Kenya's Water Towers Protection and Climate Change Mitigation and Adaptation (WaTER) Programme

2ND INTERIM NARRATIVE REPORT

Component 4: Science to Inform Design of Community-Level Actions and Policy Decisions

Contract number: FED/2015/360-270

Reporting period: 16Th September 2016 - 15Th September 2017

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Kenya Forestry Research Institute (KEFRI)

Second year of project implementation

Programme title: Kenya's Water Towers Protection and Climate Change Mitigation and Adaptation (WaTER) Programme

Contract period: 2015-2020 (60 Months)

Programme Coordinator: Ministry of Environment and Natural Resources

Cover photo: A view of Mt Elgon Forest Ecosystem at Koitobos peak

Implementing agencies:	Kenya Forestry Research Institute (KEFRI), Kenya Forest Service (KFS), Kenya Water Towers Agency (KWTA), Kenya Wildlife Service (KWS), and Climate Change Directorate (CCD)

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List of acronyms

ATC	Agricultural Training Centre
AWM	Agricultural Water Management
CCD	Climate Change Directorate
CMO	Component Management Office
CSC	Component Steering Commitee
CIC	Component Implementation commitee
CFA	Community Forest Association
EDF	European Development Fund
GIS	Geographical Information System
GPS	Global Positioning System
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
KWS	Kenya Wildlife Service
KWTA	Kenya Water Towers Agency
LULC	Land Use Land Cover
LVBERP	Lake Victoria Basin Eco-region Research Programme
MENR	Ministry of Environment and Natural Resources
NPSC	National Programme Steering Committee
NRM	Natural Resource Management
NWFPs	Non Wood Forest Products
PGIS	Participatory Geographic Information System
RPIC	Regional Project Implementation Committee
RS	Remote Sensing
RVERP	Rift Valley Eco-Region Research Programme
SLM	Sustainable Land Management
USGS	U.S. Geographical Survey
WRUA	Water Resource Users Association

1. Description

1.1 Name of Coordinator of the grant contract: **Kenya Forestry Research Institute (KEFRI)**

1.2 Name and title of the Contact person: **Ben E. N. Chikamai (PhD), Director**

1.3 Name of Beneficiary(ies) and affiliated entity(ies) in the Action: **Kenya Forestry Research Institute (KEFRI)**

1.4 Title of the Action: **Science to inform design of community-level actions and policy decisions: Evidence-based identification and targeting of interventions and policy decisions**

1.5 Contract number: **FED/2015/360-270**

1.6 Start date and end date of the reporting period: **16th September 2016 – 15th September 2017**

1.7 Target country(ies) or region(s): **Mt. Elgon and Cherangany Forest ecosystems in Western and North Rift parts of Kenya respectively**

1.8 Final beneficiaries &/or target groups[1] (if different) (including numbers of women and men):

a) Target group:

The number of people targeted by the action depends on the site location and covers a large part of Kenya:

- Community memebers living on the catchments of both Mt. Elgon and Cherangany Hills water towers.
- Special interest groups including women, the youth and people with disabilities in communities in both Mt. Elgon and Cherangany Hills Ecosystems.
- Community Forest Associations (CFAs) and Water Resource Users Associations (WRUAs).
- Kenya Forest Service (KFS), Kenya Wildlife Service, Water Towers Agency, Climate Change Directorate and Water Resources Management Authority.
- County Governments in the eleven counties of the project area: West Pokot, Elgeyo Marakwet, Uasin Gishu, Kakamega, Vihiga, Nandi, Bungoma, Trans Nzoia, Kisumu, Siaya and Busia.
- Ministry of Environment and Natural Resources (MENR), Ministry of Energy, Ministry of Agriculture, Ministry of Water and Irrigation, Ministry of Tourism and Marketing.

b) Final beneficiaries:

- Communities living downstream who benefit from high level water tables of the river systems and carry out their agricultural and other land based activities.
- Two Water companies (Lake Victoria North and lake Victoria South) downstream that rely on rivers in order to distribute water to urban and peri-urban residents who benefit from the two

[1] "Target groups" are the groups/entities who will be directly positively affected by the project at the Project Purpose level, and "final beneficiaries" are those who will benefit from the project in the long term at the level of the society or sector at large.

ecosystems. In addition, reduction in sedimentation and pollution levels of rivers will decrease and reduce water purification costs.

- Universities and other learning institutions offering their expertise and at the same time benefiting from research results.
- The society in the project targeted areas and beyond since the ecosystems will improve and also contribute to poverty reduction and livelihoods improvement. More so, the policies, protocols and management frame works to be developed based on the research results, and demonstrations done will impact on the society in the counties , the country, the region and the globe at large.

1.9 Country(ies) in which the activities take place (if different from 1.7):

2. Assessment of Implementation of Action Activities

Executive summary of the Action

Component 4 of the WaTER Tower Programme being implemented by KEFRI aims to identify and actualize scientific evidence-based support for policy decisions and local interventions in both Mount Elgon and Cherangany Hills Ecosystems to enhance participation by local communities, and improve their livelihoods. Information generated benefit stakeholders working with KEFRI in the two water Towers as well as communities upstream and further afield. The main focus for the component is baseline assessment of the biophysical and socio-economic status of the 2 Ecosystems; development of Payment for Ecosystem services (PES) models; Integration and demonstration of selected rehabilitation technologies; demonstrating management of Bamboo and other high value tree crops including fruit trees; development of Nature based enterprises; and providing data and information through communication and knowledge management systems.

Implementation of Component 4 activities started in September 2015, after a grant agreement was signed between the EU and KEFRI with the first year of action ending on 15th September 2016. Most of the activities planned for the first were implemented within the period with about 60% of project activities being completed. The first interim report was presented to and accepted by the EU on time. During the first year of implementation, Component 4 established project management structures, recruited personnel, secured office space, built capacity of the staff, implemented activities covering all the 7 outputs, hosted various meetings, visited many project sites and procured 70% of the equipment and services planned for the year. Component 4 managed all the accounting matters and the requirements for expenditure verification by the external auditors within the institute with reference to EU requirements and regulations.

Year two of action started in September 2016 and ended on 15th September 2017. Many activities which were not accomplished in year one of the action continued into year two with a number of new activities being implemented during this second year. Much progress has been realized in year two with most of the Technical work done to completion. Among the activities now finalized include; project website which is up and running; Monitoring and evaluation framework ; Communication strategy for the component; Identification and prioritization of nature based enterprises targeting women , youth and special interest groups; Baselins surveys on status and characterization of wetlands - springs and riverine forests; Baseline surveys on Utilization of public areas; Baseline survey on demographic and economic profiles of hot - spots; Baseline survey on erosion, sedimentation and pollution; Survey on energy sources; Baseline survey of trees on farm and Communities' capacity needs in indigenous tree propagation and analysis of Land use systems in the two eco-systems. In addition to technical implementation, Procurement has managed 90% of all year two planned equipment, goods and services while the accounting activities are well on course.

In the course of implementation of action in years one and two, component 4 team have encountered some challenges including late disbursement of funds especially for the second year of the project which delayed implementataion of planned project activities, receipt of counterpart financing from Treasury, tax exemption from Treasury and complaints by some few indigenous communities in the project sites. The year two interim report contains a summary of the status of implementation of specific objectives and sub activities is elaborated in detail in '**Results and Activities**' section below. Full reports on complete activities are available on the component website www.kefriwatertowers.org while the hard copies of the reports are availbe at the Component Mangement Office.

3. Component 4 Results and Activities progress

Project Meetings

3.1.1 Component Management Office (CMO) meeting

The CMO held over seven (7) consultative meetings within the year two project period: four (4) were quartely planning and review meetings, three (3) meetings were held to assess progress and ensure compliance in acquiring key project equipment and maps while others were held to plan and facilitate consultancy exercises. During these meetings the members deliberated on wide range of issues affecting the effective running and administration of the Project.

3.1.2 Component Steering Commitee (PSC) meeting

The steering commitee held two meetings in the second year of the project. The steering commitee used the meeting to give direction to the project team and approved the work plans that were prepared by the PIC. The PSC took the opportunity to give direction to teams on matters that were unresolved during the previous implementation period

3.1.3 Meetings held at the regions

Both regional offices held at least 3 planning meetings each. During these meetings, the teams planned implementation of activities, agreed on teams composition and reviewed progress. During these regional team meetings, the team leaders and regional directors who coordinates the project activities in the region get to learn and provide solutions to challenges faced by the teams in the field.

3.1.4 Component Implementataion Committee

Further Component 4 team held 3 implementation Commitee meetings during the year two project period. The CIC meetings were heldat KEFRI Headquaters in October 2016, Londiani and Kakamega in February/March 2017 and in Naivasha in July 2017. During these meetings the implemenntation commitee gave direction and and advise to implementing teams ensuring that the best teams are put in place to implement the project activities. Quality assurance checks were also deliberated on as well as field visits to verify actions. Two (2) meetings were held to deliberate on arising issues with indigenous communities at Mt. Elgon ecosystem.

3.1.4 Workshops and Seminars

During year two of the Project, two consultative workshops were held in Eldoret and Bungoma (covering Cherengany Hills and Mt. Elgon Ecosystems respectively) in an effort to bring together stakeholders and review progress as well as solutions to identified challenges. The stakeholders were given an opportunity to develop web maps for project perceived collaborators which was incoporated in the communication strategy. The project also supported a number of teams and staff to attend at least 4 different workshops and seminars during year 2 of the action, resulting into papers and presentations. The workshops and seminars were in relation to water towers rehabilitation as follows; AFROMONT presentation in Daaresalaam Tanzania in February 2017 by Paul, Phesto and Benjamin. This resulted into publications (Annex 1,2 and 3 are abstracts of the published full papers); Non Wood Forest Products poster presentation in Canada by Rose Chiteva and Nathan Maitha (Annex 4); Socio-Economics presentation and paper on “Exclusion of Community Forest Associations in decision making and its impact on forest condition; Case study of Mt. Elgon and Cherangany ecosystems” by Roxventa Othim and Benjamin Owuor done in India in April 2017 (Annex 5). Presentation by Thalma Khalwale in September 2017 at Bogota, University of Colombia on “Factors influencing adoption of on-farm tree planting in Shinyalu Sub-county, Kakamega, Kenya” (Annex 6) was the last among conferences and workshops in year two. The project supported training for four project staff on forest practioners

training from 20th to 25th February 2017 organized by the Forestry Society of Kenya Held at KEFRI headquarters to improve implementation capacity on forestry actions.

3.1.5 Component 1 and 2 Partners Field Visits

Component four team organised field visits to introduce collaborators and partners to their project sites so that they can share in the experiences of the Component 4 team. The field visits were conducted in April 2017 when the Team of WaTER Programme Technical commitee led by the Ministry of Environment and Natural Resources visited the project sites . In May 2017, Component two team comprising of representatives from Kenya Forest Service (KFS) (Coordinates component two), Kenya Wildlife Service (KWS), Kenya Water towers Agency (KWTA) and the Climate Change Directorate (CCD) also visited the Component four project sites in the two eco-systems. On September 14th 2017, the WaTER Programme Technical Assistance team led by the Ministry organized and visited the Component management office and subsequently the project implementation sites at the two eco-systems.

Results and Activities progress under each component

4. ER1:1 Land use and cover trend analysis to identify hotspots and drivers conducted

Activities implemented under this objective aims towards establishing the biophysical and socio-economic status of the 2 ecosystems to inform rehabilitation and conservation actions to be undertaken. Initial activities were carried out in Year One and completed in the current year.

Sub-activity 1,2,3 and 4 -Progress

The project acquired high resolution images to validate land use / land cover change under sub-activities 1, 2, 3 and 4. Project implementation teams organized and held consultative meetings to develop a methodology for analyzing land use and land cover changes over time using the acquired high resolution images. Further the team undertook ground truthing to the project sites in the two regions to validate image data.

Key findings from validation exercise

Mount Elgon water tower ecosystem

Closed canopy forest cover was observed to be decreasing steadly as the area under grassland and farmland increased. Open forest declined in 1995 and appears to have recovered/regenerated slightly in 2000 (Table 4-1). The class categorized as others (riparian vegetation, bare areas and rock surfaces) appeared to be decreasing, probably as a result of increase in the area under farmland and grassland. The decline in closed canopy forest cover was attributed to forest fires, destruction of trees by medicinal herbs harvesting, and browsing by large animals.

Plate 4-1: Land Cover transformation in Mt. Elgon ecosystem

Biophysical analysis of forest condition in Mount Elgon-ADapTEA project suggested that between the periods 1984, 1995 and 2008, significant areas in Mount Elgon forest ecosystem transitioned from high canopy cover to low/no canopy cover. Figure 4-2, Figure **4-3** and Figure 4-4 of this analysis present land uses in the years 1984, 1995 and 2000 with change results summarized inTable 4-1 and Figure 4-1. This

transition is further corroborated by IFRI plot-level forest vegetation sampling data from both Chorlim and Kimothon IFRI sites in Mount Elgon, showing trending decline in tree cover since 1997-2013. Farmlands and grasslands have taken over the forest according to the historical trend analysis. Most tree clearing are a function of subsistence agriculture, though logging and infrastructure development has also contributed to forest loss (Russel, 2012).

Table 4-1: Land use coverage (Km^2) for Mt. Elgon Ecosystem

Class Type	1984(AreaSq Km)	1995(AreaSqkm)	2000(AreaSqkm)
Closed Forest	469.21	388.06	262.20
Open Forest	121.40	185.63	131.97
Grasslands	536.98	559.13	618.00
Farmland	691.32	727.76	872.13
Water body	0.51	0.31	0.76
Others	318.71	277.84	253.07
Total	2138.13	2138.13	2138.13

Plate 4-2: Forest disturbance in Mt. Elgon ecosystem

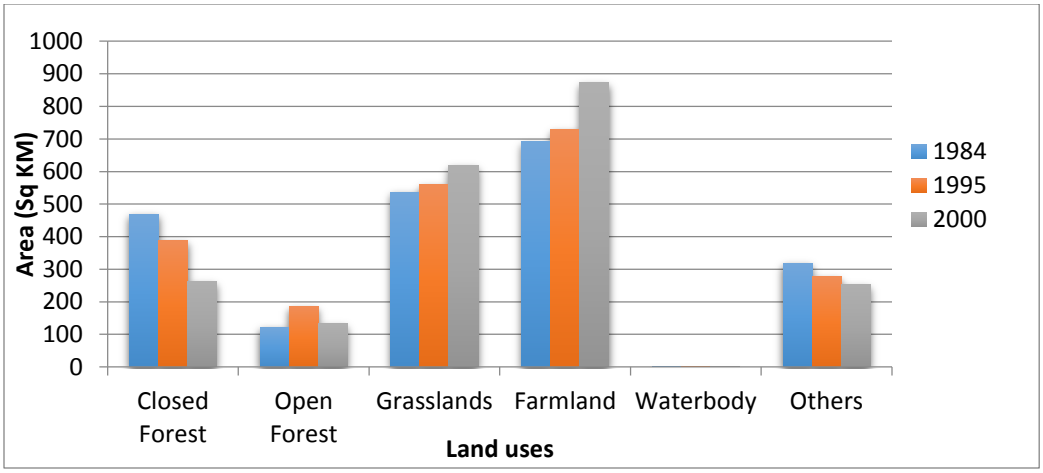


Figure 4-1: A summary of land use / cover changes in Mt. Elgon Forest Ecosystem between 1984 and 2000

Plate 4-3: Forest disturbances assessment in Mt. Elgon ecosystem

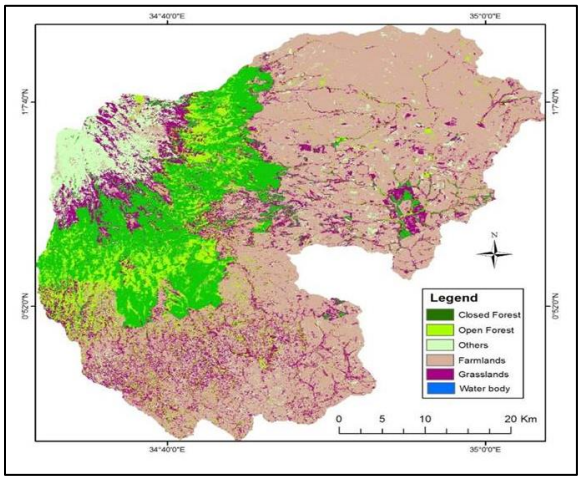


Figure 4-2: 1984 Land Use Map for Mt. Elgon Ecosystem

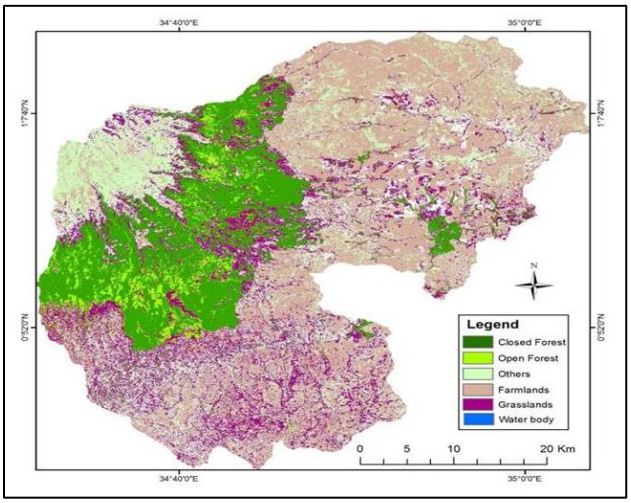


Figure 4-3: 2000 Land Use Map for Mt. Elgon Ecosystem

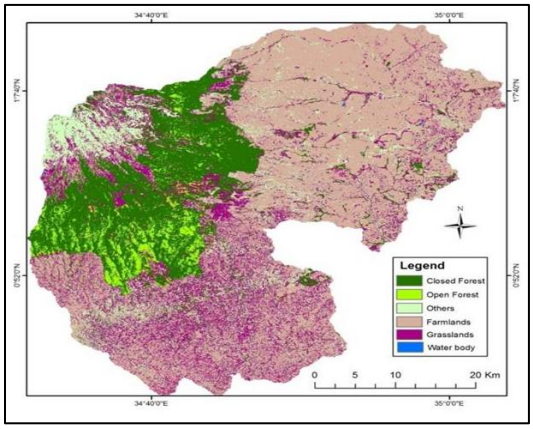


Figure 4-4: 1995 Land Use Map for Mt. Elgon Ecosystem

Cherangany Water tower forest ecosystem

Like the case of Mt. Elgon Forest Ecosystem, closed canopy forest cover in Cherangany Forest Ecosytem decreased between 1984 and 2000, while the area under grassland and farmland increased (Table 4-2). The decline in closed canopy forest cover was caused by competing land uses and unsustainable extraction of forest products.

Plate 4-4: Land Cover transformation in Cherangany ecosystem

A high increase in grasslands and farmlands was noticed in the analysis output indicating a higher contribution of anthropogenic drivers towards degradation. This change analysis output is further corroborated by forest catchment report on the five Kenyan water towers by KFWG and DRSRS, 2000-2003, which revealed significant changes in forest cover, pointing out degraded hotspots within each ecosystem.

Regeneration was noticed to occur in few spots, though this was outweighed by degradation levels. In addition, forest fires were reported to be frequent in the area, suppressing and destroying forest growth and regeneration. The analysed results of land uses in 1984, 1995 and 2002 are as presented in Figure 4-6, Figure **4-7** and Figure **4-8** with result summary in Table 4-2 and Figure 4-5.

Table 4-2: Land use coverage (Km^2) for Cherangany Ecosystem

Class Type	1984(AreaSq Km)	1995(AreaSqkm)	2000(AreaSqkm)
Closed Forest	949.66	938.80	860.55
Open Forest	1555.57	1424.58	1036.85
Grasslands	822.54	779.33	1162.90
Farmland	623.59	718.27	1214.50
Water body	0.94	1.44	1.21
Others	1042.22	1131.60	918.01
Total	4994.02	4994.02	4994.02

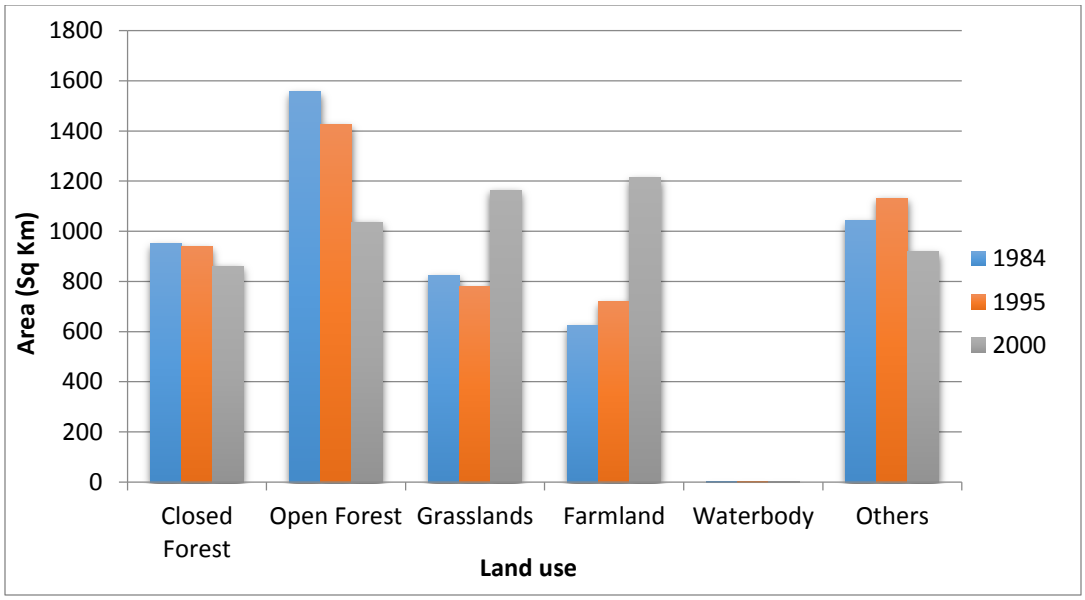


Figure 4-5: Summarized historical trend for Cherangany forest ecosystem

Plate 4-5: Animals grazing in Cherangany Forest ecosystem

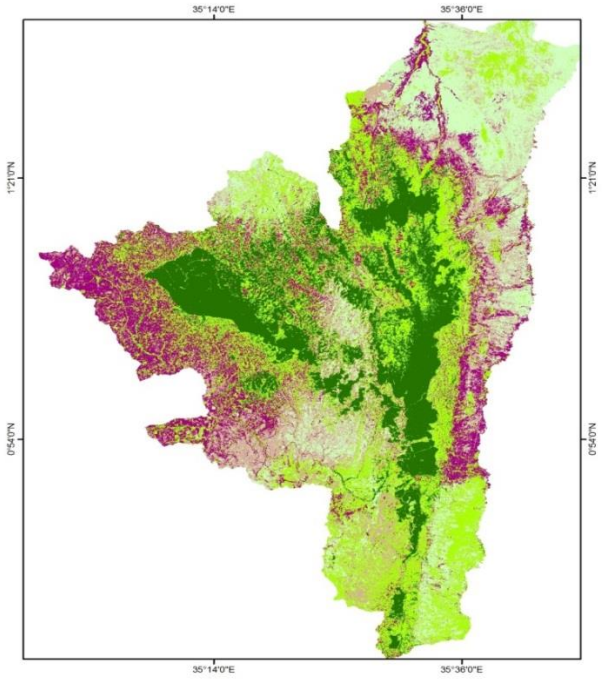


Figure 4-6: 1984 Land Use Map for Cherangany Ecosystem

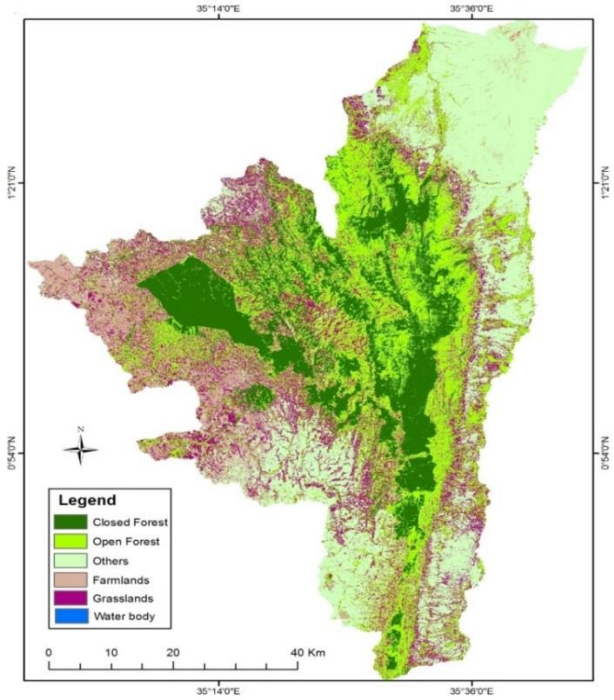


Figure 4-7: 1995 Land Use Map for Cherangany Ecosystem

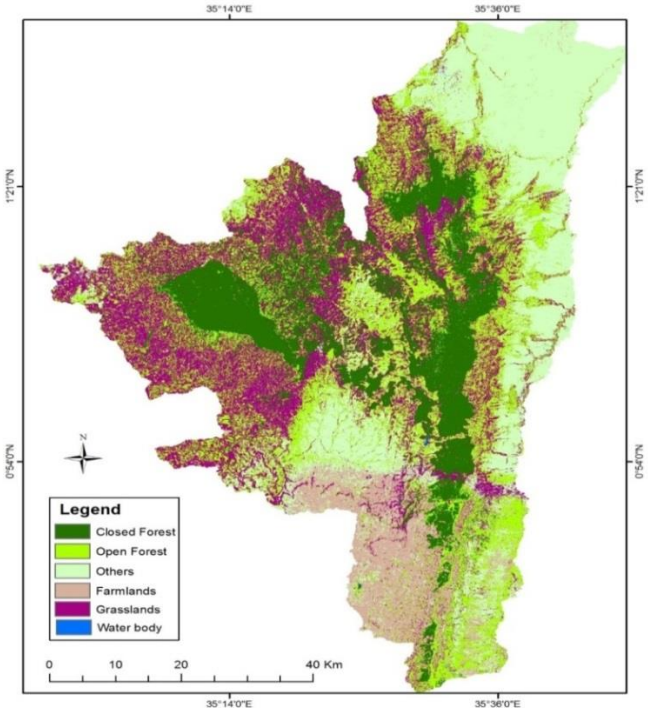


Figure 4-8: 2000 Land Use Map for Cherangany Ecosystem

Recent Land Use Maps

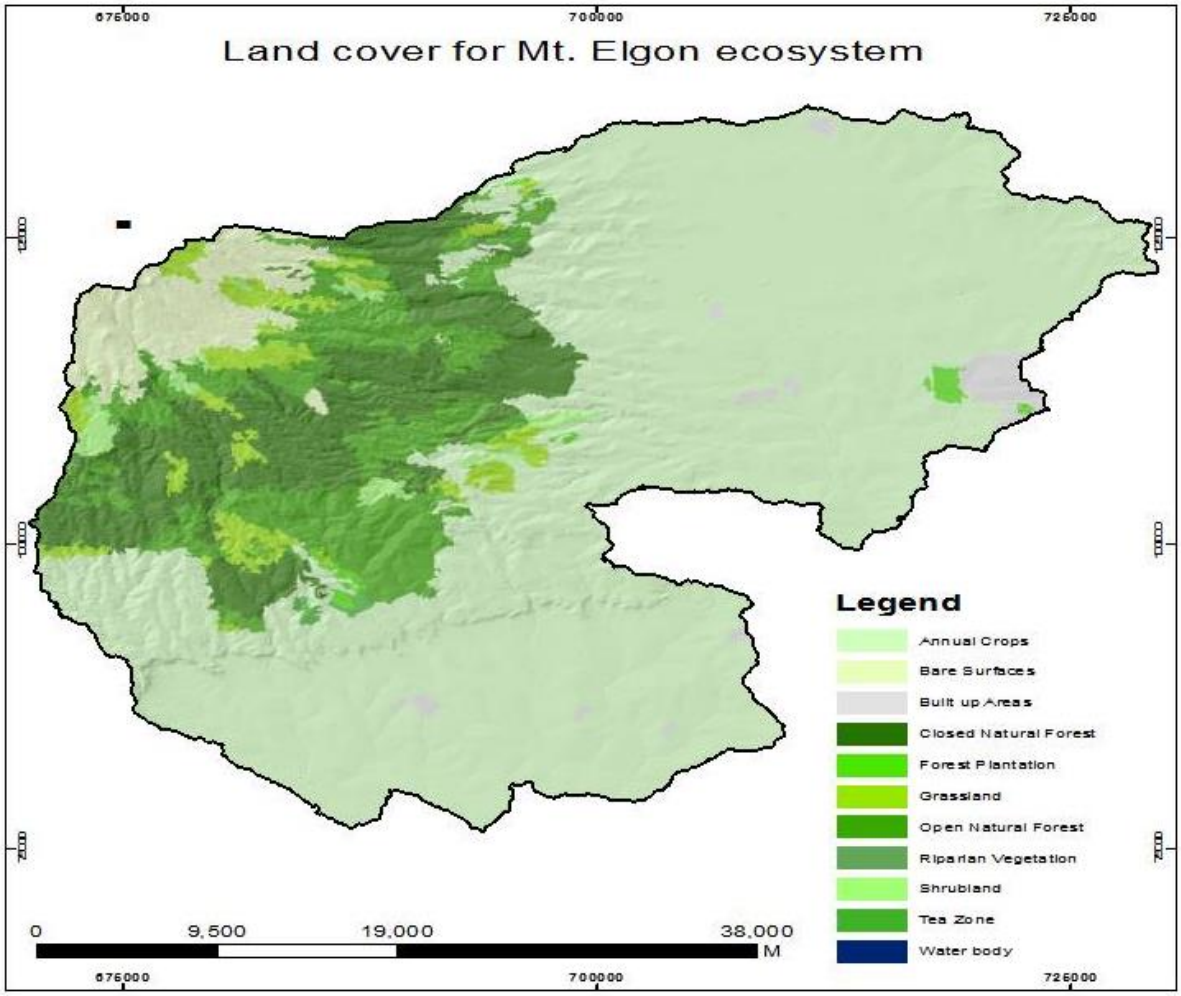


Figure 4-9: 2016 Land use land cover for Mount Elgon Ecosystem

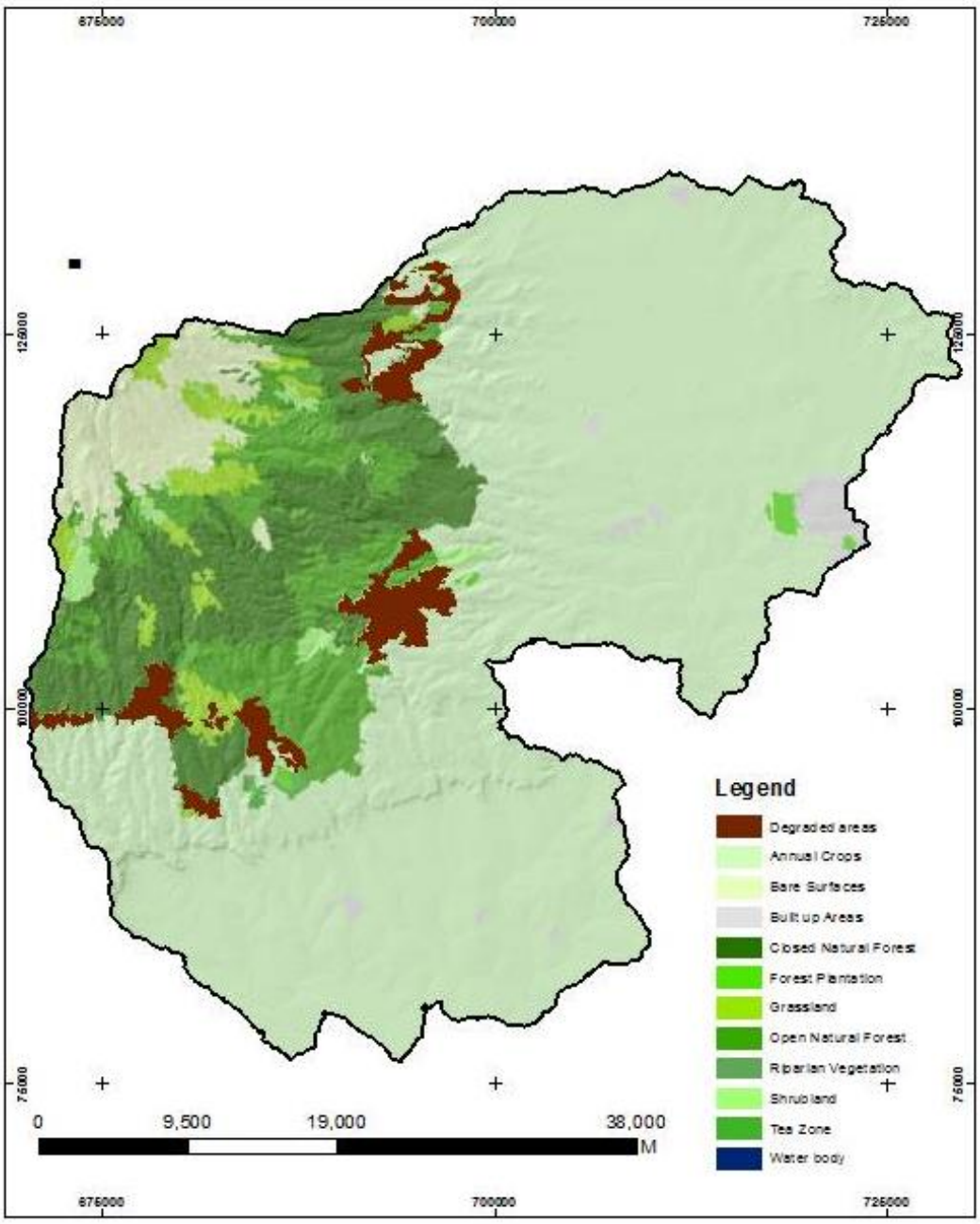


Figure 4-10: Degraded areas generated using 2017 High resolutioin satellite image Elgon Ecosystem

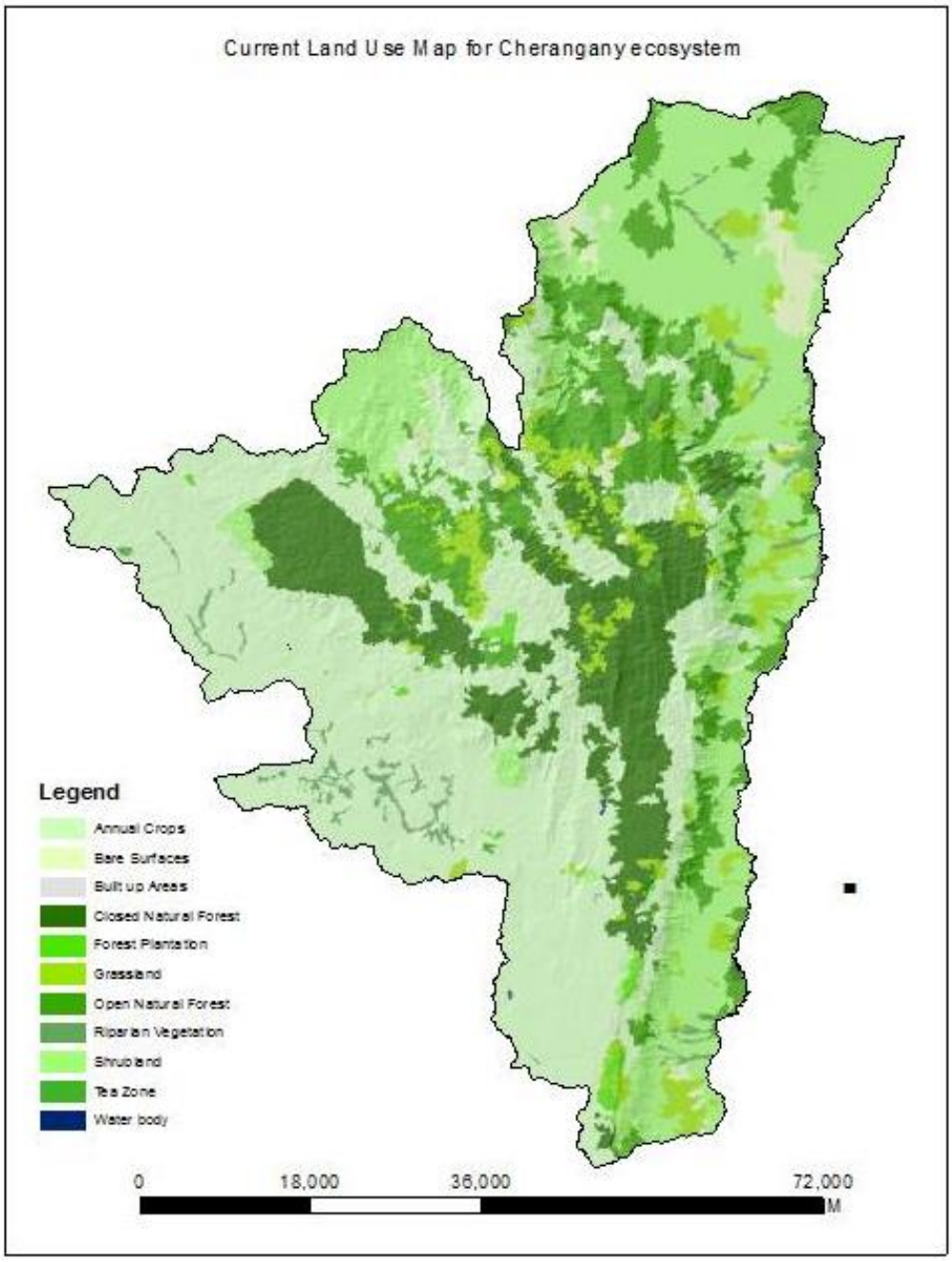


Figure 4-11: 2016 Land use land cover for Cherangany Ecosystem

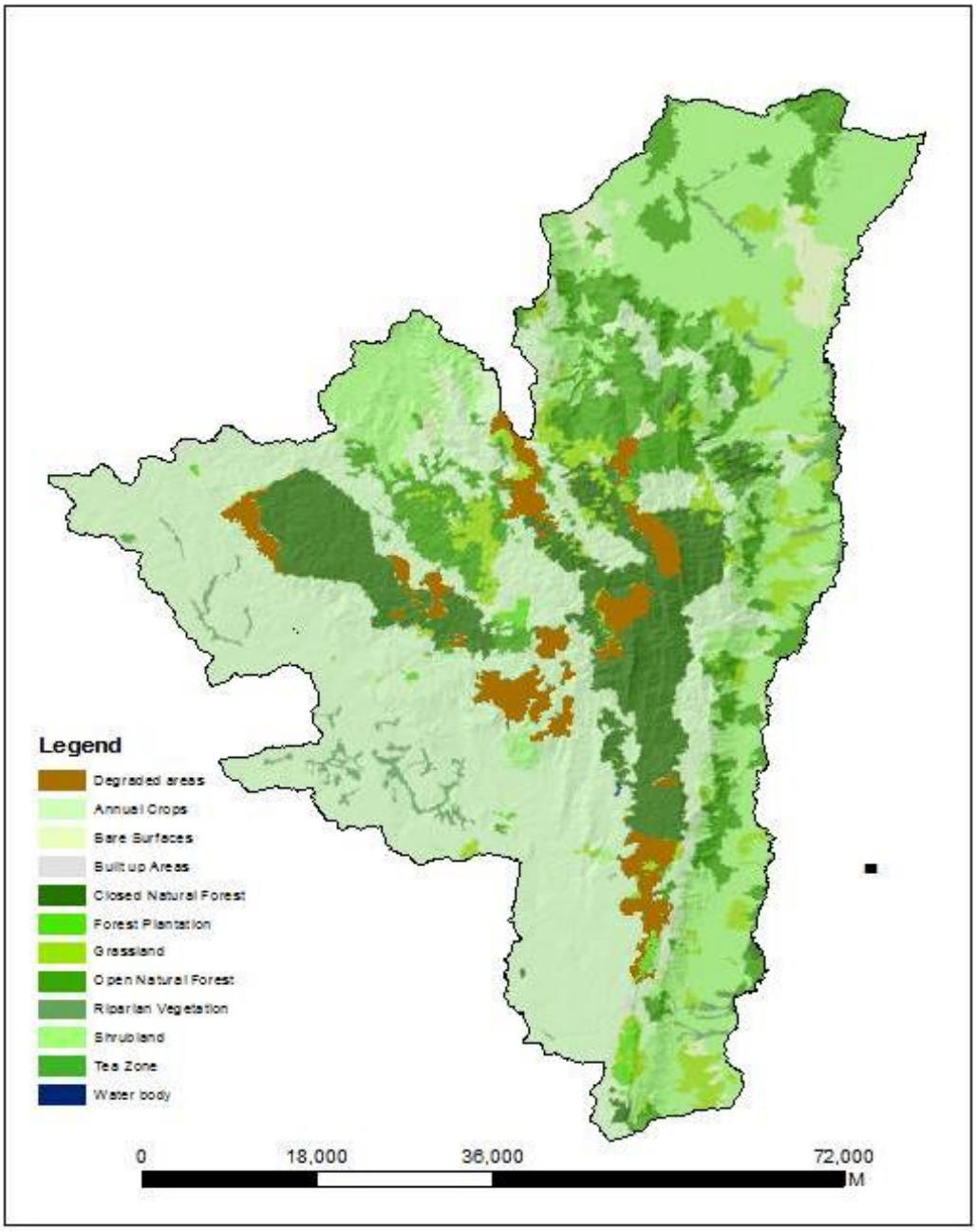


Figure 4-12: Degraded areas generated using 2017 High resolution image for Cherangany Ecosystem

Discussion on Degradation and Hot spot mapping

The approach of the study in Mt. Elgon and Cherangany ecosystems to asses and monitor forest degradation and disturbance using high resolution satellite images was a success as the resultant hotspot areas mapped, with ground validation shows tree cutting remains an ongoing problem in these major water towers, especially cutting of the larger, mature trees with the severity along the forest edges. From the result, degradation in Cherangany was experienced more on the southern part of the ecosystem with patches spreading throughout the ecosystem.

During the fieldwork and interactions with the adjacent communities within Mt. Elgon and Cherangany water towers, there was some indication that forest management in these areas is poor. From the

discussion with the local communities, it appeared that timber was being “leaked” out of Mt. Elgon and Cherangany hills ecosystems, both legally and illegally. Remoteness in terms of accessibility, inadequate forest governance, and authorized and unauthorized overuse of local forest rersources in Mt. Elgon and Cherangany hills have resulted in continuing deforestation and forest degradation. The outcome of one of the objectives which was to conduct land use land cover change provide important information derived from historical Landsat satellite images included in this report can help increase awareness and understanding of the problems, support the development of appropriate management plans, and provide a low-cost means for detailed monitoring of forest status within Mt. Elgon and Cherangany ecosystems.

Plate 4-6: Forest Degradation in Mt. Elgon through Charcol burning

Plate 4-7: Illegal logging in Cherangany ecosystem

Plate 4-8: Clearing of Forest through burning in Cherangany ecosystem

Plate 4-9: Forest Degradation in Cherangany ecosystem through Charcol burning

Plate 4-10: Forest disturbance through grazing

Conclusion

Land use and land cover change may be grouped into two broad categories as conversion and modification of the forest landscapes. Conversion refers to changes from one cover type or use type to another, while modification involves maintenance of the broad cover or use type in the face of changes in its attributes (Daniels et al., 2008). Both ecosystems showed a significant change in land use and cover, in terms of land conversion and modification. However, the Cherangany hills ecosystem showed more change in land use and cover change as compared to Mt. Elgon ecosystem. The ground truthing and validation processes of both areas showed that there were less land conversion activities around Mt. Elgon forest. This could be attributed to the fact that this ecosystem is more protected due to the presence of wild animals and their management by KWS. Also, the Cherangany ecosystem was observed to be entirely surrounded by community members which increases its accessibility and subsequently the chances of encroachment.

(Complete document for ER1 is available at the Component management office and will soon be available on the project website at www.kefriwatertowers.org)

5. ER1:2 Land tenure profiles and maps developed

Sub-activity 7-Conducting a survey on utilization of land

In the year under review, a baseline survey on utilization of public areas, gazetted forests and community lands in the two ecosystems was conducted.

Objective of the study: The purpose of this study was to understand the demographic and economic profile of the most degraded areas in the two ecosystems as identified through satellite imagery, and vulnerable areas on public and community land. The work involved mapping land tenure in both ecosystems in order to design better land management approaches. The information generated was used to understand the role of population increase/decrease in degradation of the ecosystems. Further, the economic profile sequence showed the relationship between population dynamics with degradation of the hotspots. The information obtained was used to come up with recommendations for community interventions in conserving the ecosystems.

Key findings: Land plays a very important role in determining the economic well-being and livelihoods of rural households. Tenure arrangements and property rights play a central role in the management of land resources.

Increase in human population has led to increased pressure and diminishing of natural resources such as forests, grassland and water in the catchment areas. Demand for arable land to cope with high increase in human population has necessitated the degazettement of foresst reserves in to farmlands, followed by letters of allotment to secure land rights. This tendency has caused clearing and removal of indigenous forest trees. Deforestation has reduced forest coverage from 12% in the 1960s to currently 6.9%. This has affected the ability of Kenya's forest ecosystems to provide critical ecosystem services. It is estimated that deforestation costs the Kenyan economy an estimated KES 5.8 billion per year. The contribution of forests to GDP is estimated at around 3.6% but climate change is estimated to cost Kenya's economy as much as KES 50 billion a year, equivalent to 2% of country's GDP hampering long-term economic growth.

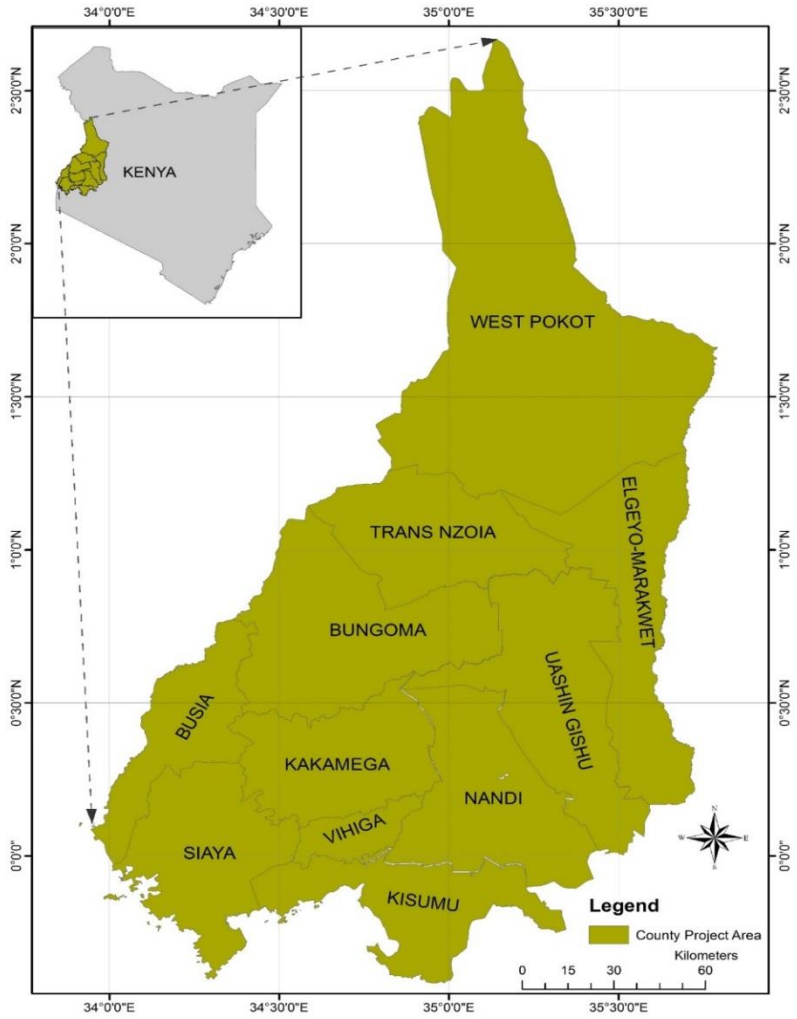


Figure 5-1: Geographic location of the study area

Forms of land tenure systems in Kenya

Public land ; Public land includes (among others) government-owned or occupied land. The State retains the right to regulate the use of land in the interest of defence, public safety, public order, public morality, public health, or land use planning. The State has the right to acquire other land for a public purpose or in the public interest provided the acquisition is carried out in accordance with the Constitution, which requires prompt and just compensation for owners as well as good-faith occupants.

Community land; Community land consists of land legally registered to a group, transferred to a community through a legal process, or declared community land by an act of Parliament, as well as lands traditionally occupied by hunter gatherer communities, lands held, managed, or used by specific communities as "forests, grazing areas, or shrines", and land held in trust by a county government for a specific community.

Private land; Private land consists of registered land under freehold tenure and land held under leasehold tenure. The Private land owners have absolute proprietorship and the rights of exclusion except in cases of compulsory acquisition by the Government, as outlined in sections 107-120 of the Land Act, 2012.

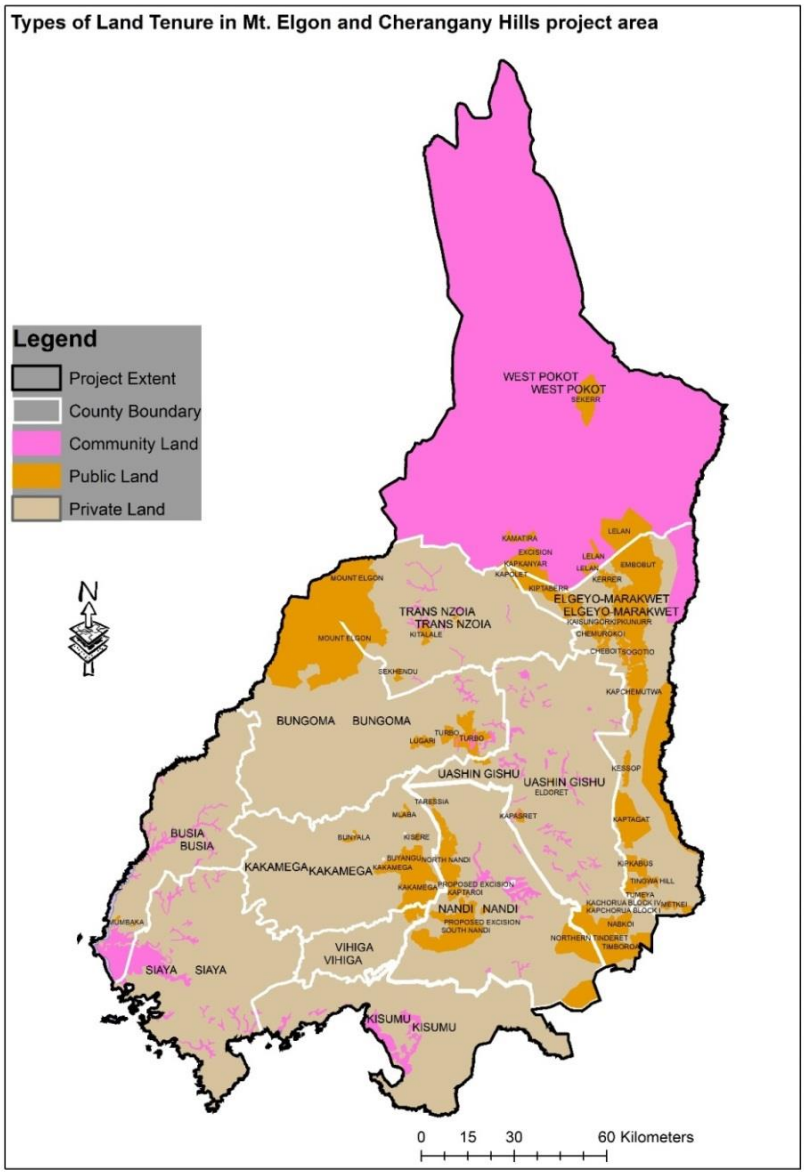


Figure 5-2: Distribution of types of land tenure in Mt. Elgon and Cherangany Hills Ecosystem project area.

Conclusions

The survey indicated that:

- Respondents were dominated by males in all the study areas. There was fair age representation between youthful and old respondents.
- Majority of the respondents were literate.
- The average household size was 5-8 members.
- The most important sources of livelihood are crop farming and small livestock keeping that is practiced on small farm sizes ranging 2-4 acres.
- Majority of the respondents' farms experienced land degradation. The main types of land degradation are water erosion and fertility decline.
- The root cause of land degradation were poverty and income inequality, high rate of population growth and rapid immigration in Mt. Elgon, while high population growth, poverty and income

inequality, and rapid migration and land clearance considered the main cause of land degradation in Cherang'any.

- Respondents practiced soil conservation methods which included: crop rotation, intercropping, organic fertilizer application and live fence hedgerows.

Recommendations

The study recommended the adaptation of measures and strategies such as:

- Soil conservation practices such as agro forestry, composting, cover cropping, soil fertility management and erosion prevention measures.
- Farmer education and training of the development agents and resource user association officials to build the local understanding, management capabilities and community responsiveness to natural resource management;
- Extending the use of alternative livelihood sources such as bee keeping and intensify agro-forestry to decrease the deforestation.
- Further research on participatory land degradation assessments and quantification and matching with agricultural production.

(Final version of this report is available at the Componenet Management Office and also on the component website on www.kefriwatertowers.org)

Sub-activity 8: Review secondary information on demographic and economic profile of "hotspot" and vulnerable areas on public and community lands.

A survey of demographic and economic profiles of hot spots and vulnerable areas on public and community land was carried out by KEFRI during Year Two of the action. This survey was aimed at understanding the demographic and economic profile of the most degraded areas in the two ecosystems and vulnerable areas on public and community land.

Fieldwork was conducted in the upper catchments of Mt. Elgon and Cherangany hills ecosystems where environmental degradation has occurred in the recent times especially on areas around major forests. The questionnaire was structured in a way so that it captures interrelationships of human socio-economic activities with land degradation in Mt. Elgon and Cherangany ecosystems.

The information generated included understanding the role of population increase/decrease in degradation of the ecosystems. Further, the economic profile sequence showed its relationship with degradation of the hotspots.

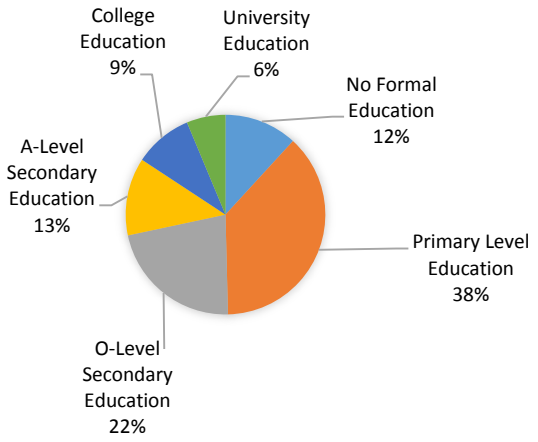
Key findings:

The main sources of energy are firewood and charcoal. The major economic activities common in all the 11 counties are crop, livestock and fish production, forestry and agro forestry, mining, tourism and industrialization.

An enumerator being trained at Kaptama in Mt Elgon

Enumerators being trained at Kaboywo in Mt Eilgon

Plate 5-1: Photographs showing instruction exercise on how to fill questionnaire and understand content of questions



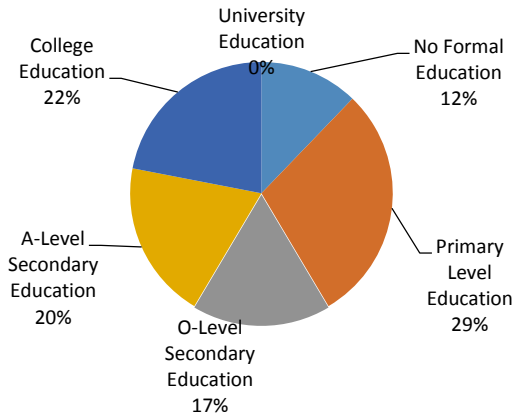


Figure 5-3: Educational status of the respondents in Cherang'any

Vihiga County was found to be the most densely populated county with 1869 persons per square kilometer, and a majority (52%) of the inhabitant were females. This exerted more pressure on land and other resources. The situation leads to low agricultural production, which results in food insecurity, high unemployment rate and unending land disputes. About 80% of the population in all the 11 Counties are dominated by young people (below 40 years). Poverty levels are generally high in all counties. The main sources of energy are firewood and charcoal.

Other impotatnt sources of revenue include levies, rates, fees and entertainment taxes and charges for its services. Improving the business environment and automation of revenue collection as well as broadening the tax base can help improve the total revenue base. Most of the towns have emerged as either agricultural and/or trade centers due to construction of roads and railway. Major sectors of the economy are therefore; agro-based industries, service industry, transport and communication, tourism, mining and quarrying. The survey indicated that:

- Respondents were dominated by males in all the study areas with fair age representation between youthful and old respondents.
- Majority of the respondents were literate.
- Marriage was highly prevalent, with large family households. The most common number of households was 5-8 members.
- The most important sources of livelihood are crop farming and small livestock keeping that is practiced on small farm

Recommendations

- Promotion of awareness on environmental conservation is needed. Diversification on secondary and tertiary sources of income should be initiated in the upper catchment to reduce pressure on land by land related socio-economic activities.

(Final version of this report is available at the Componenet Management Office and also on the component website on www.kefriwatertowers.org)

6. ER 1:3 Status of Biodiversity established

Sub-activity 9: Baseline survey of flora and fauna of of Mt. Elgon

Biodiversity assessment was carried out on Mt. Elgon ecosystem in May 2017 to ascertain the current faunal and floral diversity of the ecosytem. The assessment captured plants, birds, small and large mammals and herpetofauna (reptiles and amphibians). This information can be used by all agencies and collaborators in management, policy aspects and planning for the management of Natural Resources. The assessment was carried out in three ecological zones; namely; mixed montane forest, bamboo and sub-alpine zones.

Plate 6-1: Rapid vegetation assessment in the sub-alpine heath forest during biodiversity assessment in Mt Elgon Forest Ecosystem in May 2017

Floral diversity

A total of 116 plant species were recorded from 55 families in the three vegetation zones of the forest ecosystem. Trees and shrubs were the most abundant, while ferns and tree seedlings were the least represented plant life-forms (Table 6-1).

Table 6-1: Plant species representation by life-form categories in Mount Elgon Forest Ecosystem

Life-form category	No. of plant species	Proportion of total (%)
Climbers	9	6.4
Fern	1	0.7
Grasses	13	9.2
Herbs	30	21.3
Shrubs	37	26.2
Saplings	10	7.1
Seedlings	4	2.8
Trees	37	26.2

Analysis of species distribution by vegetation zones indicated that the mixed montane forest had the highest number of plant species, a majority of which were shrubs. It was also the only vegetation zone without ferns (Table 6-2). The sub-alpine zone had the least number of plant species. It was also the only

vegetation zone without tree seedlings. The bamboo zone was the vegetation zone with all the plant life-form categories (Table 6-2). Species richness among climbers, shrubs, saplings and trees appeared to decrease with increase in altitude, with the mixed montane forest having the highest and the sub-alpine zone having the least (Table 6-2). On the other hand, species richness among grasses increased with increase in altitude.

Table 6-2: Plant species distribution by life-form categories in the four ecological zones of Mount Elgon Forest Ecosystem

Life-form category	**Eco-zone**			
	Mixed montane forest	**Bamboo**	**Sub alpine**	**Alpine**
Climbers	8	4	1	0
Ferns		1	1	1
Grasses	7	8	10	5
Herbs	16	15	17	8
Shrubs	22	17	14	6
Saplings	6	4	2	1
Seedlings	2	2		0
Trees	26	11	10	0
Total no. of species	**87**	**62**	**55**	**21**

Mixed montane forest and bamboo vegetation had relatively higher species richness that the sub-alpine heath forest, but the latter had a significantly higher Shannon diversity index (Table 6-3). This suggested that many of the 80 species in the mixed montane forest had relatively few individuals, which lowered their relative abundance. On the other hand, most of the 51 species in the sub-alpine heath forest had relatively more individuals, which raised their relative abundance. Similarly, the bamboo zone had a very low species diversity index, implying that the population of most of its species was relatively smaller than those of the sub-alpine zone.

The Simpson's index of evenness indicated that the variation in species evenness among the three vegetation zones was not significant. However, the sub-alpine zone had a relatively higher index than the rest (Table 6-3), suggesting that its species were more evenly spread than those of the other two vegetation zones. The mixed montane forest had the lowest species evenness, suggesting that most of it species were not evenly distributed. Overall, all the three vegetation zones had fairly low species evenness.

Table 6-3: A comparison of plant species richness with Shannon diversity index and Simpson index of evenness in mixed montane, bamboo and sub-alpine heath forests in Mt Elgon

Ecological zone	**Species richness**	**Shannon index**	**Simpson index**
Mixed montane forest	80	$1.158 \pm 0.226_{a}$	$0.018 \pm 0.008_{a}$
Bamboo forest	53	$0.681 \pm 0.143_{a}$	$0.053 \pm 0.035_{a}$
Sub-alpine heath forest	51	$1.928 \pm 0.356_{b}$	$0.068 \pm 0.027_{a}$
p value		0.014	0.539
l.s.d.		0.636	0.119

Woody species composition

Of the 21 woody species found in the mixed montane forest, *Neoboutonia macrocalyx* and *Casearia battiscombei* were the most abundant within Kaberua Forest Reserve, while *Ficus thonningii* and *Podocarpus falcatus* were the most dominant in the gazetted national park. The bamboo zone had 17 woody species of which, *Podocarpus latifolius, Bersama abyssinica* and *Neoboutonia macrocalyx* were the most represented within Kaberua Forest Reserve. The bamboo zone within the national park and in Sossio block had *Podocarpus latifolius* and *Schefflera abyssinica; and P. falcatus* and *P. latifolius* as the most dominant woody species respectively.

Of the 9 woody species of the sub-alpine vegetation, *Juniperus procera*, *Erica arborea* and *Rapanea melanophloeos* were the most dominant within Kaberua Forest Reserve. The sub-alpine vegetation within Sossio had *Hypericum keniense, Olea europea* subsp *caudata*, *Juniperus procera* and *Nuxia congesta* as the key species. The sub-alpine zone in the national park comprised mainly grass. The key woody species found in the mixed montane forest, bamboo zone and sub-alpine zone are presented in Table 6-4 below.

Table 6-4: Key woody species of vegetation zones of Mt Elgon Forest Ecosystem

Vegetation zone	Woody species richness	Forest area	Key woody Species
Mixed montane forest	21	Kaberua	*Neoboutonia macrocalyx, Casearia battiscombei, Ekebergia capensis, Aningeria adolfi-friedericii, Celtis africana*
		Mt. Elgon N. Park	*Ficus thonningii, Podocarpus falcatus, Croton microstachyus, Olea europea subsp caudata, Trichocladus ellipticus*
Bamboo vegetation	17	Kaberua	*Podocarpus latifolius, Bersama abyssinica, Neoboutonia macrocalyx*
		Kaberua	*Podocarpus latifolius, Schefflera abyssinica, Bersama abyssinica, Afrocrania volkensii*
		Mt. Elgon N. Park	*Podocarpus falcatus, Dovyalis abyssinica, Teclea nobilis, Diospyros abyssinica*
		Sossio	*Podocarpus falcatus, Podocarpus latifolius*
Sub-alpine heath forest	9	Kaberua	*Juniperus procera, Erica arborea, Rapanea melanophloeos. Hagenia abyssinica, Hypericum keniense*
		Sossio	*Hypericum keniense, Olea europea subsp caudate, Juniperus procera, Nuxia congesta*

Key herbaceous species

Of the 59 herbaceous species in the mixed montane forest, *Pennisetum clandestinum, Cyperus articulates* and *Setaria plicatilis* were the dominant grasses, while *Hypoestes forskhalii* and *Galinsonga parviflora* were the dominant herbs within Kaberua Forest Reserve. In the national park, *Cyperus difformis* and *Oplesmenus hirtelus* were the dominant grasses, while *Hypoestes forskhalii* and *Achyranthus aspera* were the most represented herbs.

In the bamboo zone, of its 36 herbaceous species, *Yushania alpina* and *Pennisetum clandestinum* were the dominant grasses, while *Hypoestes forskhalii* and *Cyathula polycephala* were dominant herbs within Kaberua Forest Reserve. *Yushania alpina* was the dominant grass, while *Hypoestes forskhalii* and *Achyranthus aspera* were dominant herbs in the national park. In Sossio, *Pennisetum clandestinum* and

Adropogon gayanus were the most abundant grasses, while *Centella asiatica* and *Hypoestes forskhalii* were the most dominant herbs in the bamboo zone.
Of the 42 herbaceous species in the sub-alpine heath forest, *Cyperus difformis, Cyperus kyllinga, Cyperus articulates* and *Digitaria scalarum* were the abundant grasses, while *Centella asiatica, Impatiense pseudoviola* and *Oxalis comiculata* were the most abundant herbs within Kaberua Forest Reserve. *Cyperus articulates, Cyperus kyllinga* and *Digitaria scalarum* were dominant grasses, while *Commelina benghalensis* and *Tephrosia uniflora* were dominant herbs within the national park. *Pennisetum clandestinum, Cyperus articulates* and *Adropogon gayanus* were dominant grasses, while *Centella asiatica, Impatiense pseudoviola* and *Oxalis comiculata* were dominant herbs within Sossio. The key herbaceous species across the different eco-zones of Mt. Elgon is show inTable 6-5 below.

Table 6-5: Key herbaceous species in different vegetation zones of Mt Elgon Forest Ecosystem

Vegetation zone	Herbaceous species richness	Forest area	Life-form	Key herbaceous species
Mixed montane forest	59	Kaberua	Grass	*Pennisetum clandestinum, Cyperus articulates, Setaria plicatilis*
		Kaberua	Heb	*Hypoestes forskhalii, Galinsonga parviflora*
		Mt. Elgon N. Park	Grass	*Cyperus difformis, Oplesmenus hirtelus*
		Mt. Elgon N. Park	Heb	*Hypoestes forskhalii, Achyranthus aspera*
Bamboo	36	Kaberua	Grass	*Yushania alpine, Pennisetum clandestinum*
		Kaberua	Heb	*Hypoestes forskhalii, Cyathula polycephala*
		Mt. Elgon N. Park	Grass	*Yushania alpine,*
		Mt. Elgon N. Park	Heb	*Hypoestes forskhalii, Achyranthus aspera*
		Sossio	Grass	*Pennisetum clandestinum, Adropogon gayanus*
		Sossio	Heb	*Centella asiatica, Hypoestes forskhalii*
Sub-Alpine	42	Kaberua	Grass	*Cyperus difformis, Cyperus kyllinga, Cyperus articulates, Digitaria scalarum*
		Kaberua	Heb	*Oxalis comiculata, Alchemilla rothii*
		Mt. Elgon N. Park	Grass	*Cyperus articulates, Cyperus kyllinga, Digitaria scalarum*
		Mt. Elgon N. Park	Heb	*Commelina benghalensis, Tephrosia uniflora*
		Sossio	Grass	*Pennisetum clandestinum, Cyperus articulates, Adropogon gayanus*
		Sossio	Heb	*Centella asiatica, Impatiense pseudoviola, Oxalis comiculata*

Structural composition

The seedling density of the forest ecosystem ranged between zero and 24,800 per ha. There were no seedlings in both the national park and Sossio in all the three vegetation zones. Thus, all the seedlings recorded were found in Kaberua Forest Reserve. The sub-alpine heath forest had relatively fewer seedlings than the mixed montane forest and the bamboo zone in Kaberua (Table 6-6). Sapling density, on the other hand, ranged between zero and 2,400 per ha. Saplings were recorded in all the three vegetation zones, except the Kaberua part of the mixed montane forest (Table 6-6). The sub-alpine heath forest and the bamboo zones had relative lower sapling density (400 to 800 saplings per ha) than the mixed montane forest (2,400 saplings per ha).

Table 6-6: Seedling and sapling density in different vegetation zones of Mt. Elgon Forest Ecosystem

Vegetation zone	Forest area	Seedlings per ha	Saplings per ha
Mixed montane forest	Kaberua F. Reserve	10800	
	Mt. Elgon N. Park		2400
Bamboo forest	Kaberua F. Reserve	24800	800
	Mt. Elgon N. Park		400
	Sossio		400
Sub-Alpine heath	Kaberua F. Reserve	10400	400

The stem density of woody stems ≥ 10 cm DBH ranged between 175.2 ± 47.28 in the bamboo zone and 304.1 ± 58.89 in the mixed montane forest (Table 6-7). The variation in stem density among the three vegetation zones was, however, not statistically significant. Similarly, there was a variation in mean stem DBH among the three vegetation zones. Mean stem DBH ranged between 28.06 ± 15.42 cm in the sub-alpine heath forest and 63.67 ± 14.21 cm in the bamboo low canopy forest (Table 6-7).
The mean canopy height of the three vegetation zones ranged between 10.97 ± 2.759 m in the sub-alpine heath forest and 20.47 ± 2.759 in the mixed montane forest (Table 6-7). The variation in mean canopy height among the three vegetation zones was, however, not statistically significant. The basal area of the three vegetation zones ranged between 30.42 ± 24.11 m^2 per ha in the sub-alpine heath forest and 58.69 ± 22.22 m^2 per ha in the bamboo zone. The variation was also not statistically significant

Table 6-7: Stem density, mean DBH, mean canopy height and basal area of woody plants ≥ 10 cm in DBH in three vegetation zones of Mount Elgon Forest Ecosystem

Eco-zone	Stems ha^{-1}	Mean DBH (cm)	Mean canopy height (m)	Basal area (m^2 per ha)
Mixed montane forest	304.1 ± 58.89 $_a$	31.98 ± 17.7 $_a$	20.47 ± 2.759 $_a$	42.26 ± 27.68 $_a$
Bamboo	175.2 ± 47.28 $_a$	63.67 ± 14.21 $_a$	16.01 ± 3.168 $_a$	58.69 ± 22.22 $_a$
Sub alpine	257.4 ± 51.29 $_a$	28.06 ± 15.42 $_a$	10.97 ± 2.759 $_a$	30.42 ± 24.11 $_a$
p value	0.222	0.239	0.169	0.716
l.s.d.	191.8	57.66	10.32	90.17

Comparing floristic and structural composition under different management regimes

The forest reserve in Kaberua had a higher species richness than the national park and areas dwelt by indigenous communities in Sossio (Table 6-8). Similarly, the forest reserve had significantly higher species diversity and species evenness than the national park and areas dwelt by indigenous communities (Table 6-8). Areas dwelt by indigenous communities had relatively higher species evenness than the national park.

Table 6-8: Analysis of species richness, species diversity and evenness in areas under different resource management regimes in Mount Elgon Forest Ecosystem

Forest area	Species richness	Shannon index	Simpson index
Kaberua	93	2.274 ± 0.130 $_{b}$	0.231 ± 0.035 $_{b}$
Mt. Elgon N. Park	47	0.719 ± 0.129 $_{a}$	0.024 ± 0.002 $_{a}$
Sossio	39	0.798 ± 0.156 $_{a}$	0.153 ± 0.043 $_{ab}$
p value		0.009	0.032
l.s.d.		0.724	0.154

The forest reserve and the national park had similar woody species richness within the mixed montane forest. However, the forest reserve had a higher woody species richness than both the national park and areas occupied by indigenous forest dwelling communities within the bamboo zone (Table 6-9). The national park and areas dwelt by indigenous communities had similar woody species richness within the bamboo zone. In the sub-alpine heath forest, the forest reserve had a higher woody species richness than areas dwelt by indigenous communities.

The national park had a relatively higher stem density than the forest reserve within the mixed montane forest (Table 6-9). In the bamboo zone, the forest serve had a higher stem density than the both the national park and areas dwelt by indigenous forest communities. In the sub-alpine heath forest, the forest reserve had a higher stem density than areas dwelt by indigenous forest communities. The vegetation within the national park in the sub-alpine heath forest comprised largely grassland.

Trees in the forest reserve had relatively larger diameter than those of the national park within the mixed montane forest zone (Table 6-9). However, in the bamboo zone, trees in areas occupied by indigenous forest dwelling communities had significantly larger stem diameter than both the national park and the forest reserve. Trees of the national park had also larger stem diameter than those of the forest reserve. Similarly in the sub-alpine heath forest, trees in areas occupied by indigenous forest dwelling communities had relatively larger stem diameter than those of the forest reserve.
Among trees found in the mixed montane forest zone, those of the forest reserve were significantly taller than those found in the national park (Table 6-9). In bamboo zone, however, trees found in areas occupied by indigenous forest dwelling communities were relatively taller than those of the national park and the forest reserve. Those of the national park were relatively taller than those of the forest reserve in this vegetation zone. In the sub-alpine heath forest, trees found in areas occupied by indigenous forest dwelling communities were relatively taller than those of the forest reserve.

The forest reserve had a relatively higher basal area than the national park within the mixed montane forest zone (Table 6-9). In the bamboo zone, trees in areas occupied by indigenous forest dwelling communities had relatively larger basal area than those in the national park and the forest reserve. Those in the national park also had relatively larger basal area than those in the forest reserve. Similarly, in the sub-alpine heath forest, trees in areas occupied by indigenous forest dwelling communities had relatively larger basal area than those in the forest reserve.

Table 6-9: A comparison of woody species richness, stem density, DBH, canopy height and basal area in areas under different forest management in Mount Elgon Forest Ecosystem

Ecological zone	Forest area	Woody species richness	Stems ha-1	Mean DBH (cm)	Canopy height (m)	Basal area (m^2 per ha)
Mixed montane forest	Kaberua	12	89.3 ± 18.3 $_a$	46.0 ± 1.48 $_a$	30.7 ± 2.0 $_b$	18.1 ± 2.8 $_a$
	Mt. Elgon N. Park	12	125.7 ± 5.2 $_a$	32.4 ± 1.8 $_a$	19.5 ± 1.9 $_a$	13.1 ± 3.81 $_a$
Bamboo	Kaberua	11	83.3 ± 25.5 $_a$	53.7±20.7 $_a$	15.0 ± 3.5 $_a$	21.2 ± 11.5 $_a$
	Mt. Elgon N. Park	7	78.1 ± 3.1 $_a$	77.0 ±38.8 $_a$	17.9 ± 1.6 $_a$	97.7 ± 84.9 $_a$
	Sossio	7	49.3 ± 0.7 $_a$	145.7 ± 48.2 $_b$	27.2 ± 3.1 $_a$	112.6 ± 55.1 $_a$
Sub-Alpine	Kaberua	7	137.5 ± 28.2 $_a$	24.2 ± 5.3 $_a$	9.5 ± 1.9 $_a$	9.6 ± 4.5 $_a$
	Sossio	4	100 ± 1.0 $_a$	44.3 ± 7.7 $_a$	16.4 ± 3.2 $_a$	12.6 ± 3.8 $_a$

Reptiles and amphibians

A total of 10 herpetofaunal species were recorded. This included three amphibians and seven reptiles (Table 6-10). The natural forest had the highest species richness (six species). The bamboo and Sub-alpine zones had three species each. Grauer's puddle frogs were the most abundant within the natural forest. On the other hand, one of the rare species was the Alpine lizard with only a single individual documented in the heath grassland.

Other species which were only recorded in singletons were Montane side-striped chameleon, Jackson's forest lizard and Striped skink.

Table 6-10: The recorded number of species in Mt Elgon in May 2017

Species	Eco-Climatic Zone			Species Abundance
	Forest	Bamboo	Sub-alpine	
Phrynobatrachus graueri	27	0	0	**27**
Amietia nutti	12	5	0	**17**
Trioceros hoehnelii	6	0	0	**6**
Trioceros ellioti	1	0	0	**1**
Philithamnus battersbyi	1	0	0	**1**
Adolfus jacksoni	1	0	0	**1**
Trachylepis striata	0	12	1	**13**
Xenopus borealis	0	10	0	**10**
Trachylepis varia	0	0	19	**19**
Adolfus masavensis	0	0	1	**1**
Species Richness	**6**	**3**	**3**	**12**

Nutt's river frog

Northern clawed frog

Variable skink

Von Hoehnell's chamaeleon

Battersbyi's green snake

White-lipped snake

Plate 6-2: Some amphibians and reptiles of Mt. Elgon ecosystem

Avian diversity

A total of 206 bird species were recorded in the Ecosystem. This included 6 globally endangered species as listed in Table 6-11.

Table 6-11: Endangered Bird Species recorded in Mt. Elgon

1	Sharpe's Longclaw
2	Splendid Glossy Starling
3	White-breasted Cuckoo-shrike
4	African Golden Oriole
5	Fan-tailed Raven
6	Yellow-billed Shrike

Small mammal

Plate 6-3: Montane forest at Kaberua where small mammal transect was set

Plate 6-4: visual structure of bamboo habitat where small mammal sampling transect was set

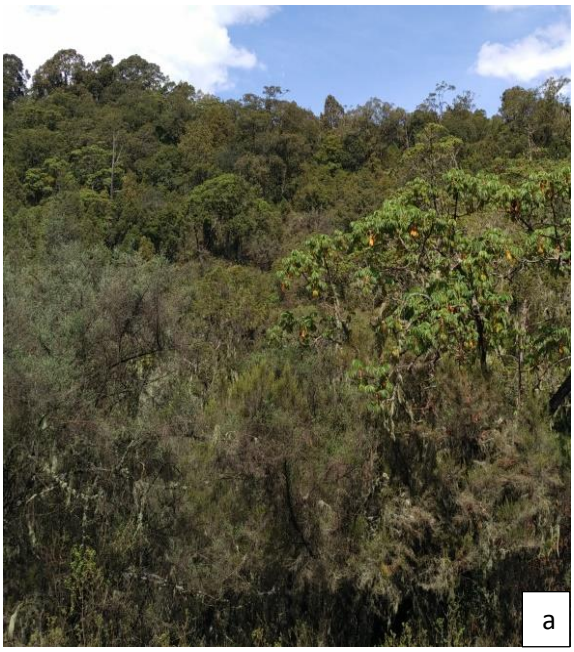


Plate 6-5 a and b: Higher section of subalpine habitat where small mammal transect was established

Plate 6-6: Visual habitat structure of lower section of alpine habitat where small mammals were sampled

Plate 6-7: Sherman live trap for sampling rodents

Plate 6-8: Pitfall traps with drift fence for sampling shrews on forest floor

Twenty eight (28) species from 14 families representing four orders were recorded. These include those recorded in the systematic trapping, observational survey (24 species) and opportunistic sightings (3 species).
The recorded species comprise of rodents (16 species), bats (7 species), Shrews (4 species), and lagomorphs (1 species).
Species richness varied with elevation from eight species in Montane forest to three in bamboo zone, (Table 6-12),
Sub-alpine forest had second most diverse small mammal species, with fairly even abundance. The moorland though not as poor as bamboo habitat, was less heterogeneous compared to the adjacent habitat (Table 6-12). The low small mammal diversity in both bamboo and moorland can be attributed to their low habitat heterogeneity.

Table 6-12: Small mammal species dioversity in different ecological zones of Mt. Elgon forest ecosystem

Attribute	Montane Forest	Bamboo	Sub-alpine Heath
No of species	8	3	8
Simpson Diversity (1-D)	0.825	0.679	0.545
Shannon Weiner H'	2.63	1.406	1.47
Brilluoin H	2.365	1.06	1.187
Simpson Evenness1/D)	0.662	0.821	0.418
Modified Nee	0.195	0.464	0.142

Large mammal

A total of 15 large mammals species were recorded in the mixed montane forest, 11 species were recorded in bamboo zone while 6 species were found in Sub-alpine zone(Table 6-13).

Table 6-13: Large mammal species recorded in the Mixed montane forest, bamboo zone and sub-alpine heath zone of Mount Elgon Forest Ecosystem

No.	Wildlife species	Population recorded		
		Montane	Bamboo	Sub-alpine
1	Aardvark		13	
2	Defassa waterbuck	4	4	2
3	African civet	4		
4	Baboon	2		
5	black and white colobus monkey	80	23	
6	Blue monkey	29	4	
7	Buffalo	54	15	61
8	Bushbuck	30	14	7
9	Bush pig		2	
10	Elephant	86	70	
11	Giant forest hog	4		
12	Grey duiker			1
13	Burchell's zebra	10		
14	Red duiker	13	9	
15	serval cat	1	1	
16	silver backed jackal			1
17	spotted hyena	6	1	3
18	Starck's hare	3		
19	Tree squirrel	1		
	Species richness	**15**	**11**	**6**

Sub-activity 12: Select germ-plasm and support establish quality nurseries

This activity aimed at identifying key tree species with high perfomance that will become germplasm sources for establishment of woodlots and for the rehabilitation of natural forests. The sub-activity began by an initial survey to identify key tree species in both Mt. Elgon and Cherengany Hills ecosysytems. Assessment in the two ecosystems focused on; important indigenous tree species in the two ecosystems, socio economic and cultural uses of the identified species, physiology of the species identified, rainfall patterns in the regions, challenges in ensuring sustainabile utilization within the communities and the indigenous tree species within the CFA and community self-help nurseries.

The research team worked in Cheptais, Kaberua, Kiptogot and Kimothon forest blocks in Mt. Elgon ecosystem. Similarly in Cherangany Hills, the study sites were Kapolet, Chemurkoi, Kaisungor, Kiptaberr Forest blocks. The sites selected are from the different forest blocks that make up different ecological zones in the ecosystems.
Data collection involved a field visit to Cherangany and Mt. Elgon to carry out a survey on the diversity of indigenous tree species found in the two ecosystems. Data was collected based on the indigenous knowledge systems associated with the cultural and economic values tagged to the tree species. The survey involved the use of Focus Group Discussions and Key informants' checklists. Observations were also made to access the presence and the performance of the different indigenous tree species in the area.
From the data collected the following species were selected for stage two activities based on the attributed values listed in the Table 6-14 below;

Table 6-14: FGD at Kaberwa Forest Block

Tree species	Attributed value for selection
Olea welwischii (Elgon teak)	Growth aspects Good performance in the site Good habitat for wildlife Tertiary species for rehabilitation areas with other tree species Medicinal aspects
Prunus africana	Economic aspects One of the best hard wood trees e.g construction of bridges, vehicle chassis Medicinal aspects
Syzigium cordatum	Good for rehabilitation of water catchment areas
Croton macrostachyus	Good agroforestry tree
Juniperus procera (Cedar)	Endangered species because of its economic value- high demand Good performance in the site
Aningeria Adolfi (muna)	Endangered and main predominant species Kapolet forest Performs very well at the site
Hagenia abyssinica	Good agroforestry Main predominant species at Koisungur forest block Good economic value
Dombeya goetzenii	Good agroforestry Manure and forest soil collection for nurseries
Podocarpus falcatus	Economic value Bee keeping in the forest Growth performance good
Yushania alpina (Indigenous Bamboo)	Good for rehabilitation of water sources

Plate 6-9: Seedlings of *Hagenia abyssinica* at the nursery at Kapcherop Forest Station

Plate 6-10: unsustainable extraction of *Prunus africana* bark for medicinal purposes at Koisungur Forest Block

7. ER 1:4 Erosion, sedimentation and pollution assessed

Sub-activities 13, 14, 15, 17, 18 and 19

Component 4 Project implemented sub activities 13, 14, 15, 17, 18 and 19 during the action period. The activity aimed and establishing baseline information on the extent of erosion, sedimentation in the rivers as well as pollution in the two ecosystems covered by the project. The activities which were carried out involved planning and design, sampling schemes, delianation of source and sink pollution, geo referencing, ground survey of soil; sedimentation and geo statistical analysis and mapping of land degradation.

Findings: The study findings showed that Mt. Elgon and Cherangany Hills are under continuous LULC dynamics and the two ecosystems are prone to soil erosion. The model showed the erosion risk areas of the two ecosystems and the factors which affect soil erosion. From the Participatory geographic Information System (PGIS) activity, the findings minimize the gap between the stakeholders' and scientists' understanding. Land degradation in the steeper slopes is severe which needs urgent land rehabilitation intervention such as forestation programs, terracing and other remedial solutions.

Recommendations: The slope gradient and slope length factor are dominant in the magnitude of potential soil erosion in the areas studied, it is possible to modify them through soil conservation practices at a small scale on agricultural land using detailed field assessment.

Creating awareness among the communities concerning optimum use of natural resources, conservation systems, driving forces including population pressure and their respective benefits is vital for sustainable land resource management. Therefore, local managers and responsible sectors in Mt. Elgon and Cherangany should emphasize the importance of participation of the local communities in conservation activities and decision making regarding land use within the ecosystems.
Methodology for assessment of soil erosion C factor value used during this study is presented in Figure 7-1 below:

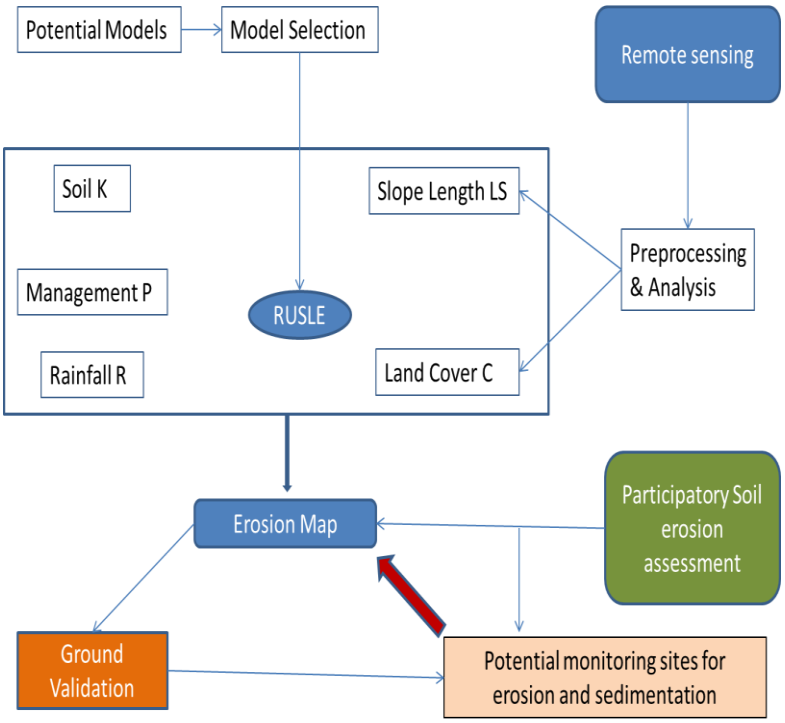


Figure 7-1: Methodology for Erosion assessment

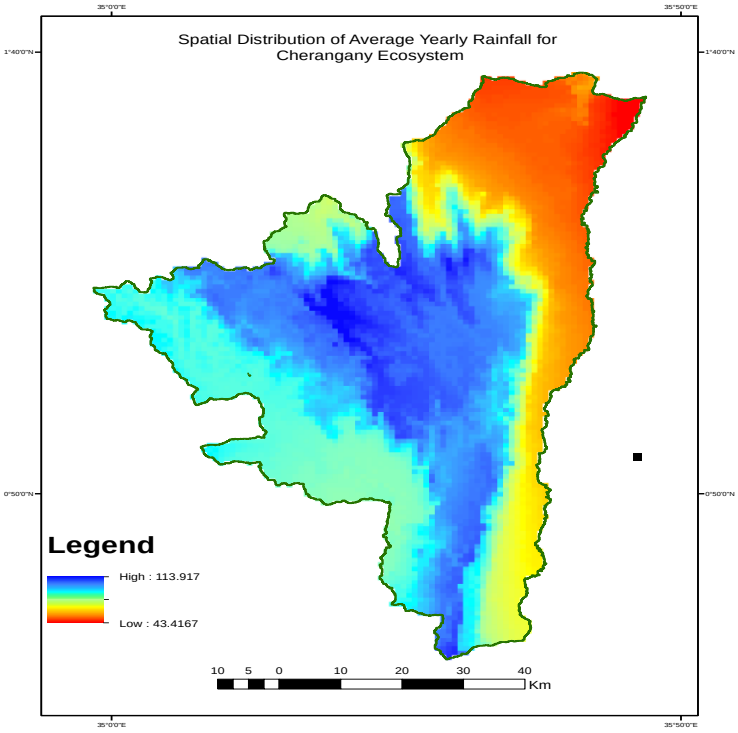


Figure 7-2: Rainfall Map for Cherangany ecosystem

Rainfall factor (Mt. Elgon)

In Mt. Elgon Ecosystem, the spatial distribution of rainfall erosivity varies greatly with its values ranging from 87 to 156 MJ* mm/ha/yr. The north-eastern part of the ecosystem receives low rainfall compared to the Western and Southern parts of the ecosystem.

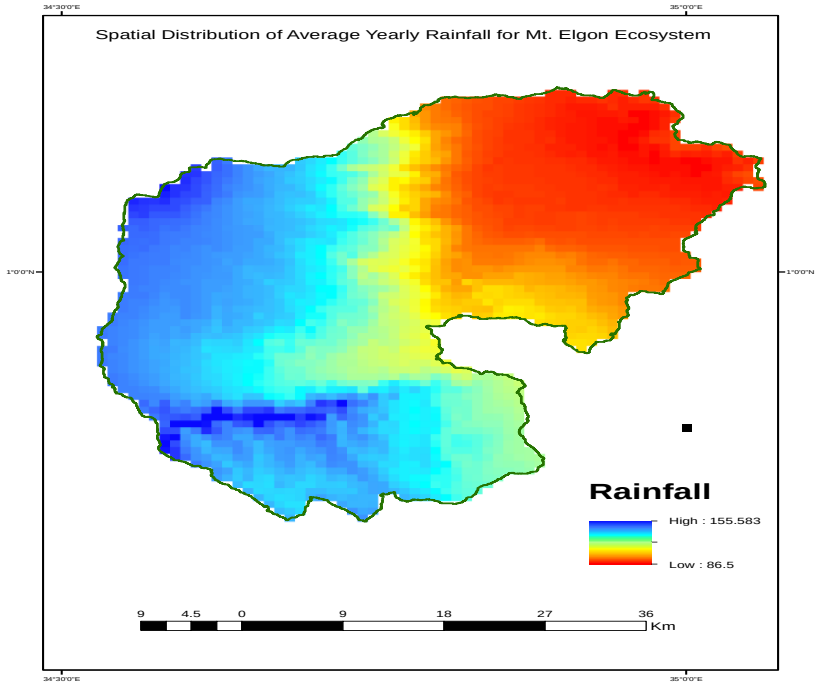


Figure 7-3: Rainfall Map for Mt. Elgon ecosystem

Mt. Elgon Ecosystem

Mt. Elgon ecosystem was divided based on the administrative boundaries into eight Zones namely; Cheptais, Kapsokwony, Sirisia, Kimilili, Webuye, Mt. Elgon Forest, Saboti and Kwanza. Kwanza region covers the largest part of the ecosystem with an area of 763.58 Km^2, followed by Mt. Elgon forest zone which covers an area of 487 Km^2. In Mt. Elgon Ecosystem, Tongareni covers the smallest extent of 37.57 Km^2. In terms of erosion and sedimentation within the ecosystem, the highest erosion rate value is 35 tons per year with the lowest erosion value of 0.2 tons of soil per year. The high erosion class is common in Kapsokwony, Cheptais and Kimilili regions of the ecosystem. Over 50% of Kapsokwony region is losing over 30 tons of soil per year. This can be attributed to soil type within the zone, steeply slope of the ecosystem together with the land use which is majorly agriculture without erosion control measures.

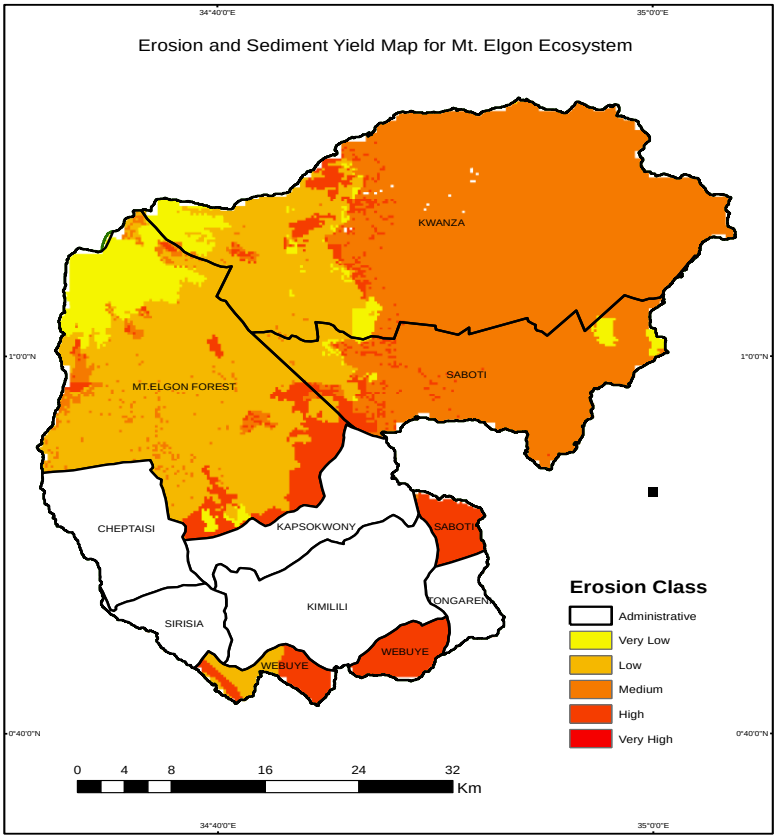


Figure 7-4: Zonal erosion distribution Map in Mt. Elgon

Low erosion is taking place in Mt. Elgon Forest zone which is majorly closed forest, open forest and national park as the major land use land cover. However, the ecotone zone which is the lower part of the zone is also experiencing high erosion due to land cover degradation. High erosion in the lower part of the ecosystem can also be attributed to high amount of rainfall as compared to North-West part of the ecosystem which receives low rainfall.

Plate 7-1: Measuring the Depth of Gully in Cherubei Village, Mt. Elgon Ecosystem

The reduction in runoff results into increased infiltration and percolation. In Mt. Elgon ecosystem, river Kaptkateny, Kibisi, Kaptesang, Sosio and Musindet receive a lot of sediments due to high erosion rate in the lower region of the ecosystem which can be attributed to soil type, slope length factor and land use which is majorly crop farming without management practices to reduce the erosion. However, river Koitobos, Nai Swamp, Kapkukul, Kabewyan, Chepereiwe receice slightly lower sediments due to low rate of erosion on the Northern part of the ecosystem. This is due to low annual rainfall and reduced slope-length factor together with compact soil within the upper part of the ecosystem.

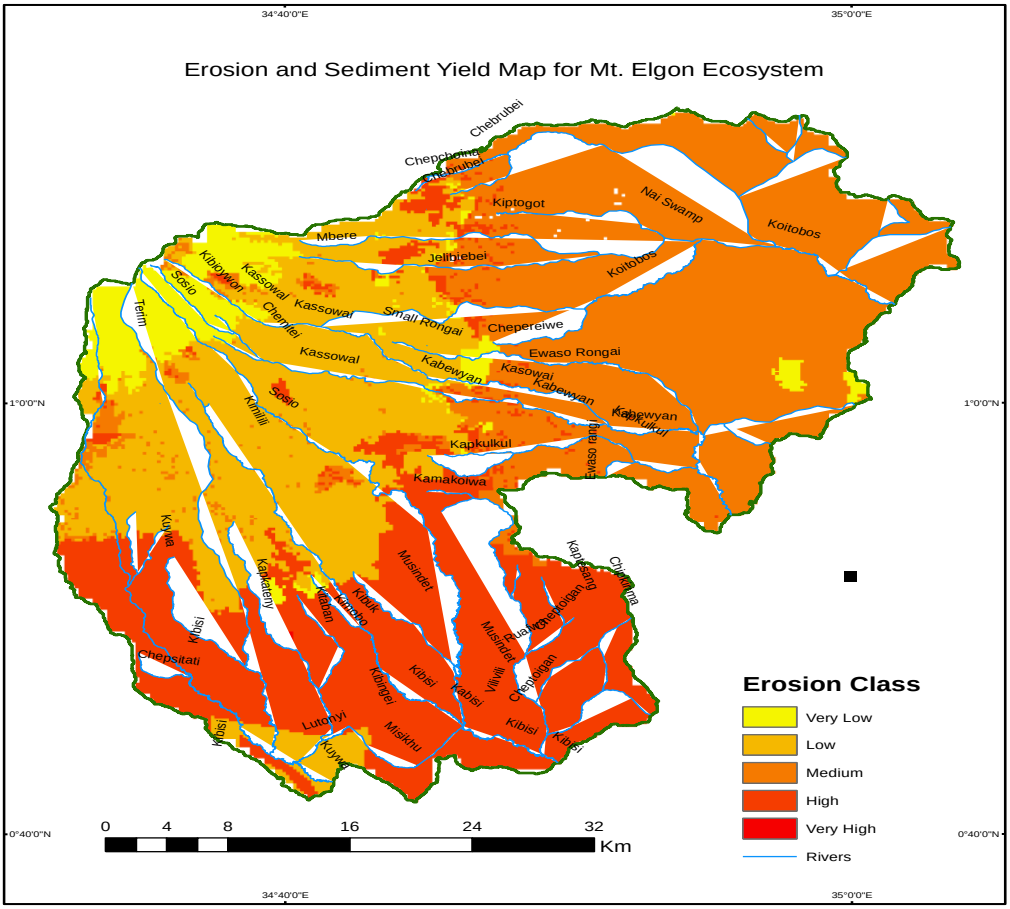


Figure 7-5: Rivers and sediment yield Map for Mt. Elgon Ecosystem

Plate 7-2: Sediment in River Kibisi,Mt. Elgon ecosystem

Cherangany ecosystem

Climatic, edaphic and human activity varies greatly within Cherangany ecosystem. On the Northern part of the ecosystem, main human activity is pastoralism.

Plate 7-3: Measuring Rills/Gully erosion in Chepareria, Cherangany ecosystem

Plate 7-4: Gully erosion in Chepareria, West Pokot

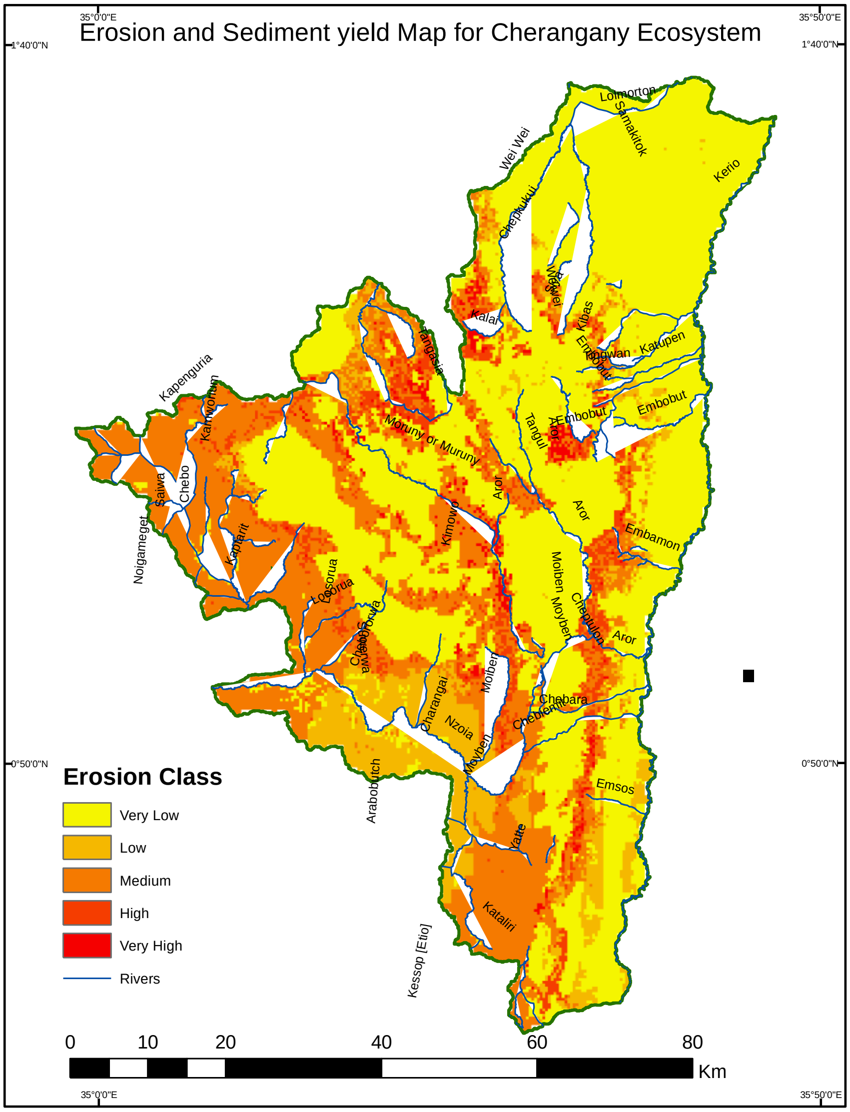


Figure 7-6: Drainage system in Cherangany ecosystem

Plate 7-5: Sedimentation in Kapcherop, Cherangany ecosystem

Pollution in the Ecosystems

In the context of Mt Elgon and Cherangany Ecosystems, it is easier to connect with the larger, more easily felt need of the region. There is no doubt that the best body that easily demonstrates pollution effects on the region is Lake Victoria. The two ecosystems are connected to the Lake through the commonly shared Nzoia River Basin.

This report is therefore a synthesis of some available reports on various aspects of pollution around the lake, with special reference to Nzoia River Basin. Specifically, the report covers general changes - water temperature, pH and conductivity levels, changes in dissolved oxygen (DO), biological and chemical oxygen demand (BOD and COD), total dissolved solids (TDS) especially heavy metals, nutrients in river water and total suspended solids

BOD and COD: Findings of study show that effluent from Mumias Sugar Factory caused significant changes on upstream water by increasing BOD, COD, TDS and TSS by 24% (2663 to 3340.6 mgL^{-1}), 100.6% (5562 to 11158 mgL^{-1}), 183.6% (542.5 to 1538.5 mgL^{-1}) and 266% (220 to 805.1 mgL^{-1}). The treatment systems at the sugar miller were obviously not very effective in handling the waste being directed at the river. Western Kenya is a key producer of sugar, and it is not clear how compliant the other sugar millers are with respect to environmental standards. Going by the discharge at Mumias, stricter measures clearly need to be enforced. In another study, Twesigye et al (2011) demonstrated that there were also increases of TDS, EC and TSS, mixed results of NO3- and PO4-, and consistent decreases in DO for water samples taken from Nzoia at Pan Paper, Nzoia Sugar, Mumias Sugar and lower Nzoia River.

Metals, Sediments and feacal coliforms: The results indicate that concentration values for Zn during dry and the wet was 0.16-0.50 mgL^{-1} and 0.20-0.60 mgL^{-1} respectively. Concentrations varied from one sampling station to another but all values remained within the WHO recommended limits. The main sources of heavy metal and trace element contaminants are industrial effluents such as from the leather, sugar and coffee factories and fertilizers.

The turbidity of Malakisi river alone before joining the Ndakaru river was 54 – 62 NTU. Turbidity seems to increase significantly in wet seasons as it is associated with soil erosion and transport to the rivers. In a similar study of the Mara River using a different parameterit was found that sediment concentration for two of the major tributaries of Mara River showed Nyang'ores River with 35.5-268.5 mgL^{-1} and Amala River with 26.4-258 mgL^{-1}).

The study also found that water samples in both wet and dry seasons had high levels of fecal coliforms during dry and wet seasons which ranged from 28 – 46 cfu/100ml, well above the WHO standards. In the case of Sosiani River, the authors concluded that the reason of the high abundance of macro invertebrates in uppermost area where there was nutrient inflow in sewage was probably due to high abundance of tolerant taxa to the sewage discharge from Eldoret Municipality. Pesticides transport was by storm water run-off and air drift into the lake. Fourteen pesticides were identified as commonly used of which four are toxic to bees and five to birds.

Recommendations

Land degradation in the steeper slopes is severe which needs urgent land rehabilitation intervention such as forestation programs, terracing and other remedial solutions such as on farm tree planting within Mt. Elgon and Cherangany ecosystems.

Basically, man cannot modify rainfall erosivity and soil erodibility factors. However, as the slope gradient and slope length factor is dominant in the magnitude of potential soil erosion in the area, it is possible to

modify them through soil conservation practices at a small scale on agricultural land using detailed field assessment.

Creating awareness among the society concerning optimum use of natural resources, conservation systems, driving forces including population pressure and their respective benefits is vital for sustainable land resource management. Therefore, local managers and responsible sectors in Mt. Elgon and Cherangany to emphasize the importance of participation of the local communities in conservation activities and decision making regarding land use within the ecosystems.

(Full and comprehemssive report for the erosion, pollution and sedimentation is available at the CMO and the Project website; www.kefriwatertowers.org)

Sub-activity 16: Sample Soil and water for quality analysis

Component 4 team of scientists from the headquarters and the regional programmes in Maseno and Londiani have designed a frame work within which the activity will be delivered. The team carried out initial baseline survey, set up river gauging points and collected samples for the initial analysis. Some results are already available while others are undergoing laboratory analysis.

The survey was made possible with the help of GPS maps and collaborating Hydrologists from the Ministry of Water and Irrigation. Soils throughout the region are volcanic clay and clay barns classified as feralo-chromic. Farming is the key activity in the region and its large population is resulting in conversion of forest land to crop land. Streams from Mt Elgon forest and west of the Cherangany watershed feed the Nzoia River system, which flow into Lake Victoria and streams to the east of Cherangany flow into the Kerio river streams. River Moiben which is one of the tributaries for Nzoia River feed into Chebara Dam which is the source of water for Eldoret Town and its outskirts while Kapolet River which originates from Kapolet Forest station and a tributary of Nzoia river provide water that is consumed in Trans Nzoia and Bungoma Counties.

This survey captured the river gauging stations representing upper, mid and lower parts of the catchment and also at the tributary confluences with the Nzoia River and at a point in the Lower Nzoia. The major challenges in Nzoia Catchment include soil erosion, sedimentation, pollution and encroachment. These areas and their foot slopes have suffered severe degradation resulting in drying of springs and wetlands, loss of valuable indigenous forest species that are water friendly and landslides.

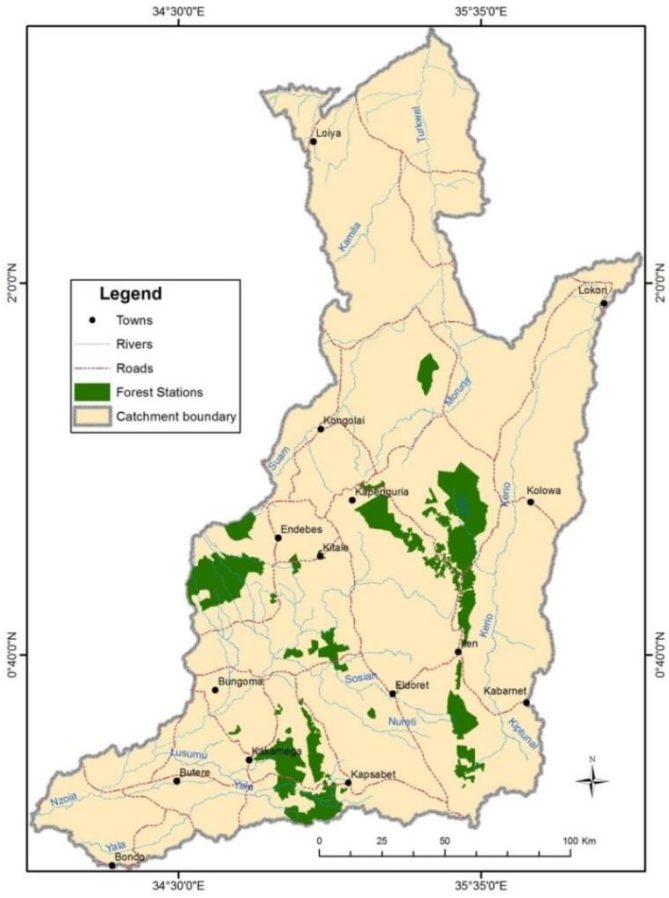


Figure 7-7: Map showing River Nzoia catchment areas from Mt. Elgon and Cheranagany

The activity achieved the following:

-Established the status of existing river gauges in both Mt. Elgon and Cherangany ecosystems,

-Identified and geo-referenced water sampling points, soil and sediment sampling sites for analysis and monitoring

-Established collaborative framework with ELDOWAS, KIWASCO and WRMA laboratories; for water quality parameters which require analysis within 24 hours of sampling

Sampling Sites

The survey established twenty (20) sampling points representing upper, mid and lower parts of the catchment and also at the tributary confluences with the Nzoia River and at a point in the Lower Nzoia. The first sampling site will be located near the margin of the forest, the second site in the upland agricultural area, site 3 in the lowland agricultural area and the last site near the shores of Lake Victoria (Figure 6-8). Sterilized plastic bottles will be used during sampling and the samples stored in cooler boxes at 4^{o}C and forwarded to the laboratory for analysis. The analysis data will form the baseline of the sediment load and water pollution in the River Nzoia basin. Existing data will be provided by the Water Resources Management Authority while discharge measurements at the sampling points will be taken by WRMA after establishing the baseline data. The sampling sites identified include the following rivers: Koitobos, Kiptogot, Sabwani, Lusumu, Kiminini tributary, Kuywa, Sergiot, Moiben, Niongamet, Mbeere (mubere), Siosian (Germagut), Larger Nzoia (brigadier bridge), Nzoia River IDA02 (Webuye), Nzoia River IDD01 (Mumias bridge), Nzoia (Sigomere bridge), Nzoia river (Rwamba Bridge). All these sites were geo referenced during the survey.

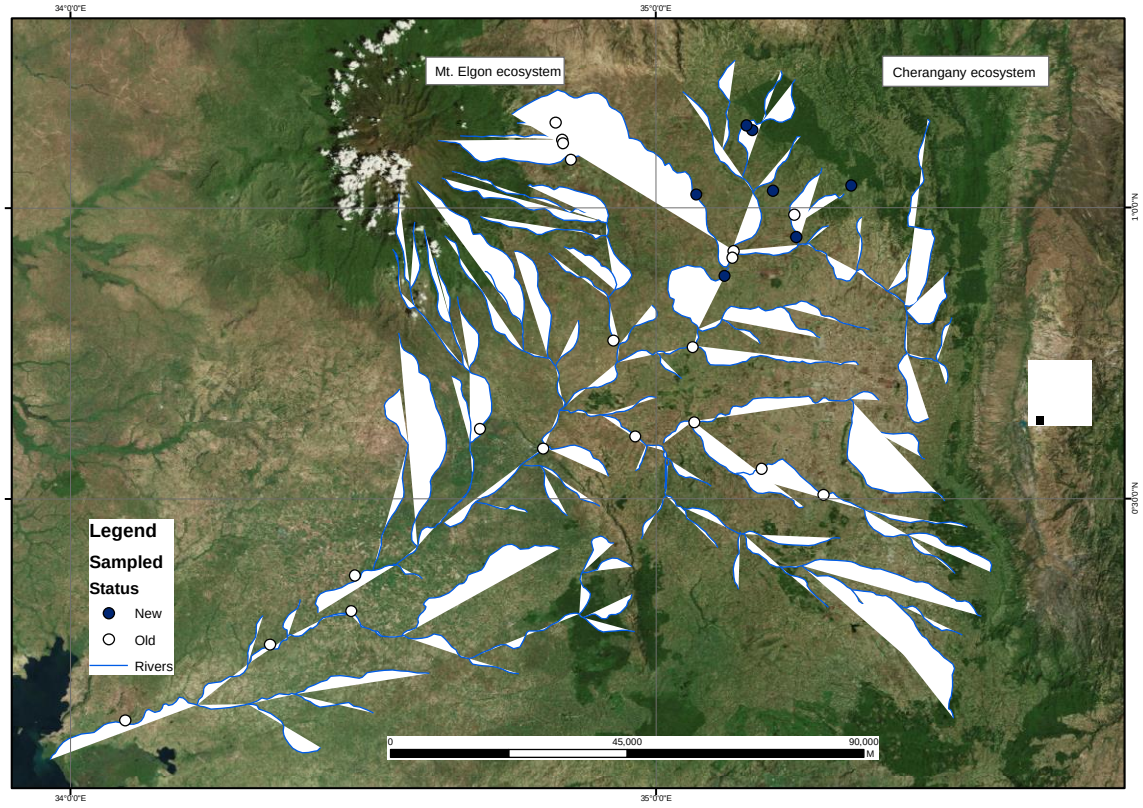


Figure 7-8: Proposed Monitoring stations for Mt. Elgon and Cherangany ecosystem (River Nzoia

catchment)

River gauge stations

WRMA has 104 River Gauge Stations distributed within various rivers in the Nzoia River catchments as shown in the figure below. The River Gauging Stations help to determine water discharge from the rivers. The River Gauging Stations are classified into station of national importance and river management units. The River Gauging Stations are all geo-referenced. However, during the survey, most of them were not functioning due to activities in and around the rivers studied as summarized in pictures in plate 6-6 bellow.

Plate 7-6: Selected gauge stations at different points on River Nzoia river

20 sampling points were determined and geo-referenced. Status of the river gauge stations were established and during the survey and river discharge measurements and hydrological parameters will be determined with assistance of WRMA after baseline data on water and soil analysis is done for the sites where the gauges are missing. However, hydrological measurements where river gauges are present will be done during sampling. Soil and sediment analysis will be done at KEFRI soil laboratory while water quality analysis will be done at either ELDOWAS or water quality laboratory in Kisumu. The team recommends that sampling and analysis of water, soil, sediment and aquatic life be done in the last week of July 2017.

(Full and comprehemssive report is available at the CMO and the Project website; www.kefriwatertowers.org)

8. ER 3.1 Technologies for rehabilitation of water towers developed and implemented

Sub-activity 36: Identify and prioritize technologies for rehabilitation of hotspots

This activity aimed to sharing best bet technologies to speed-up rehabilitation efforts in the action areas. Based on field visits and previous research work three suitable technologies were identified; namely, passive restoration techniques (liberation thinning and natural regeneration), active restoration techniques (aided/assisted regeneration, dense planting, and strip planting) and techniques for rehabilitating degraded riparian areas using bamboo. Natural forest rehabilitation guideline was developed giving steps, timelines and expected results on rehabilitation of hotspots in Cherangany and Mt. Elgon ecosystem.

(Full and comprehemssive report is available at the CMO and the Project website; www.kefriwatertowers.org)

Sub-activity 37: Assess and build capacity of stakeholders to undertake rehabilitation

One of the targets in this sub-activity was to generate and share a training manual to continuously guide rehabilitation actions among communities and institutions around the action area. In the year under review, the training manual was developed on natural forest rehabilitation techniques.

(Full and comprehemssive report is available at the CMO and the Project website; www.kefriwatertowers.org)

Sub-activity 38: Rehabilitation of forest degradation hotspots with local communities

Actual rehabilitation of selected hotspots was undertaken in year one. During year two, enclosures were erected around rehabilitataion demo plots in kaberua and Kongit in Mt.. Elgon to protect them from external interference. The enclosures were constructed using fencing posts and barbed wire. In an effort to improve community participation and to enhance sustainability of the activities, community scouts were engaged to assist in protection/ guarding of the rehabilitation demo plots in Kaberua and Kongit in Mt. Elgon.

9. ER 3.2 On farm tree production intensified and diversified

Sub-activity 40 and 41: Baseline survey of trees on farm and communities' capacity asseessment

This study was carried out during the action period to establish baseline information of trees on farm and the communities' capacity needs on propagation of indigenous trees. The teams made logistical arrangements to visit study sites, developed data collection tools and carried out FGDs and other targeted interviews in order to achieve the expected outputs. The baseline survey on on-farm trees covered all 11 counties (Busia, Kisumu, Siaya, Bungoma, and Trans-Nzoia in Mt. Elgon; and Elgeyo Marakwet, Pokot West, Uasin Gishu, Kakamega, Vihiga and Nandi in Cherangany.

Expectations of Study

Generate information on on-farm tree cover to ascertain the proportion of the ecosystems covered with trees;

Generate information that would define the extent of interventions with technologies for on-farm trees;

Assess the community needs in propagation and management of the indigenous trees;

Assess the communities' capacity (knowledge, competence and skills) in propagation and management of indigenous trees;

Tree Cover: While it was appreciated that tree cover is specific to particular tree species and even regions, the study attempted to calculate and determine tree cover based on:
Basal cover: the average amount of an area occupied by tree stems. It is defined as the total cross-sectional area of all stems in a stand measured at breast height, and expressed as per unit of land area.
Canopy Cover: The percent of a fixed area covered by the crown of an individual plant species or delimited by the vertical projection of its outermost perimeter; small openings in the crown are included.

On Farm Tree Products

On farm tree products in study area were for subsistence (49%), commercial 51,5% while the main tree products on farm were firewood, timber, poles, fruits and other uses (Table 8-1)

Table 9-1: On-farm Tree Products

Product	Percentage use
Timber	70%
Poles	43%
Firewood	86%
Charcoal	35%
Fruits	36%
Herbs	8%
Fodder	2%
Honey	0%
Amenity	11%
seedlings	5%
Others	3%

Indigenous Trees Species Nurseries

There was very low (11%) ownership of nurseries at household level. Ownership in counties were as follows; Kakamega (14%), West Pokot (4%), Kisumu (6%), Bungoma (14%), Nandi (21%) and Uasin Gishu (5%). Ownership of the few existing nurseries was primarily private (96%) with a few (4%) being owned by groups as shown in Table 9-2. There was slightly higher percentage of nurseries in Kakamega and Bungoma, owing to existence of forestry based NGOs, such as VI Agro-forestry which in 2016 planted over 5 million trees in collaboration with communities and local partners. Those who didn't own nurseries or undertake any propagation of indigenous trees mainly said this was because of lack of knowledge (38%) and also due to lack of sufficient land sizes (23%) as shown in Figure 9-1. Other reasons cited included labuor intensive (14%), lack of certified seeds (8%), time it takes to propagate seedlings and lack of water (6% each). There were also some cultural reasons (taboos) claimed by a small (9%) percentage of households (Table 9-3).

Table 9-2: Tenure of Indigenous Tree Nurseries

Ownership	Percentage
Full/private	96%
partly as group	4%

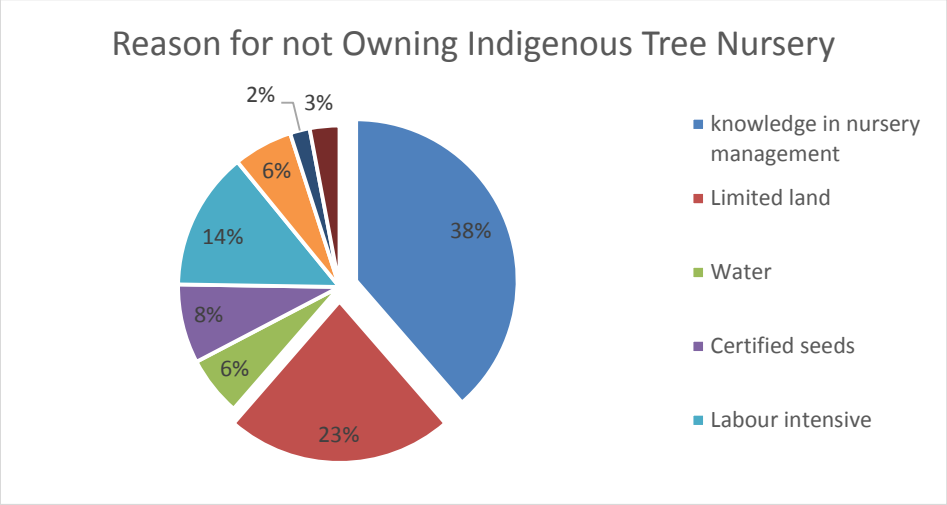


Figure 9-1: Reasons for not Owning Indigenous Tree Nurseries

Table 9-3: Taboos Associated with Propagation of particular Indigenous Trees

	Overall	Kakamega	West Pokot	Kisumu	Bungoma	Nandi	Uasin Gishu
Yes	9%	19%	0%	7%	7%	2%	0%
No	91%	81%	100%	93%	93%	98%	100%

Overall, there is need for those counties with less than 10% tree cover to plant more trees, while those above should maintain their cover. To meet this target, there is need to have more trees per farm and per hectare. For each of the Counties, the following is recommended in terms of extra trees per farm and per hectare.

Table 9-4: Recommended increase of trees per farm/hectare across counties

County	Tree per HH	Percentage cover	Required trees to achieve 10% cover	Trees per ha	Extra trees to plant pe HH to achieve 10% cover	Required trees per Ha to achieve 10% cover	Extra trees per Ha to plant to achieve 10% cover
Bungoma	55	7.9%	69.6	106.60	14.62	135	28.3
Kakamega	117	9.9%	118.2	85.65	1.18	87	0.9
Kisumu	89	6.5%	138.0	143.54	48.97	223	79.0
Nandi	590	10.7%	551.4	572.81	38.60	535	37.5
Uasin Gishu	450	12.8%	351.6	283.01	98.44	221	61.9
West Pokot	192	10.0%	192.0	17.66	-	18	-
Overall	30.51	9.6%	31.7	11.45	1.19	12	0.4

Bungoma needs to increase their trees per household by 15%, (28 trees per ha) to get to the 10% cover, while Kakamega should slightly increase overall number of trees by 1. On the other hand, Kisumu needs to increase their cover by 49% (79 trees per Ha).

Recommendations

In West Pokot County, there is need to intensify on farm tree planting through training, establishment of Farmer Field Schools (FFSs) and demonstration plots. The same could be replicated in all the eleven Counties.

There is need to establish on farm tree nurseries in West Pokot, as KFS tree nursery is not adequate for the area. It was noted that Giant Bamboo species does well in the area and its propagation and planting should be enhanced.

Water is a challenge in West Pokot, hence there is need to support water harvesting technologies, to provide water for homes and for tree growing.

There is need to promote sustainable charcoal production in West Pokot using modern technologies, with high recovery rates. Destruction of Acacia trees for charcoal production has long term impact on livelihoods engaging in honey production, which need to be addressed using alternative tree species, or policy direction, such as for every permit given for charcoal transportation, a given number of seedlings are planted.

In Bungoma County there is need for intensification of tree growing campaign and conflict resolution training, on boundary tree planting. In addition, there is need for capacity building of CFAs to enhance their tree seedlings production, and forestry management.

Kakamega County has high potential for tree seedlings production, hence there is need to link farmers to markets outside the County.

In Kisumu County there is need to demystify tree planting of certain species associated with bad omens. Nandi County has high potential for tree seedlings on farm, which need to be exploited. This can be done through capacity building of Community Forest Associations which are in their formative stages.

In Uasin Gishu County there is need to promote indigenous trees propagation as the frequency count is low, as most farmers plant exotic trees, leading to loss of biodiversity. There is also need to promote efficient on farm charcoal production methods using modern kilns with high potential for recovery. This will also build capacity of locals who outsource technicians from other counties such as Elgeyo Marakwet.

Forest extension service has been devolved. However, in all counties save for West Pokot which has three officers, is wanting, and need to be supported as an entry point in promoting on farm forestry.

There is need to provide information on appropriate trees for various agro-ecological zones and their management practices, to enable farmers adopt the technologies. Advice farmers on appropriate harvesting techniques, value added processing technologies and suitable marketing strategies of farm-based tree products.
Provide technical information on growth rates, silvicultural operations (spacing, thinning, and pruning), and interaction with agro crops of indigenous species.

10. ER 3.3 Integrated Pests and diseases management options integrated and implemented

Sub-activity 45: Conduct surveillance and establish action thresholds of forest pests and diseases

The main objective of this sub activity was to increase awareness and knowledge of integrated pest and disease management as necessary tools for communities to rehabilitate and conserve Cherangany Hills and Mt. Elgon water towers ecosystems.

A reconnaissance survey to the two water towers ecosystems was undertaken by the IPM team to help them understand the project area terrain, landscape and the vegetation cover. The team covered 10 counties where the project activities are being undertaken. The team observed that the landscape varied greatly from the Mt. Elgon/Cherangani hilltops to the lowlands of Lake Victoria regions. Most of the farmlands were dominated by tree species that included Eucalyptus, Grevillea, Markamia, Acacia, and Croton. There is a wide range of both cash and food crops such as maize, wheat and sugarcane.

The natural forests are restricted mostly in the high altitude areas of Mt Elgon and Cherangani. Other natural forests were found in Nandi and Kakamega counties. The natural forests were mostly composed of different indigenous tree species. The major rivers transecting the project area include Nzioa, Nyando and Yala. In the lowlands, swampy habitats were observed in some counties. Plantations of Cypress, Pines and Eucalyptus were dominant in the project area.
Specifically the objective will:

- Document diversity of insects, micro-flora and mushroom species and their different functions in Cherangany Hills and Mt. Elgon water towers.
- Monitor and assess incidence and severity of forest pests and diseases in the two ecosystems
- Document socio-economic and environmental impacts of tree pests and diseases in the two ecosystems
- Document potential pathways of spreading pests and diseases across regions and between farmlands and natural forests in the two water tower ecosystems in order to enhance preventive forest health measures
- Develop appropriate Integrated Pest Management (IPM) guidelines for specific pests and diseases found to occur within Cherangany Hills and Mt. Elgon water tower ecosystems

The IPM team have carried out a reconaince survey in the two eco-systems and developed necessary tools to implement the sub activity. The team have also compiled baseline information that will go into their initial field studies.

11. ER 3.4 Alternative biomass energy sources promoted to reduce forest degradation

Sub-activity 48: Undertake baseline survey on energy sources

Main objective of this assignment was to generate baseline data on energy sources and potential prefered energy interventions among communities in the study area This baseline survey was undertaken in 6 out of the 11 targeted Counties. The criteria of choosing the counties were based on the counties homogeneity to the ecosystem while the households were selected using simple random sampling. The baseline survey aimed at generating baseline data on energy sources and potential energy interventions among communities in the study area. Specifically, the survey was to:

- Determine and map out energy sources used by the communities in the project areas;
- Explore possible and potential energy interventions within the communities in the project areas;
- Identify and characterize dominant tree species preferred for energy use in the counties
- Assess cross-cutting issues related to energy and impact on livelihoods, shelter and education;
- Determine energy preferences for communities in the project areas

Methodology: The socio-economic and livelihood profile of the households indicate that the average gross monthly household income from below € 46.51 to those earning above € 371.1 with majority (22.2%) earning between € 186.05 and € 279.06. In terms of formal education, of all the household heads who completed primary education, 60.2% were males, while 39.8% were females, among those who finished secondary school education 88.4 % of the household heads were males while 11.6% were female, 82.6 % of household heads completed college were males while 17.4% females, 83.3% of those who have completed university were males while 6.7% were female. This implies that more of the males are literate as compared to the females. The type of housing for the households were surveyed revealed that majority of the respondents (48%) were having mud walled houses.

Findings: The study identified firewood, charcoal, electricity, paraffin, solar, LPG gas as energy sources utilized in Mt. Elgon and Cherengany ecosystems. Other sources of energy identified included saw dust, crop residues (Maize stalk, maize cobs) and biogas. The main source of energy for majority (91%) of the households was firewood and charcoal (52%). The situation on preferred source of energy (firewood and charcoal) over the past five years had improved as indicated by 50% of the respondents, 30% indicated no change, while 20% indicated that the situation had worsened.

The tree species used for firewood and charcoal in order of preference were *Ecalyptus Sp, Grevillea robusta, Cupressus lusitanica, Markhamia lutea, Mangifera indica, Persea Americana, Acacia mearnsii, Pinus patula, Croton macrostachyus, Albizia coriara, Psidium guajava, Jacaranda mimosifolia, Ficus sycomorus, Acacia Sp, Euphorbia tirucali.*

Of all the households surveyed across the Counties, 62% sourced firewood from existing exotic trees from the farm while 45% sourced from indigenous trees from the farm. 47% purchased charcoal from sellers while 29% sourced charcoal from either existing indigenous trees on farm or exotic trees from the farm.

Charcoal production in all the Counties is still done using the traditional earth kiln. The low adoption of the improved charcoal conversion technologies may be linked to low awareness on improved methods of charcoal production as indicated by 96% of the households in all the Counties.

Majority (79%) of the households still use the traditional three (3) stones for cooking. A number of initiatives on the introduction of improved cook stoves were noted in all the counties studied. However the adoption rate is still low as some households indicated lack of knowledge on their use and high cost

of purchase as reasons for low adoption rates. Several energy intervention initiatives are currently going on, including tree planting, introduction of improved cook stoves and use of alternative sources of energy. Despite the initiatives to ensure energy sustainability, fuel wood energy is still not economically and environmentally sustainable in the Counties surveyed. More deforestation has been experienced in these Counties mainly due to population increase and need for income. To reduce further deforestation due to high demand of firewood and charcoal, the following possible intervention measures are suggested to ensure sustainability within the study area.

- Promotion of the integration of wood fuel production on farm
- Promotion of the use of improved charcoal production technologies and sensitization on charcoal rules
- Promotion of improved cook stoves with higher energy efficiency
- Promotion of use of alternative sources of energy
- Strengthening of existing energy centres

Conclusion and Recommendations

Despite the initiatives to ensure energy sustainability, fuel wood energy is still not economically and environmentally sustainable in the counties surveyed with the exception of West Pokot County where fuel wood is not a problem because the tree population in the forest is still high and are well maintained.

More deforestation has been experienced in other counties mainly due to population increase and need for income. To reduce further deforestation due to high demand of firewood and charcoal the following possible intervention measures are suggested to ensure sustainability in the study area.

Promotion of integration of wood fuel production on farm

Woodfuel production need to be integrated into local farming systems to supplement wood fuel sourced from indigenous forests. This can be supported by intensifying on-farm tree planting initiatives amongst the individual households by promoting fast growing trees species which match specific environmental and ecological conditions for maximum productivity. Forestry and Agriculture extension officers at the County and Sub-County levels can be used to promote on farm growing of fast growing trees and establishment of commercial woodlots.

Promotion of use of improved charcoal production technologies and sensitization on charcoal rules

The study showed that almost 100% of the charcoal producers in the study area were using traditional method of charcoal production with between 10% and 20% efficiency. Improved charcoal kilns with efficiency of > 25% should be promoted. Use of dry wood during carbonisation should also be encouraged. The technologies to be used should be simple, cheap and easily adopted by charcoal producers like the improved earth kiln developed by KEFRI (Oduor, 2006). This would lead to a reduction of wood needed for charcoal making significantly.

The continued use of traditional production methods by charcoal producers means low level of awareness on best charcoal conversion methods and the Charcoal Rules 2009 which require them to use efficient charcoal production methods. There is need to create awareness in the area on charcoal production guidelines.

Promotion of improved cook stoves with higher energy efficiency

The conservation of wood energy should be given a priority through promotion of improved stoves with higher efficiency and low emissions. It was observed that over 79% of the households in the study area use 3 stone stoves which were inefficient and also contribute to respiratory health problems. A number of initiatives on the introduction of improved cook stoves were noted in all the counties studied. However the adoption rate is still low as some households indicated the lack of knowledge on their use

and also the high cost of purchasing. The improved stoves to be promoted for adoption should consider user needs which include cooking comfort, convenience, health and safety. To ensure availability of cook stoves of affordable prices, training can be offered to artisans at village level on making and maintenance of improved cook stoves.

Promotion of use of alternative sources of energy

The government policy of promoting cleaner energy use and rural electrification, envisages that the households will slowly substitute woodfuels to alternative cleaner fuels. This will reduce pressure on woodfuel for domestic use leading to its decrease in demand. The use of alternative energy is supported by the Energy Policy of 2004, which promotes the use of cleaner fuels like LPG through subsidies (MoE, 2004). A different system of retailing LPG should be introduced to enable customers to buy whatever quantities of gas they can afford.

Alternative uses of energy sources such as solar, biogas and micro hydro power units needs to be promoted in the study area to reduce pressure on fuelwood energy sources used for lighting and cooking. Most of the communities in the study area keep cows in their homesteads and they can be taught the technologies of producing biogas from animal wastes for cooking and lighting. Micro hydro power units have potential to provide energy at a community level on suitable sites remote from the national grid.

Strengthening of existing energy centres

The existing energy centers under the Ministry of Energy should be strengthened to assist in disseminating of efficient biomass energy processing and utilization technologies (Biogas production, improved charcoal production kilns, improved cook stoves).

(Full and comprehenssive report for the energy sources report is available at the CMO and the Project website; www.kefriwatertowers.org)

Sub-activity 49: Promote use of improved biomass technologies and sustainable charcoal production

The baseline survey on energy sources and potential energy interventions in activity 48 above identified firewood, charcoal, electricity, paraffin, solar, LPG gas as the main energy sources utilized in the ecosystems. The main source of energy for majority (91%) of the households was firewood and charcoal (52%). Of all the households surveyed across the Counties, 62% sourced firewood from existing exotic trees from the farm while 45% sourced from indigenous trees from the farm. 47% purchased charcoal from sellers while 29% sourced charcoal from either existing indigenous trees on farm or exotic trees from the farm. This scenario has a direct contribution to forest degradation and as such the project carried out training on the fabrication and use of various energy saving devices/ technologies (Kuni mbili, portable jikos, solar lamps, moto stoves, drum kilns, casamance kilns, earth kilns amd metal kilns in both ecosystems.

A total of 160 solar lamps and 80 portable jikos were issued to community members in Cherangany ecosystem. Twenty of the solar lamps and 10 of the portable jikos were issued to each of the following sites in Cherangany ecosystem targeting women and people living with disability in Kaisagat, Lelan, Kapolet, Kapsara, Kapsait, Kapcherop, Kapsowar and Kamasia.

A total of 75 energy saving devices (kuni mbili and moto stoves) were issued to women with disability, widows, aged and vulnerable women in Bugaa, Kapsokwony, Kimobo, Nomorio, Koshok, Kibuk and Sambocho villages of Mt. Elgon forest ecosystem

Plate 11-1: Capacity building of community members on energy conservation devices/ technologies in Mt. Elgon ecosystem

Plate 11-2: Some of vulnerable beneficiary women; *women with disability, widows* and *aged*

Plate 11-3: Some of the solar lamps beneficiary women in West Pokot, Cherangany hills ecosystem

Plate 11-4: Aged and disabled man receiving a solar lamp in Cherangany ecosystem

Sub-activity 51: Document indigenous technical knowledge on production and utilization of NWFPS

Information was gathered on indigenous technical knowledge for production and utilization of NWFPs. **Methodology**: Five focused group discussions (FGDs) and two key informant interviews were conducted on NWFPs targeting a total of 336 randomly selected respondents from 21 villages in 7 forest blocks.

With the exception of vegetables, honey and bush-meat, harvesting of NWFPs was a joint responsibility of all household members in greater than 10% of the households with harvesting of exotic fruits and Aloes being the case in greater than 60% of the households. Harvesting of honey and bush-meat was the responsibility of adult male in greater than 60% of the households while vegetables and mushrooms was the responsibility of the adult female in greater than 40% of the households.

Cosmetics, ropes, indigenous fruits, and fodder were considered easily available by more than 50% of the respondents. All the recorded NWFPs were considered moderately to easily available by at least 75% of the respondents. Only Mushrooms, honey, bush meat root & tubers, and Aloes were considered to difficult to get by about 20% of the respondents (Table 11-1)

Table 11-1: Respondents' perception on availability of NWFPs

	Opinion on abundance, % frequency		
Non-wood forest product	**Easily available**	**Moderately available**	**Difficult to get**
Medicine	43.2	47.9	8.9
Mushrooms	22.4	55.6	22.0
Ropes	55.4	41.8	2.7
Honey	21.5	54.7	23.8
Vegetables	48.7	46.7	4.5
Exotic fruits	41.0	53.2	5.8
Bush meat	31.8	33.5	34.7
Cosmetics	61.8	32.2	6.0
Roots and tubers	44.4	33.3	22.2
Gums and saps	27.4	56.5	16.1
Indigenous	58.7	39.7	1.5
Fodder	51.8	42.4	5.9
Dyes	0.0	100.0	0.0
Aloe	47.4	28.9	23.7

(Full and comprehenssive report is available at the CMO and the Project website; www.kefriwatertowers.org)

Sub-activity 53: Establish status of wetlands and springs within the 2 ecosystems

The activity was implemented by Component 4 of the project through expert scientists. It involved both desktop and field observations to achieve the target objective. The expertise involved included ornithologist, herpetologist, wetlands specialist, spatial analyst and plant taxonomist. Information gathered from the surveys was used to characterise wetlands based on the current observed conditions e.g. size and condition of wetlands, threat status of biodiversity observed, wetland use, land use around and within the wetlands among other variables.

The two ecosystems support critical terrestrial and wetland habitats in addtion the much needed ecosystem functions e.g Nzoia River drains to Lake Victoria through a system of swampy valleys in Uasin Gishu and Trans- Nzoia. The different habitats support important biodiversity ranging from birds, mammals, reptiles and amphibians, plants among other biodiversity. The flagship bird species for these wetland ecostems is the Grey Crowned Cranes. This is a species of conservation concern globally, since its status has been recently listed to Endangered category by IUCN. Their populations are under pressure mainly due to wetland habitat degradation.

The wetlands visited included rivers, springs, swamps and dams. The wetlands were of various sizes and were also under different management systems. The management ranged from communal, private and government to open access wetlands consequently exhibiting varying levels of threats and biodiversity importance. Different land use systems were noted within and outside the wetland. These included mainly farmlands. Both ecosystems are located in high agricultural potential area with farming ranging from small to large scale mechanized farming systems. The expansion of farmlands into these wetlands is by far the greatest driver of land use change in the region and the escalating human population. These have resulted in degradation and fragmentation of wetlands due to clearing and draining wetlands to open up areas for farming and grazing activities. However, other causes for wetland/spring degradation were also identified such as unsustainable use of wetland vegetation, excessive water abstraction, siltation of the wetlands due to soil erosion besides lack of respect for existing laws leading to wetlands being converted into private property.

A significant number of wetlands in the Mt. Elgon-Cherengany ecosystem face considerable threat from human activities because they have no formal protection. This therefore subjects them to the risk of extinction. Some of the activities posing threats include industrial pollution, untreated sewage disposal, agricultural run-off from pesticides and agriculture (e.g. in Nzoia River), excessive water abstraction for irrigation, damming or drainage (e.g in Yala Swamp), for large scale agriculture and settlements and siltation of rivers arising from soil erosion in degraded watersheds. Other notable threats include Grazing within the swamps and over havesting of papyrus for craft industry, conflicts of open access to wetlands leading to users setting fires to the vegetation and demarcating them as private property.

All the springs visited were set up and protected for use by local communities in the early 20th century by colonial government and have been used over time with not much rehabilitation efforts. Their conditions are in disrepair with minimal water trickling through. The communities are however, still using them and they all wished to have them rehabilitated to enhance the water flow for their domestic use, especially in areas where these are the only sources for drinking water.

Most of the threats identified are tied to pressing issues of human well-being and livelihoods. Effective wetland conservation in the region therefore, will depend on providing solutions for the pressing human livelihoods and well-being. Consequently, for long term conservation efforts to be successful, efforts must

enroll the support of people living around protected areas and be seen to be addressing some of their livelihood concerns. Law enforcement and promotion of wise use of the wetlands within the catchment areas is critical for sustainability.

Recommendations

In view of the observations made during this study has a series of further action. These include:

Laws, Regulations and Policies: Considering that the study area is located in high agricultural potential area with farms ranging from small to large scale mechanized farming systems, and that the expansion of the farms is by far the greatest driver of land use changes in the region coupled by the escalating human population, it is imperative that matters of law enforcement have to be taken seriously to safeguard the wetlands and their catchments. As captured in this study Kenyan laws and policies are very clear on the status and place of wetlands in the environment but from our study it is clear that the law has not been enforced effectively on the ground. We further recommend that avenues be created so that a comprehensive review, harmonisation, application and enforcement of policies, legislations, regulations and standards governing wetlands and their catchments is undertaken for effective conservation of these critical ecosystems to take place.

Related to this, it is highly recommended that the relevant Ministry finalises the development and release of the "*National Wetlands Conservation and Management Draft Policy, 2013"* for public use. The current draft has very powerful statements which could go along way in strengthening wetland conservation in the country. The following four statements extracted from the report, attest to this:The Government shall:

Policy Statement 1: Ensure that any drainage, conversion, burning, alteration of a wetland, or introduction of alien and invasive species in a wetland will be subjected to approved standard procedures including Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), Cost Benefit Analysis (CBA), and adequate public participation.

Policy statement 2: Promote restoration and rehabilitation of degraded wetlands.

Policy Statement 3: Undertake socio-economic valuation of wetlands to inform planning and decision making.

Policy Statement 4: Harmonize wetland riparian (buffer) zones and setback limits for all wetland ecosystems in the country.

Waste and Effluent Disposal : Wetlands in or near urban centers were often times found to be in use as waste (solid or liquid) disposal sites. It is recommended that urban and industrial waste management adhere to proper disposal and sanitation systems to protect those wetlands that are in their neighbourhood. Furthermore, local government authorities should develop special programmes to protect these sites from encroachment and use as dumpsites. This would go a long way in strengthening enforcement of existing laws, governing solid and liquid waste management. Construction and use of man-made wetlands for cleaning up toxic elements from effluents before discharging into streams should also be encouraged.

Soil Erosion and Land degradation: Signs of erosion activities such as rills and galleys on land near wetlands or on river banks were observed. Soil erosion is a threat because it destroys riparian areas where vegetation occurs thus opening up the wetland for subsequent sedimentation and siltation. Most of the springs visited during field survey had minimal water trickling through due to silted reservoirs. It is

therefore recommened that appropriate technologies be applied to reduce on soil erosion and silting of the wetlans and springs. Technologiesthat have been identified in this study include: Promoting *agroforestry around the catchment,* contouring with vegetative (e.g nappier grass) barriers, contouring with earth banks and waterways, tillage practices such as sub-soiling, improved farming (cropping) systems, vegetative ground cover, mulching and manuring.

Rehabilitation of Springs: All the springs visited were constructed and protected for use by local communities in the early 20th century by colonial government and had been used decades with not much rehabilitation efforts. Their conditions were observed to be in disrepair with minimal water trickling through. The communities were however, still using them and they all wished to have them rehabilitated to enhance the flow of water for their domestic use, especially in areas where these were the only source for drinking water. It is recommnded that a spring rehabilitation programme be initiated by relevant government structures to restore the springs for local use.

Education and awareness: The old adage "***information is power***" remains true even in the current setting. Empowering local communities, especially the youth and women, with education and awaresss of the value of wetlands and their sustainable use, therefore, will go a long way in preserving these valuable ecosystems. A follow-up series of public awareness and education campaigns to sensitize the local communities on the importance of the two ecosystems could change attitudes and perceptions. Patnerships with local CBOs, NGOs, International organizations with a local presence is therefore highly desirable for awaress creation, local management and subsequent conservation of these wetlands and springs.

Alternative Livelihoods: The study recommends identification and promotion of alternative livelihoods through small to medium size enterprises that are necessary for sustaining ecological quality of wetlands. This will check the over-reliance on natural wetland resources. The example of Dunga Ecotourism Project in Kisumu presents a successful story for sustainable use of wetland resource that focuses on improving livelihoods while preserving biodiversity. Public awareness of the benefits of biodiversity conservation coupled by adoption of wetland user-friendly alternatives, and sustainable income generating enterprises offers a unique opportunity to sustainably manage and conserve wetlands amidst increasing population, poverty and limited resources. Observations were made of diverse income generating activities based on wetland resources which currently appear to be a threat to the conservation of wetlands, such as massive harvesting of papyrus vegetation for handicraft industries. Such activities can be turned around to be a point of entry in educating and training the locals on sustainable and wise use of these valuable resources. Furthermore, other nature based enterprises such as Bee keeping, butterfly farming, sustainable fish farming, silkworm farming, etc could be promoted in all the counties. (Maps of wetlands and springs and photographs in the photo gallery (Annex 7))

Full report for the activity is available at the CMO and the Project website; www.kefriwatertowers.org

12. ER 3.6: Wetlands, riverline forests and water springs conservation

Sub-activity 54: Based on ER1-characterize and develop models for conservation and rehabilitation

Categorization of wetlands resources requires three basic characteristics of wetlands, namely: a) permanence and seasonality of their moisture regime, b) the main vegetation and land cover types, c) resource pressure from human use (Tiner, 1999). This section therefore attempts to categorize Mt. Elgon and Cherengany wetlands by the three characteristics. About 75% of Kenya's wetlands are ephemeral, majority of which are dominated by *poaceae*. On other hand the permanent wetlands are in most cases dominated by cyperaceae. In western Kenya the dominant vegetation in most permanent wetlands is *Cyperus papyrus*. Papyrus wetlands occupy the transitional zone between permanently wet and generally dry environments (Morrison et al., 2012). The outcome of this assessment indicate that wetlands in Mt. Elgon and Cherengany regions are dominated by permanent wetlands with cyperaceae as the dominant vegetation. However during the time of the survey a greater proportion of these wetlands appeared to be seasonal. This was probably attributed to the long dry spell (Scheffer et al., 2001) that has affected the eastern part of the Africa for the past six months. Theses wetlands provide various services to the local resents including tourism, water provision, harvesting of resources such as papyrus reeds, brick making among others. Most of the wetlands were faced with various pressures including encroachment for crop farming, grazing water abstraction and invasion by alien species.

Seasonality: The rapid wetland assessment outcome indicates that majority (85%) of wetlands within Mt. Elgon and Cherengany are permanent. Majority of these wetlands were dominated by either fresh water marshes or swamps. Other wetland types documented included riverine and manmade wetlands. Most counties surveyed contain many permanent wetlands. However Uasin Gishu and Kitale registered the largest number of permanent wetlands. See (Figure 12-1) on wetland distribution and seasonality in Mt. Elgon and Cherangany Ecosystem.

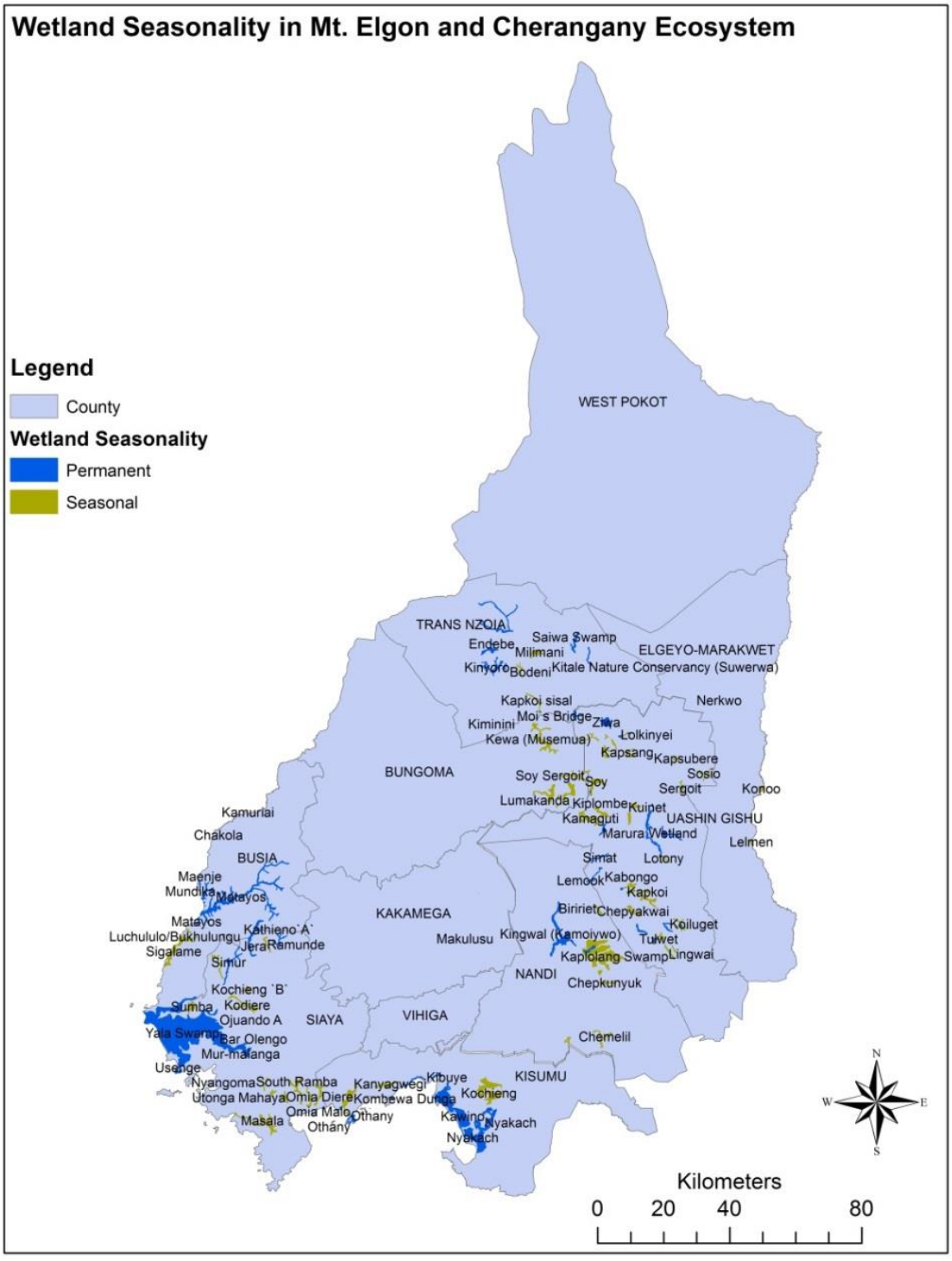


Figure 12-1: Wetland distribution and seasonality in Mt. Elgon and Cherangany Ecosystem

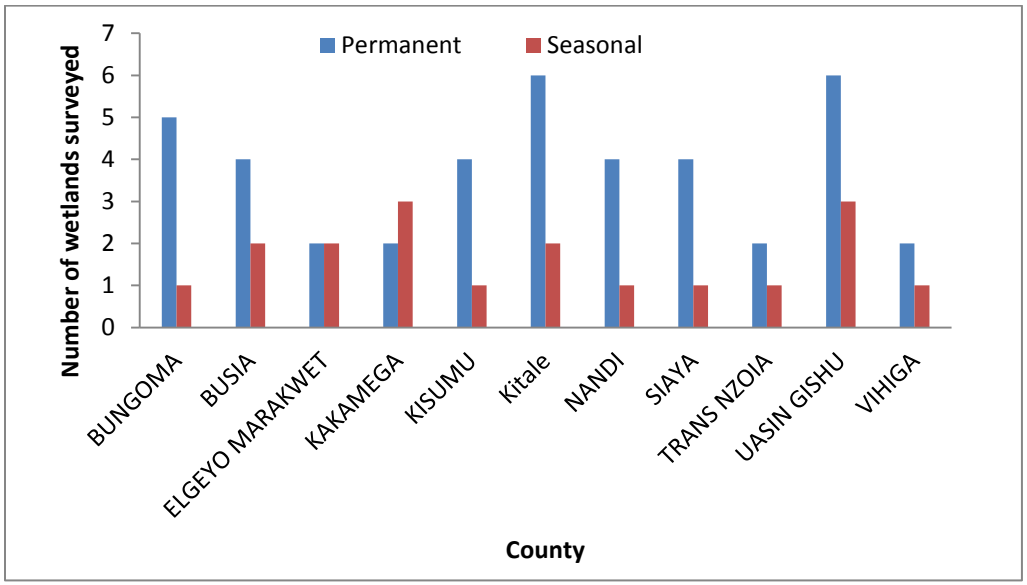


Figure 12-2: Seasonality of wetlands by county

Most of the wetlands in both Mt. Elgon and Cherengany are dominated by fresh water swamps (39%) and marshes (28%) (Figure 12-3).

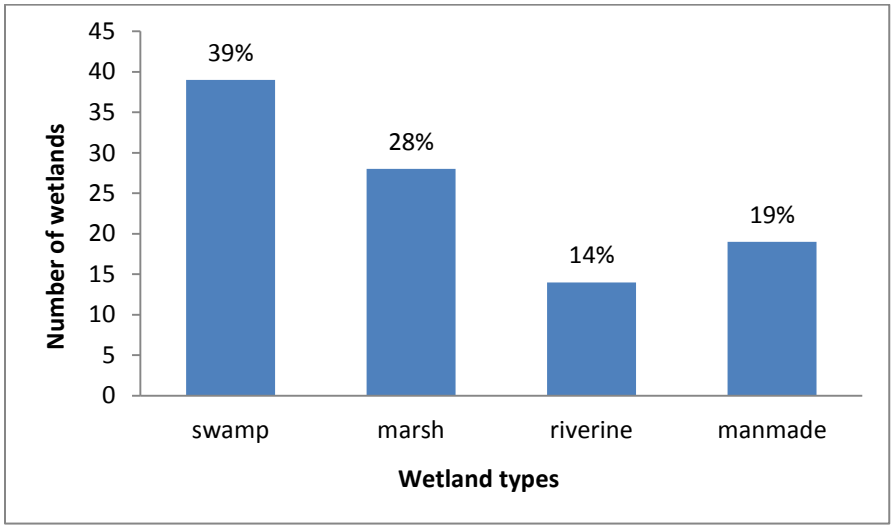


Figure 12-3: Proportion of wetland types surveyed in Mt. Elgon and Cherengany

At the county level the distribution of these wetlands also shows dominance by fresh water swamps and marshes (Figure 12-4).

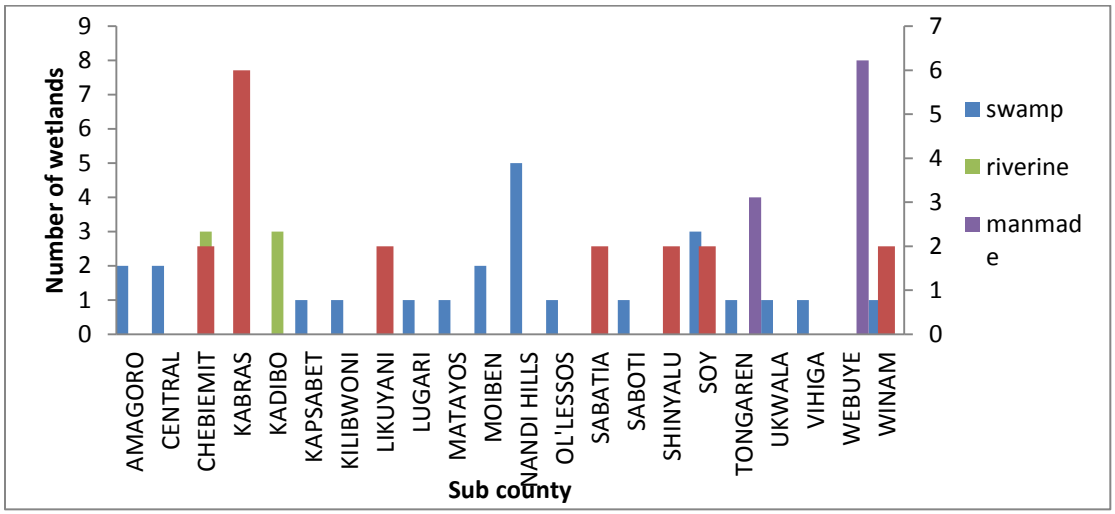


Figure 12-4: Wetland types by sub county

Dominant Vegetation

Of the wetlands surveyed, the dominant vegetation was of genus Cyperaceae (sedges) accounting for 40% of the wetlands surveyed and Poaceae (grasses) on wetlands that were less disturbed. On the other hand Typha sp and food crops dominated wetlands that were either manmade or those completely drained and transformed into agricultural land (Figure 12-5).

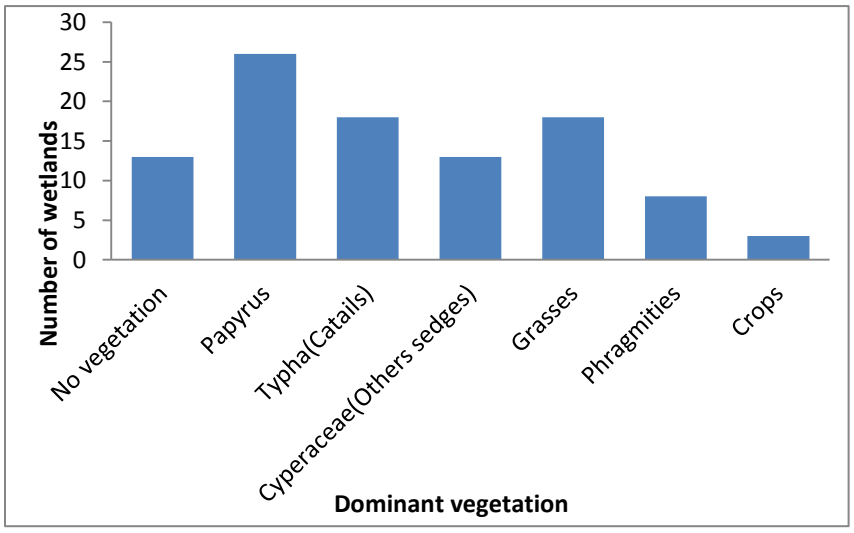


Figure 12-5: Dorminant vegetation in wetlands sampled

Table 12-1: Riverine LULC distribution along the length of drainage network based on the LULC in the ecosystems. *(The length covered by LULC in a county is provided in percentage (%) of the total area of the land use land cover in a county)*

	Bare soil or Built up Areas	Cultivated Areas	Forest	Grassland	Shrubs
BUNGOMA	5	21	37	1	37
BUSIA	8	23	31	1	36
ELGEYO-MARAKWET	12	27	21	0	40
KAKAMEGA	3	10	21	0	65
KISUMU	10	33	16	2	37
NANDI	3	12	21	0	64
SIAYA	15	26	14	1	44
TRANS NZOIA	21	25	16	6	33
UASHIN GISHU	23	33	16	3	25
VIHIGA	1	9	19	0	71
WEST POKOT	44	34	7	6	9

Proposed Agro-Forestry And Soil Conservation Technologies For Rehabilitation

Despite escalating threats to the wetlands due to human activities, the Mt Elgon-Cherengany Ecosystem remains a key site for biodiversity and water catchment for the country. Susequently, this calls for urgent measures to protect those sites that are still viable wetlands from further fragmentation and drainage to preserve their ecosystem functions and livelihoods that are supported by these ecosystems, not to mention biodiversity conservation. The current study has identified agriculture and poor land use practises as the key drivers of the threats facing wetlands in the region. It is therefore imperative that one of the key measures that must be taken to conserve and or rehabilitate the degraded wetland /spring sites is identification and implementation of appropritae agro-forestry and soil conservation technologies.

Proposed Specific Technological Measures

There are isolated documented efforts seeking to improve the productivity and sustainability of land use systems in selected watersheds in western Kenya (e.g. Njuguna, 2004). However, no deliberate attempts have been made to conserve the seemingly threatened wetlands. The process of watershed improvement involves several important aspects. Some of these include the selection and application of technical methods for bringing about stabilization of degraded land surfaces through the reversal or stoppage of degradation, or protection against it in newly exposed watersheds. Similarly, addressing the loss in agricultural productivity due to diminished soil and nutrient status has also been used effectively.

Specific measures include agronomic practices, farm and range plants for erosion control and water conservation, forestry, contouring, terracing, water disposal, tillage operations, gullies, dams, water spreading, wildlife, and flood control. These can be implemented as either on-sight or off-site:

On Site: Arable land

Contouring with vegetative (e.g napier grass) barriers: This approach was found most productive in a study using calliandra (*Calliandra calothyrsus* Meissner), leucaena (*Leucaena trichandra* (Zucc. Urban) and napier grass (*Pennisetum purpureum)* (Schumach) and a combination hedges of either calliandra or leucaena with napier grass on slopes (Mutegi *et. al*., 2008). In general, a combination of hedges provides the best solution for reducing soil erosion, combined with improvement of maize crop yields and soil fertility enhancement. We propose that this method can also be applied in the rehabilitation of riparian wetland habitats.

Contouring with earth banks and waterways: Contour banks are designed to reduce the velocity of overland flow and to intercept water before it concentrates in rills, thereby reducing the risk of soil erosion and land degradation. These can either be applied as earth banks on field boundaries, furrowing, ridging, and ridge tying.

Tillage practices such as subsoiling has been documented to improve water percolation (Pikul and Aese, 2003) and hence could be a useful practise.

Vegetative ground cover, mulching and manuring: The investigations of this technique indicated that there are significant and important differences in runoff generation and sediment production with respect to the different types of vegetative cover. Forest and natural vegetation treatments exhibit the lowest amounts of runoff. Grass cover, grass strips, grass barriers have also been shown to yield similar results.

Improved farming (cropping) systems. Investigations of organic farming have demonstrated greater long-term soil benefits than conventional no tillage practices, despite the use of tillage in organic farming.

Agroforestry. Domestication of indigenous trees with high-value crops enhances profitability, particularly those that can be marketed as ingredients of several finished products (Sanchez, 1995). Profitable agroforestry systems are potentially sustainable in controlling erosion, enhancing biodiversity and conserving carbon, provided nutrient offtake is balanced by nutrient returns via litter and the strategic use of fertilizers, particularly phosphorus. Table 11-2 below provides information on trees under Agro-forestry found on community farm land around the Mt Elgon National Park.

Table 12-2: Agro-forestry trees found in communities around the Mount Elgon National Park

Purpose	Species	Source of information
Agroforestry	Grevillea robusta[2], Maesopsis eminii, Fucus natalensis, Markhamia lutea,Ricinus communis, Ekebergia ruppeliana, Eucalyptus grandis, Ficus ovata and Napier grass[1]	UWA official per. com; Reed and Clokie, 2000
Agro-forestry and Fodder	Leuceana leucocephala[2] and Caliandra calothyrus[2]	Key informants
Support for beehives	Calliandra calothyrus, Cordia Africana2, Sesbania sesbans2 and Sesbania bispinosa2	Key informants
Tree species under plantation forestry	Cyperuss lusitanica, Pinus patura, Pinus radiate , Ecalyptus saligna and Eucalyptus grandis	Observation and UWA official These trees are all exotic

[1]*Napier grass is planted on terraces to reduce soil erosion and also as fodder. It is also a min food supplement for cattle in zero grazing systems (Reed & Clokie, 2000)*
[2]*main trees species promoted by IUCN during the concluded MECDP*
Adapted from: MEICDP, (2000). A 5-Year Tourism Strategy Framework for the Western Region of Kenya with Specific Focus on Mt. Elgon National Park Part I (Final Report, June 2000. Report, unpubl.

Land leveling and smoothing.

Land leveling is a form of soil disturbance that alters soil physical properties and is commonly conducted in fields such as rice fields to facilitate more uniform distribution of irrigation water (Brye et al, 2005).

Non-arable land

Vegetative barriers on contour have been used as an effective soil and water conservation mechanism. This can be achieved through afforestation, reforestation or revegetation. Similarly, earth or rock barriers can be used for the same purpose. Poor water quality due to poor soil and water conseravtion measures and use of exotic trees as vegetative barriers (Plate 12-1) was observed in some of the wetlands visited. The benefits of using indigenous trees should be explored. Some of the agro-forestry tress listed in Table 12-2 can be used for this purpose.

A. Sergoit Wetland (Uasin Gishu)

B. Miti Jambazi (Trans Nzoia)

Plate 12-1: Poor water quality due lack of vegetative barriers or use of inappropriate vegetative barriers

Silvipastoral plantations. Cattle rearing is a common practice among many communities within Mt Elgon and Cherengany ecosystems. For this reason, mechanisms to reduce grazing pressure, stall feeding pasture improvement are recommended for soil and water conservation.Plantations have been evaluated for their potential as silvopastoral systems, and the possibilities of integrating local farmers into their appropriate sustainable utilization has been documented (Garrison and Pita, 1992). Grazing was a major landuse posing threat in most wetlands visited (Plate 12-2). In such cases, the adoption of silvipastoral planatation technologies is recomemnded to redice pressure on the wetland ecosystem.

A) Miti Jambazi Swamp (Trans Nzoia)

B) Sosiyo Swamp (Uasin Gishu)

Plate 12-2: Grazing as a land use within wetlands visited

Buffer zones. A study of buffer zones in Europe showed that organic farming enhanced the biodiversity of plants and birds in all landscapes, but only improved the potential for biological control in heterogeneous landscapes (Winqvist *et al*, 2011). This study underscored the importance of taking both local management and regional landscape complexity into consideration when developing future agri-environment schemes, and suggest that local-regional interactions may affect other ecosystem services and functions. For instance, poor farming practices were documented in many places such as Busia (Plate 12-3) without consideration of buffer zones around the wetland.

Plate 12-3: Agricultural encroachment within wetland in Malakisi River Swamp (Busia)

Trail, rural road and forest road constructions. Owing to the fact that most wetlands are found within human-settled landscapes, infrastructural developments such as trails, rural and forest roads are unavoidable. However, if not well designed and managed, these pathways could lead to serious negative impacts in terms of soil and water loss.

Drainage lines

Gully control structures. Preventing the effects of soil erosion is an essential part of good catchment management. This can be achieved through check dams and silt traps. In the field such as riparian wetland habitats, it is not only important to select the most efficient erosion control measures but also to determine their optimum location in the catchment (Mekonnen *et. al.,* 2015). Other techniques include diversion drains and vegetative stabilization of natural drainages. This is most appropriate especially around springs. Many springs visited during this study were highly degraded due to poor management practices within the catchment. Proper gully control structures are proposed as part of the rehabilitation for such springs.

A

B

Plate 12-4: Impacts of catchment degradation in A Muyuchi and B Lunyu springs (Kakamega)

Off-Site

While considerable effort must be put on site, it is equally important to take some measures off site as well.

Drainage lines. Management of drainage lines has been achieved by either grassing of artificial waterways or stream bank protection. In other circumstances, channelization has also been used. Some of the local within the visited wetlands already adopt this techniques (Plate 12-5). This should be further promoted in other areas.

Plate 12-5: Channelization in Kewa Swamp (Uasin Gishu)

Compacted areas. Construction of roads often result in high soil compaction mechanisms. This usually leads to increased run-off and soil loss. Some of the techniques that have been proposed to mitigate such effects include proper design and retaining walls for cut barriers. Settlements such as the ones observed in Kisumu (Plate 12-6) require adequate diversion drains for similar reasons.

Plate 12-6: Peri-Urban development in Hippo Point Swamp (Kisumu)

Conclusion and Recommendations

Current study indicate that the majority of wetlands within the Mt Elgon-Cherengany Ecosystem are on private farmlands with no formal protection and many are under considerable threat. They face a variety of problems, including pollution from industry, sewage or agricultural run-off (e.g. Nzoia River), excessive off-take of water for irrigation, large-scale projects involving damming or drainage (Yala Swamp), and siltation arising from soil erosion in the degraded watersheds.

Reclamation of wetlands for agriculture in both Mt Elgon and Cherengany is of great concern, as modification of wetlands is also taking place rapidly. The use of pesticides and fertilizers in agriculture is a potential problem, and could threaten biodiversity both directly (through poisoning) or indirectly (through eutrophication of aquatic habitats). Anecdotal reports on a number of dead birds such as raptors and storks being encountered in agricultural areas including Elgon and Busia grasslands indicate the need for action to protect them againt poisoning.

Most of the threats identified are tied to pressing issues of human well being. Solutions for conserving these ecosystems in the region will therefore depend on solutions for people and many of these critical issues are beyond the means of conventional conservation. To be successful in the long run, conservation efforts must enroll the support of people living around protected areas. Promotion of bird conservation goes hand-in-hand with efforts to promote wise use of the environment and the conservation of biodiversity in general. In July 1990 Kenya became a signatory to the Ramsar Convention which advocates for wise use of wetlands. This encouraging action paves way towards protection of the country's most important wetlands and associated water birds under the convention.

Kenya's environmental concerns extend much further than biodiversity alone, and conservation efforts must take place across a broad front if they are to be effective. Nonetheless, there are good reasons to concentrate on biodiversity conservation and, a strategy to conserve birds in particular, would validly form part of an overall plan for wise use of the environment and wetlands for that matter.

Full report for this activity is available at the CMO and the Project website; www.kefriwatertowers.org

13. ER 4.1: Needs Identification

Sub-activity 57: Undertake capacity needs assessment

Capacity needs assessement on status of bamboo resource in Bungoma, Siaya and Busia Counties was carried out in October 2016. Most of the available bamboo resources comprise indigenous bamboo in Mt. Elgon. On farm bamboo resource was negligible in Bungoma, Siaya and Busia Counties. On farm planting of bamboo resources was found to be low because of high cost of seedlings, poor skills in processing bamboo into finished products and lack of awareness as alternative to wood forest products. The study identified bamboo farming as a viable low cost opportunity for livelihood improvement and sustainable environmental protection.

The assessment recommended capacity building on bamboo propagation, management onfarm and sustainable harvesting

14. ER 4.2 Capacity to implement activities built

Sub-activity 58: Development of bamboo and high value tree management guidelines

Four greenhouses were procured and installed at 4 sites in Cherangany to support the community groups on propagation of bamboo planting materials. These are Kokwo Porokon self help group tree nursery, Rift Valley Eco-Region Research Programme tree nursery, Cheptengis Okilgei Women Group tree nursery and Marakwet Highlands Farmers Association tree nursery.

Green house installed at Cheptengis Okilgei Women Group in Cherangany ecosystem

Well established bamboo seedlings raised under a green house

Training manual on bamboo: A training manual for bamboo processing and utilisation was developed. The guideline on propagation and management of bamboo was developed as well as guidelines on establishment and management of *Cupressus lusitanica, Gravellia robusta* and *Eucalyptus grandis* developed

Eleven assorted artisanal bamboo products were made in Maseno ecoregion for training on bamboo processing with below as examples;

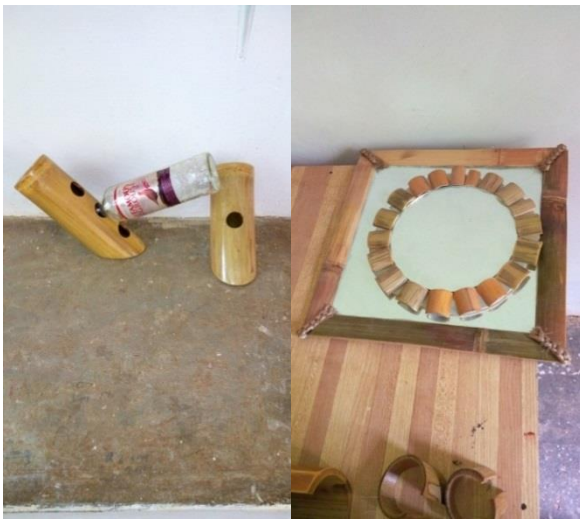
1. Sofa set

2. Lamp shade

3. Cup holder and plate holder

4. Glass holder and wine glass holder

6.Bottle holder and wall mirror



7 Candle stands and hand bag hanger

Plate 14-1 (1-7): Bamboo artisanal products made at KEFRI-Maseno

Plate 14-2: General view of bamboo workshop at KEFRI-Maseno

Sub-activity 59: Build capacity on sustainable production and harvesting

Stakeholder training was carried out at ATC Maseno in October 2016 on sustainable bamboo harvesting. Thirty six (36) bamboo farmers drawn from Kisumu, Siaya, Busia ,Bungoma, Vihiga and Trans nzoia Counties were trained; out of these, 34% were women.

Plate 14-3: Participants' of the bamboo training at Maseno ATC after official opening

Plate 14-4: Chopping board and wine/whisky bottle holders (C) and dish/plate holder (D)

Plate 14-5: Fancy bamboo items such as a cup (E) and chair made of bamboo splits (F)

Plate 14-6: A facilitator explaining a point during one of the training sessions

Plate 14-7: A facilitator demonstrating how bamboo preservation is done at KEFRI - Londiani

Plate 14-8: Trainees' busy making fancy bamboo products at Londiani workshop

15. ER 5.1 Needs identified

Sub-activity 63: Identify and prioritize key nature based enterprises

In the review year a study was undertaken aimed to identify and prioritize key nature based enterprises (NBEs) in Mt. Elgon and Cherangany ecosystems. The objectives of the activity were; to identify the nature based enterprises in the two ecosystems; to prioritize the nature based enterprises in the ecosystems; and to identify the importance of nature based enterprises. This was with an aim to largely focused on targeting benfits to men, women, youth and people with disabilities.

Methodology: The overall approach to this assignment was structured in Identification and prioritization needs assessment design summarized in Figure 15-1below.

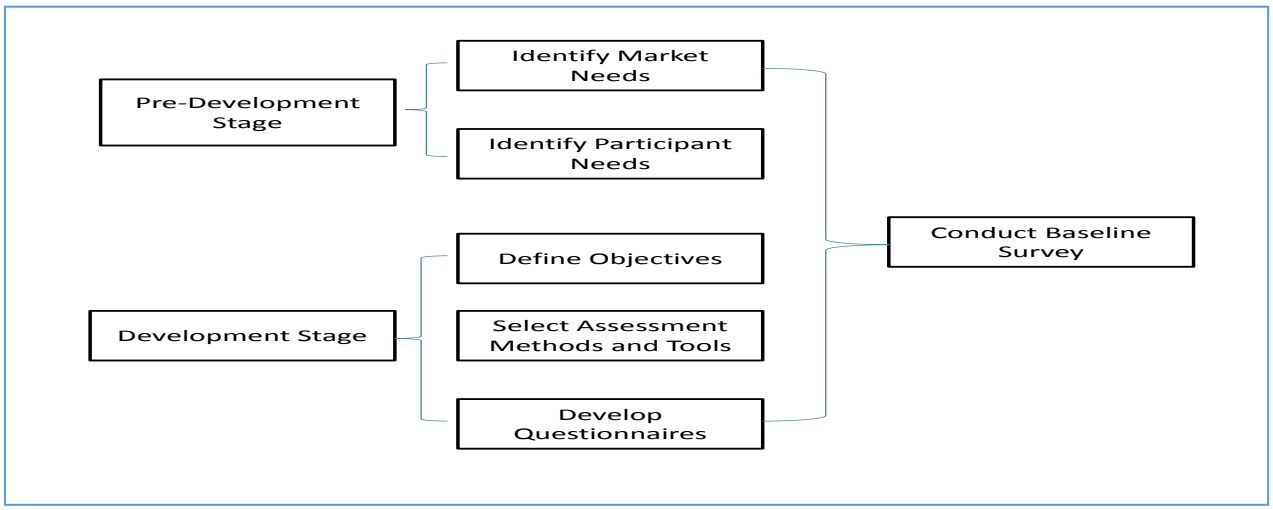


Figure 15-1: Priority Assessment Design

Findings: Some of the identified ongoing/existing enterprises are beekeeping, butterfly, mushroom, medicinal herbs, ornamentals, weaving and beading. There is a high potential for bee-keeping especially along the Kerio Valley which is characterized by a rich vegetation of various acacia tree species known for production of high

quality honey. Traditional log beehive is the main form of beekeeping technology used. Trees, shrubs, plants and crops that bees actively forage on include; *Acacia species*, *Croton megalocarpus*, Bananas, Citrus fruit plants, maize, Lucerne, *Eucalyptus spp*, Mangoes, paw paws, *Dombeya spp, Coleous spp, Grevillea sp* and oranges which the County is richly endowed with (County Integrated Development Plans (CIDP) 2013 – 2017).

Interventions for rehabilitation tend to disadvantage livelihoods of local nature dependent communities. Tension arising from the resultant deprivation poses threats to the sustainability of interventions which can be offset by promoting NBEs to these groups of people in the community.

Nature Based Enterprises priority

The interest in undertaking NBEs are as shown in Figure 15-2 below.

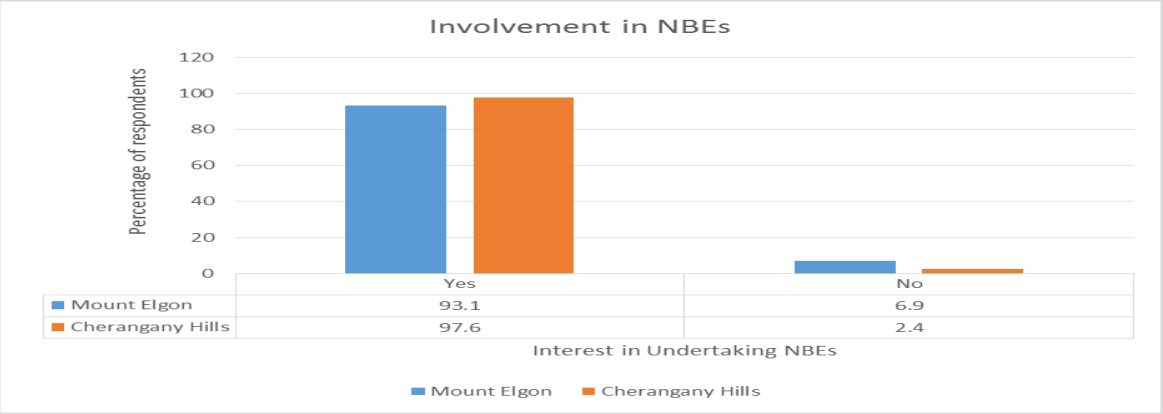


Figure 15-2: Household involvement in NBEs

Preference of NBEs

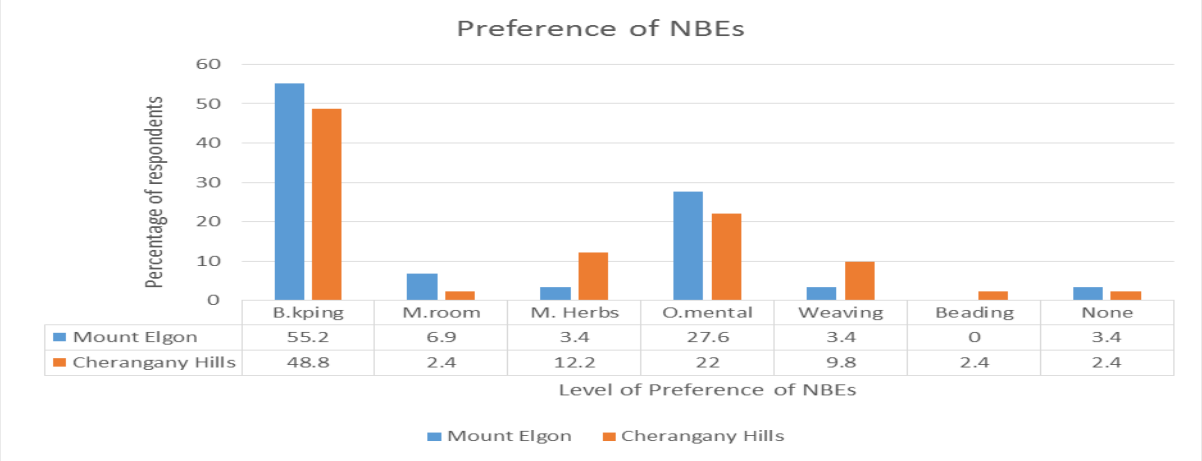


Figure 15-3: Preference of NBEs

Very few households in Cherangany did not identify bee keeping activities, while all households interviewed in Mt Elgon identified bee keeping activities. However, 49% and 38% of households in Cherangany and Mt. Elgon identification of bee keeping activities was medium, with the number reducing and relatively similar for high identification. In butterfly activities, 100% and 90% of households Mt. Elgon and Cherangany did not identify the activities. There was 7.3% and 2.4% identification of butterfly activities in Cherangany and Mt. Elgon respectively. There was a 79% and 61% no identification of mushroom activities in Mt Elgon and Cherangany respectively. There was a relatively similar 9% low, medium and high identification of mushroom in Mt. Elgon, while low identification was 22% in Cherangany, medium and high level of identification significantly reduced

9.8% and 7.3% respectively.

There was a 38% and 12% no identification of medicinal herbs in Mt. Elgon and Cherangany. The medium identification of medicinal herbs increase in Mt Elgon and Cherangany, with Mt. Elgon having a higher medium identification than Cherangany. However, Cherangany had 32% identification of medicinal herbs compared to 6.9% identification in Mt. Elgon.

There was a 31% and 20% no identification of ornamentals in Mt Elgon and Cherangany. However, the percent households with low, medium and higher identification increased but were relatively similar in Mt. Elgon and Cherangany. The level of identification was relatively higher in Cherangany compared to Mt. Elgon.
There was a 76% and 29% no identification of weaving activities, with low identification of 32% and 3.4% in Cherangany and Mt. Elgon respectively. However there was no medium identification of weaving activities in Mt. Elgon, with a 3.4% and 22% high identification of weaving activities in Mt. Elgon and Cherangany respectively. There was a 76% and 37% no identification of beading activities in Mt. Elgon and Cherangany. The level of low and medium identification declined in Mt. Elgon and Cherangany, and a slight increase in High identification of 20 and 6.9% in Cherangany and Mt. Elgon Respectively.

Priority Needs
The survey identified the priority needs to include among others; value addition, marketing and use of technology. The lack of priority within the NBEs has resulted in negative returns from the enterprises. The following was quoted from the WRUA Chairman-Kitale (Mt. Elgon) Phase 1 Bee Keeping Group:
"……The members are all well informed and the quality of life has improved. However, the poverty level is still very high because of the poor access to markets and use of technology…." The following indicators of priority needs were identified during the baseline survey. This survey is based on 29 respondents from Mount Elgon and 41 respondents from Cherangany Hills.

Conclusions and Recommendations
The baseline assessment survey was successful in achieving the expected results which in turn positively contributed towards the overall objectives and project purpose.
The Identification and Prioritization Baseline Assessment Survey findings revealed lack of marketing, processing, production even though there were interest and community involvement.

(Full report for this activity is available at the CMO and the Project website; www.kefriwatertowers.org)

Sub-activity 64: Undertake a capacity needs assessment

This was a baseline study on capacity needs assessment for the nature based enterprises (NBEs), with a focus on understanding of NBEs, knowledge of identified NBEs, and understanding of (harvesting, processing and marketing) of NBEs in Mt. Elgon and Cherangany ecosystems.
The major impact of undertaking the capacity needs assessment was to improve the operations of NBEs to enhance livelihoods and ensure a sustainable natural environment especially among persons with disability, women and elderly.

Findings:

Understanding of Ornamentals: As per Figure 15-4 on Understanding of Ornamentals, comparisons between the 2 ecosystems, Mount Elgon had 37.9% with No Understanding and Cherangany Hills had 41.5%. For the Low Understanding, Mount Elgon had 13.8% and Cherangany Hills had 14.6%. For the Medium understanding, Mount Elgon had 20.7% and Cherangany Hills had 17.1%. For High understanding, Mount Elgon had 27.6% and Cherangany had 26.8%.

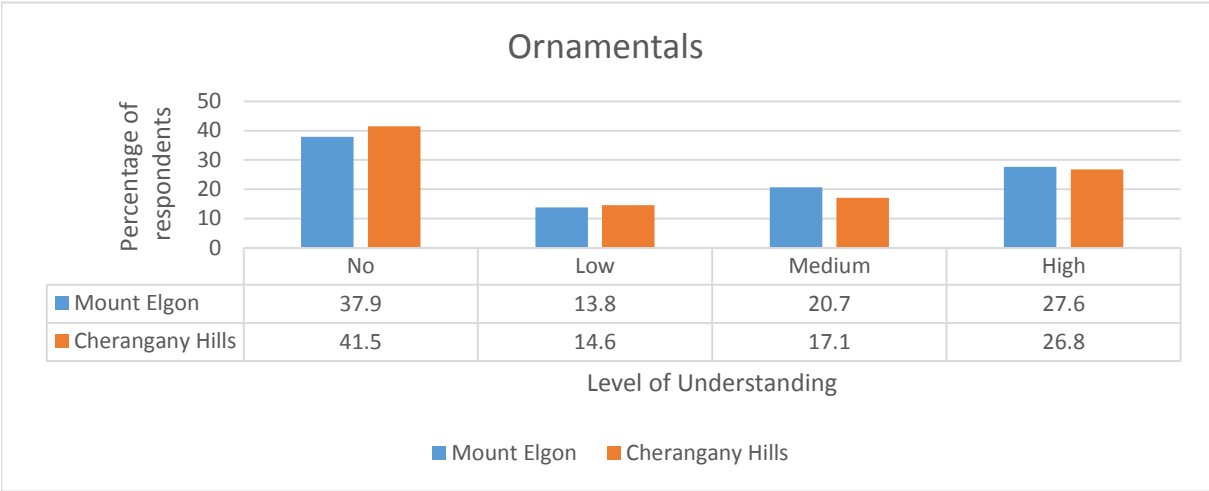


Figure 15-4: Level of Understanding of Ornamentals

Knowledge of Medicinal Herbs: As per Figure **15-5** on Knowledge of Medicinal Herbs, comparisons between the 2 ecosystems, Mount Elgon had 55.2% with No Knowledge and Cherangany Hills had 46.3%. For the Low Knowledge, Mount Elgon had 3.4% and Cherangany Hills had 9.8%. For the Medium understanding, Mount Elgon had 27.6% and Cherangany Hills had 29.3%. For High understanding, Mount Elgon had 13.8% and Cherangany had 14.6%.

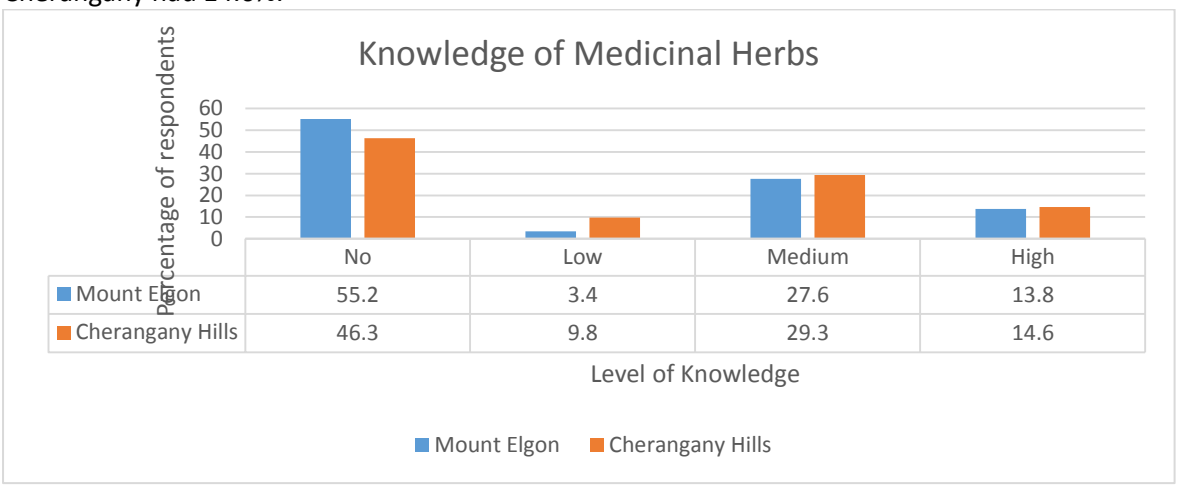


Figure 15-5: Level of Knowledge of Medicinal Herbs

Understanding of Harvesting of NBEs

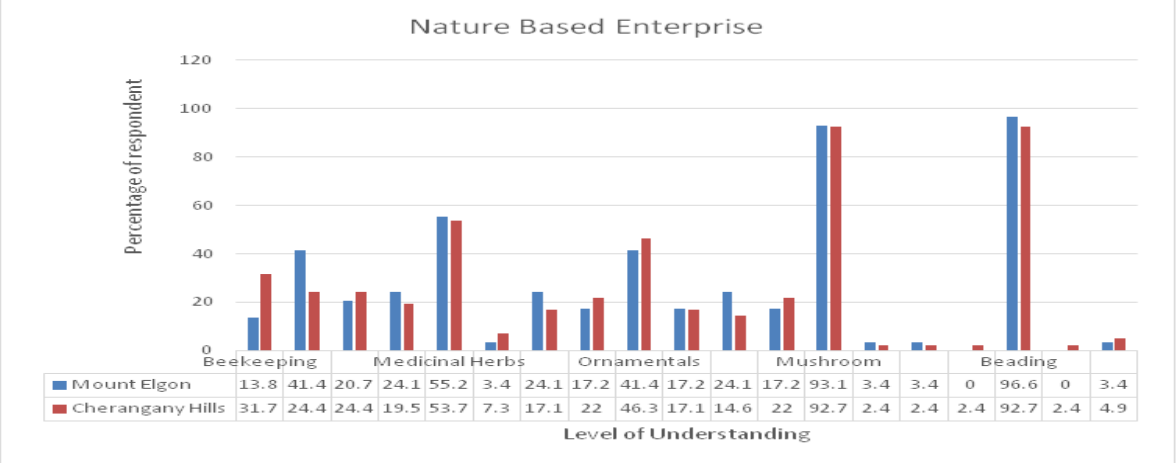


Figure 15-6: Level of Understanding of NBEs

Understanding of Processing (value addition) of NBEs: As per Figure 15-7 on understanding of Processing Honey above, comparisons between the 2 ecosystems, Mount Elgon had 27.6 with No understanding and Cherangany Hills had 43.9%. For the Low understanding, Mount Elgon had 41.4% and Cherangany Hills had 31.7%. For the Medium understanding, Mount Elgon had 20.7% and Cherangany Hills had 17.1%. For High understanding, Mount Elgon had 10.3% and Cherangany Hills had 7.3%.

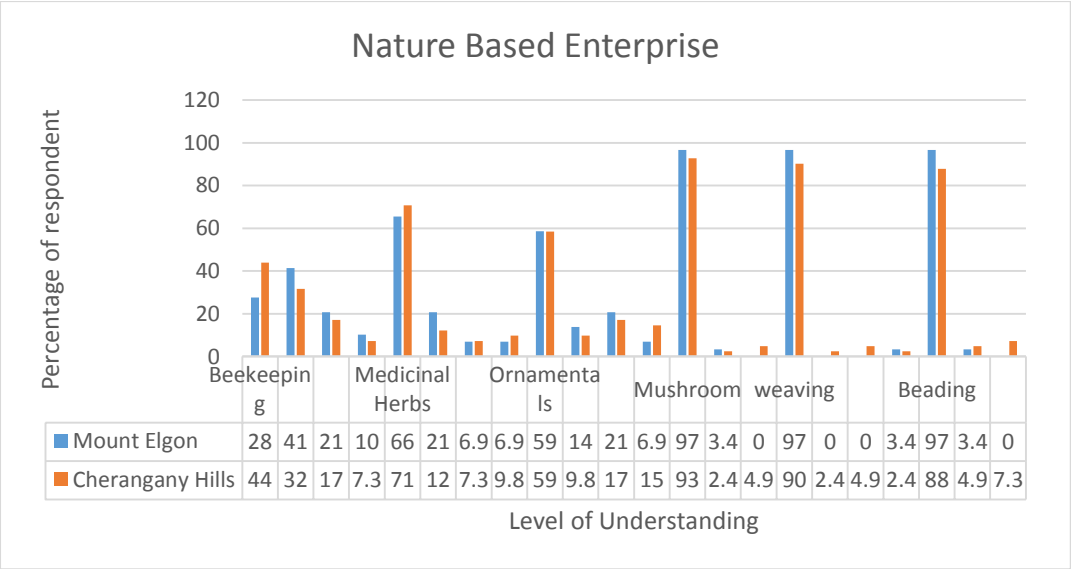


Figure 15-7: Level of Understanding of Processing NBEs

Conclusions and Recommendations

This feasibility study was conducted to determine the viability of NBEs located in the two study areas. Based on the framework set out in this feasibility study the following conclusions can be made regarding the feasibility of the NBEs based on level of priority, Beekeeping, Ornamental, medicinal herb, Mushrooms and weaving and beading.Within the context of capacity assessment survey findings, the following recommendations are pertinent:

1. There should be periodic capacity building on harvesting, processing and marketing of NBEs;
2. Technical support to NBEs farmers should be provided.

(Full report for this activity is available at the CMO and the Project website; www.kefriwatertowers.org)

16. ER 6.1: A communication and knowledge management strategy developed

Develop a component communication strategy

The project developed a communication strategy. The process was accomplished through a participatory process that included among others focus group discussion (FGGs), interviews, workshop and Media content analysis. The Communication strategy will now help component 4 to specifically build and increase awareness among the WaTER project defined audiences, reach out to stakeholder and channel mapping for the WaTER project, mobilize defined target groups and to increase outreach among project target audiences in the whole country.

Several key issues were identified as important during the implementation of the Communication Strategy for the Kenya Water Towers (WaTER) Programme. However, for maximum impact more mediums need to be explored,specifically the local Radio & TV stations that enjoy popularity within the ecosystems (Cherangany & Mount Elegon). Some of the Key issues emerging from media content analysis were as follows:

- Land conflict
- Attacks on conservation stations
- Disregard of Minorities rights
- Poor Understanding
- Political Interference
- Climate Change
- Feuds between KFS and the locals
- Activism against WaTER project
- Destruction of wetlands by local communities
- EU funding/Support

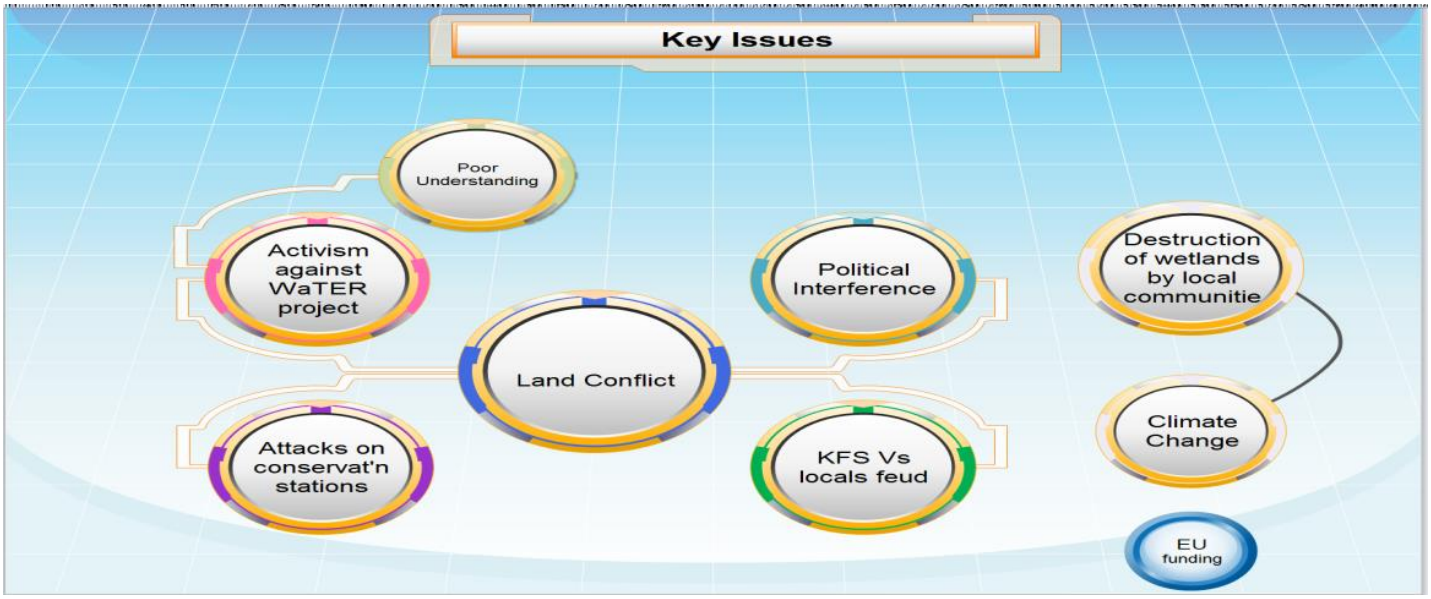


Figure 16-1: key issues were identified as important during the implementation of the Communication Strategy for the Kenya Water Towers (WaTER) Programme

(Full Communication Strategy document is available at the CMO)

Sub-Aactivity 71-Dissemination of component outcomes

Knowledge management:

A knowledge management system was developed in the review year through a consutative process that involved most of the stakeholders of component f4 as well as stakeholders. the system developed witkk ensure that all the project's outputs in constant generation will bedeposited in a central place. The knowledge management system will act as a platform where reports, publications, maps, documentaries, photographs and data will be accessed. The Componennt 4 team with support from KEFRI knowledge management and IT experts are have developed the project's website which now stores all project outputs. The platform which is now operational and regularly updated can be accessed through www.kefriwatertowers.org, will be maintained throughout the project period.

17. A monitoring and Evaluation

In the review year various M&E activities and forums were undertaken as follows:

Development of detailed year two work plan and implementation teams

The project is being implemented by Rift Valley and Lake Victoria Eco regional Research Programmes. The activity implementation teams were formed in year one of the project. During year two of the project, teams were reviewed based on performance and efficiency of delivering project outputs as experienced in year one of the project. The CMO organised joint meeting between the regional implementation teams and those based at the headquaters to agree on the activities planned for implementation in year two. Year two procurement plan with appropriate specifications was developed for use to acquire project goods and services. Specifically the project targeted to acquire laboratory equipment, data monitoring and GIS/Remote sensing equipment thus detailed specifications and procurement modalities were developed.

A monitoring and Evaluation framework developed

The project developed a monitoring and evaluation framework for component 4. This will tool will support planning and management to help the project team to monitor achievements of results. In particular the framework will:

- Define the key forums to be held on a regular basis by the project team to monitor, discuss and analyse progress and quality implementation.
- Establish criteria and indicators towards achieving component 4 strategic directions/objectives
- Define all the expected outputs per each activity both qualitative and quantitative and where possible timelines.
- Define methods for measuring project achievements
- Define criteria for measuring project relevance ,efficiency effectiveness, sustainability and impact

The M&E framework elaborates the process through 4 main stages; the Logical framework, monitoring plan, performance evaluation plan and an indicator matrix. The final document contains a results and reporting tempelate to guide project team. Further, the document guides team at every point when they plan an M&E activity to focuss on: Purpose, scope and objective, evaluation question, methodology, deliverables, evaluation team composition, ethics, implementation arrangements and time frames.

(Full M&E framework document is available at the CMO)

Revised Log Frame

1.1 If relevant, submit a revised logframe, highlighting the changes.

Table 17-1: Revised logframe

Full Text of Objective / Result	Indicator (OVI)	Source & means of verification	Assumptions
Overall objective: To contribute to poverty reduction and sustainable livelihoods by applying scientific principles to inform design of community level actions and national policy decisions on rehabilitation and conservation in Cherangany and Mt. Elgon water towers	Extent of contribution of Water Towers intervention in improving wellbeing of populations through a better management and conservation of Cherangany and Elgon Water Towers; iIncreased tree cover	KenyaSocio-economic assessments / reports over socio-economic indicators / data / statistics including MDGs	Political stability and security in all project areas and good political relations Sustained interest of government, donors and investors Required legislation is approved Enhanced production of tree seeds
To apply science based approaches in characterising degradation of Water Towers of Mt. Elgon and Cherangany ecosystems including testing and demonstrating incentive based interventions in order to inform rehabilitation programmes at County and national levels	Ecosystem goods and services are enhanced for improved livelihoods in the two Water Towers	Satellite land cover maps – before and after Household survey reports Reports on change in water quality and quantity	
	The capacity of communities and their institutions, public agencies to undertake integrated ecosystem management enhanced	Public institution strategies, community action plans and budgets on NRM, SLM, AWM	
	Incentive framework policies for rehabilitation and maintenance of water towers developed	Water and ecosystems related policy documents at County and National level	
ER 1: Current status of the 2 ecosystems in terms of land use, land tenure, biodiversity status, sedimentation levels, hydrological and water characteristics to inform rehabilitation and conservation actions established	1.1 Land use and cover trend analysis to identify hot spots and drivers conducted 1.2 Mapping of Land tenure and consultations with stakeholders conducted 1.3 Biodiversity assessment of the two Water Towers conducted and report produced 1.4 Assessment of erosion, sedimentation and pollution conducted 1.5 Hydrological modelling of the 2 Water Towers using SWAT model conducted 1.6 Water Quality Analyses and monitoring conducted	Trend maps and report depicting land use changes, hotspots and drivers of change Report and maps on Land tenure Report and maps on the status of biodiversity A report of land use management interventions Functional hydrological model for scenario analysis Baseline water quality report Quarterly water quality monitoring reports	Affordability and availability of satellite imagery data Local communities are willing to share information Favourable weather for conducting hydrology studies Secondary up to date hydrological and water quality data exists and is accessible Field equipment is protected by stakeholders

The log frame was revised at the end of the first year of action.

ER 2: A Payment for Ecosystem services (PES) model for enhanced participation by communities, common interest groups (CIGs), community based organizations (CBOs) in rehabilitation, conservation and for improved livelihoods piloted	2.1 Existing and potential institutional and financial frameworks for implementation of PES reviewed 2.2 Business case for PES and other incentive mechanisms developed 2.3 Operational PES model piloted	Report of existing and potential institutional and financial frameworks for implementation of PES Report on Business cases At least 2 Operational PES model piloted in the 2 ecosystems	Financing mechanisms can be established and sustained; Acceptable beneficiary models are established;
ER3 Integration of selected rehabilitation and conservation technologies for improved NRM, SLM and AWM in the 2 water towers demonstrated	3.1 Socio-economic assessment on current drivers of degradation conducted and priority technologies for rehabilitation and conservation identified 3.2 Intensified on farm tree production and diversity promoted 3.3 Integrated pests and diseases management options are recommended and implemented 3.4 Alternative biomass energy sources and efficient technologies to reduce forest degradation promoted 3.5 Sustainable utilization of Non Wood forest Products promoted 3.6 Conservation of wetlands and water springs promoted	Socio-economic survey report Report listing priority technologies for water tower rehabilitation sites Tree species inventories report and vegetation maps 4 Technologies demonstrated in the 2 ecosystems 10 technology demonstration plots per County Training manuals and guidelines Training and workshop reports Tree valuation reports Register tree nurseries and tree grower associations Pests inventory records IPM Manual Reports on alternative energy sources and efficient technologies Reports on NWFPs Models on conservation of wetlands and water springs	Technical support from County governments Land availability Security of demonstration sites Willingness of communities and stakeholders to participate
ER4 Enhanced production of bamboo promoted and capacity on value addition built	4.1 Baseline status and capacity needs assessment on bamboo technologies conducted 4.2 Training and support provided on bamboo production and management and marketing techniques to at least 1,000 community members in the 2 ecosystems 4.3 Training and support on utilization, processing and marketing techniques to 200 Artisans provided 4.4 At least 20 ha demonstration plot of bamboo established in each ecosystem 4.5 At least one show room established and equipped per ecosystem 4.7 At least 300 households adopting bamboo technologies	Baseline status and capacity needs assessment report; Training materials; Training reports Demonstration plots Show rooms and equipment Monitoring report	Willingness of the community, artisans and other stakeholders to participate Sufficient Land is available for demonstration plots Artisans willing to operate shows rooms
ER 5 Nature based enterprises developed and promoted	5.1 At least 5 different enterprise categories identified 5.2 At least 250 individuals in selected hot spots are trained and supported in setting up nature based enterprises 5.3 At least 10 nature based businesses established at the participating counties	Report on enterprises Training materials; Training reports Business enterprises Monitoring report	Willingness of the community and other stakeholders to participate Markets are functioning well

ER 6 Communication and knowledge management strategy developed and implemented	6.1 A communication and knowledge management strategy for program visibility action established and launched 6.3 Synthesis and sharing of knowledge products generated by the programme	Communication and knowledge management strategy report Website Promotional materials: Brochures, Leaflets etc. Policy and community briefs Radio and TV programmes Synthesis and sharing Reports	Communication infrastructure existing and servicing stakeholders Decision makers support the recommendations from project findings;
ER7 Monitoring and Evaluation	7.1 M&E tools developed 7.2 Baselines status of programme outputs and activities established Mid-term and end-term Project evaluations conducted 7.4 Impact assessment studies 7.5 Annual audits 7.6 M&E forums	Reporting templates Baseline reports Mid-term evaluation report Final/end-evaluation report Impact report Annual audit reports Fore reports	Programme implementation proceeds as planned

Please list all contracts (works, supplies, services) above € 60 000 awarded for the implementation of the action during the reporting period, giving for each contract the amount, the award procedure followed and the name of the contractor.

Consultancy services; These were contracted to provide baseline information on biophysical and socio-economic status of Mt. Elgon and Cherengany Forest Ecosystem under the EU Financed project – Cost: Euros 171,567.02 (Award procedure: Open tender procedure published on two local newspapers. Contract awarded to 3 different consultancy firms (Alpex Consulting Africa Ltd, Geosynchrony Limited and EMC Consulting Ltd) as five separate lots(**Status: Complete**)

1.1. Please provide an updated action plan [2]

YEAR 3 WORK PLANS AND BUDGETS

Table 17-2: Year 3 Activities Action Plan for Component 4: Science to inform design of community-level actions and policy decisions

Main Activity	Sub-Activities	Objectively Verifiable Indicators	Year 3 Budget	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12
Specific Objective 1: To undertake a baseline survey on biophysical and socio-economic status of the 2 Ecosystems to inform rehabilitation and conservation actions.															
ER 1:3 Status of Biodiversity established	12. Select germ plasm and support communities to establish quality nurseries, and agro forestry systems- consider under agroforestry interventions (3.2)	Tree Nursery Germ plasm Training report and guidelines	9,084.00												
ER 1:4 Erosion, sedimentation and pollution assessed-	16. Sample Soil and water for quality analysis	Soil quality reports Water quality reports for key river systems.	10,000.00												
ER 1:6 Water Quality Analyzed and monitored **End of water and soil quality budget**	25. Collect, analyze and monitor water quality along rivers and reservoirs.	Water quality reports at key sampling points along rivers and reservoirs.	40,784.00												

[2] This plan will cover the financial period between the interim report and the next report.

Total Objective 1			**59,868.00**											
Objective 2: Payment for Ecosystem services (PES) model for enhanced participation by communities, common interest groups (CIGs), community based organizations (CBOs) in rehabilitation, conservation for improved livelihoods piloted.			**Year 3**											
EER 2:2 An operational PES model established	33. Identify and apply strategy to motivate potential players to co-invest in PES and other reward schemes	Report on strategies and rewards to motivate players co-invest in Ecosystem services	53,000.00											
	34. Facilitate establishment of working PES model for improved social economic benefits and conservation of the 2 ecosystems (cases of Ndakaini and Naivasha)	Report on feasible PES models for enhancing flow of quantity and quality water in the two ecosystems. Guidelines on use of land and water metrics for operationalizing environmental reward schemes	20,500.00											
	35. Assess indigenous mechanisms on conflict management that could impact PES	Report on role of ITK in conflict resolution in relation to PES management	6,000.00											
Total Objective 2			**79,500.00**											
Objective 3: Integration of Selected rehabilitation and conservation technologies for improved Natural Resource Management demonstrated and			**Year 3**											

integrated in the 2 water towers developed																
ER 3:1 Technologies for rehabilitation of water towers developed and implemented	38. Engage communities in rehabilitation of hot spots	Reports on number of stakeholders and household mobilized for rehabilitation of hotspots Report on the number of hectares of degraded land per year rehabilitated	34,000.00													
	39. Assess the recovery of rehabilitated hotspots	Reports on recovery of the rehabilitated hotspots (vegetation, numbers and species)														
ER 3.3 Integrated Pests and diseases management options integrated and implemented	46. Build capacity of farmers/ para taxonomists, KEFRI, KFS, NGOs, CBOS and CFAs, on forestry health. Trainings at local and a national level workshop.	National Workshop reports Training reports	15,000.00													
ER 3.4 Alternative biomass energy sources promoted to reduce forest degradation	49. Promote use of improved biomass technologies and sustainable charcoal production and utilization technologies Work with village polytechnics in production of technilogies.	Number of community members in each water tower trained on construction of improved: domestic Earth Kilns, gasifiers, Portable Metal Kilns	15,000.00													

		drum and Casamance Kilns-replace. Report on the number of adopted improved biomass technologies in the 2 ecosystems.													
ER 3.5 Sustainable utilization of Non Wood forest Products promoted	52. Build capacity of communities on sustainable production, harvesting, utilization and marketing. Consider the potential for prunus Africana tea	A report on community capacity building on sustainable production ad utilization of NWFPs. Market survey reports on NWFPs	14,250.00												
	53. Demonstrate and promote new and improved technologies for NWFPS	Reports on number of new and improved technologies demonstrated and promoted Report on the number of household that adopt the new and improved technologies.													

Total Objective 3			**78,250.00**												
Objective 4: Production, management processing and utilization of bamboo and high value tree resources promoted in the 2 ecosystems			**Year 3**												
ER 4.2 Capacity to implement activities built	60. Train 200 (as per budget) artisans on processing, utilization and marketing of bamboo products in partnership with local institutions. Endeavor to work with village polytechnics and local institutions to ensure retention of the skill.	Training manual 200 artisans trained A list of local institutions involved in bamboo business	50,000.00												
Total Objective 4			**50,000.00**												
Objective 5: Nature based enterprises targeting women, youth and people with disabilities promoted and developed			**Year 3**												
ER 5.2 Training of communities carried out	64. Introduce and support in setting up of nature based enterprises	A report on number of nature based enterprises set up and supported Existing operational manual on enterprises	20,000.00												
	65. Develop a training programme and carry out trainings	Report on training modules Report on groups trained on nature based enterprises.	30,000.00												

	66. Link communities with existing and potential markets-promotion of markets through having value added products.	Report on number of linkages between communities and potential markets-Listed enterprises and potential customers directory													
ER 5.3 M&E carried out	67. Continuously monitor progress of adoption and implementation	Progress monitoring reports on adoption and implementation of active enterprises	10,000.00												
Total Objective 5			**60,000.00**												
Objective 6: A communication and knowledge management strategy developed and implemented			**Year 3**												
ER 6.1 A communication and knowledge management strategy developed	68. Establish and maintain database, library and website of programme findings and reports	Developed database for online libraly, and an interactive web portal to host publications in open access platforms e.g. data verse (Harvard University)	3,000.00												
	6.4. Disseminating project outcomes of WaTER program in scientific forums to contribute to scientific knowledge	Reports presented in conferences, workshops, seminars and international forums on WaTER Scientific publications on project activities	20,000.00												

		produced													
Total Budget Objective 6			**23,000.00**												
TOTAL BUDGET			**350,618.00**												

18. Beneficiaries/affiliated entities and other Cooperation

How do you assess the relationship between the Beneficiaries/affiliated entities of this grant contract (i.e. those having signed the mandate for the Coordinator or the affiliated entity statement)? Please provide specific information for each Beneficiary/affiliated entity.

1.2. How would you assess the relationship between your organisation and State authorities in the Action countries? How has this relationship affected the Action?

The relationship between KEFRI and state authorities is strong both at the national and county levels. This was strengthened when the action was being developed as part of the bigger programme being implemented with MENR, KFS, KWS, KWTA, CCD, and County governments of the eleven counties where the project is being implemented. Frequent consultations have continued since the action started. KEFRI have engaged with these stakeholders at different levels where they have had opportunities to experience how KEFRI has implemented its activities so far. For instance, joint field visits took place when the Technical committee coordinated by the MENR and representatives from all other components visited component 4 field sites. Another field visit was organised by the MENR to introduce the Technical Assistance (TA) team to component 4 project sites where representatives of the state authorities were present. In addition, a joint exhibition was successfully carried out by the representatives of state authorities engaged in the programme and KEFRI during World wetlands day marked in Trans Nzoia County during the action period. Further, a National Programme Steering Committee (NPSC) was formed and its membership comprises directors of partner institutions. Members of this committee meet biannually to give strategic direction to the programme.

At the regional level, state authorities are always informed and/or engaged in implementation of the action. During implementation of the action, experts from KFS, universities and county governments and other research instituitions are usually called upon to offer their expertise. These engagements have fortified the relationship between KEFRI and state authorities hence paving way for the smooth implementation of the action. KEFRI has had good interations and meetings with various stakeholders and beneficiaries within the project sites including the indigenous communities with whom they have had many discussions.

1.3. Where applicable, describe your relationship with any other organisations involved in implementing the Action:

- Associate(s) (if any)
- Contractor(s) (if any)
- Final Beneficiaries and Target groups
- Other third parties involved (including other donors, other government agencies or local government units, NGOs, etc.)

1.4. Where applicable, outline any links and synergies you have developed with other actions.

- Kenya Water Tower Climate Change Resilience (USAID Water Towers Project)
- GOK projects

1.5. If your organisation has received previous EU grants in view of strengthening the same target group, in how far has this Action been able to build upon/complement the previous one(s)? (List all previous relevant EU grants).

19. Visibility

How is the visibility of the EU contribution being ensured in the Action?

During the reporting period for year two of the action, KEFRI has focused on the visibility of the project and the European Union in line with the visibility guidelines. The project has continues to implement sensitisation programmes with an aim of raising awareness of EU support to target groups and key stakeholders in the project areas both in Cherengany and Mt. Elgon. In addition, all materials developed and equipment including motor vehicles have been branded with EU logo on them.

Below is list of completed activities in year 2:

Table 19-1: Project visibility activities done in year 2

No.	Communication activities	Status
1	Exhibition (open day) at the Kenya Private Sector Alliance (KEPSA) in collaboration with KEFRI and KFS organized an private investors on 16th November 2016 at KEFRI Centre, Karura. Objective was to share technologies and opportunities on forestry and allied natural resources products developed by KEFRI and KFS for enhnaced uptake and commercialization by the private sector. Project exhibited bamboo artisanal products and other bamboo products.	Done 16th - 18th November 2016
2	World wetlands day: The two-day event involved removal of invasive grass species (Elephant grass) at Saiwa Swamp National Park and cleaning of Kipsaina market on 1st February 2017 and actual celebrations at Kipsaina secondary school grounds on 2nd February 2017.	Done 1st to 3rd February 2017
3	200 polo T-shirts were produced, distributed to target groups and stakeholders during meetings and field visits	Done
4	Agricultural Society of Kenya (ASK) show where tailor made bamboo products made through the EU finance were displayed. Project banner, brochures and pamphlets were also displayed	Two done, one in Eldoret and another in Kitale
5	All 5 project vehicles and (1 prado, 3 doule cabins and 1 omni bus) and two motorbikes are properly stuck with the EU sticker	Done
6	2000 project bamboo catalogues developed and distributed in various visibility events and community meetings	Done
7	20 different Project reports, publications and publicity material produced and shared with partners and collaborators. Some reports and Documents produced with support from the Water Towers Project are shared in annex 7	Done
8	Photographs produced through project activities (Annex 8)	Done and are available at the component management office
9	Development of the project website and Knowledge Management platform where all publications and information related to the project are uploaded: www.kefriwatertowers.org	Done

***The European Commission may wish to publicise the results of Actions. Do you have any objection to this report being published on the EuropeAid website? If so, please state your objections here*.**

No, we do not have any objection to this report being published on EuropeAid website.

Name of the contact person for the Action:
Ben E. N. Chikamai (PhD)
Director, KEFRI

Signature: ……
Location: **Nairobi, Kenya**
Date report due: **15.11.2017 (Official date, sixty days after the end of the financial year)**
Date report sent: **20.11.2017**

20. Financial Report

21. List of Annexes

Annex 1: Detecting Forest degradation in Kenya: An analysis of hot spots and rehabilitation techniques in Mt. Elgon and Cherangani Hills ecosystems (Abstract of a Publication by; Paul Ongugo, Benjamin Owuor and Phesto Osano during the AFROMONT meeting in Tanzania

Annex 2: Detecting Forest degradation in Kenya: An analysis of hot spots and rehabilitation techniques in Mt. Elgon and Cherangani Hills ecosystems (Abstract of a Publication by; Benjamin Owuor*, Paul Ongugo, Phesto Osano, Therezah Achieng and Maureen Kabasa during the AFROMONT meeting in Tanzania

Annex 3: Detecting Forest degradation in Kenya; an analysis of hot spot areas and rehabilitation techniques in Mt. Elgon and Cherangany Hills ecosystems - Abstract of a Publication by; Paul Ongugo and Phesto Osano during the AFROMONT meeting in Tanzania

Annex 4: Poster Presentation of by Rose Chiteva and Nathan Maitha Presentation made in a IUFRO conference held in Canada.

Annex 5: Exclusion of Community Forest Associations in decision making and its impact on forest condition; Case study of Mt. Elgon and Cherangany ecosystems – Abstract from a publication by Roxventa Othim and Benjamin Owuor during a conference in India

Annex 6: Factors influencing adoption of on-farm tree planting in Shinyalu Sub-county, Kakamega, Kenya - Abstract from a publication by Thalma Khalwale, David Langat, Paul Abuom, Samson Okoth presented at a workshop in Bogota , University of Colombia in September 2017

Annnex 7: List of Publications/Documents and reports Produced with support from Component 4 Water Towers Project.

Annex 8: Action Photographs

ANNEX 1: Publication by Paul Ongugo, Benjamin Owuor and Phesto Osano

Detecting Forest degradation in Kenya: An analysis of hot spots and rehabilitation techniques in Mt. Elgon and Cherangani Hills ecosystems

Paul Ongugo* Benjamin Owuor and Phesto Osano
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Kenya Forestry Research Institute (KEFRI), Nairobi

ABSTRACT
Forest management in Kenya has been challenged by undefined boundaries, illegal access, forest excision, competing claims for its products amongst other factors as communities depend on the forests for various products. While forests are owned by state, private individuals or communities, gazette public forests have also been claimed by indigenous groups, and in some cases, private entities.
Such claims have resulted in conflicts of management which limit monitoring of forest access by the state through Kenya Forests Service (KFS). As a result, forests' ability to produce quality ecosystem goods and services has been curtailed by the declining forest cover. Mt. Elgon and Cherangany hills forest ecosystems provide ecosystem goods and services, which impact positively on the livelihoods of communities. They are also water towers; a source of numerous rivers and streams, which supply millions of people downstream in Kenya and Uganda. The ecosystems' ability to provide direct and indirect benefits has been affected by declining forest cover and competing claims of ownership. As a result of destruction and degradation, the local climate has changed leading to migration or alteration of flora and fauna altitudinal habitation, product and service provision thus affecting ecosystem dependent livelihoods.
Reducing forest degradation to improve its condition through Participatory Forest Management (PFM), Natural Resource Management and local forest institutional strengthening through training and capacity building has been conducted to enhance sustainable forest management.
Using ground trothing techniques and analysis of satellite imagery, degraded hot spots were identified in the two ecosystems for intervention through rehabilitation. Results showed that degradation occurred from unmonitored access and exploitation of the forest for charcoal production. Others included over-grazing, farming and harvesting of timber, poles and fuel wood. Rehabilitation was carried out by establishing demonstration plots on forest blocks, encouraging tree planting on farms, carrying out training activities and improving forest based enterprises.

Key words: Degradation; livelihoods; and, hot spots.

Linking biophysical change to land use land cover dynamics to community socio-economic structure in Mt. Elgon water tower ecosystem.

Benjamin Owuor*, Paul Ongugo, Phesto Osano, Therezah Achieng and Maureen Kabasa.
benjaminowuor@yahoo.com

ABSTRACT
Mountain ecosystems are vital for provision of ecosystem goods and services which provide direct and indirect benefits to proximate communities and those further apart. They are not only water towers-(sources of rivers which supply water downstream and a habitat to endemic flora and fauna), but providers of climates important for agriculture, livestock production amongst other livelihood activities. Dependence on mountain ecosystems for livelihoods has lead to land use-land cover change to meet socio-economic demand. Management of mountain ecosystems has been challenged by continued access and product extraction, leading to degradation, migration and extinction of plants and animals. Through this study, Mount Elgon forest ecosystem presents a trend analysis of land use land cover, linked to socio-economic structure of communities domiciled up stream. International Forestry Resources and Institutions (IFRI) and Poverty and Environments Network (PEN), tools and methodologies were used to track biophysical and socio-economic condition of Kimothon forest for the year 1997, 2001, and 2012. Historical change detection analysis of land use land cover in Mount Elgon was integrated with the tools for a comparative methodological framework. Results from Mt. Elgon forest ecosystem revealed ecosystem previously dominated by trees and bushes but currently covered by other land uses as farms and settlements. It presented instability in socio-economic status of adjacent dwellers and skewed extraction of resources in response to secure and obtain livelihoods. The research further recommends a multi-stakeholder involvement in forest management, by engaging local institutions while to ensure a forest landscape management approaches.

Key words: Mountain ecosystems, Livelihoods, Land use/cover.

Detecting Forest degradation in Kenya; an analysis of hot spot areas and rehabilitation techniques in Mt. Elgon and Cherangany Hills ecosystems

Paul Ongugo* and Phesto Osano
paulongugo@live.com
Kenya Forestry Research Institute (KEFRI)

ABSTRACT
Forest management in Kenya has been challenged by undefined boundaries, illegal access, forest excision, competing claims for its products amongst other effects as communities depend on the forests for various consumable products. While forest ownership status is state, private or communal, gazetted forests have been claimed by indigenous groups and private entities.
Such claims have resulted to conflicts of management which limit monitoring of forest access activities by the state through Kenya Forests Service (KFS). As a result, forests ability for quality ecosystem goods and service provision has been curtailed by the declining forest cover. Mt. Elgon and Cherangany hills forest ecosystem provide ecosystem goods and services, which positively affect community livelihoods. They are also water towers; a source of numerous rivers and streams, which supply millions of people downstream in Kenya and Uganda. The ecosystems ability to provide direct and indirect benefits has been affected by declining forest cover. As a result of destruction and degradation, the local climate has changed leading to migration or alteration of flora and fauna altitudinal habitation, product and service provision thus affecting ecosystem dependent livelihoods.
Reducing forest degradation to improve condition through Participatory Forest Management (PFM), Natural Resource Management and local forest institutional strengthening through training and capacity building has been conducted to increase autonomy in participation in sustainable forest management.
Using ground truthing and analysis of satellite imagery, degraded area hot spots were identified in the two ecosystems for rehabilitation intervention. Results showed degradation occurred from unmonitored access and utilization for charcoal production, over-grazing, farming and harvesting of timber, poles and fuel wood. Rehabilitation was aided by establishing demonstration plots-on farm forestry, trainings and improving forest based enterprises.
Improving forest conditions therefore requires participation of all relevant stakeholders, considering a bottom-up approach to identify effects of degradation, challenges of utilization to provide solutions and ensure sustainability.

Key words; Degradation, livelihoods, hot spots.

ANNEX 4: Poster Presentation of by Rose Chitevaand Nathan Maitha

EUCLEA DIVINORUM DYE: A POTENTIAL MEDIA IN NON TIMBER FOREST PRODUCTS FOR A GREENER FUTURE

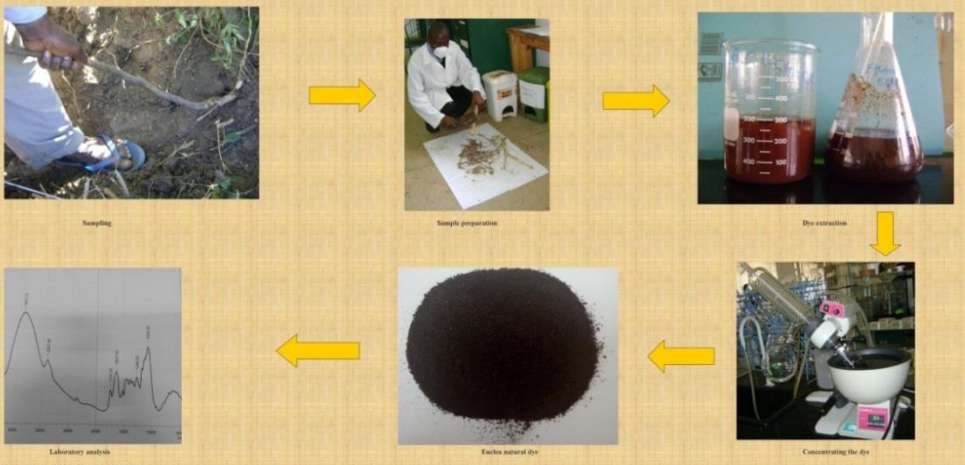
Rose Chiteva* and Nathan Maitha

Kenya Forestry Research Institute (KEFRI) -
National Forest Products Research Program
P. O Box 64636, 00620
Nairobi, Kenya

INTRODUCTION

The root bark of *Euclea divinorum* contains a rich combination of dyeing compounds and can be used with or without salts and mordant due to the mordanting effect of tannins in the plant. The roots and twigs are also popular as toothbrushes and roots are chewed as a disinfectant and to color the lips and mouth red (Ng'ang'a et al., 2012). Natural colorants and dyestuffs are an important group of Non-wood forest products which find use in industries producing confectionery, other food products, textiles, cosmetics, medicines, leather, paper, paint, ink, etc. The effluents from textile industry contain a variety of harmful chemicals. These chemicals severely affect the quality of water. Hence the need to use natural dyes.

METHODOLOGY



Sampling | Sample preparation | Dye extraction | Concentrating the dye | Euclea natural dye | Laboratory analysis

RESULTS AND DISCUSSION

Presence of tannins, quinones which are part of the dye composition were confirmed by Thin Layer Chromatography (TLC). Presence of elements: K, Ca, Mg, Ni and Cu responsible for colour. Dye properties also confirmed by Fourier Transform Infra Red (FTIR)

CONCLUSION

The results obtained together with Information already in published literature confirms that *Euclea divinorum* tree bark is a potential media for the green technology that is needed for a sustainable green environment.

ACKNOWLEDGEMENTS

We are grateful to the European Union (EU) for the travel grant to present this work, and to the Government of Kenya for funding the research, to KEFRI for the technical support , to the community members in Kakamega County for allowing us collect samples from their farms and Kenya Wildlife Services (KWS), Mt Elgon region for giving us access to the protected area for sample collection.

REFERENCES

Ng'ang'a, M. M., Hussain, H., Chhabra, S., Langat-Thoruwa, C., Al-Harrasi , A., Krohn, K., Green, I. R. (2012). Eucleanal A and B: Two new napthalene derivatives from *Euclea divinorum*. *Chinese Chemical Letters* 23: 576 – 578.

Tazooa, D., Krohn, K., Hussain, H. Z., et al. (2007). *Naturforsch* 62B: 1208.

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ANNEX 5: Publication by Roxventa Othim and Benjamin Owuor

Exclusion of Community Forest Associations in decision making and its impact on forest condition; Case study of Mt. Elgon and Cherangany ecosystems

By Roxventa Othim[1] and Benjamin Owuor [2]

Abstract

Governance of forestry structure through Participatory Forest Management is backed by Forest Act 2005, which is undergoing a review process. It has been shown that adoption of PFM in some forest stations has resulted in improved forest condition. Community Forest Associations (CFAs) form the major governance structure for implementing PFM. The Constitution of Kenya 2010 created a devolved governance structure which created the County Governments to take services closer to the local communities along- side those to be provided by the Central Government. Though it is not exclusively stated, services from the forestry sector are expected to devolve to the County government. The process of devolution has left out communities in decision making and formulation of rules. It is apparent that CFAs, which represent communities, are not being given their rightful place in the process. Because of this exclusion, the participation of CFAs in forest management is likely to be lower than it was before devolution and this may have impact on the way forests are managed. The objective of the study was to look at the level of CFA involvement in PFM implementation through formulation of rules and decision making. The study used International Forestry Resources and Institutions (IFRI) tools and methodology to analyse CFAs' roles, activities and participation in inclusive governance in the forest sector. The study was conducted in two water towers in Kenya: Mt. Elgon and Cherangany hills where CFAs are involved in managing the catchment areas. Preliminary results showed that where rules were formulated without the participation of local communities, the forests were more degraded than where local communities were involved.

Key words: Community forest associations, rules and decision making

ANNEX 6: Publication by Thalma Khalwale, David langat , Paul Obuom and Samson Okoth

Factors influencing adoption of on-farm tree planting in Shinyalu Sub-county, Kakamega, Kenya

Thalma Khalwale, David Langat, Paul Abuom, Samson Okoth

Department of Sociology and Anthropology, Maseno University, P.O. Box Private Bag, Maseno, Kenya Socioeconomics policy and governance, Kenya Forestry Research Institute (KEFRI), P.O. Box 20412-00200, Nairobi, Kenya

Abstract

On-farm tree planting has been promoted for decades as an intervention to ease local community dependence on forest resources in Kenya with little success. There have also been few studies to understand why this past initiative has not been fully embraced. Most rural people depend on forests for firewood, timber, and other products, hence the need for adoption of on-farm tree planting to ensure sufficient supply and reduce dependence on forests. This study sought to determine the factors that influence adoption of on-farm tree planting premised on the fact that farmers allocate land to on-farm tree planting based on the household subsistence needs and surplus to earn income for the household. The study population of 13,411 households consisted of farming households from Shinyalu Sub-county. Simple random sampling was used to select a sample size of 384 respondents from households. Primary quantitative and qualitative data was collected using household questionnaires, key informant interview guides and focus group discussion guides. Data was analyzed and interpreted using descriptive statistics, frequencies and cross tabulation analysis. 70.8% of the farmers reported that land was the biggest challenge to adoption. With the small land sizes of less than 1 acre and large families of over 9 members, they opt to plant food crops and rear livestock for milk production in order to feed their families. In conclusion, 90% of farmers have the desire to plant trees as they fully understand their contribution in their lives. They however face a lot of constraints. If they can be provided with capital to enable them buy more land, trained and sensitized on tree planting, provided with high quality seedlings and taught the right way to propagate them, they would gladly adopt planting trees on their farms.

Key words: Adoption, On-farm tree planting, Factors, Household,

ANNEX 7: List of Publications/Documents and reports Produced with support from Component 4 Water Towers Project.

List of Report/Documents Produced with support from Component 4 Water Towers Project
1. First Interim Narrative Report for year 1
2. Establishment of the Status of Wetlands and springs within the Mt. Elgon and Cherengany Hills Ecosystems; and Characterization and Development of Models for Conservation
3. Guidelines for Establishing Payment for Ecosystem Services Schemes in Kenya
4. Guidelines for Integrating Trees in the Irrigated Agricultural Landscapes of Kenya
5. Forestry Research Strategy on Climate Change
6. Bamboo Products Catalog
7. Assessing Erosion, Sedimentation and Pollution in Mt. Elgon and Cherengany Ecosystems
8. Monitoring and Evaluation Framework
9. Baseline Survey Report of Trees on Farm and Assessing community's needs in Indigenous tree Propagation and Management in Mt. Elgon and Cherengany Ecosystems
10. Guidelines for Market Surveys for farm Forestry Tree Products in Kenya
11. Baseline Survey Report on Energy Sources in Mt.Elgon and Cherengany Ecosystems
12. Demographic and Economic Profile of "Hotspots" and Vulnerable Areas on Public and Community Lands in Mt. Elgon and Cherengany Hills Ecosystem
13. Land Tenure Profiles in "Hotspots" and Vulnerable Areas on Public and Community Lands in Mt. Elgon and Cherengany Hills Ecosystem
14. Training Manual on Bamboo and Indigenous Fruit Tree Propagation
15. Communication strategy for Component 4 of WaTER Programme
16. Forest Rehabilitation Guidelines
17. Baseline Survey Report on Capacity Needs Assessment of Nature based Enterprises (NBEs)
18. Baseline Survey Report on Identification and Prioritization of Nature based Enterprises (NBEs)
19. Baseline Survey Report on Village Savings and Loans Associations (VSLAs
20. Capacity Building on Sustainable Production and Harvesting of Bamboo and Development of Bamboo and High Value Tree Resources Management Guidelines in Mt.Elgon Forest Ecosystem
21. Community Tree Nursery training In west Pokot (Kapchila), Trans-Nzoia (Kapolet) and Elgeyo Marakwet (Kamasia,Kapcherop,Kaptek and Chebara) Counties.
22. Guidelines for Rehabilitating Degraded Water Tower Ecosystems in Kenya.

YEAR TWO ACTION PHOTO GALLERY

Annex 8: Year two action Photographs

Programme Technical Committee and Technical Assisstance teams visit component 4 Project sites


Teachnical Assistance (TA) team visit bamboo enterprise in Shamakhoko and Maragolo Hills


TA team meeting with Communities in Kapchilla, West Pokot and in Busia

Technical committee team members visiting Component 4 project sites

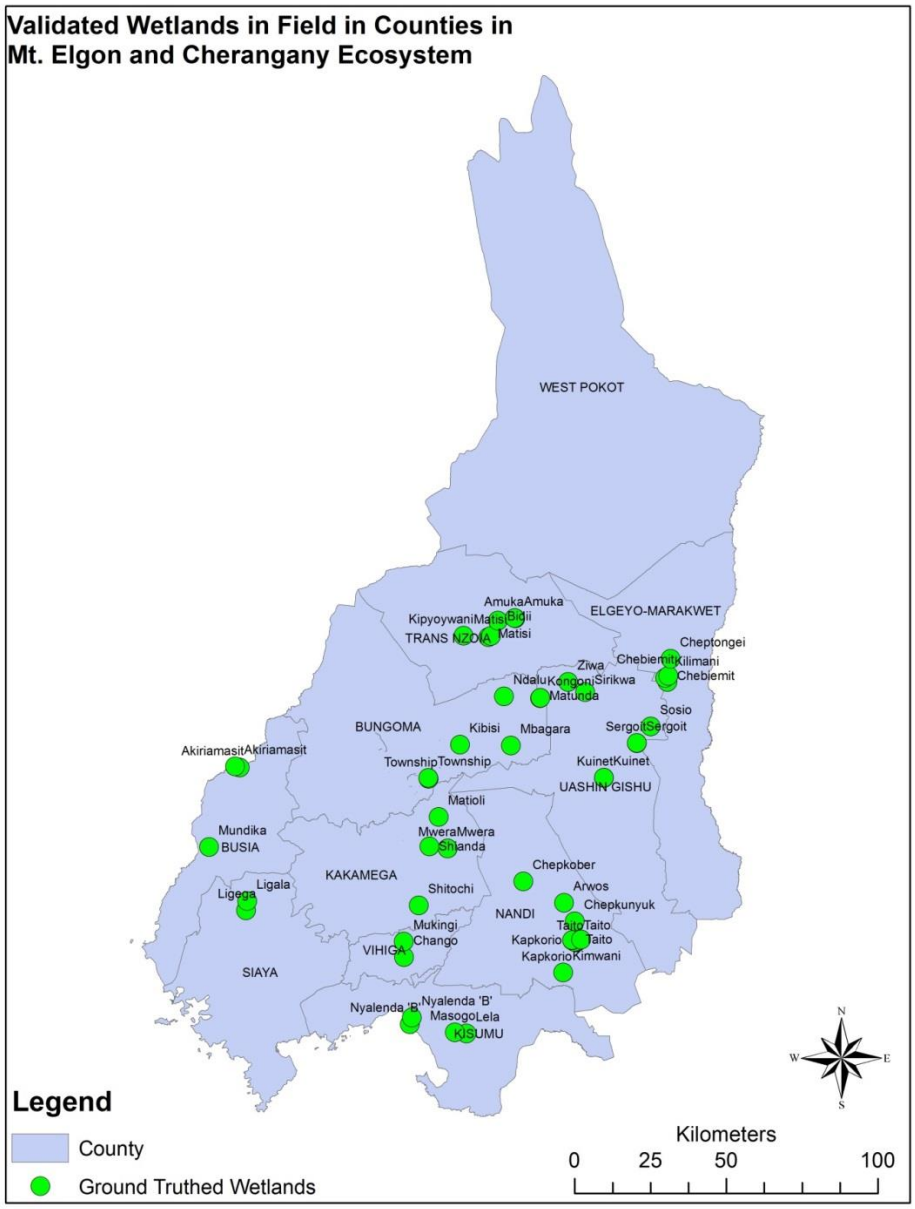
Soil and Water Quality analysis

River Koitobos at Molem, Endebess

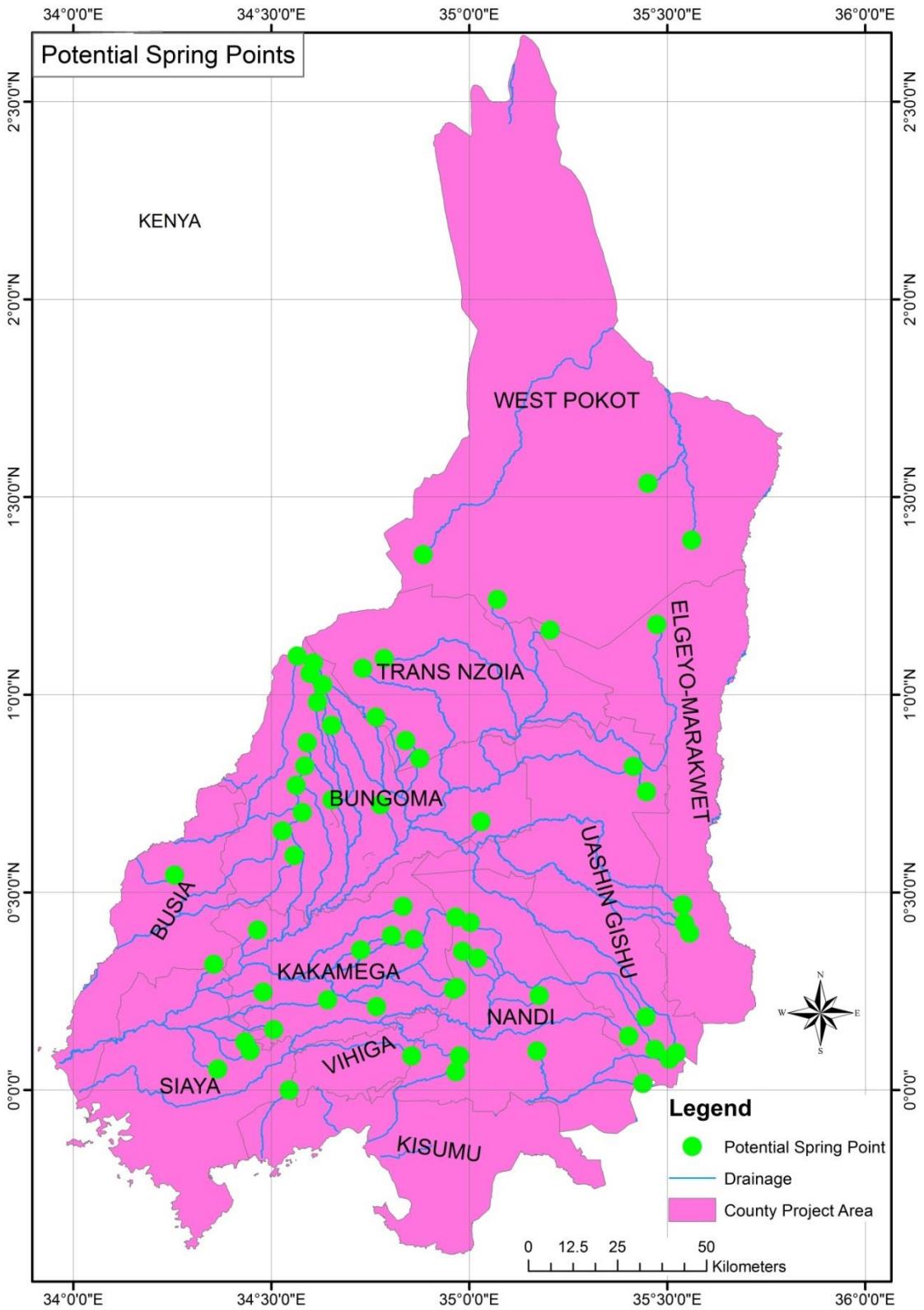
Watering of livestock contributing to water pollution

A working hydrological gauge on Kiminini tributary

Sand harvesting in River Nzoia



Validated Wetlands in Cherengany and Mt. Elgon



Potential Spring Points in the two ecosystems

Enhancing visibility of the project

On farm Demonstration plot and Tecnical committee member giving a Water Towers T-shirts to community members in Kapcherop (Cherengany Hills)

Project team after winning award at the Eldoret Show during year 2

Component 4 demonstrating land conservation model and visibility Banner for Nakuru show