership?

Total members	Male members	Female members	People with special needs	Youth members

3. What are the objectives of this association?
4. What is the situation of human wildlife conflict in this area?
    a. Which are the main problem animals?
    b. Where do most of the human-wildlife conflicts happen?
    c. When do they occur?
5. Any human lives lost? And any wildlife and livestock live lost?) due to human wildlife conflicts?

Deaths in the last 12 months	Number of deaths

Human

Wildlife

Livestock

6. During which period are wildlife – human conflicts highest and Why?
7. How do people/communities cope with human-wildlife conflicts?
    a. How do people protect themselves and their property from wildlife?
    b. Is there any compensation?
    c. How do people living with disability and the very elderly cope?
8. Are there illegal wildlife practices like snaring or poaching
    a. If yes what are the number of incidences and target animals in last 3 years?
    b. When does this usually occur – all year or seasonal?
    c. Is it common and when are numbers high?
9. Do you think an electric fence to prevent movement of wildlife to people's farms would improve the situation of human wildlife conflict? Why do you say so?

	No of participants saying so	**Reasons for their response**
Yes		
No		

Adult and youth community members

1. What is the occupation of most of the community members in this area ***(probe for male and female youth? male and female adults)***
2. When was the fence put up in your area?
3. Do you think that this fence was necessary? Why?

	No of participants saying so	**Reasons for their response**
Yes		
No		

4. What was the general situation in the area before the fence was put up?
5. What were the social problems experienced before the fence?
6. What economic costs did community members incur before the fence?
7. How were you involved in the fence erection?
    a. Do you consider the involvement of community members as adequate? Why?

	No of participants saying so	**Reasons for their response**
Yes		
No		

8. How were the community members involved in the fence erection?
    a. To what extent were community members with special needs involved?
    b. How much was the community contribution and how was it managed?
    c. How are community members like yourselves involved in fence management?
9. Overall has this fence brought positive or negative benefits to the community members like yourselves?

Type of benefit	**No of participants saying so**	**Reasons for their response**
Positive benefits		
No Benefits		
Negative Benefits		

10. What is the impact of the fence on human-wildlife conflicts in the area?

Frequency of conflicts before (daily, weekly, monthly etc)	**Problem animals before**	**Frequency of conflicts currently**	**Problem animals currently**

11. Overall has this fence brought a negative or positive impact to incomes of community members

Impact of fence on incomes	No of participants who say so	Reasons for their response/ **What are the impacts**?
Positive impact		
No impact at all		
Negative Impact		

a. Have some people change their occupation?

12. What new crops have the community members started growing since the fence was put up?
13. Are there any new technologies that the community members have embraced since the fence?
14. Is the area food secure?

	No of participants saying so	**Reasons for this response**
Food secure		
Food insecure		

a. What was the situation before?

15. What is the overall impact of the fence on livestock husbandry in the area?

Impact	No of participants saying so	Reasons for this response
Positive impact		
No impact at all		
Negative Impact		

a. Has fence impacted on access to grazing fields and water for livestock keepers?
b. Are communities introducing new livestock breeds?

16. What is the overall impact of the fence on firewood and other energy access of households?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

17. What is the overall impact of the fence on water access by households?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

30. Is there improved agro-forestry activities on-farm?

	Number of participants who say so	Reasons for their response
Yes		
No		

31. What is the impact of fence on security?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

32. What is the impact of the fence on Health of community members? Social cohesion? Education?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

33. What is the impact of fence on Social cohesion? Education?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

34. What is the impact of fence on Education?

Impact	**No of participants saying so**	**Reasons for this response**
Positive		
No impact		
Negative		

35. Do you think the fence transferred the problem of human-wildlife conflicts elsewhere?

	No of participants saying so	**Reasons for response**
Yes		
No		

18. What social problems have been resolved or reduced by the fence?
    a. Are marriages more stable?
    b. What about community cohesion

19. Have you and other community members been sensitised on the dangers of the fence and what not to do?
20. Has the fence led to any positive unintended impacts? Please explain
    a. Has the fence led to any negative unintended impacts? Please explain

For non-fenced areas:

1. What is the situation of human wildlife conflict in this area?
    a. What are the main problem animals?
    b. Where are human-wildlife conflicts?
    c. Where and when do they occur?
2. Any human lives lost? And any wildlife and livestock live lost?) due to human wildlife conflicts?

Deaths in the last 12 months	**Number of deaths**
Human	
Wildlife	
Livestock	

3. During which period are wildlife – human conflicts highest and Why?
4. How do people/communities cope with human-wildlife conflicts?
    a. How do people protect themselves and their property from wildlife?
    b. Is there any compensation?
    c. How do people living with disabilities and the elderly cope with the human-wildlife conflicts?
5. Are there illegal wildlife practices like snaring or poaching
    a. If yes what are the number of incidences and target animals in last 3 years?
    b. When does this usually occur – all year or seasonal?
    c. Is it common and when are numbers high?
6. Do you think an electric fence to prevent movement of wildlife to people's farms would improve the situation of human wildlife conflict? Why do you say so?

	No of participants saying so	**Reasons for their response**
Yes		
No		

Guideline for FGDs with Children around fenced area

Introductions

- *Seek the consent to interview children from the teachers*
- *Children will be sampled from classes 5-8 only* ***(where there is more than 1 stream in each level, choose the stream whose class teachers first name starts with the first letter of the alphabet)***
- *In each class sample 3 children as follows class 5, (2 boys 1 girl), class 6 (2 girls 1 boy), Class 7 (2 boys 1 girl) and class 8 (2 girls 1 boy)*
- *Begin with a song or a game before getting to the questions.*
- *After that allow children to introduce themselves probably saying what they wish to be when they grow up.*
- *Introduce the study carefully and in simple language. Emphasising that we need to know how the fence has affected their lives as children.*

Materials needed

- Pencil, plain paper-A4, rubber

Questions

1. Ask the children to take 20 minutes to draw the animals that they see or know that destroy or used to destroy crops and property on the farm?
    a. After they finish drawing discuss with them the sketches, they drew, with a view to know the animals they have drawn and the crops they destroy or used to destroy
2. Have a discussion on whether the animals still destroy the crops even after the fence.
3. Ask the children how else the fence has affected them as children (probe for both positive and negative effects)
4. Find out if children were sensitised on dangers of the fence, what not to play with etc

APPENDIX 111: HOUSEHOLD QUESTIONNAIRE – FENCED AREAS

Questionnaire for wildlife control fence social economic and ecological study in Mt. Kenya ecosystem (Thuchi River to Thingithu River).

INTRODUCTION

Good morning/ afternoon my name is .....from Juniperus Consulting. We are currently carrying out a wildlife control fence social economic and ecological study in Mt. Kenya ecosystem (Thuchi River to Thingithu River). We are talking to randomly selected adults and we are here today to discuss with you know and understand to have resulted from the erection of the fence around this area. All information that you give me will be kept confidential and you will not be identified personally in any reports resulting from this research. Your participation in this study is completely voluntary and you may refrain from answering any questions and end the survey at any point in time. It will take an approximately 45 minutes to complete this survey.

Do you consent to participating in this survey? Yes 1
(Please circle as appropriate) No 2 (Indicate reason for refusal and End interview)

SECTION 1: GENERAL INFORMATION AND HOUSEHOLD DEMOGRAPHICS			
001	County		1
			2
			3
002	Sub county		1
			2
001	Forest Station		1
			2
			3
			4
			5
002	River Basin		1
			2
			3
			4
002	Village		1
			2

CAPTURE GPS LOCATION

ID	Name of Household Member *(Start with the primary respondent)*	What is [NAME'S] **Sex?** 1 =Male 2 =Female	What is **[NAME]** age? (in years)	Is **[NAME]** the Head of the Household? 1= Yes 2= No	What is the highest level of formal education has **[NAME]** completed?	What is the marital status of **[NAME]**?	What is the main occupation of **[NAME]**	Does [NAME] have any form of disability? (Please specify)
	101	**102**	**103**	**104**	**105**	**106**	**107**	**108**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

105

1= No formal Education
2= Primary level (7 or 8)
3= Secondary (form 4 or 6)
4= Undergraduate Degree
5= Post graduate Degree
6= Diploma or another Certificate
7= Tertiary level training including TVET

106

1= Married
2= Single, Never Married
3= Widow/Widower
4= Divorced
5= Separated
6= Don't Know

107

1= Crop Farming
2= Livestock farming
3= Selling Timber and forest products
4= Casual employment/labour
5= Permanent employment
6= Other businesses(self-employed)
7= Other (Specify)

108

1= None
2= Physical Disability
3= Hearing Challenge
4= Sight challenge
5= Mental challenge
6= Don't Know

SECTION 2: HOUSEHOLD CHARACTERISTICS			
201	About how many kilometres is the fence from your household?	Less than 1 KM	1
		1-2 KM	2
		3-4 Km	3
		5-6 Km	4
		7-8 Km	5
		9-10 KM	6
		More than 10km	7
202	What is the total land area (acres) that the HH has?	Less than 1 acre	1
		Between 1-2 acres	2
		Between 2-3 acres	3
		Between 3-4 acres	4
		Between 4-5 acres	5
		More than 5 acres	6
203	Which year did the HH settle here?		
204	What is the farm ownership Status	Private with title	1
		Private with no title	2
		Communal land	3
		Family held	4
		Other (specify)	5
205	What is the type of the main house?	Permanent	1
		Semi-Permanent	2
		Temporary	3
206	Which are the main assets owned by the household? *(Where more than 1 specify the number)*	Motor Bikes	1
		Motor vehicle (Cars, lorries, canters etc)	2
		Water tank	3
		TV	4
		Radio	5
		Bicycles	6
		Mobile phones	7
		Gas Cooker	8

		Gas Cylinder	9
		Solar Panel	10
		Other (specify)	11
207	What the average HH income each year (assist to calculate)	0-10,000	1
		10,000-50,000	2
		50,000-100,000	3
		100,000-200,000	4
		200,000-300,000	5
		300,000-400,000	6
		400,000-500,000	7
		500,000-1,000,000	8
		Above 1,000,000	9
208	What is the main source of income for the household?	Farming and sale of farm products	1
		Sale of livestock and livestock products	2
		Sale of timber and other forest products	3
		Casual labour	4
		Permanent employment	5
		Business income	6
		Other (Specify)	7
209	What proportion of household annual income is spent on the following	Food Purchases	
		School Fee	
		Medication/ Family health	
		Farm inputs	
		Livestock inputs	
		New investments	
		Water	
		Energy	
		Savings	
		Other (Specify)	
210	What is the main source of water for the household?	Piped Connection	1
		Spring	2
		River	3

		Borehole	4
		Well	5
		Dam	6
		Other (specify)	7
211	How much water does your household use per day in litres?	Less than 10 litres	1
		Between 10-20 Litres	2
		Between 20-30 litres	3
		Between 30-40 litres	4
		Between 40-50 Litres	5
		Above 50 Litres	6
212	How much do you pay for water per month *(If per day calculate cost per month)*	Less than Kshs 20	1
		Between Kshs 20-30	2
		Between Kshs 30-40	3
		Between Kshs 40-50	4
		Above Kshs 50	5
213	What is the main source of lighting for the household	Kerosene Lamb	1
		Kerosene tin lamb	2
		Electricity	3
		Solar Lantern	4
		Solar Home System	5
		Candles	6
		Biogas	7
		Other (Specify)	8
214	What is the main source of cooking energy for the household?	Firewood	1
		Charcoal	2
		Agricultural wastes	3
		Biogas	4
		LPG (Gas)	5
		Electricity	6
		Briquettes	7
		Other (Specify)	8
215		Firewood	

	How much do you spend for each energy type per month in Kenya Shillings?	Charcoal		
		Agricultural Wastes		
		Biogas		
		LPG		
		Electricity		
		Briquettes		
		Other (specify)		
216	Are household members involved in community Groups?		Yes	1
			No	2
217	If yes, what is the name and type of groups			
218	How does the HH benefit from members' participation in such groups?	Source of financial capital		1
		Source of technical information on Agricultural production		2
		Marketing produce		3
		Cash lending and saving services		4
		Mutual Social support		5
		Other (specify)		6

SECTION 3: FARMING AND CROPPING CHARACTERISTICS

301. What area is under the following on farm?	Crops: _____ Farm Forestry: _____ Grazing: _____Fodder: _____ Others (Specify)			
302. How was it before the fence	Crops: _____ Farm Forestry: _____ Grazing: _____Fodder: _____ Others (Specify)			
303. What is current price of land per acre?	Kshs: _____			
304. What was the price of land per acre before fence was erected?	Kshs: _____			
305. What crops are currently grown and what is their yield and prices?	Crop type	Area grown (acres)	Yield (Kgs)	Price per Kg
	Crop type	Area grown (acres)	Yield (Kgs)	Price per Kg

306. What crops were grown before the fence and what were the yields and prices?				
307. Do you experience crop damage by animals?	□Yes □No			
308. If yes which animals cause crop damages?				
309. If yes, what is the estimated loss?	Crop	Area	Problem animal(s)	Estimated lass per annum
310. Have you received any compensation for damaged crops?	□Yes □No			
311. If yes, how much and from whom?	Kshs: _____			
312. If no, why?				
313. Before the fence was erected, did you experience crop damage?	□Yes □No			
314. What was the estimated loss?	Crop	Area	Problem animal(s)	Estimated loss
315. How did you protect your crops before the fence was erected?	I would watch over crops and chase animals away			
	I would light fires to keep animals at bay			
	I would plant chilli			
	I would team with community to make noises to scare animals			
316. What did you consider to be some of the social implications of protecting your crops	Did not get enough sleep most days			1
	I was generally less productive during the day			2
	Did not spend the night at home with spouse and children			3
	Other specify			4

				5
317. What was the economic cost of protecting your crops?	Item	Economic cost		
318. What would you say are the benefits of the fence with regards to crops protection?	Item	Estimated social benefits	Estimated savings (Kshs)	
319. Do you undertake irrigation?	□Yes □No			
320. If yes, what type of irrigation do you undertake?	□ Drip □Overhead □Farrow □Other			
321. Do you pay for irrigation water?	□Yes □No			
322. If yes, how much per month?	Kshs			
323. If yes, which crops do you grow under irrigation	Crop	Area	Yield	Price per Kg
324. Did you undertake irrigation before the fence erection?	□Yes □No			
325. If No, why				

Livestock Farming			
326. What types and numbers of livestock do you keep on-farm, and what is their value?	Livestock type	No.	Value (Kshs)
327. What types and numbers of livestock did you keep on-farm before the fence, and what was their value??	Livestock type	No.	Value (Kshs)
328. What type of livestock husbandry do you use?	□ Zero grazing – own fodder □ Free grazing □ Grazing in Forest □ Cut and carry from forest □ Purchase fodder □ Other		
329. What type of livestock husbandry did you use before the fence?	□ Zero grazing – own fodder □ Free grazing □ Grazing in Forest □ Cut and carry from forest □ Purchase fodder □ Other		
330. How has the fence affected your grazing?	Item	Yes	No
	Reduced predation		
	Reduced pasture		
	Reduced livestock pasture		
	Reduce livestock diseases		
	Reduced access to water for livestock		
331. Where do you get water for livestock?	□ Piped connection □ Spring □ River □ Borehole □ Well □ Dam □ Other		
332. Where did you get water for livestock before the fence was erected?	□ Piped connection □ Spring □ River □ Borehole □ Well □ Dam □ Other		
333. Where did you get water for livestock before the fence was erected?	□ Piped connection □ Spring □ River □ Borehole □ Well □ Dam □ Other		
	Livestock product	Before fence	After fence

334. Has the fence changed the prices of livestock products?					
335. Has the price of fodder changed after the fence?	Item	Before	After fence		
	Bag of grass				
	Napier grass				
336. Have there been changes in animal diseases after the fence was erected?	Disease	Before Affected	Dead	After Affected	Dead
	East coast fever				
	Red water				
	Anthrax				
	FMD				
	Nagana				
	TBD				
Water and Energy					
337. How has the fence affected souring of water for the HH?	Item	Social cost/benefit	Economic cost/benefit		
	Destruction of pipes				
	Distances to water source				
	Cost of water				
338. How has the fence affected souring of energy for the HH??	Item	Social cost/benefit	Economic cost/benefit		
	Distances travelled				
	Time spent				
	Cost of fuelwood				
	Cost of charcoal				
339. What are your sources of fuelwood now?					
340. How has the fence affected your source of other forest products?	Item	Before – Kshs	After – Kshs		
	Poles				
	Thatch grass				
	Herbs				

341. How has the fence affected your access of other forest products?	Item	Increased	Decreased
	Access to firewood		
	Access to poles		
	Access to herbs		
342. What is the impact of the fence on security?			
343. What is the impact of the fence on health?			
344. What is the impact of the fence on education?			
Human-Wildlife Conflicts			
345. Are there any human-wildlife conflicts in the area?	□Yes □No		
346. If yes, how would you rate the trend of human wildlife conflict	□ High □ Medium □ Low □ Scarce		
347. If yes, what are the problem animals in the last one year as a HH	Problem animal	Damage/injury	Damage/Compensation value in Kshs
348. How many hours in a week on average does your household spend guarding your crops from animals?			
349. Were there human -wildlife conflicts in this area before the fence	□Yes □No		
350. If yes, how would you rate the trend of human wildlife conflict at that time	□ High □ Medium □ Low □ Scarce		
351. If yes, which were the problem animals before the fence was erected?	Problem animal	Damage/injury	Damage/Compensation value in Kshs

352. How many hours in a week on average did your household spend guarding crops from animals?			
353. What benefits do you see arising from the fence?			
354. What disadvantages does the fence pose to the household?			
355. Were you involved in the erection of the fence?			
356. If yes how were you involved			
357. Who manages the fence?			
358. Are you involved in fence management?	□Yes □No		
359. If, yes, how, and are there any advantages in being involved in fence management?			
360. If, No, why?			
361. Are there any challenges in fence management?			
362. What recommendations would you give on fence management to overcome these challenges?			

APPENDIX IV: HOUSEHOLD QUESTIONAAIRE – NON-FENCED AREAS

Questionnaire for wildlife control fence social economic and ecological study in Mt. Kenya ecosystem (Thuchi River to Thingithu River).

INTRODUCTION

Good morning/ afternoon my name is .....from Juniperus Consulting. We are currently carrying out a wildlife control fence social economic and ecological study in Mt. Kenya ecosystem (Thuchi River to Thingithu River). We are talking to randomly selected adults and we are here today to discuss with you know and understand to have resulted from the erection of the fence around this area. All information that you give me will be kept confidential and you will not be identified personally in any reports resulting from this research. Your participation in this study is completely voluntary and you may refrain from answering any questions and end the survey at any point in time. It will take an approximately 45 minutes to complete this survey.

Do you consent to participating in this survey? Yes 1
(Please circle as appropriate) No 2 (Indicate reason for refusal and End interview)

SECTION 1: GENERAL INFORMATION AND HOUSEHOLD DEMOGRAPHICS			
001	County		1
			2
			3
002	Sub county		1
			2
001	Forest Station		1
			2
			3
			4
			5
002	River Basin		1
			2
			3
			4
002	Village		1
			2

CAPTURE GPS LOCATION

ID	Name of Household Member *(Start with the primary respondent)*	What is [NAME'S] **Sex?** 1 =Male 2 =Female	What is **[NAME]** age? (in years)	Is **[NAME]** the Head of the Household? 1= Yes 2= No	What is the highest level of formal education has **[NAME]** completed?	What is the marital status of **[NAME]**?	What is the main occupation of **[NAME]**	Does [NAME] have any form of disability? (Please specify)
	101	**102**	**103**	**104**	**105**	**106**	**107**	**108**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

105	**106**	**107**	**108**	
1= No formal Education 2= Primary level (7 or 8) 3= Secondary (form 4 or 6) 4= Undergraduate Degree 5= Post graduate Degree 6= Diploma or another Certificate 7= Tertiary level training including TVET	1= Married 2= Single, Never Married 3= Widow/Widower 4= Divorced 5= Separated 6= Don't Know	1= Crop Farming 2= Livestock farming 3= Selling Timber and forest products 4= Casual employment/labour 5= Permanent employment 6= Other businesses(self-employed) 7= Other (Specify)	1= None 2= Physical Disability 3= Hearing Challenge 4= Sight challenge 5= Mental challenge 6= Don't Know	

1. HH distance from fence (Kms)	
1. GPS Location	
Socio-Economic Data	
2. What is the total land area (acres) that HH has	
3. Which year did the HH settle here?	
4. What is the farm ownership status of the area?	□ Private with titles □ Private with No titles □Communal □ Family held □ Other (please specify)
5. What is the total land area (acres) that HH has	
6. What is the number of persons in the Household	
7. Literacy level of HH members (insert number of persons in each level)	[] Primary level [] Secondary level [] College / University [ ] Others. Please specify_____
8. Type of house (s)on farm	□ permanent □ semi-permanent □ temporary
9. Main assets owned by household (please tick, but where more than one, put numbers)	□Motor bikes ____ □Cars _____ □ Water tank □ TV □ Radio □ Bicycles □ Mobile phones □ Gas cooker □ gas cylinder □solar panel□ others (list)
10. What is the occupation of household members (insert number in each segment)	[ ] Formal employment [ ] Informal employment [ ] work in own farm [ ] Self employed [ ] Others. Please specify_____
11. Average total HH income per year	□0-10,000 □ 10,000 – 50,000 □50,000 -100,000 □100,000 – 200,000 □ 200,000 – 300,000 □300,000 – 400,000 □400,000 – 500,000 □500,000 – 1 million □over 1 million
12. Main sources of income for HH (list in order of priority – formal employment,	

casual labour, milk sales, agricultural produce sales indicating approx. amounts)	
13. How is the HH income spent?(approx. per annum) – school fees, farm inputs, livestock inputs, new investments, energy, water etc.	
14. What is the main source of water for the household?	□ Piped connection □ Spring □ River □ Borehole □ Well □ Dam
15. How much water do you use per day?	_____Litres
16. How much do you pay for water per day/month?	Kshs_____per day Kshs _____per month
17. What is the main source of lighting for the household?	□ Kerosene lamp □ kerosene tin lamp □ Electricity □Solar lantern □ Solar home system □ Candles □ Biogas □Other (specify)
18. What is the main source of cooking energy for the household?	□ Firewood □ Charcoal □ Agricultural wastes □ Biogas □LPG □ Electricity □ Briquettes □ Other (specify
19. How much do you spend for each energy type per month?	Firewood Kshs _____Charcoal Kshs_____ Agricultural wastes Kshs_____ Biogas Kshs_____ LPG Kshs _____ Electricity Kshs____ Briquettes Kshs _____ □ Other (specify
20. Are family members involved in community groups?	□Yes □No If yes name the type of groups If No, why?
21. How does the HH benefit from members' participation in such groups?	1. Source of financial capital: □Yes □No 2. Source of technical information on agricultural production: □Yes □No 3. Marketing produce □Yes □No 4. Cash lending services □Yes □No 5. Others (specify)

Farming and Cropping Characteristics				
22. What area is under the following on farm?	Crops: _____ Farm Forestry:_____ Grazing: _____Fodder: _____ Others (Specify)			
23. What is current price of land per acre?	Kshs : _____			
24. What crops are currently grown and what is their yield and prices?	Crop type	Area grown (acres)	Yield (Kgs)	Price per Kg
25. Do you experience crop damage by animals?	□Yes □No			
26. If yes, what is the estimated loss?	Crop	Area	Problem animal(s)	Estimated lass per annum
27. Have you received any compensation?	□Yes □No			
28. If yes, how much and from whom?	Kshs: _____			
29. If no, why?				
30. What is the price (social and economic) of protecting your crops?	Item	Social cost	Economic cost	

31. Do you undertake irrigation?	□Yes □No		
32. If yes, what type of irrigation do you undertake?	□ Drip □Overhead □Farrow □Other		
33. Do you pay for irrigation water?	□Yes □No		
34. If yes, how much per month?	Kshs		

35. If yes, which crops do you grow under irrigation	Crop	Area	Yield	Price per Kg

Livestock Farming			
36. What types and numbers of livestock do you keep on-farm, and what is their value?	Livestock type	No.	Value (Kshs)

37. What type of livestock husbandry do you use?	□ Zero grazing – own fodder □ Free grazing □ Grazing in Forest □ Cut and carry from forest □ Purchase fodder □ Other		
38. Where do you get water for livestock?	□ Piped connection □ Spring □ River □ Borehole □ Well □ Dam □ Other		
Human-Wildlife Conflicts			
39. Are there any human-wildlife conflicts in the area?	□Yes □No		
40. If yes, how would you rate the intensity trend of human wildlife conflict	□ High □ Medium □ Low □ Scarce		
41. How does human-wildlife conflict affect human health in the area			
42. How does human-wildlife conflict affect education standards in the area			
43. How does human-wildlife conflict affect human cohesion in the area			
44. If yes, what are the problem animals in the last one year as a HH	Problem animal	Damage/injury	Damage/Compensation value in Kshs
45. How many hours (on average does your household spend in a week guarding crops from animals			

APPENDIX V: TOOL FOR LAND COVER MAPPING AND TRANSECT WALKS

Land Use/Land Cover Change Location Tool for Impact Study of Wildlife Barrier UTaNRMP

Date

yyyy-mm-dd

1. Location

2. Item identified

3. Status

- [ ] Mature
- [ ] Regeneration
- [ ] Degraded
- [ ] Healthy growing
- [ ] Cultivated land
- [ ] Neglected
- [ ] Bare land
- [ ] Normal
- [ ] Rainfed
- [ ] Irrigated

4. Photo

Click here to upload file. (< 10MB)

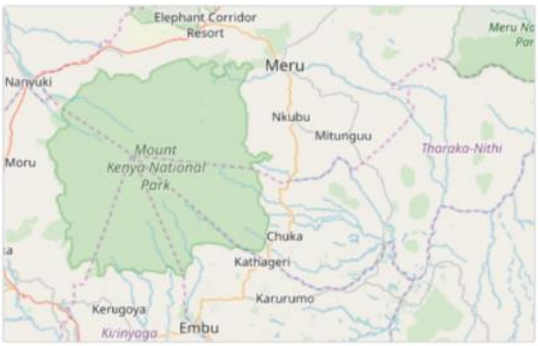
5. GPS

latitude (x.y °)

longitude (x.y °)

altitude (m)

accuracy (m)



6. Observations

(the form can be accessed on the link https://ee.kobotoolbox.org/x/#LpCNw2Er, ad)

FIELD DATA SHEET FOR TRANSECTS

Name
Date: Start time
Altitude: Coordinates
Forest Station
Transect Number: Length of Transect

Species	Number	Time/Distance from transect start	Remarks
Persons			
Stumps			
Chains saws			
Trucks			
Sheep			
Cows			

Other observations:
Signs of people's presence/activity in the area:

P**hysical changes** (natural or man-made) on the landscape such as eroded banks, landslides, new log-roads, and excavations,

Flora

Habitat/ Ecosystem*	No. of sample plot from start of Transect (1 – 10)	Species Local/ Name	No. of Individuals (stand)/Density	Stage of Growth **	DBH (CMs)	Other Remarks (girdled, dying, etc.)

*Primary forest (PF) Forest Second growth forest (SF) Grassland (G) Logged forest (LF) Cultivated areas (CA)
**Sapling (Sa) Flowering (Fl) Seedling (S) Fruiting (Fr) Mature Stand (MS)
***Food (F) Medicinal (M) Ornamental (O) Lumber (L)
**** Endangered (En) Endemic (End) Rare (-10) (R) Abundant (+10) (A)

Fauna

Species/ Local name	Habitat Type*	Number	Time /Distance From Transect Start	Conservation Status**	Remarks on what was recorded (heard, tracks, seen, droppings, signs of droppings, etc)

* Primary forest (PF) Secondary Forest (SF) Grassland (G) Logged forest (LF) Cultivated area (CA)
**Threatened; Rare' Endemic; Declining Cultural value
For unfamiliar species, it is desirable that a sketch of the animal or plant be made emphasizing distinguishing features as such as color, shape of beak, relative size (length or height), etc.

APPENDIX V1: TRANSECTS FINDINGS FOR FLORA AND FAUNA

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Chogoria	1	1	28	Saplings	100%	60	4
Chogoria		2	15	Saplings	100%		4
Chogoria		3	13	Saplings	92%		4
Chogoria		4	11	Sapling	91%	15	4
Chogoria		5	17	Saplings	82%	60	6
Chogoria		6	10	Saplings	70%	30	7
Chogoria		7	10	Saplings	50%	40-145	3
Chogoria		8	7	Mature	57%	50 - 130	3
Chogoria		9	12	Saplings	67%		4
Chogoria		10	10	Saplings	90%		4
Chogoria	2	1	25	Saplings	72%	25	4
Chogoria		2	21	Saplings	100%		6
Chogoria		3	8	Saplings	57%	14 -48	3
Chogoria		4	12	Saplings	75%	44	4
Chogoria		5	9	Saplings	100%		4
Chogoria		6	17	Saplings	100%		3
Chogoria		7	9	Saplings	67%	140	4
Chogoria		8	19	Saplings	95%	32	5
Chogoria		9	11	Saplings	27%	22-298	4
Chogoria		10	7	Saplings	86%	60	3
Chogoria	3	1	19	Saplings	100%		6
Chogoria		2	20	Saplings	95%	19	5
Chogoria		3	10	Saplings	80%	38	3
Chogoria		4	11	Saplings	100%		5
Chogoria		5	17	Saplings	100%		4
Chogoria		6	13	Saplings	100%		3
Chogoria		7	9	Saplings	100%		2
Chogoria		8	11	Saplings	82%	33	3
Chogoria		9	14	Saplings	79%	300	5
Chogoria		10	14	Saplings	86%	348-456	3
Chogoria	4	1	27	Saplings	100%		8
Chogoria		2	15	Saplings	100%		6
Chogoria		3	17	Saplings	100%		5
Chogoria		4	6	Saplings	100%		4
Chogoria		5	19	Saplings	58%	12 to 18	4
Chogoria		6	10	Saplings	20%	10 to 14	4
Chogoria		7	6	Saplings	83%	15	4
Chogoria		8	7	Saplings	100%		3
Chogoria		9	5	Saplings	100%		2
Chogoria		10	11	Saplings	100%		4

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Chogoria	5	1	12	Saplings	42%	14-16	4
Chogoria		2	10	Saplings	40%	28-40	5
Chogoria		3	10	Saplings	90%	40	7
Chogoria		4	7	Saplings	57%	40	3
Chogoria		5	9	Saplings	78%	20-22	5
Chogoria		6	22	Saplings	86%	10	5
Chogoria		7	26	Saplings	100%		3
Chogoria		8	7	Saplings	86%	24	4
Chogoria		9	7	Saplings	86%	26	3
Chogoria		10	8	Saplings	63%	28-40	5
Chogoria	6	1	21	Saplings	52%	8 to 18	6
Chogoria		2	13	Saplings	100%		2
Chogoria		3	10	Saplings	100%		5
Chogoria		4	14	Saplings	86%	152	5
Chogoria		5	11	Saplings	91%	18	4
Chogoria		6	31	Saplings	100%		4
Chogoria		7	12	Saplings	100%		4
Chogoria		8	18	Saplings	89%	220	3
Chogoria		9	9	Saplings	0%	12 to 18	2
Chogoria		10	20	Saplings	0%	12 to22	5
Chogoria	7	1	13	Saplings	100%		6
Chogoria		2	7	Saplings	86%	22	4
Chogoria		3	10	Saplings	30%	8-163	3
Chogoria		4	10	Saplings	100%		3
Chogoria		5	6	Saplings	100%		4
Chogoria		6	6	Saplings	100%		3
Chogoria		7	5	Saplings	100%		2
Chogoria		8	13	Saplings	92%	324	5
Chogoria		9	6	Saplings	100%		4
Chogoria		10	6	Saplings	83%	26	4
Chogoria	8	1	7	Saplings	100%		5
Chogoria		2	5	Saplings	100%		4
Chogoria		3	28	Saplings	100%		5
Chogoria		4	10	Saplings	100%		3
Chogoria		5	17	Saplings	41%	18-220	6
Chogoria		6	15	Saplings	100%		7
Chogoria		7	11	Saplings	100%		4
Chogoria		8	6	Saplings	100%		4
Chogoria		9	5	Saplings	100%		4
Chogoria		10	16	Saplings	69%	20-33	6
Chogoria	9	1	12	Saplings	92%	345	5
Chogoria		2	11	Saplings	100%		4

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Chogoria		3	5	Saplings	100%		4
Chogoria		4	12	Saplings	100%		4
Chogoria		5	14	Saplings	93%	22	6
Chogoria		6	11	Saplings	82%	30-228	5
Chogoria		7	15	Saplings	93%	230	4
Chogoria		8	19	Saplings	89%	190-210	3
Chogoria		9	1	Saplings	0%	358	1
Chogoria		10	4	Saplings	0%	10 to 51	4
Chuka	1	1	2	Saplings	0%	90-106	1
Chuka		2	3	Saplings	100%		1
Chuka		3	1	Saplings	0%	19	1
Chuka		4	7	Saplings	86%	62	3
Chuka		5	1	Saplings	50%	124	2
Chuka		6	12	Saplings	83%	26-96	7
Chuka		7	19	Saplings	79%	74-98	8
Chuka		8	2	Saplings	100%		1
Chuka		9	6	Saplings	100%		1
Chuka		10	4	Saplings	100%		1
Chuka	2	1	5	Saplings	100%		4
Chuka		2	4	Saplings	100%		4
Chuka		3	2	Saplings	100%		2
Chuka		4	2	Saplings	100%		2
Chuka		5	2	Saplings	100%		2
Chuka		6	2	Saplings	100%		2
Chuka		7	8	Saplings	100%		3
Chuka		8	3	Saplings	33%	31-36	2
Chuka		9	5	Saplings	60%	172-177	4
Chuka		10	11	Saplings	82%	78-157	6
Chuka	3	1	29	Saplings	55%	78	3
Chuka		2	4	Saplings	75%	101	2
Chuka		3	5	Saplings	40%	28-63	3
Chuka		4	2	Saplings	100%		2
Chuka		5	4	Saplings	75%	81	2
Chuka		6	2	Saplings	0%	33-40	2
Chuka		7	5	Saplings	80%	26	3
Chuka		8	4	Saplings	75%	28-121	2
Chuka		9	4	Saplings	75%	86	3
Chuka	4	10	4	Saplings	75%	77	3
Chuka		1	0	Saplings	100%		1
Chuka		2	0	Saplings	100%		1
Chuka		3	1	Saplings	0%	36	2

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Chuka		4	0	Saplings	100%		1
Chuka		5	0	Saplings	100%		2
Chuka		6	1	Saplings	100%		3
Chuka		7	3	Saplings	100%		2
Chuka		8	3	Saplings	100%		2
Chuka		9	3	Saplings	100%		4
Chuka		10	6	Saplings	100%		3
Chuka	5	1	14	Saplings	86%	120-456	6
Chuka		2	7	Saplings	100%		4
Chuka		3	8	Saplings	100%		5
Chuka		4	10	Saplings	100%		5
Chuka		5	6	Saplings	100%		5
Chuka		6	4	Saplings	100%		4
Chuka		7	15	Saplings	93%	65	4
Chuka		8	8	Saplings	100%		5
Chuka		9	5	Saplings	80%	96	4
Chuka		10	4	Saplings	25%	32-143	4
Chuka	6	1	11	Saplings	91%	222	4
Chuka		2	3	Saplings	67%	104	2
Chuka		3	12	Saplings	92%	270	4
Chuka		4	3	Saplings	33%	83-130	3
Chuka		5	11	Saplings	73%	61-376	5
Chuka		6	5	Saplings	60%	112-224	4
Chuka		7	13	Saplings	38%	8 to 81	3
Chuka		8	7	Saplings	100%		4
Chuka		9	23	Saplings	100%		5
Chuka		10	3	Saplings	33%	34-143	3
Chuka	7	1	2	Saplings	50%	177	2
Chuka		2	3	Saplings	67%	97	3
Chuka		3	5	Saplings	80%	152	5
Chuka		4	4	Saplings	100%		4
Chuka		5	17	Saplings	100%		4
Chuka		6	14	Saplings	86%	74-310	5
Chuka		7	8	Saplings	88%	456	5
Chuka		8	8	Saplings	88%	304	3
Chuka		9	3	Saplings	67%	124	3
Chuka		10	3	Saplings	100%		3
Chuka	8	1	7	Saplings	43%	132	3
Chuka		2	12	Saplings	75%	78	4
Chuka		3	2	Saplings	50%	152	2
Chuka		4	3	Saplings	67%	133	3
Chuka		5	9	Saplings	100%		6

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Chuka		6	4	Saplings	100%		4
Chuka		7	45	Saplings	100%		4
Chuka		8	6	Saplings	100%		4
Chuka		9	6	Saplings	100%		5
Chuka		10	8	Saplings	75%	43	4
Chuka	9	1	5	Saplings	20%	86	2
Chuka		2	5	Saplings	20%	67-349	4
Chuka		3	2	Saplings	100%		1
Chuka		4	5	Saplings	80%	359	2
Chuka		5	3	Saplings	100%		2
Chuka		6	1	Saplings	0%	35	1
Chuka		7	4	Saplings	0%	86	1
Chuka		8	3	Saplings	67%	53	2
Chuka		9	5	Saplings	100%		2
Chuka		10	2	Saplings	0%	53	1
Chuka	10	1	0	Saplings	100%		2
Chuka		2	1	Saplings	100%		1
Chuka		3	4	Saplings	100%		2
Chuka		4	1	Saplings	100%		1
Chuka		5	0	Saplings	100%		1
Chuka		6	1	Saplings	0%	56	1
Chuka		7	2	Saplings	50%	56	2
Chuka		8	2	Saplings	100%		2
Chuka		9	2	Saplings	0%	80-89	2
Chuka		10	2	Saplings	0%	99-143	2
Chuka	11	1	9	Saplings	100%		4
Chuka		2	16	Saplings	100%		6
Chuka		3	5	Saplings	80%	69	5
Chuka		4	3	Saplings	33%	57-456	3
Chuka		5	13	Saplings	100%		4
Chuka		6	12	Saplings	83%	45-93	5
Chuka		7	22	Saplings	100%		3
Chuka		8	7	Saplings	100%		4
Chuka		9	4	Saplings	0%	52-74	1
Chuka		10	5	Saplings	100%		3
Chuka	12	1	2	Saplings	0%	88-161	2
Chuka		2	1	Saplings	0%	22	1
Chuka		3	1	Saplings	0%	52	1
Lower Imenti	1	1	22	Saplings	95%	22	5
Lower Imenti		2	4	Saplings	88%	8	4
Lower Imenti		3	3	Saplings	100%		1

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Lower Imenti		4	1	Saplings	0%	11	2
Lower Imenti		5	1	Saplings	100%		2
Lower Imenti		6	3	Saplings	33%	22	4
Lower Imenti		7	1	Saplings	100%		2
Lower Imenti		8	2	Saplings	0%	8 to 22	2
Lower Imenti		9	2	Saplings	100%		3
Lower Imenti		10	3	Saplings	50%	21	3
Lower Imenti	2	1	4	Saplings	33%	42-45	2
Lower Imenti		2	0	Saplings	100%		1
Lower Imenti		3	5	Saplings	80%	22	2
Lower Imenti		4	11	Saplings	64%	8	3
Lower Imenti		5	7	Saplings	29%	18	2
Lower Imenti		6	4	Saplings	0%	8	1
Lower Imenti		7	4	Saplings	0%	4	1
Lower Imenti		8	14	Saplings	64%	21	3
Lower Imenti		9	18	Saplings	100%		3
Lower Imenti		10	15	Saplings	100%		3
Lower Imenti	3	1	1	Saplings	100%		1
Lower Imenti		2	1	Saplings	100%		1
Lower Imenti		3	1	Saplings	100%		1
Lower Imenti		4	5	Saplings	100%		2
Lower Imenti		5	0	Saplings	100%		0
Lower Imenti		6	1	Saplings	100%		1
Lower Imenti		7	0	Saplings	100%		0
Lower Imenti		8	0	Saplings	100%		0
Lower Imenti		9	0	Saplings	100%		0
Lower Imenti		10	0	Saplings	100%		2
Lower Imenti	4	1	3	Saplings	0%	9	1
Lower Imenti		2	3	Saplings	0%	7	1
Lower Imenti		3	0	Saplings	100%		2
Lower Imenti		4	0	Saplings	100%		2
Lower Imenti		5	0	Saplings	100%		2
Lower Imenti		6	1	Saplings	100%		2
Lower Imenti		7	0	Saplings	100%		0
Lower Imenti		8	0	Saplings	100%		2
Lower Imenti		9	0	Saplings	100%		2
Lower Imenti		10	0	Saplings	100%		2
Ruthumbi	1	1	7	Saplings	57%	57-126	4
Ruthumbi		2	1	Saplings	100%		1
Ruthumbi		3	1	Saplings	100%		1
Ruthumbi		4	0	Saplings	0%		0

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Ruthumbi		5	1	Saplings	0%	86	1
Ruthumbi		6	5	Saplings	100%		1
Ruthumbi		7	2	Saplings	100%		2
Ruthumbi		8	4	Saplings	100%		1
Ruthumbi		9	4	Saplings	100%		1
Ruthumbi		10	4	Saplings	100%		1
Ruthumbi	2	1	2	Saplings	100%		1
Ruthumbi		2	3	Saplings	100%		3
Ruthumbi		3	15	Saplings	100%		4
Ruthumbi		4	4	Saplings	100%		3
Ruthumbi		5	20	Saplings	100%		2
Ruthumbi		6	7	Saplings	100%		3
Ruthumbi		7	10	Saplings	100%		3
Ruthumbi		8	9	Saplings	100%		3
Ruthumbi		9	9	Saplings	89%	158	158
Ruthumbi		10	1	Saplings	0%	162	3
Ruthumbi	3	1	0	Saplings	0%		0
Ruthumbi		2	0	Saplings	0%		0
Ruthumbi		3	2	Saplings	100%		3
Ruthumbi		4	3	Saplings	67%	378	3
Ruthumbi		5	0	Saplings	0%		0
Ruthumbi		6	0	Saplings	100%		0
Ruthumbi		7	0	Saplings	100%		0
Ruthumbi		8	6	Saplings	100%		1
Ruthumbi		9	1	Saplings	0%	351	2
Ruthumbi		10	1	Saplings	0%	305	2
Ruthumbi	4	1	2	Saplings	0%	71-142	2
Ruthumbi		2	2	Saplings	0%	100-456	2
Ruthumbi		3	4	Saplings	100%		2
Ruthumbi		4	4	Saplings	75%	99	2
Ruthumbi		5	2	Saplings	0%	81-86	2
Ruthumbi		6	0	Saplings	0%		1
Ruthumbi		7	3	Saplings	100%		3
Ruthumbi		8	0	Saplings	0%		1
Ruthumbi		9	0	Saplings	0%		1
Ruthumbi		10	0	Saplings	0%		1
Ruthumbi	5	1	2	Saplings	100%		2
Ruthumbi		2	2	Saplings	100%		2
Ruthumbi		3	1	Saplings	0%	94	1
Ruthumbi		4	1	Saplings	0%	238	1
Ruthumbi		5	5	Saplings	100%		2
Ruthumbi		6	1	Saplings	0%	145	1

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Ruthumbi		7	1	Saplings	0%	122	1
Ruthumbi		8	1	Saplings	0%	106	1
Ruthumbi		9	1	Saplings	0%	26	1
Ruthumbi		10	3	Saplings	0%	71-99	2
Ruthumbi	6	1	4	Saplings	100%		3
Ruthumbi		2	6	Saplings	100%		2
Ruthumbi		3	0	Saplings	0%		0
Ruthumbi		4	3	Saplings	100%		2
Ruthumbi		5	10	Saplings	100%		1
Ruthumbi		6	14	Saplings	100%		1
Ruthumbi		7	16	Saplings	100%		1
Ruthumbi		8	19	Saplings	100%		3
Ruthumbi		9	8	Saplings	100%		2
Ruthumbi		10	2	Saplings	50%	97	2
Ruthumbi	7	1	1	Saplings	0%	114	1
Ruthumbi		2	0	Saplings	0%		1
Ruthumbi		3	1	Saplings	0%	456	1
Ruthumbi		4	2	Saplings	100%		1
Ruthumbi		5	1	Saplings	0%	708	1
Ruthumbi		6	2	Saplings	0%	106-304	2
Ruthumbi		7	1	Saplings	0%	99	1
Ruthumbi		8	1	Saplings	0%	43	2
Ruthumbi		9	1	Saplings	0%	54	1
Ruthumbi		10	1	Saplings	100%		1
Ruthumbi	8	1	2	Saplings	100%		2
Ruthumbi		2	2	Saplings	100%		2
Ruthumbi		3	1	Saplings	100%		1
Ruthumbi		4	1	Saplings	100%	94	1
Ruthumbi		5	1	Saplings	100%		1
Ruthumbi		6	0	Saplings	0%		1
Ruthumbi		7	0	Saplings	0%		1
Ruthumbi		8	1	Saplings	0%		1
Ruthumbi		9	1	Saplings	0%	228	1
Ruthumbi		10	5	Saplings	20%		3
Ruthumbi	9	1	0	Saplings	0%		0
Ruthumbi		2	7	Saplings	0%	21	1
Ruthumbi		3	0	Saplings	0%		0
Ruthumbi		4	0	Saplings	0%		0
Ruthumbi		5	0	Saplings	0%		0
Ruthumbi		6	6	Saplings	83%	195	2
Ruthumbi		7	2	Saplings	0%	118-213	2
Ruthumbi		8	0	Saplings	0%		1

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Ruthumbi		9	0	Saplings	0%		1
Ruthumbi		10	0	Saplings	0%		0
Ruthumbi	10	1	1	Saplings	0%	304	2
Ruthumbi		2	0	Saplings	0%		1
Ruthumbi		3	1	Saplings	100%		1
Ruthumbi		4	2	Saplings	100%		1
Ruthumbi		5	2	Saplings	100%		2
Ruthumbi		6	1	Saplings	0%	152	1
Ruthumbi		7	1	Saplings	100%		1
Ruthumbi		8	2	Saplings	100%		2
Ruthumbi		9	2	Saplings	100%		2
Ruthumbi		10	1	Saplings	0%	100	1
Ruthumbi	11	1	0	Saplings	0%		1
Ruthumbi		2	0	Saplings	0%		1
Ruthumbi		3	0	Saplings	0%		2
Ruthumbi		4	0	Saplings	0%		1
Ruthumbi		5	0	Saplings	0%		2
Ruthumbi		6	1	Saplings	100%		1
Ruthumbi		7	2	Saplings	100%		2
Ruthumbi		8	2	Saplings	0%	223	1
Ruthumbi		9	1	Saplings	0%	104	1
Ruthumbi		10	0	Saplings	0%		3
Ruthumbi	12	1	0	Saplings	0%		3
Ruthumbi		2	1	Saplings	0%	198	1
Ruthumbi		3	0	Saplings	0%		2
Ruthumbi		4	7	Saplings	100%		1
Ruthumbi		5	5	Saplings	100%		1
Ruthumbi		6	0	Saplings	100%		1
Ruthumbi		7	2	Saplings	100%		4
Ruthumbi		8	5	Saplings	20%	92-208	2
Ruthumbi		9	8	Saplings	100%		3
Ruthumbi		10	5	Saplings	100%		2
Ruthumbi	13	1	2	Saplings	100%		2
Ruthumbi		2	6	Saplings	100%		1
Ruthumbi		3	4	Saplings	100%		4
Ruthumbi		4	4	Saplings	100%		4
Ruthumbi		5	4	Saplings	100%		4
Ruthumbi		6	0	Saplings	0%		3
Ruthumbi		7	0	Saplings	0%		4
Ruthumbi		8	0	Saplings	0%		3
Ruthumbi		9	0	Saplings	0%		3
Ruthumbi		10	0	Saplings	0%		3

Station	Transect	Quadrant	No. of trees	Stage of Growth	% saplings	DBH range	Species mix
Ruthumbi	14	1	3	Saplings	100%		3
Ruthumbi		2	9	Saplings	100%		3
Ruthumbi		3	3	Saplings	67%	192	4
Ruthumbi		4	3	Saplings	100%		3
Ruthumbi		5	0	Saplings	0%		0
Ruthumbi		6	8	Saplings	100%		2
Ruthumbi		7	6	Saplings	100%		3
Ruthumbi		8	1	Saplings	0%	38	3
Ruthumbi		9	12	Saplings	100%		1
Ruthumbi		10	0	Saplings	0%		1
Ruthumbi	15	1	5	Saplings	100%		2
Ruthumbi		2	6	Saplings	100%		3
Ruthumbi		3	3	Saplings	33%	78	2
Ruthumbi		4	5	Saplings	80%	12	3
Ruthumbi		5	1	Saplings	0%	215	2
Ruthumbi		6	6	Saplings	33%	118	2
Ruthumbi		7	3	Saplings	100%		3
Ruthumbi		8	10	Saplings	100%		3
Ruthumbi		9	4	Saplings	100%		2
Ruthumbi		10	9	Saplings	100%		2

FOREST STATION	TRANSECT NO.	QUADRANT NO.	HABITAT/ECOSYSTEM	SPECIES LOCAL NAME	NO. OF INDIVIDUALS	DISTANCE FROM TRANSECT START/FENCE(KM)	REMARKS ON WHAT WAS RECORDED
Chogoria	T1		PF	Birds	Many	0.7	Heard / seen
Chogoria			PF	Elephants	1	0.9	Droppings
Chogoria			PF	Shoal	1	0.85	Seen
Chogoria	T2		PF	Birds	Several types		Heard
Chogoria	T3		PF	Elephants		0.2	Tracks
Chogoria			PF	Birds	Several types		Heard
Chogoria	T4		SF	Snake		0.05	Seen skin
Chogoria			SF	Birds		0.05	Heard
Chogoria			PF	Dik-dik		0.35	Droppings
Chogoria			PF	Bird		0.48	Heard/seen
Chogoria			PF	Bird		0.55	Heard
Chogoria			PF	Bird		0.65	Heard
Chogoria			PF	Elephant		0.85	Dropping
Chogoria			PF	Bird		0.85	Heard/seen
Chogoria	T5		CA Nyayo Tea	Elephant		0.1	Dropping
Chogoria			PF	Columbus monkey	1	0.3	Seen
Chogoria			PF	Birds	Many	0.4	Heard
Chogoria			PF	Elephant	1	0.57	Dropping
Chogoria			PF	Elephant	1	0.6	Dropping
Chogoria			PF	Gazelle	1	0.8	Dropping
Chogoria	T6	Q7	PF	Antelope	Single footstep	0.65	Footsteps seen
Chogoria	T7	Q6	PF	Elephant		0.52	Dropping
Chogoria	T8		PF	Kwaare'	2	0.6	Seen
Chogoria	T9	Q1	PF	Monkey	1	0	Seen on trees
Chogoria		Q2	PF	Birds		0.1	Seen

Chogoria		Q9	PF	Hornbill	2	0.8	Seen
Chuka	T1	Q6	PF	Elephant	Several (herd)steps	0.5	Tracks/steps/footprints
Chuka	T2		PF	Birds	Several types	0.3	Seen, heard
Chuka		Q1	PF	Chameleon	1	0.005	Seen
Chuka		Q4	PF	Dik-dik			Heard
Chuka		Q8	PF	Elephant		0.7	Droppings
Chuka		Q9	PF	Elephant		0.8	Droppings
Chuka	T3		PF	Elephant		0.5	Droppings
Chuka			PF	Birds		0.6	Heard singing
Chuka			PF	Cricket		0.6	Heard singing
Chuka	T4		SF	Elephant		0.3	Droppings
Chuka			SF	Birds		0.4	Heard
Chuka			SF	Monkey		0.6	Seen
Chuka			SF	Monkey		0.8	Heard
Chuka			SF	Birds		0.9	Heard
Chuka			SF	Butterfly		0.9	Seen
Chuka			SF	Mongoose		0.9	Seen
Chuka	T5		PF	Bees	5 beehives	0.11	Bee hives observed
Chuka			PF	Elephant		0.11	Droppings
Chuka			PF	Bees		0.31	Hives, bees
Chuka			PF	Bees		0.61	Hives, bees
Chuka	T6		PF	Elephant		5.5	Droppings
Chuka			PF	Bees		5.5	Bee hives observed
Chuka			PF	Snail	4		Seen
Chuka			PF	Elephant		5.6	Droppings
Chuka	T7		PF	Millipede		0.5	Observed
Chuka			PF	Elephant		0.5	Droppings

Chuka	T8		SF	Birds		0.408	Droppings
Chuka			SF	Birds		0.408	Feathers
Chuka			SF	Butterfly		0.508	Seen
Chuka			SF	Praying mantis		0.508	Seen
Chuka			SF	Butterflies		0.608	Seen
Chuka			SF	Birds		0.6	Seen
Chuka			SF	Birds		0.708	Seen
Chuka			SF	Insects		0.708	Seen
Chuka			SF	Butterflies		0.801	Seen
Chuka			SF	Grasshoppers		0.808	Seen
Chuka			SF	Snail		0.808	Seen
Chuka			SF	Ants		0.908	Seen
Chuka			SF	Butterflies		0.908	Seen
Chuka			SF	Birds		0.908	Droppings
Chuka			SF	Frog		0.908	Seen
Chuka							
Chuka	T9		PF	Birds			Seen
Chuka	T10		PF	Elephant	Signs	0.05	Animal droppings
Chuka			PF	Bees			Seen, heard
Chuka			PF	Birds			Singing
Chuka			PF	Mouse		0.95	Seen
Chuka	T11		PF	Elephant		0.2	Droppings
Chuka				Birds	10		Observed
Chuka				Elephant		0.3	Droppings
Chuka	T12		PF	Elephant		0	Droppings
Chuka			PF	Birds	Many (various)	0.2	Singing
Lower Imenti	T1	Q1	SF	Hornbill	1	0.05	Seen

		Q3	SF	Hawk	1	0.25	Seen
		Q9	SF	Squirell	1	0.8	Seen
			SF	Birds	2	0.8	Seen
Lower Imenti	T2	Q6	PF	Gazelle		0.5	Tracks
		Q7	PF	Birds		0.6	Heard
Lower Imenti	T3		SF	Birds	4	0.1	Heard
			SF	Gazelle		0.28	Tracks
			SF	Birds	2	0.3	Seen
			SF	Elephant	Tracks seen	0.4	Tracks
Lower Imenti	T4	Q5	SF	Antibear	1	0.5	Seen
		Q7	SF	Birds	Various kinds	0.7	Singing/heard
Ruthumbi	T1	Q4	PF	Birds	3	0.31	Heard
Ruthumbi	T2	Q1	PF	Columbus monkey	5	0.05	Seen on trees
			PF	Birds	2		Heard
			PF	Monkey	1		Sound on trees
Ruthumbi	T3		PF	Birds	Several	Seen, heard	
Ruthumbi	T4		PF	Elephant		0.2	Droppings
			PF	Birds			Heard
			PF	Columbus & Skyes monkey		0.5	Seen
		Q10	PF	Birds		1	Heard
Ruthumbi	T5	Q2	PF	Columbus monkeys		0.22	
				Birds		0.22	
Ruthumbi		Q5	PF	Birds		0.52	Heard
Ruthumbi	T6	Q5	PF	Birds	2		Sounds
			PF	Elephant			Elephants damage
Ruthumbi	T7	Q1	PF	Elephant		0.1	Footmarks
				Birds			Heard, seen

Ruthumbi		Q6	PF	Elephant		0.6	Droppings
Ruthumbi	T8		PF	Birds		0.001	Heard
				Columbus monkey		0.01	Seen
Ruthumbi	T9		PF	Birds	4		Seen, heard
Ruthumbi	T10		PF	Birds	4		Seen, heard
Ruthumbi	T11		PF	Birds		0.01	Heard
				Skye monkeys		0.005	Seen
Ruthumbi	T12		PF	Elephant			Droppings
			PF	Birds			Sounds
Ruthumbi	T13	Q3	PF	Birds		0.2	Heard
Ruthumbi	T14	Q5	PF	Birds		0.4	Several types heard
Ruthumbi	T15		PF	Elephants			Droppings
			PF	Birds	10		Sounds
			PF	Elephant			Fresh droppings

APPENDIX VII: LIST OF PERSONS MET/INTERVIEWED

No.	Name	Organization	Designation	Forest Station/Location
1	Mr. Paul Njuguna	UTaNRMP	Land and Environment Coordinator	Embu
2	Grace N. Mwangi	UTaNRMP	Monitoring and Evaluation	Embu
3	Joyce W.Mathenge	UTaNRMP	Community Empowerment	Embu
4	Mr. Simon Mumbere	UTaNRMP	Knowledge Management	Embu
5	Japheth Kithuchi	Chogoria CFA	Chairman	Chogoria
6	Mr. Mugambi Mutambo	Mutindwa Mixed Day Secondary School	Head Teacher	Chogoria
7	Mrs. Lucy Nyaga –	PCEA Gitare Primary School	Headmistress	Chogoria
8	Mr. Kevin Opondo	Kenya Wildlife Service	Warden	Chogoria
9	Mr. Edwin	Kenya Forest Service	Forest Manager	Ruthumbi
10	Mrs. Wilbroda Ngobira	Kenya Forest Service	Ruthumbi Forest Officers	Ruthumbi
11	Mrs. Isabella Muite	Kenya Forest Service	Ruthumbi Forest Officers	Ruthumbi
12	Geoffrey Leraryan	Kenya Forest Service	Assistant Forest manager	Ruthumbi
13	Mr. Linus Mugambi	Community Forest Association	Chairman	Ruthumbi
14	Ms Frida Mwenda	Community Forest Association	Treasurer	Ruthumbi
15	Mr. David Gitonga	Rhino Ark	Maintenance Team	Ruthumbi
16	Mr. Humphrey Munene	Mt. Kenya Trust	Field Coordinator	Ruthumbi
17	Mr. Gerald Mbabu	Irimbene Primary School	Headteacher	Lower Imenti
18	Mrs. Lucy Kagwiria	Kamitongu Primary School	Deputy Headmistress	Lower Imenti
19	Mr. Mohammed Mandera	Kenya Wildife Service	Warden	Meru
20	Mr. Simon Githinji	Rhino Ark	Maintenance Team	Meru
21	Mr. Simon Murithi	Rhino Ark	Maintenance Team	Lower Imenti
22	Mr. John Gacheru Kamau	Upper Tana County Project Coordinator	CPC	Chuka
23	Mr. Simon Kiragu	Upper Tana Chuka	Water Officer	Chuka
24	Henry Mwangi	Kenya Forest Service	Forest Manager	Lower Imenti
25	Mr. Mburugu Eric	Department of Social Services	Social Service Officer	Chogoria
26	Christine Karimi	Ministry of Agriculture	Agriculture Officer	Chogoria
27	Moses Kariuki	Kiamuruki Primary school	Headteacher	Chuka
28	James Mburu	Tharaka-Nithi County	Ecosystem Conservator-KFS	Chuka
29	Richard O.Arunga	Tharaka-Nithi County	Ass. Ecosystem Conservator-KFS	Chuka
30	John K Maina	Chuka forest station	Forest Manager	Chuka
31	Salome Biwott	Chuka forest station	Ass. Forest Manager	Chuka
32	Elias Mwamba	Chogoria Forest Station	Forest Manager	Chogoria
33	Abel Kimutai	Chogoria forest station	Ass. Forest Manager	Chogoria
34	Mr Mukaya	Departmenent of Agriculture-Chuka	Sub-County Agriculture Officer	Chuka
35	Madam Lilian	Departmenent of Agriculture-Chuka	Ass. Sub County officer livestock	Chuka
36	Elizabeth Kiogora	Lower Imenti CFA	Chairlady/CBO	Lower Imenti
37	Kenneth Muriithi Kamanda	Chuka CFA	Chairman	Chuka
38	Sebastian Marangu	South Mara WRUA	Chairman	Chogoria

No.	Name	Organization	Designation	Forest Station/Location
39	Mr Mbae	Tungu WRUA	Secretary	Chuka
40	Mr. Mugendi	Upper Thuci WRUA	Chairman	Chuka
41	Mr. Ndwiga	NIWASCO-CHUKA	General Manager	Chuka
42	Antony Njagi	Magumoni water project	General Manager	Chuka
43	Mr Njiru	Muthambi water 4K Association	General Manager	Chuka
44	Mr. P. Njeru	Ministry of Agriculture	Agriculture Officer	Lower Imenti
45	Mr. Kibia Mariti	Mitunguru Secondary School	Headteacher	Ruthumbi
46	Ms Amina	KWS	KWS Officer	Chuka
47	Mr. Mureithi	Kiamuga WRUA	Chairman	Ruthumbi

APPENDIX VIII: FGD PARTICIPANTS LIST

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
1	Caroline Kiende	Female	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	35839123
2	Moses Wambugu	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	33724873
3	Hellen Kirito	Female	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	225585894
4	Faith Mukiri	Female	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	28784231
5	Lucy Kayuyu	Female	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	25875560
6	Petar Mutabari	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	25217723
7	Haron Kirimi	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	23785737
8	Eliud Kathurima	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	22102493
9	David Mwiti	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	14446061
10	Elias Ntongai	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	27201420
11	Jeremy Mutuma	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	29909744
12	Andrew Mbabu	Male	Youth	Youth Kamitongu	Lower Imenti	Lower Imenti	11551048
13	Peter Ntangwiri	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	22135794
14	Gideon Kaai	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	9295690
15	David Karithi	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	22218395
16	George Muriki	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	25419918
17	Nicholas Kiambi	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	22218191
18	John Mburugu	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	23086013
19	Peter Kathurima	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	8880335
20	Joseph Mwiti	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	14639391
21	Joseph Ntarangwi	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	7676989
22	Peter Mungori	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	10613685
23	Julius Ntoburi	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	4465098
24	Stephen Mutwiri	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	12886134
25	Wilson Kathurima	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	14604169
26	Paul Muthee	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	13478988
27	Christopher Bariu	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	5548556
28	Nafftary Nkanda	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	7763656
29	Benson Mwenda	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	7465507
30	David Munjuri	Male	Adults	Male Adults Kamitongu	Lower Imenti	Lower Imenti	7763336
31	Sarah Gatui	Female	Youth	Chuka Station	Chuka	Chuka	5097261
32	Maricella Kathuni	Female	Youth	Chuka Station	Chuka	Chuka	4526730
33	Breter Giagutari	Female	Youth	Chuka Station	Chuka	Chuka	_
34	Zachary Munene	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	10898116
35	Mary Kendi	Female	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	28219084
36	Agnes Kagwira	Female	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	37175197
37	Judith Kendi	Female	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	30477626
38	Esther Muthoni	Female	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	29812683
39	Isaiyah Muugathia	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	12622077
40	Solomon Kinoti	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	21024295

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
41	Barbra Irai	Female	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	1107606
42	Burijet Kagendo	Female	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	26897239
43	Evans Mwenda	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	21989278
44	Robert Mukaria	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	12621415
45	Edward Mutabari	Male	Youth	Central BIT Youth Group	Lower Imenti	Lower Imenti	22256388
46	Kelvin Mwenda	Male	Class seven	Kiamuruki Primary School	Rugae	Rugae	_
47	Tony Njagi	Male	Class seven	Kiamuruki Primary School	Kanugoru	Kanugoru	_
48	Antony Fundi	Male	Class eight	Kiamuruki Primary School	Rugae	Rugae	_
49	Lisbel Kinya	Female	Class six	Kiamuruki Primary School	Rugae	Rugae	_
50	Vizto Kathure	Female	Class seven	Kiamuruki Primary School	Rugae	Rugae	_
51	Clinton Karani	Male	Class eight	Kiamuruki Primary School	Kanugoru	Kanugoru	_
52	Morris Mugambi	Male	Class six	Kiamuruki Primary School	Kibige	Kibige	_
53	Ian Muteli	Male	Class six	Kiamuruki Primary School	Kanugoru	Kanugoru	_
54	Grace Njeri	Female	Class six	Kiamuruki Primary School	Rugae	Rugae	_
55	Maureen Gakii	Female	Class eight	Kiamuruki Primary School	Rugae	Rugae	_
56	Hope Joy Muthoni	Female	Class eight	Kiamuruki Primary School	Kanugoru	Kanugoru	_
57	Liza Mukami	Female	Class seven	Kiamuruki Primary School	Rugae	Rugae	_
58	Sarah Kabweria	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	13177519
59	Susan Nthama	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	10253456
60	Sabina Mukamau	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	2378955
61	Rose Gatheki	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	_
62	Naomi Ngathaa	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	_
63	Roselyn Makena	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	23831066
64	Damaris Kariri	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	22290281
65	Eunice Karimi	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	16091046
66	Gladys Gateria	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	23823391
67	Rebecca Nduta	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	_
68	Gladys Kaweria	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	_
69	Catherine Kaguda	Female	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	12892066
70	Simon Gituma	Male	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	2443565
71	Elias Mwire	Male	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	2532424
72	Peter Mutavari	Male	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	25217723

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
73	Andrew Mururu	Male	Youth	Lower Imenti CFA Committee	Kamitongu	Lower Imenti	11609493
74	Loise Gataaka Gitonga	Female	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	12731751
75	Charles Mutwiri	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	23973948
76	Gladys Murugi	Female	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	4453272
77	Jeska Kaari	Female	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	3111983
78	John Muthee Nyaga	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	2531793
79	David Micheni	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	1728219
80	Stanley Mutegi	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	1005709
81	Justin Muthee	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	4453196
82	Justin Njoka	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	2530545
83	Elius Nyaga	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	5773151
84	Kenneth Muriithi Kamanda	Male	Youth	Mt. Kenya East Environmental Conservation	Meru South	Chuka	8861258
85	Faith Gatwiri	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	24838209
86	Betty Mwendwa	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	35404733
87	Mwongela Mitu	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	22591562
88	Consolata Mwatwana	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	26440190
89	Mirriam Mpinja	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	3526443
90	Jane Mbaya	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	20604681
91	Rhoda Kigetu	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	23937143
92	Zaka Sakaluma	Female	Youth	Rwambeka CBO	Mbeu	Lower Imenti	23897553
93	Paul Njogu	Male	Youth	Rwambeka CBO	Mbeu	Lower Imenti	31269638
94	Keldin Makena	Female	Class six	Ngine Primary School	Imenti Meru	Lower Imenti	_
95	Dessy Mwendwa	Female	Class seven	Ngine Primary School	Imenti Meru	Lower Imenti	_
96	Josephine Naitore	Female	Class six	Ngine Primary School	Imenti Meru	Lower Imenti	_
97	Jolly Ntinyari	Female	Class five	Ngine Primary School	Imenti Meru	Lower Imenti	_
98	Violet Kawira	Female	Class five	Ngine Primary School	Imenti Meru	Lower Imenti	_
99	Kelvin Munene	Male	Class seven	Ngine Primary School	Imenti Meru	Lower Imenti	_
100	Solovodon Waithaka	Male	Class five	Ngine Primary School	Imenti Meru	Lower Imenti	_
101	Brendah Gaichuiri	Female	Class seven	Ngine Primary School	Imenti Meru	Lower Imenti	_
102	Kelvin Mutugi	Male	Class seven	Ngine Primary School	Imenti Meru	Lower Imenti	_

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
103	Pawel Mwiti	Male	Class five	Ngine Primary School	Imenti Meru	Lower Imenti	_
104	Lewis Ihirinya	Male	Class six	Ngine Primary School	Imenti Meru	Lower Imenti	_
105	Nathan	Male	Class six	Ngine Primary School	Imenti Meru	Lower Imenti	_
106	Martha Kanyira	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	_
107	Dorcas Kanario	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	1317718
108	Teresia Katwiria	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	27196470
109	Rael Kiamuiri	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	8871338
110	Elizabeth Keroche	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	7447522
111	Marycella Ngeta	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	2489869
112	Joanina Kinya	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	12694078
113	Lucy Ngatha	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	20776781
114	Jennifer Bulenywa	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	9087053
115	Joyce Ngiring'a	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	12617625
116	Nancy Kariuki	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	4516689
117	Peter Maingi	Male	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	7670891
118	Francis Murimi	Male	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	2365353
119	Festus Mikwa	Male	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	7762444
120	George Nkurou	Male	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	4517478
121	Zipporah Mbebegu	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	7671272
122	Philis Mwendwa	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	8883142
123	Rael Munyiva	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	7207204
124	Faith Kendi	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	35636615
125	Cecilia Kirote	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	23330074
126	Chanty Karabu	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	12890322
127	Agnes Kagwira	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	2482061
128	Joyce Makena	Female	Youth	Gankere Central Beat CFA	Lower Imenti	Lower Imenti	7671643
129	Dorothy Kawira Kaburu	Female	Youth	Chogoria CFA	Chogoria	Chogoria	9047008
130	Kingshford Mutegi	Male	Youth	Chogoria CFA	Chogoria	Chogoria	13619957
131	Lloyd Njeru	Male	Youth	Chogoria CFA	Chogoria	Chogoria	2515200
132	Nicholas Muriithi	Male	Youth	Chogoria CFA	Chogoria	Chogoria	2462676
133	Edwin Mburia	Male	Youth	Chogoria CFA	Chogoria	Chogoria	_
134	Pamela Wanja	Female	Youth	Chogoria CFA	Chogoria	Chogoria	9096503
135	Loyford Riungu	Male	Youth	Chogoria CFA	Chogoria	Chogoria	1140626
136	Gerrard Mwebia	Male	Youth	Chogoria CFA	Chogoria	Chogoria	2463169

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
137	Japheth Kithuci	Male	Youth	Chogoria CFA	Chogoria	Chogoria	517439
138	Sharon Mukami	Female	_	PCEA Gitare Primary School	Gitombani	Chogoria	_
139	Vivian Kendi	Female	_	PCEA Gitare Primary School	Mwiriani	chogoria	_
140	Kelly Kananu	Female	_	PCEA Gitare Primary School	Mwiriani	Chogoria	_
141	Pauline Kathambi	Female	_	PCEA Gitare Primary School	Mwiriani	Chogoria	_
142	Grace Gatugi	Female	_	PCEA Gitare Primary School	Kanyamweni	Chogoria	_
143	Glory Mwende	Female	_	PCEA Gitare Primary School	Mwiriani	Chogoria	_
144	Kelvin Murimi	Male	_	PCEA Gitare Primary School	Gikamurita	Chogoria	_
145	Edwin Mwenda	Male	_	PCEA Gitare Primary School	Mwalia	Chogoria	_
146	Kelvin Kirimi	Male	_	PCEA Gitare Primary School	Mwalia	Chogoria	_
147	Victor Mwenda	Male	_	PCEA Gitare Primary School	Kanyamweni	Chogoria	_
148	Jayson Mugendi	Male	_	PCEA Gitare Primary School	Mwiriani	Chogoria	_
149	Cohen Njenga	Male	_	PCEA Gitare Primary School	Mwiriani	Chogoria	_
150	Ireen Gatiye	Female	Youth	Mutindwa Secondary School	Gitombani	Chogoria	_
151	Brendah Gatugi	Female	Youth	Mutindwa Secondary School	Kauroko	Chogoria	_
152	Christine Mukami	Female	Youth	Mutindwa Secondary School	Kianjagi	Chogoria	_
153	Brendah Nyawira	Female	Youth	Mutindwa Secondary School	Rwanchoge	Chogoria	_
154	Caroline Kendi	Female	Youth	Mutindwa Secondary School	Mwiriani	Chogoria	_
155	Glory Nyawira	Female	Youth	Mutindwa Secondary School	Nkabu	Chogoria	_
156	Erick Kariuki	Male	Youth	Mutindwa Secondary School	Karimamwaro	Chogoria	_
15	Fortune Muriithi	Female	Youth	Mutindwa Secondary School	Nkabu	Chogoria	_
158	Jabez Kimani	Male	Youth	Mutindwa Secondary School	Kanyamweni	Chogoria	_
159	Dennis Mwiti	Male	Youth	Mutindwa Secondary School	Kanyamweni	Chogoria	_
160	Dennis Murimi	Male	Youth	Mutindwa Secondary School	Kibaranu	Chogoria	_
161	Ian Mwiti	Male	Youth	Mutindwa Secondary School	Kibaranu	Chogoria	_
162	Ezekiel Muchai	Male	_	Kamitongu Primary School	Nkilubu	Chogoria	_
163	Brendah Mwendwa	Female	_	Kamitongu Primary School	Nkilubu	Chogoria	_
164	Risper Gatuiri	Female	_	Kamitongu Primary School	Nkilubu	Chogoria	_
165	Antony Muriuki	Male	_	Kamitongu Primary School	Nkilubu	Chogoria	_
166	Glory Kathure	Female	_	Kamitongu Primary School	Kanjai	Chogoria	_
167	Josephine Wanja	Female	_	Kamitongu Primary School	Kanjai	Chogoria	_
168	Alex Muragiri	Male	_	Kamitongu Primary School	Nkilubu	Chogoria	_

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
169	Ken Muchui	Male	_	Kamitongu Primary School	Nkilubu	Chogoria	_
170	Cosmas muchui	Male	_	Kamitongu Primary School	Nkilubu	Chogoria	_
171	Clinton Mutwiri	Male	_	Kamitongu Primary School	Nkilubu	Chogoria	_
172	Nelly Mugure	Female	_	Kamitongu Primary School	Nkilubu	Chogoria	_
173	Eva Mukiri	Male	_	Kamitongu Primary School	Kanjai	Chogoria	_
174	Colombiana Kagendo	Female	Youth	Kithiria Bio- diversity Conservation Centre	Muthumbi	Muthumbi	3936335
175	Linus M. Amos	Male	Youth	Kithiria Bio- diversity Conservation Centre	Muthumbi	Muthumbi	8074716
176	Samwel Mungania	Male	Youth	Kithiria Bio- diversity Conservation Centre	Muthumbi	Muthumbi	2462828
177	Maricella kajau	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	13814008
178	Sophia Girindi	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	2530218
179	Edith Giamutegi	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	31642460
180	Violet Kaari	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	2383080
181	Caroline Mwimbi	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	_
182	Purity Kamunyu	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	3737506
183	Juliet Ngucu	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	4526312
184	Mary Muthoni Njeru	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	3516793
185	Doreen Maitha	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	21086670
186	Aileen Ndeke	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	_
187	Mary Njoki Ndwiga	Female	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	3512321
188	Patrice N Njagi	Male	Youth	CFA Nthambo Network Self- Help Group	Chuka	Chuka	3514141
189	Moses Gitari	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	1142736
190	Eldad Miriti Muthuya	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	269164
191	Pilford k Riungu	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	13353545
192	Dickson Kaburu	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	23560888
193	Fredrick Mwandiki	Male	Youth	Sambana Bee Keepers	Chogoria	chogoria	11256158
194	Gitonga Nabica	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	_
195	Kaburu Michek	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	508856
196	Riungi Baruthi	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	7459193
197	Kithirigi Nkambu	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	745854
198	Elsas Javan	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	2462957
199	Charles Njeru	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	1090539
200	Jackson Bundi	Male	Youth	Sambana Bee Keepers	Chogoria	Chogoria	2490247
201	Riungu Mutharuciu	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	2495841
202	Muriithi Muriu	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	4492452

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
203	David Mbabu	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	133359441
204	George Karani	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	2495741
205	Basti Muinavuciu	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	2514682
206	M'Ndaka Riungu	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	4492483
207	Julius Ndege	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	2515428
208	Geoffrey Marangu	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	8876935
209	Paul Ngaruthi	Male	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	2494375
210	Judith Japhet	Female	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	6756830
211	Edith Francis	Female	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	7460658
212	Idah Mirewa	Female	Youth	Kathiira Bio- Diversity Conservation Centre	Uthumbi	Uthumbi	_
213	Augustino Lancaster	Male	Youth	Thuci WRUA- Chuka	Chuka	Chuka	23645
214	Mureithi njoka	Male	Youth	Thuci WRUA- Chuka	Chuka	Chuka	_
215	Franklin Mutegi	Male	Youth	Thuci WRUA- Chuka	Chuka	Chuka	443388
216	John Njeru	Male	Youth	Thuci WRUA- Chuka	Chuka	Chuka	2382110
217	Mutegi Mbaka	Female	Youth	Thuci WRUA- Chuka	Chuka	Chuka	4453167
218	Casty Murigi	Female	Youth	Thuci WRUA- Chuka	Chuka	Chuka	_
219	Susan Kambura	Female	Youth	Thuci WRUA- Chuka	Chuka	Chuka	21086671
220	Jennifer Ciakirimo	Female	Youth	Thuci WRUA- Chuka	Chuka	Chuka	21940780
221	Elssy Muthen	Female	Youth	Thuci WRUA- Chuka	Chuka	Chuka	4527599
222	Margaret Mawita	Female	Youth	Thuci WRUA- Chuka	Chuka	Chuka	_
223	Linus M. Amos	Male	Youth	Ruthumbi Environmental Conservation	Ruthumbi	Ruthumbi	7863704
224	Celina Kathambi Joshua	Female	Youth	Ruthumbi Environmental Conservation	Ruthumbi	Ruthumbi	7715045
225	Mary Kinanu Mburugu	Female	Youth	Ruthumbi Environmental Conservation	Ruthumbi	Ruthumbi	8870366
226	Charles Bundi	Male	Youth	Ruthumbi Environmental Conservation	Ruthumbi	Ruthumbi	13757597
227	Kenneth Mugambi Kirimi	Male	Youth	Ruthumbi Environmental Conservation	Ruthumbi	Ruthumbi	27701700
228	Emily Kawira	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	4540252
229	Lydia Karambu	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	31547554
230	Maritha Jabani	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	20970438
231	Peninah Nkatha	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	16120581
232	Jane Kathira	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	1260405
233	Hildah Kaari	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	10149824
234	Julia Makena	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	7457784
235	Salome Mutuma	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	_

NO.	NAME	GENDER	DESIGNATION/ CLASS	GROUP	LOCATION	FOREST STATION	ID NUMBER
236	Alice Nkirote	Female	Youth	Rwambeka Women Group	Rwambeka	Rwambeka	10486255
237	Elizabeth Kiogora	Female	Youth	Lower Imenti CFA	Lower Imenti	Lower Imenti	3747072
238	Stanley Mungatha	Male	Youth	Lower Imenti CFA	Lower Imenti	Lower Imenti	11696821
239	George Nyonta	Male	Youth	Lower Imenti CFA	Lower Imenti	Lower Imenti	7670892
240	Salome Karwira	Female	Youth	Lower Imenti CFA	Lower Imenti	Lower Imenti	2482892
241	Zipporah Muuna	Female	Youth	Lower Imenti CFA	Lower Imenti	Lower Imenti	16100049
242	Norman Mutethia	Male	Form 3	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
243	Daniel Mutethia	Male	Form 1	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
244	Eric Mwongela	Male	Form 2	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
245	Bonface Muthomi	Male	Form 3	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
246	Caleb Kiumbi	Male	Form 2	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
247	Jacob Bundi	Male	Form 1	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
248	Elsy Kananu	Female	Form 1	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
249	Eunice Wanjiru	Female	Form 2	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
250	Nancy Kendi	Female	Form 2	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
251	Sarah Gakii	Female	Form 1	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
252	Belindah Gatwiri	Female	Form 3	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
253	Beth Kairuthi	Female	Form 3	Kamitongu Secondary School	Kamitongu	Lower Imenti	_
254	Jane Kanyai	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	24088971
255	Ann Kathure	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	_
256	Agnes Nkatha	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	21408899
257	Caroline Kendi	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	24516982
258	Harriet Kinya	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	21936694
259	Jennifer Rwane	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	8693799
260	Avanjile Karambu	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	21354870
261	Faith Makena	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	33903460
262	Susan Kainda	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	21488085
263	Grace Mwari	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	12621348
264	Eunice Karimi	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	_
265	Sarah Mwontune	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	32305240
266	Catherine Mukiri Mboya	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	_
267	Harriet Gateti	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	_
268	Abinja Karwira	Female	Youth	Kanja Women Group	Ruthumbi	Ruthumbi	20719260

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