STRATEGIES FOR INTEGRATED LAND AND WATER MANAGEMENT FOR SUSTAINABLE LIVELIHOODS IN KATUK ODEYO SUB WATERSHED

Nyando River Basin,

Lake Victoria basin,

Kenya.

PREAMBLE

WESTERN KENYA INTERGRATED ECOSYSTEM MANAGEMENT PROGRAMME (WKIEMP)

INTRODUCTION

Western Kenya Integrated Ecosystem Management Project (WKIEMP) is anticipated to build the capacity of local communities and other institutions in identifying and managing ecosystem issues as well as the implementation of conservation and/or mitigation measures. The project also addresses the linkages between upstream and downstream land use practices through the development of community managed integrated ecosystem management plans.

The sustainability of agricultural land use will be enhanced by the project through the financial support of Integrated Ecosystem Management (IEM) planning, capacity building, creating awareness of the need for improved farm management practices, and the protection of habitat areas of critical importance. It is expected that, the integrated ecosystem management interventions such as sustainable land management will with time increase above and below ground carbon sequestration while simultaneously reducing erosion and harmful agricultural run-off into waterways.

The project will also target improvements in the health of wetlands and other critical habitats. The protection and restoration of forest habitat for improved biodiversity will increase carbon sequestration, reduce soil erosion and maintain hydrological cycles thereby having a positive effect on both climate change and downstream land and water uses. The project objectives will be achieved through a community driven development process whereby communities decide by themselves on resources for infrastructure investments, technical assistance and implementation of ecosystem management activities.

Specific objectives of the project

1. To improve the productivity and sustainability of land use systems in selected watersheds in the Nzoia, Yala and Nyando river basins through adoption of an integrated ecosystem management approach.
2. To promote a set of integrated ecosystem management interventions so as to achieve local and global benefits.

Sub Project activities include:

- Tree panting for woodlots, in boundaries or as scattered trees in farms for poles fuel wood and charcoal
- Planting high value trees such as fruits, timber and medicinal trees
- Introduction of improved soils and water management technologies
- Management of natural forests patches for poles, timber and fodder
- Establishment of tree nurseries
- Agroforestry for soil fertility replenishment and improved crop production
- Introduction of improved fallows, biomass transfer and mixed cropping
- Proper management of residues on the farm
- Introduction of non wood products (honey, crafts, oils and medicines)
- Adding value to primary products
- Improve technologies for energy saving and production(e.g. charcoal, stoves)

TECHNICAL COMMITTEE

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Acknowledgement

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The technical committee that comprised officers from Ministry of Agriculture, Ministry of Livestock and Fisheries development, KARI, KEFRI, and Ministry of Water and Irrigation, wishes to thank their respective heads of department for granting time off their routine duties to participate in this process.

The technical committee is grateful to the WKIEMP Coordination for providing financial and logistical support towards field visits, literature review, writing and compilation of the technical report.

Executive Summary

The Katuk-Odeyo Sub-Watershed lies in Nyando river basin zone and is characterized by active erosion, gully development and acute water shortage. Poverty levels are high and agricultural production is low. Most people rely primarily on subsistence agricultural and pastoral production for their livelihood. The main economic activities for the people who live in the sub basin are subsistence agriculture, livestock production, and small-scale commodity exchange.

This strategy document sets out to address the constraints and options for integrated land and water management for sustainable livelihoods in the Katuk Odeyo sub watershed. Previous efforts have focused on assessments and recommendations for interventions at the Nyando river basin scale. However, this strategy provides a concise synthesis that would lead to recommendations and interventions at a more localized and community specific scale. To this extent the approach of this strategy is novel.

Katuk Odeyo sub watershed, with a span of 20 km^2 has a high concentration of surface runoff mainly from Belgut hills in Kericho, which results into massive soil erosion and formation of deep gullies downstream. Further, the area suffers serious water shortage during the dry season due to lack of adequate and appropriate water harnessing mechanisms. There are various recommended strategies, including, stone terracing to end soil erosion, rehabilitation of the existing cut-off drains to divert excess surface and subsurface runoff, desilting and construction of water pans for impounding water for irrigation and livestock consumption as well as controlling the water flow that accelerates gully formation, roof water harvesting, semicircular bunds and fencing off the dams and gullies to limit livestock and human activities. To sustain the effort, community participation is crucial and introduction of community owned by-laws to protect the various management strategies.

Weak local institutions, low crop and livestock production poor infrastructural development and the HIV/AIDS menace reinforce cycles of poverty constraining investment in natural resource management.

Despite these challenges, huge potential exists for enhanced food security and improved livelihoods, if the target communities adopt appropriate technologies in soil fertility

improvement, soil and water management option, promotion of appropriate food security crops and improved livestock breeds and management, and the promotion of small scale irrigated horticultural production around water pans.

The exploitation of opportunities for income generation such as beekeeping, dairy goat development etc will expand livelihood options and facilitate investment in Natural Resource Management. In addition, value addition through the preservation and processing of crop and livestock products will increase household income and enhance market penetration

Lower Nyando basin is characterized by low and unreliable rainfall, massive environmental degradation, and scarcities of fuel wood, timber and dry season fodder. Agroforestry technologies hold considerable promise for alleviating three critical problems facing this region rural poverty, natural resource conservation and sustainable development. Agroforestry- options (woodlots for timber, fuel wood, fruit tree production, nurseries, fodder banks, improved fallows) have been proposed as interventions with a big potential to address most of the problems identified above.

LIST OF ACRONYMS

AF	– Agroforestry
AIDS	– Acquired Immune Deficiency Syndrome
CAP	– Community Action Plan
CBO	– Community Based Organizations
CIG	– Common Interest Group
C.M.V	– Cassava Mosaic Virus
COD	– Cut-off Drain
DEM	– Digital Elevation Model
E.C.F	– East Coast Fever
EMCA	– Environmental Management and Coordination Act.
GIS	– Geographical Information System
HIV	– Human Immunodeficiency Virus
ICRAF	– International Centre for Research in Agroforestry
IEM	– Integrated Ecosystem Management
I.G.A	– Income Generating Activity
IPM	– Integrated Pest Management
JICA	– Japanese International Cooperation Agency
KARI	– Kenya Agricultural Research Institute
K.T.B.H	– Kenya Top Bar Hive
M.A.S.L	– Meters above Sea Level
MDG	– Millennium Development Goals
M.O.A	– Ministry of Agriculture
MOLFD	– Ministry of Livestock and Fisheries Development
MOWI	– Ministry of Water and Irrigation
N.C.D	– New Castle Disease
NGO	– Non Governmental Organization
N.R.M	– Natural Resource Management
PCO	– Project Coordination Office
P.R.A	– Participatory Rural Appraisal

TAG – Technical Advisory Group

WKIEMP – Western Kenya Integrated Ecosystem Management Project.

KEFRI -Kenya Forestry Research Institute

WUA - Water Users Association

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CHAPTER 1
OVERVIEW OF NYANDO RIVER CATCHMENT

1.1 Location

Nyando River basin is one of the seven major River Basins within the Kenyan side of Lake Victoria drainage basin and covers an area of approximately 3550 km^2. It is situated between Lake Victoria to the South, Nandi escarpment to the North and Mau escarpment to the Southeast. The basin is bounded by latitudes 0^0 7' 48"N and 0^0 24' 36"S and longitude 34^0 24'36"E and 35^0 43' 12"E. figure 1.1 gives the location of the basin. This map was extracted from Geographical Information Systems (GIS) shape files obtained from International Livestock Research Institute (ILRI) website.

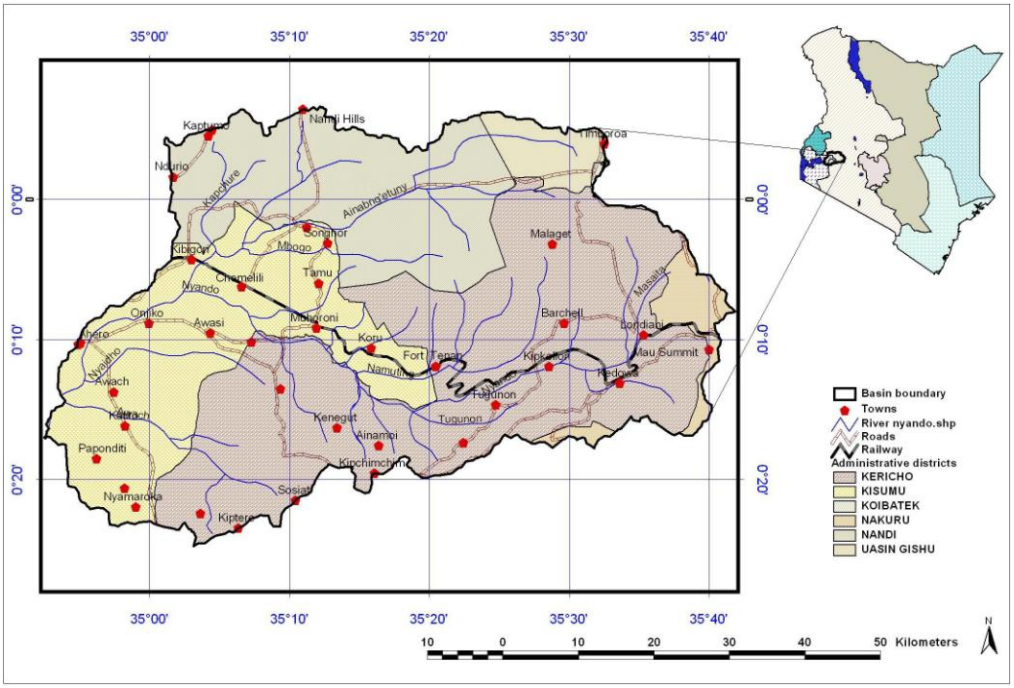


Figure 1.1 Location of the Nyando basin

1.2 Topography

In the Nyando basin the land slopes generally in the Northeast-Southwest direction. Altitude varies from about 1,100 m a.s.l at Lake Victoria shores to about 3,000 m a.s.l in Londiani and Tinderet forest. The topography of the basin is shown by the digital elevation model (DEM) given in figure 1.2. The DEM was obtained from previous study by Muthusi (2004).

The physiography of the basin consists of scarps formed by the rift faults, which shape the Kavirondo Rift of the main North-South oriented Rift Valley system. Foot slopes are typical along the Nandi and Mau escarpment. A gently sloped piedmont plain and very flat alluvial plain are mainly found in the surface of alluvial deposit and Pleistocene deposit (JICA, 1992).

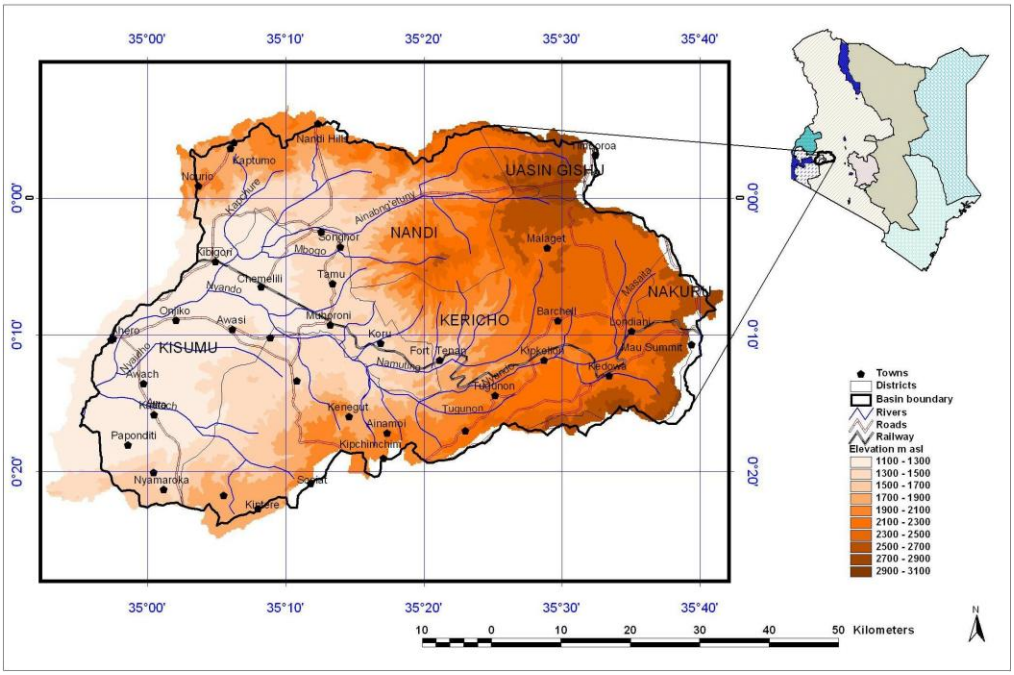


Figure 1.2: Digital Elevation Model (DEM) of the Nyando

1.3 Climate

The climate of the Nyando basin is diverse and ranges from humid to sub humid. This is mainly attributed to variation in altitude from the highlands to the shores of Lake Victoria. The mean annual rainfall varies from 1,000 mm near Lake Victoria to about 1,600 mm in the highlands (Njogu, 2000). The rainfall pattern shows no distinct dry season. Peaks occur during the long rains (March - May) and short rains (October - December). The proximity to the highlands and nearness to the lakeshore causes a considerable spatial variation in rainfall.

According to agro climatic zonation ACZ map of Kenya (Sombroek *et al.*, 1982), the catchment area fall under zone II, III and IV. ACZ II mainly covers the highland including mountains, hills, footslopes and upland areas. ACZ III and IV comprise the lowlands including piedmont plains, lacustrine plains, flood plains and the swamps. In the lowland zones, the short rains are unreliable, and sustain only drought tolerant crops like millet and sorghum.

1.4 Soils

Soils in the Nyando basin vary with change in elevation and the parent materials. Soils in the highlands are well drained and deep to very deep. They are of moderate to low fertility and have shallow humic topsoil and stable soil aggregates. These soils include nitosols, alisols, luvisols and cambisols. The soils found in degraded hills and volcanic foot ridges, however, are shallow, rocky and bouldery. These include leptosols and cambisols. In the lowland soils are moderately deep-to-deep. They have impeded drainage, sodic subsoil and less stable aggregates. They include luvisols, gleysols and fluvisols (Waruru *et al.*, 2003).

Figure 1.3 which gives the type of soils in the basin was obtained from Kenya Soil Survey (KSS).

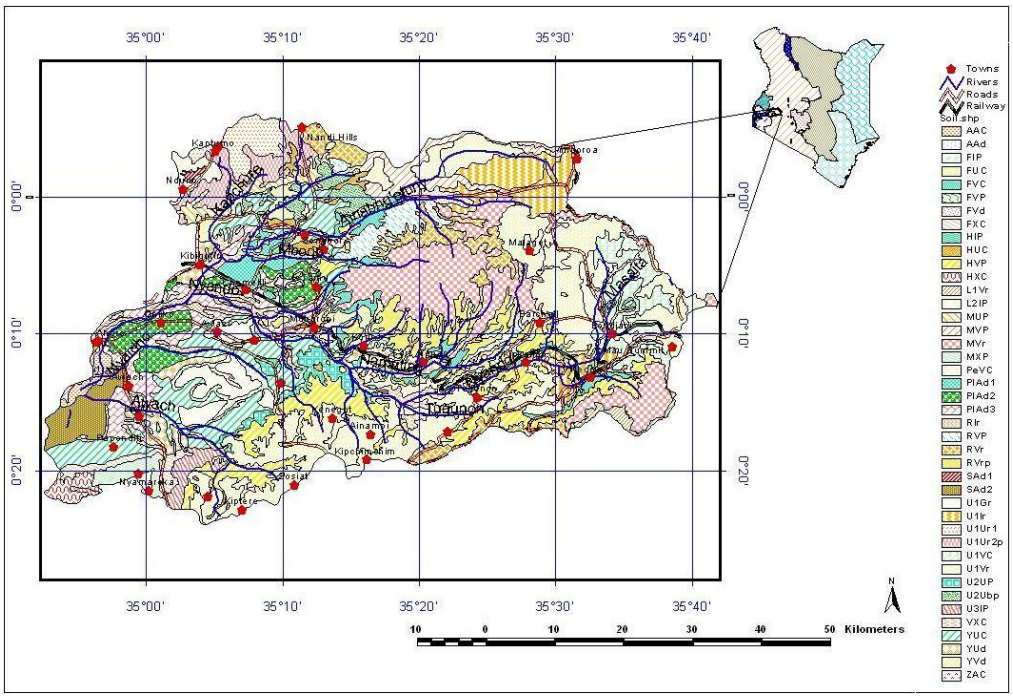


Figure 1.3: Soil map of the Nyando basin.

1.5 Hydrology

River Nyando and its tributaries drain the basin. The main river, Nyando, rises from the Western Mau hills. The river has a steep gradient in the upper reaches, but the gradient gentles as it approaches and flows through the Kano plains. A major tributary, Ainabng'etuny, rises from the Nandi hills and joins the main river near Awasi market. The other tributaries are Nyaidho, Awach, Namuting, Mbogo and Kapchure. After Nyando-Ainabng'etuny confluence the river meanders southwest in the Kano plains. It finally dissipates into swamps in Kusa area before discharging into Lake Victoria at Winam gulf. The peak flow in the River Nyando varies seasonally, but the average peak flow is estimated at 195 m^3/s while the average peak discharge in the Ainabng'etuny tributary is estimated at 96 m^3/s (MOWRMD, 2004). River Nyando traverses a distance of approximately 170km.

The drainage basin consists of five main sub-catchment areas; Nyando-Nandi; Nyando-Kericho; Awach – Kano; Nyaidho – Kano and Nyando – Kano. The Nyando and its

tributaries supply water both for domestic and livestock use and for irrigation in the sugar belt. The river gets more polluted as it approaches the Lake, the main sources of pollution are soil sediments from soil erosion processes and discharges from coffee, sugar and agro-chemical factories.

Figure 1.4 gives a map of the main drainage rivers in the Nyando basin. The map also gives the location of the river-gauging stations in the basin. The map was extracted from GIS shape files available at ILRI website, whereas the locations of the gauging stations were obtained from the Ministry of Water Resources Management and Development (MoWI).

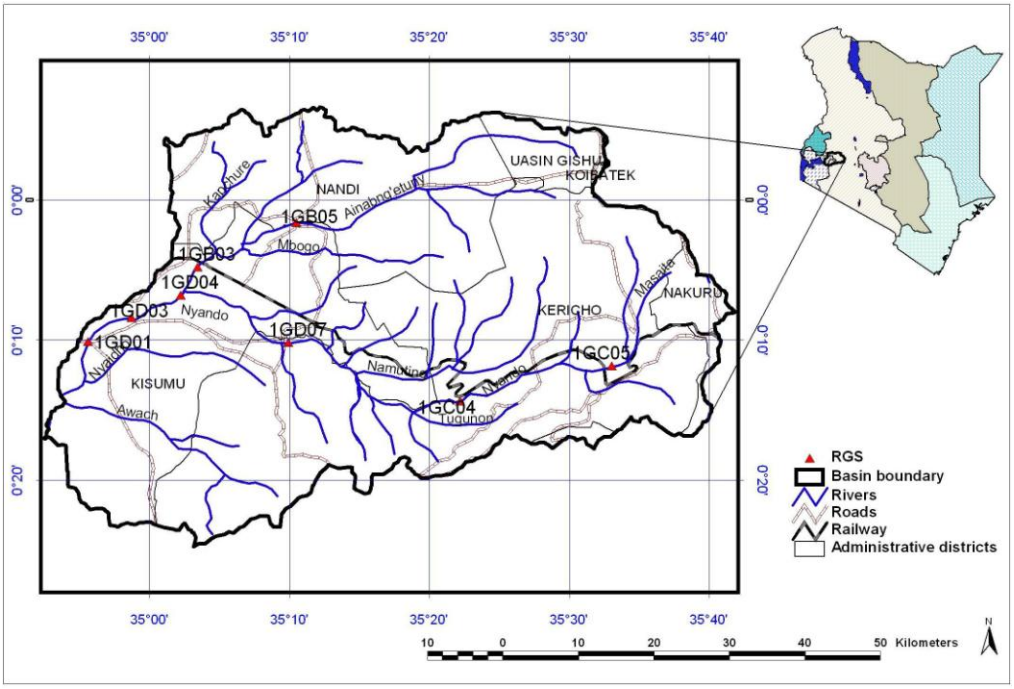


Figure 1.4: The main drainage rivers in the Nyando basin

1.6 Land use/land cover

The land use/land cover types in the basin are diverse. The diverse patterns depend on lithology, geology, topography, moisture availability and most important human activities (Van Der Kwast, 2002). The main land use types in the basin can be categorized into forestry and agriculture.

The forests fall under government designated land. They include Timboroa, Tinderet, Londiani, Western Mau and parts of South Nandi. Some parts of these forests are planted with exotic trees (*Pinus patula, Pinus radiata* and *Cupressus spp.*), which are used for commercial purposes. The main commercial purposes are harvesting of timber (both licensed and illegal), pulpwood and fuel wood (Wagate and Macharia, 2003). There is encroachment into the forests as shown by farmlands in the forest, revegetated sites, grazing lands and abandoned charcoal production kilns.

Agricultural activities in the basin are mostly subsistence and cash crop farming. In subsistence farming, which is the main agricultural activity, mixed farming is practiced. Livestock kept include cattle, goats, sheep and donkeys. On the other hand, crops grown are maize, sorghum, millet and vegetables. The intensity, type and extent of crops cultivated have changed considerably over time due to population increase (Wagate and Macharia, 2003).

The main cash crops in the basin are tea and sugar cane. These crops are grown in large plantation under the management of multinational companies. The tea growing estates are Tinderet and Kapchorua. Sugar cane is grown in the nucleus estates of Muhoroni, Chemelil, Soin and Miwani. These companies have out-growers, who grow and supply additional crop to their factories. Other land use/land cover types in the basin are permanent and seasonal swamps. These areas are mainly used for seasonal farming of vegetables and harvesting of grasses, papyrus and reeds.

There are various changes in land use in the basin. Akotsi and Gachanja (2003) reported that vegetation has changed considerably from the original woody types to the present shrub types. These changes are attributed to human activities such as overstocking, burning of charcoal and clearing of vegetation.

The land uses/land cover map of the Nyando basin is given in figure 1.5. The map was extracted from GIS Shapefiles obtained from the International Livestock Research Institute (ILRI) website.

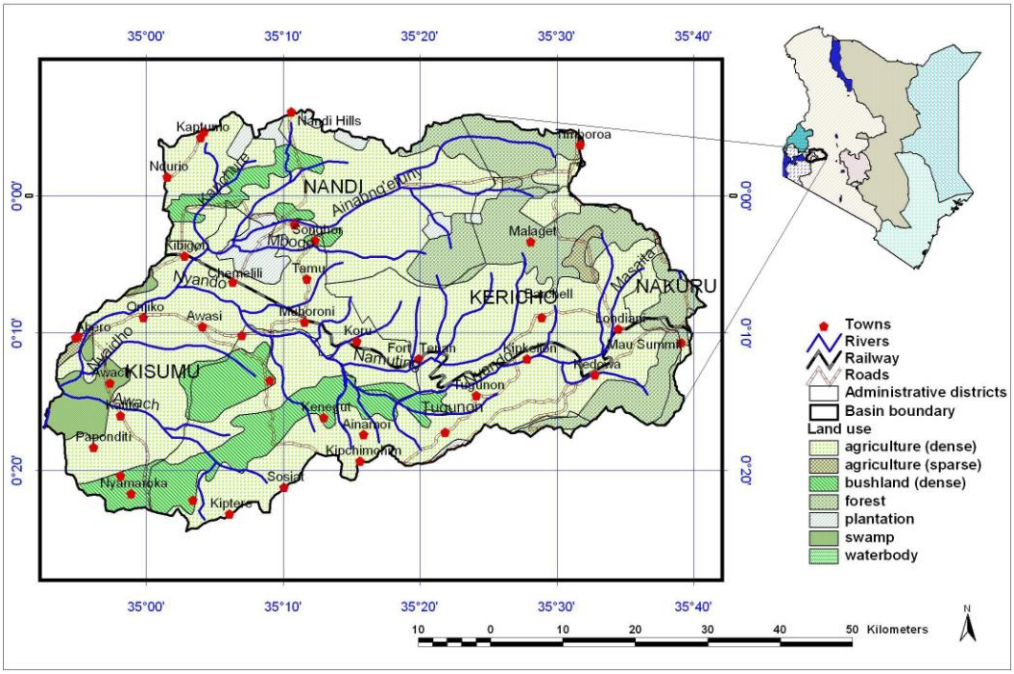


Figure 1.5: Land uses map of the Nyando basin

1.7 Socio Economic Context

Most people in Nyando rely primarily on subsistence agricultural and pastoral production for their livelihood. Poverty levels are high and agricultural production is low. Recent studies in the area by ICRAF indicate a high prevalence in malaria, HIV/AIDs, tuberculosis and water associated diseases near the lake. About 6.4% households in

Nyando are child headed and majority of street children in Kisumu originate from Nyando basin (ICRAF, 1999).

The main economic activities for the 750,000 people who live in Nyando basin are agriculture, fisheries, processing of agricultural products, extraction and processing of natural resources and small-scale commodity exchange. Commercial agriculture focuses on sugarcane, coffee, tea, dairy, irrigated rice and small-scale horticulture. Subsistence farming focuses on maize, beans, sorghum, livestock and sweet potatoes. Irrigated horticulture is done on small scale along the tributaries of river Nyando and in large scale in parts of the Kano plains. Extraction and processing of the natural resources (sand, bricks, pots, papyrus mats) and small-scale trades are much more important livelihood sources in the lower parts of the basin.

The primary occupation of women in the lower parts is small businesses, which include, hawking, selling in the markets and frying fish, while the primary occupation for men is informal employment including hawking, plumbing and carpentry. There is high incidence of consumption poverty in the Nyando basin, ranging from an average of 58% in Kericho district, 63% in Nandi and 66% in Nyando. At the administrative locational level, the locations of Nyando districts include both those with the lowest poverty rate (36% in Muhoroni division) and the highest poverty rate (71% in Miwani division). HIV/AIDS prevalence is particularly high in the lower parts of the basin with an estimated rate of 28% in Nyando, 7% in Nandi and 12% in Kericho

1.8 Land and Water Degradation in Nyando River Basin

Nyando River Basin has been identified as a major source of sediment loading into Lake Victoria (ICRAF, 1999). The entire basin is characterized by severe soil erosion and Land degradation problems that are stratified according to topography, soils types and human activities. Accelerated runoff over the basin has led to sheet erosion in the highlands and gully erosion and stream bank erosion in the midlands and lowlands.

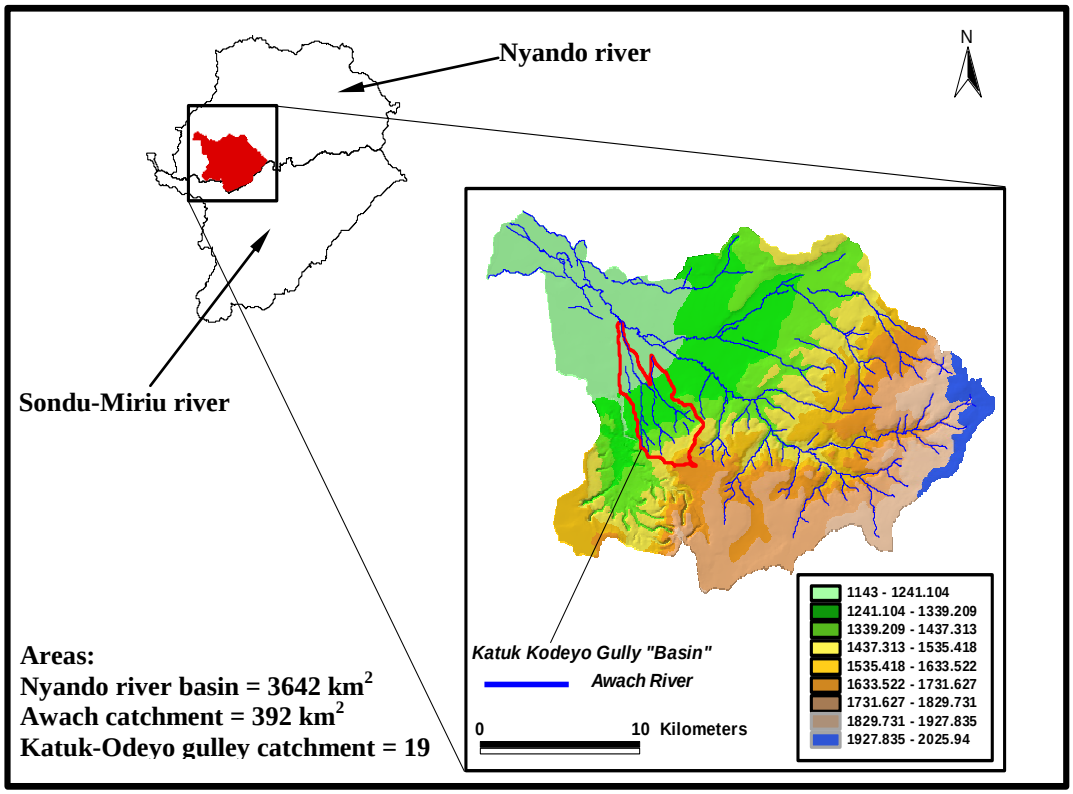
The principal causes of land and water degradation include deforestation in the highlands and extensive use of fragile lands on both hill slopes and the plans without proper land use techniques. Today, the land and water resources degradation is the major contributor to the decreasing agricultural productivity and increasing poverty levels among the local people. Socio economic issues such as widespread poverty and weak community institution are now aggravating the whole scenario. Serious gully erosion in areas such as Katuk Odeyo Sub watershed poses a great challenge to development and there is therefore an urgent need for preventative measures.

CHAPTER 2.0
PHYSICAL AND SOCIO-ECONOMIC CONTEXT OF KATUK ODEYO SUB-WATERSHED

2.1 Location

Katuk Odeyo gully area can be considered as a sub-watershed within Awach Kano watershed of the larger Nyando River Basin which lies between the latitudes 0^0 15' S and 0^0 24' S and longitudes 34^0 59' and 35^0 06' E, covering an area of four hundred square kilometers. The watershed extends from Sigowet Division of Kericho District to Lower Nyakach Division of Nyando District. The Katuk Odeyo gully area forms a sub-watershed of approximately 20 square kilometers.

Fig 2.1 Map of Katuk Odeyo sub-watershed



2.2 Climate

Due to its location in the transitional agro-climatic zone IV, Katuk Odeyo gully sub-watershed experiences two extremes of the climate: Sub-humid climate in the upland areas and Semi arid climate in the lowland areas. The temperatures are high ranging from 22^0C to 34^0C. The rainfall pattern is bimodal and varies greatly between seasons (Sombroek et al, 1982). The uplands and the lowlands have annual mean rainfall of 2134 mm and 1204 mm with monthly means of 177mm and 100mm respectively. The rainfall pattern is characterized by high variability. (Fig 2.2) Heavy showers totalling over 200 mm per storm have been reported to occur in the area (Oyasi, 2005).

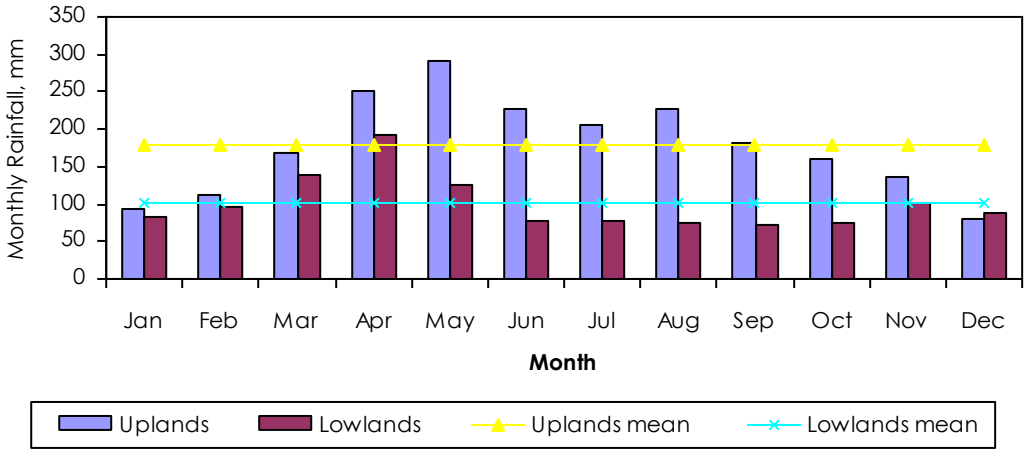


Figure 2.2: Rainfall Distribution pattern in Katuk Odeyo sub-catchment.

2.3 Soils

Soils in the Sub-watershed fall into three dominant types that are stratified according to slope zones; lowland, midland and upland soils. Lowland soils are mainly vertisols that are deep and have swelling and shrinking properties. The midland soils are gleyic /orthic luvisols that are shallow to moderately deep. On the uplands slope zone, humic nitosols alternate with humic cambisols that are shallow (less than 30 cm deep) and have a stony surface (Jaetzold and Schimdt, 1983). In the midlands and lowlands, the soils show occurrence of sodicity in the subsoil horizons, this is more pronounced in the lowlands.

2.4 Land Use Cover

Katuk-Odeyo Sub-watershed is characterized by diverse land use and cover types that are stratified according to the three dominant slope zones: lowlands (<12%), midlands (12-47%), and uplands (>47%) slope zones (Fig. 2.3).

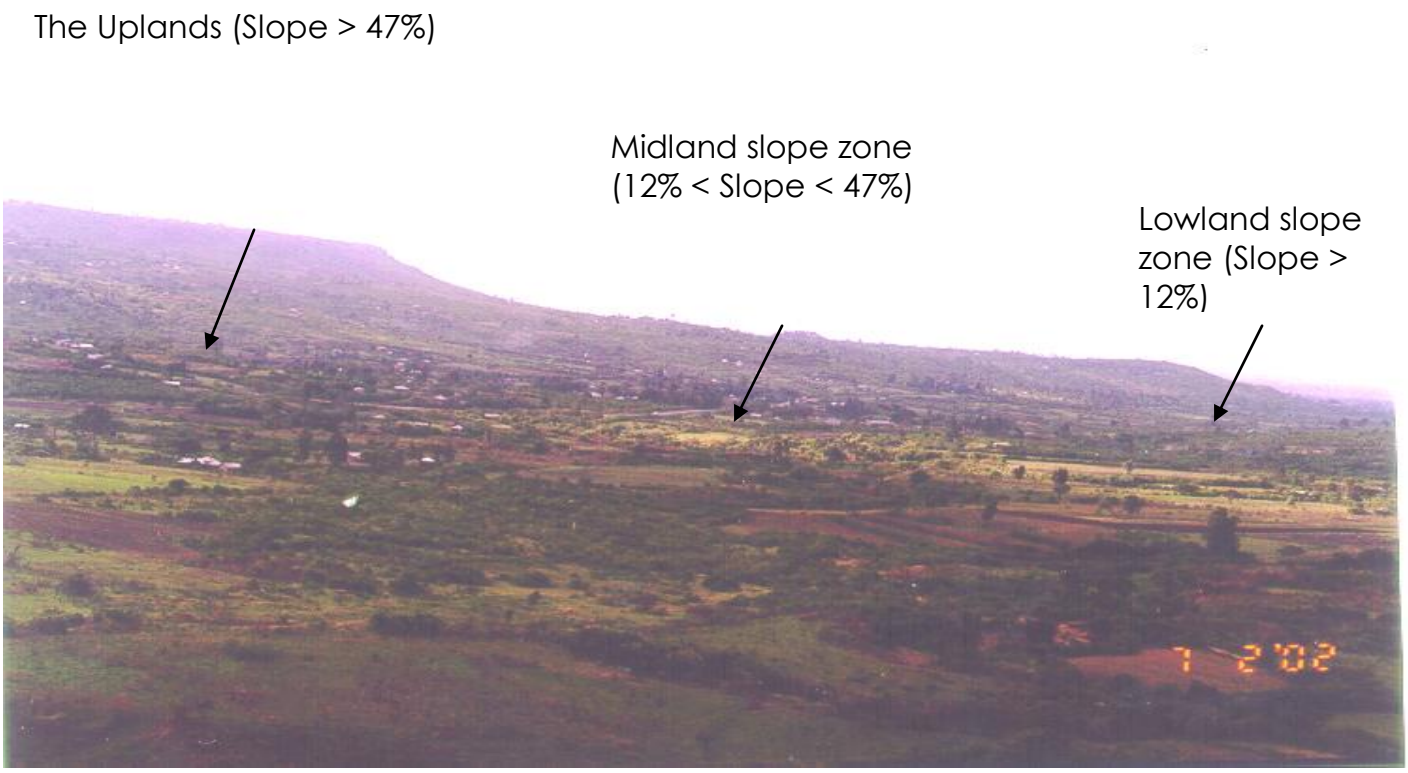


Figure 2.3: Stratification of Katuk Odeyo Sub-Watershed into slope zones

Although the local people engage in a number of livelihood options, agriculture is the most dominant choice. In the uplands, the growing of crops dominates while in the midlands slope zone, grazing is the main land use with scattered pockets of croplands. The type of livestock is mainly indigenous. In the lowlands slope zone, cultivated areas alternate with grazing lands. Acacia shrubs and grass with scattered eucalyptus trees form the major land cover on the grazing areas. The area is generally characterized by heavy livestock movement. During

the dry season when the fodder in the lowlands is scarce, farmers in the lowlands graze their livestock in the midlands and uplands on hire basis. The water scarcity in the uplands during the dry season, force farmers to water their livestock in the lowlands. (Mugo *et al.*, 2000)

2.5 Water Sources and availability

The local people in the area depend on both groundwater and surface water sources. There are has a few boreholes, shallow wells and springs which however dry up during the dry season.

The surface water sources include mainly rainwater harvested in waterpans, natural water holding depressions such as gullies and a few roof catchment systems. The water from surface sources is generally of low quality due to poor methods of collection and use coupled with low level of maintenance of the systems. Almost all the surface water sources dry up during the dry seasons resulting into a major water stress in the area. Due to the rainfall pattern and catchment characteristics, high potential exists for rainwater harvesting to meet local water requirements for irrigation, domestic use and environmental conservation.

2.6 Socio-Cultural Context of the Luo and Kipsigis communities

In order to understand the environment within which collective action takes place, a brief description of the Katuk Odeyo communities is provided. The two villages in this study are in close proximity to each other.

2.6.1 Luo Community

The Luo are formerly a cattle-herding, pastoralist culture, they adopted fishing when they migrated south from the Sudan centuries ago (Dupre 1968). In Lake Victoria, mainly using long nets and lines, they draw in the tilapia and other species, including the Nile Perch, whose introduction into the lake in the mid-1960 has upset the lake's delicate ecosystem. As well as fishing, they are agriculturalists, raising subsistence and cash crops, particularly

sugar. Today, much of their region, east of Lake Victoria, is the sugar belt of East Africa with mile after mile of succulent sugar cane (Dupre 1968).

According to oral tradition, each Luo family belonged to a clan, and each clan was made up of families who descended from one ancestor. They formed a lineage. Luo society is patrilineal, meaning that the ownership and inheritance of property is passed on from father to son. The smallest social unit is the family, which is made up of a man, his wife or wives, his sons and daughters, his sons' wives, and his grandchildren. The wealth of an individual plays a significant role in the size of a man's family, namely, the number of wives he has. If a man was known to be rich, his relatives would bring their children to stay with him. It should be noted that traditionally there were no mature, unmarried women or bachelors in Luoland. The Luo believed that everyone should marry, since full social standing and adulthood were only attained by those who were married.

2.6.2 Kipsigis Community

The Kipsigis community belongs to the larger Kalenjin community located in Kericho District, in close proximity to the Luo village. The Kipsigis are a patrilineal agro-pastoral society. Long ago, the men were associated with cattle and women with cultivation of crops, child-care and household chores (Bulow 1991:6). In a study conducted by Bulow on transgressing gender boundaries of the Kipsigis women in Kenya, the author observes that "the gender division of labor was characterized by complementarity and reciprocity; women had status not only as mothers and wives but also as autonomous producers and heads of 'houses' guarding and managing house property" (Bulow 1991:7).

Collective action is not a new concept among the Kipsigis. In fact, they have practiced collective action since long before colonization. During the colonial period, "the Kipsigis settlement pattern was dispersed with adjacent homesteads forming a neighborhood or *Kokwet*. The *Kokwet* is the basic social unit in the traditional political system of the Kipsigis - a territorial, administrative and economic unit which regulates social behavior". Historically, the men were not known to participate in groups but rather it was the women. The men were in charge of cattle while women were producers of the finger millet. The introduction of

maize and other cash crops, during colonization, weakened the position of women within the household because the men took over the running of the farms and the women had to help the men. The men controlled the income accrued from the sale of the cash crops and this weakened the women's decision-making power and control within the household. A female key informant explained that since the subdivision of land, the women were only in control of household plots that only provided for the household consumption. This suggests that women join groups in order to obtain or gain economic power.

2.6.3 Social Cultural Comparison

While both communities are polygamous, male-headed polygamous households among the Luo comprised 17 % compared to 8 % among the Kalenjin. Clan affiliation is dominant among the Luo, but less important among the Kalenjin. In both communities, religious institutions play a strong role. Common-use areas such as cattle dips, schools, gullies and riverine strips are located on individually-registered land, a disincentive for community rehabilitation and maintenance. It is mostly the Luos who lease land from the Kalenjin for crops and grazing. Again, leased lands are badly degraded since tenants have no incentive to invest in soil conservation for land they do not own, and there are no strict rules governing the use of leased land.

2.7 Crops and Livestock Production

The lower Nyando River basin is generally food insecure, producing less than 50% of its grain requirements on an annual basis and therefore overwhelmingly reliant on food imports from the Upper Catchment areas to bridge production gaps. (MOA annual reports)

The crop and livestock production systems are subsistence in nature, lack profit motive, with limited investment in the farming system.

Key crops grown in the area are maize, sorghum, cassava, groundnuts and cotton. The yield of maize and sorghum which are the main staple cereals crops are generally low, constrained by use of uncertified seed; late land preparation; inappropriate varieties, poor agronomic practices (weed management; pest and disease control; low input use etc). while huge potential exists for the production of fruit trees, especially improved mango varieties, this is

constrained by limited access to scions and limited skills in tree crops production techniques.

The production of cotton which is a traditional cash crop in the area has virtually collapsed due to limited access to clean seed, low producer prices and high production costs. Ministry of Agriculture (MOA) under its cotton revitalization programme has provided clean seed and held demonstrations in crop agronomy in order to revive production.

The traditional varieties of cassava crops have in recent years been decimated by the cassava mosaic virus (CMV). This crop is vital in enhancing food security in the area since it is drought tolerant and performs relatively well in poor soils. There's need to introduce new CMV tolerant varieties such as MM98/1669, MM98/3901, MM98/0669, MH97/0848 etc.

Improved orange-fleshed sweet potato variety (Zapallo; SPK/004), which are highly nutritious and have high value addition potential should be promoted to enhance food security and income generation.

There is need to promote farming as a business through enterprise selection, development of farm plans, record keeping, soil fertility improvement, soil conservation and integrated pest management.

Table 2.1 below shows the production levels of key crops vis-à-vis the potential yield levels.

Table 2.1: Crop Production Statistics

Crop	**Production level Bags/acre**	**Potential level Bags/acre**	**Constraints**
Maize	3	15	Production constrained by fixed Phosphate, use of traditional varieties and striga weed infestation
Sorghum	4	10	Use of traditional varieties with limited potential
groundnuts	1	6	Poor crop agronomy limiting yields
Beans/ green grams	1	6	Poor crop agronomy
Cotton	300 tons/ha	1000bgs/ha	• Lack of clean seed • Poor producer prices • Poor crop agronomy

Source: Ministry of Agriculture annual report-2005

2.7.1 Constraints to Crop Production

- Erratic weather conditions with unreliable short rain season (as low as 650mm per annum)
- Serious land degradation resulting in depleted soils. The vertisol's found in the area are plastic soils with a sub surface layer of sodium, which is very vulnerable to erosion when exposed by poor land use practices
- Limited investment in the production system
- Parasitic Striga weed associated with cereals (reducing crop yields by as much as 40%)
- Uncontrolled livestock grazing thus damaging the crops
- Less than 30% of households' own oxen drawn ploughs (results in late land preparation hence low yields.
- Limited use of farmyard manure (even farmers who own animals don't make serious use).

2.7.2 Livestock Production

Livestock plays an important role in the socio-economic set up of the communities along the Nyando basin as a source of wealth, food security, funeral expenses and other social activities. Cattle (local zebu,) are most valued form of livestock and are a store of wealth. Other livestock include goats, sheep, poultry and beekeeping. The number of livestock kept is beyond the land carrying capacity and contribute significantly to overgrazing hence the erosion problems experienced in the area. However, livestock productivity is faced by the following challenges:

- Insufficient supply of forage (over reliance on natural pasture).
- Livestock health (tick borne diseases, Foot & mouth disease etc)
- Low genetic potential of indigenous breeds
- Little investment in local breeds since their productivity is low.
- Reluctance to adopt improved stock since they are believed to be very delicate.
- Livestock theft/ rustling amongst the Luo and Kipsigis communities

The proposal that farmers reduce the number of livestock to deal with forage/erosion problems is difficult to implement. Since livestock ownership is a measure of wealth (status symbol), farmers are unwilling to reduce stock sizes unless there is attendant replacement with higher yielding breeds. Proposed interventions include

- Banning of free range grazing
- Establishment of improved pastures and fodder crops
- Improve livestock breeds
- Train paravets to improve animal health
- Train framers on animal husbandry
- Improve housing and supplementary feeding for local poultry

Table 2.2: Livestock Production Statistics

Livestock type	**Population**	**Actual yield/ animal/day**	**Potential yield/ animal/day**	**Yield gap**
Local Zebus	27,000	1.5 litres	5 litres	3.5 litres
Dairy cows/crosses	750	7 litres	15 litres	8 litres
Dairy goats	36	3 litres	5 litres	2 litres
Local goats	32,000	-	-	-
Local sheep	28,000	-	-	-
Beekeeping (Langstroth)	200 hives	10 kg (3 harvests/year)	12 kg	2 kg
KTBH	480 hives	8 kg (2 harvests/year)	10 kg	2 kg
Loghives	60 hives	5kg (1 harvest/year)	-	-

(Source: Dept of livestock production annual report 2005, Nyando district)

2.7.3 Non Agricultural Livelihood Options

Natural Resource Management (NRM)and use in Katuk Odeyo indicates that livelihood activities includes crop and livestock production, farm forestry, brick making, pottery and rope making. Fishing is not a significant economic activity. Rope, pottery and basketry are the most preferred alternative livelihoods to farming. Women generally do the primary rope weaving and basketry whole both men and women market the finished products. Sisal planting for rope making can significantly contribute to other natural resource management activities particularly soil and water conservation.

Other livelihood activities include farm labour, sand harvesting, casual labour livestock trade and small-scale trade.

There is need to improve farming as a livelihood option by promoting irrigated horticulture. The limited rage of economic activities whose ability is worsened by poor infrastructure, particularly severely eroded roads, and weak local institutions constraints the capacity of the affected communities to optimally explore and utilize the available opportunities

CHAPTER 3
3.0 LAND AND WATER RESOURCES DEGRADATION IN KATUK-ODEYO.

The larger Awach Kano watershed experiences a wide range of land and water resource management problems which are stratified according to slope and land use types (Fig 3.1). The Katuk-Odeyo Sub-Watershed is in the zone that is characterized by active erosion, gully development and acute water shortage. In order to develop a strategic management plan for reversing the current land and water resource degradation, an understanding of the major causes and possible sinks of surface runoff is pre-requisite. Biophysical research carried out by Oyasi (2005), Omuto(2003), Sjors (2001), Mungai (2000) and Daas (2002), generate sufficient scientific information to this objective. Social studies by Mugo(2000) and Njeri (2001) give adequate insight into the socio-economic implications of the land and water resource degradation.

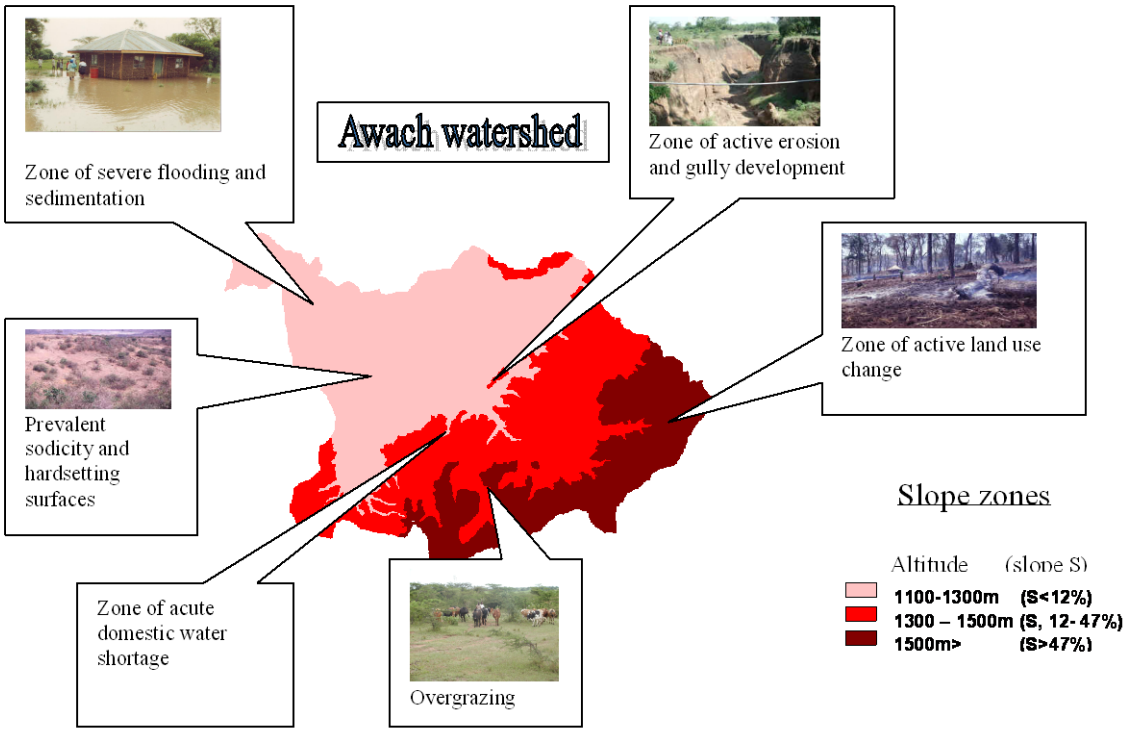


Figure 3.1: The stratification of Land management problems in Awach Kano Watershed .

3.1 Description of the land and water resource degradation processes

Evidence from research indicates that the major factors contributing to land and water resource degradation are driven by socio-economic conditions, climatic and catchment characteristics.

Due to the heavy livestock movement, the area is characterised by cattle tracks and footpaths. Grazing areas, cattle tracks and footpaths are compacted land use surfaces. Compaction destroys the soil structure reducing the steady infiltration rates while increasing hortonian overland flow generation. Similarly, cattle tracks/footpaths in the lowlands also act as interception areas for lateral flow from upslope areas. Cattle tracks/footpaths are a linear feature of the landscape that conduct concentrated runoff. Concentrated runoff entrains soil particles and is usually the major cause of gully erosion. This explains why gully development in the lowlands is always initiated along cattle tracks and footpaths (Oyasi, 2005).

According to the geological and hydrological response characteristics of the area, Upland land and Midland land use surfaces have high infiltration rates than the lowland areas (Omuto, 2003). During rainstorms, water infiltrating into the soil upslope, travels down slope within the landscape until it reaches a saturated zone in a depression or near a stream channel in the lowlands and then re-emerges as saturation overland flow. Theoretically, source areas of saturated overland flow in a landscape are usually localized and expand or contract in response to rainfall, evapotranspiration and land use/cover. The current high rate of gully development could be linked to expansion of these saturation overland source areas in the lowlands (Oyasi, 2005).

Previous studies have established that land use types in the lowlands are also associated with very low subsurface hydraulic conductivity (e.g. Omuto, 2003; Sjors, 2001). These studies report a rapid decline (to the order of 35-100%) from surface to subsurface soil hydraulic conductivity. Hydrologically, abrupt changes in soil hydraulic conductivity imply changes in runoff generation mechanisms leading to high runoff generation.

In general, the high runoff generation characteristics on the land use types in the lowlands is also attributed to soil physico-chemical characteristics. Sodicity in this slope zone is evident from the prevalence of indicators of high soil sodium content such as cream-white concretions and acacia shrubs. The problem of Sodicity coupled with the swelling and shrinking properties of the soils cause soil aggregate slaking following high rainfall intensity events, leading to high runoff generation. Soil aggregate disintegration leads to soil surface sealing resulting into low infiltration rates and subsequent high runoff generation characteristics. Therefore land use activities that lead to soil exposure such as cattle and human movement or overgrazing aggravate gully erosion.

Another soil physico-chemical effect associated with low infiltration rates and high surface runoff generation characteristics is soil crusting and compaction on the surface. Soil crusting and compaction reduces the surface infiltration rates and encourages surface ponding of rainwater leading to high overland flow generation. Surface ponding increases the detention time for runoff on the soil surface, hence slowly dissolving sodium in the soil. This process leads to entrainment of the soil in the runoff movement and eventually to soil erosion.

Of importance to soil and water conservation in the area is the surface runoff generation and infiltration characteristics of land use surfaces with high land cover in the uplands and midlands such as bush land areas. Studies have consistently reported that Bush lands in the uplands and the midlands generate the least runoff (Mungai, 2000; Omuto, 2003; Oyasi, 2005). These areas have also been found to show low variability in infiltration and slight changes in hydraulic conductivity along the soil profile. Low surface runoff generation from bush land areas is mainly attributed to rainfall interception by the canopy and high infiltration rates due to improvement in soil structure by the roots and leaf litter. Therefore, restoring the impaired soil structure, bush lands, and the growing of trees in particular have the potential of reducing lateral flow from the midlands and uplands with subsequent reduction in saturation overland flow in the lowlands. At the watershed level, trees have been found to be important in maintaining local water resources by aiding in ground water recharge

From the socio-economic point of view, the local people are resource poor whose priority in agriculture is food security. They therefore seek to maximize the benefits from the land and water resources without investing in their sustainability. Day by day, families wake up to fend for their next meal. This in turn is aggravating the degradation of land and water resources with consequently high poverty levels amongst the people.

3.2 Historical perspective of Land and Water Resources Degradation

The development of gully erosion in Katuk Odeyo is closely linked to the periods of flood occurrence in the Kano plains. Major floods have been experienced in the Kano plains of Lake Victoria in the years of 1937, 1947, 1951, 957/1958, 1961, 1964, 1985 and 1988. Exceptionally, heavy and widespread rainfall occurred during the months of October and November in 1961, which caused severe floods in the Kano plains. In the recent years, 3 major flood events in 1997-1998, 2002 and 2003 were experienced in the lake Victoria basin. A workshop on reversing environmental and agricultural decline held in 2002 was informed by farmer participants that the 1st floods were witnessed in the area in April 1947 and the river was described as a meandering and temperamental entity with a mind of its on. (William Oneya).

The basin was previously a salt lick site with cattle coming from as far as Nandi. The gulley started forming from the resultant cattle tracks during heavy rains. This forced the locals to abandon the salt pits as the gulley grew bigger, swallowing all the salty top soil and leaving the land bare and barren. (Jeremiah Keino, farmer-Kericho)

Another farmer, Mzee Gilbert Nyang'acha Okal says the gulley started forming in 1940s near Thurgem Secondary School and has since been spreading uphill defying control efforts. Initially, the community erected bridges, but the gulley grew bigger and deeper forcing them to abandon them. The gulley has continued to colonize large swaths of land and displacing many people. The community has witnessed the gully grow at a approximately 500 m/year hauling millions of tons of soil annually downstream to Lake Victoria

The gulley has now cut across Storepamba-Kapsorok road that connects the agriculturally productive Kericho highlands. The community can no longer access the markets with their produce because roads have been cut off. Their products rot in the villages due to the gulley menace (Jeremiah Jesitkei – Kapkirer Village, Kericho district). Over time other gulleys have formed to rival Katuk Odeyo, viz Kapkirer and Kamng'etuny (Lion) in Kericho district are growing fast.

A Participatory Rural Appraisal session conducted in the area revealed that, during the period 1965 – 70, overstocking and uphill-downhill grazing pattern triggered serious soil erosion. However, the community acknowledged that dams constructed in 1980-harnessed runoff water although they later silted up.

Farmers have also reported that local initiatives in an attempt to manage the scenario have focused on;

- Tree planting
- Stone terraces
- Gulley control using sand filled gunny bags, euphorbia and cattle manure to enhance re-vegetation.

An analysis of aerial photographs and satellite images from the years 1948, 1963, 1967, 1979 and 2000 for a section of the river illustrate changes in depth and width of the river and verifies the farmers perception of how farmers have removed riverine vegetation, extended cultivation to the riverbanks and established homesteads closer and closer to the river. Another analysis of the sediment cores taken from the outlet of the river into Winam gulf shows a historical trend towards higher levels of sedimentation with strong peaks in sediment deposition during high rainfall events associated with Elnino. An analysis of stream flow in the Nyando basin indicates that stream flows have become much more variable in the last 20 years than it had been in the 1950s and 1960s.

3.3 Previous Attempts to rehabilitate the gully

1. Winam gulf project coordinated by the Provincial administration constructed three dams Kokoto, Koyombe and Kamula and a COD in 1981. The Permanent Presidential Commission on soil and water conservation coordinated this effort.
2. Gabions were put by the ministry of public works and housing to protect the roads from being washed away by the gully.
3. LVEMP constructed four waterpans in 1999 on the Kericho side and assisted in desilting Kamula, Koyombe and Kokoto dams in Nyando in 2005.
4. ICRAF did fertility trials in the area and further conducted thorough hydrological studies of the area, which included survey, design and costing of runoff management structures in 2002.
5. VI Agroforestry planted several trees in the area.
6. LVEMP observed national tree planting day in 2001 by planting 10,000 seedlings.

3.3.1 Problems Associated With Previous Attempts

- The dams silted up due to the communities' lack of maintenance mechanism since the project paid for the construction of the water pans, which was not sustainable. The cutoff drain constructed in 1983 and draining from the base of Belgut hills was not properly designed causing development of another fully down stream and midway.
- Some water pans were poorly sited and designed.
- Agro forestry and fertility trials.
    i. Free range grazing, thus destroying tree seedlings and fertility trial plots.
    ii. Marginal nature of the area, especially constrained the biomass transfer trials.
    iii. Biomass transfer trials were perceived by the farmers to be labour intensive and without immediate benefits

3.3.2 Impacts of Land and Water Degradation.

Loss of life.

Due to acute poverty amongst the local people, the vulnerability of both human and livestock lives to the impacts of flooding is high. A number of cases of loss of human and livestock lives is usually reported every year.

Health and sanitation

During flooding, all the surface and groundwater water sources become contaminated leading to low quality water. Due to lack of alternative water sources, the local people still depend on these contaminated water sources and hence expose themselves to water related diseases. Stagnant floodwaters also cause vector borne diseases and induce unhygienic sanitary conditions, which are conducive for the spread of contagious diseases and sexually transmitted diseases.

Development

Floods in the area disrupt various economic activities and result in loss of alternative employment opportunities. This further increases the vulnerability of the local people and thereby perpetuating and increasing the incidence of poverty.

Environment

Gully erosion is currently increasing the extent of badlands, which in turn translate into potential source areas of high runoff flow. Soil fertility of the present croplands in the lowlands is now on decline and has triggered conversion of the once forested areas into cultivated areas. As the population rises, further expansion of agriculture and grazing is now taking place on erosion prone land with steep slopes and soils of poor physical structure. Soil erosion also pollutes surface water surface and reduces ground water recharge. Consequently, the sustainability of the land and water resources in the area is currently at stake.

Downstream, soil erosion in Katuk Odeyo is major source of sediment loading into Lake Victoria. This is the main cause of declining water quality.

Financial

Flooding in the area damages people’s homes and public utilities such as roads and schools resulting into high financial requirement for maintenance.

CHAPTER 4.0
STRATEGY FOR SOIL AND WATER MANAGEMENT IN KATUK ODEYO GULLY AREA

4.1 Introduction:

The Kenyan government developed legislation to guide development in all aspects that affect the environment. It should be emphasized that this proposed strategy for water management in Katuk Odeyo gully area has been developed in the context of all the relevant policy guidelines. The key ones include

- National water resources management strategy
- National flood management strategy in the Lake Victoria Basin.
- National Flood management concept paper
- National poverty reduction strategy paper
- National agricultural revitalisation strategy
- National environmental management act
- National water act
- National Agriculture and livestock extension policy

At the international level, the above policy guidelines are contained in the Millennium Development Goals (MDGs)

Water is priority resource for environmental, social and economic development amongst the Katuk people. Therefore, development initiatives should use water as an entry point by promoting well co-ordinated development of land, water and related resources. An approach based on the following sub-Elements should be institutionalised.

- Management of the water cycle as a whole
- Integrating land and water management
- Adopting the best mix of approaches
- Ensuring a participatory approach
- Adopting integrated risk management

4.2 Holistic Water Cycle Management

Water a finite and vulnerable resource and therefore runoff management and drought management should be intertwined through effective use of floodwaters to mitigate against the negative impacts of droughts. Although floodwaters are a problem in times of extreme flooding, runoff is the major source of water in Katuk Odeyo both for domestic purposes and agricultural production. Therefore, groundwater management and runoff water should be treated as a linked resource and interventions that enhance ground water recharge in the lowlands explored. Development of well-designed infiltration basins will offer reliable strategy for the management of ground and runoff resource. Runoff from compacted surfaces such as degraded areas, footpaths and cattle tracks can be harvested and allowed to infiltrate into the soil by using small water harvesting structures such as negarims, *Tumbukiza* pits and water holes. Apart from increasing ground water recharge, Infiltration basins and small water harvesting structures can be used for rice farming, growing of fruit trees and bananas.

4.3 Integrate land and water management.

In Katuk Odeyo, land use practises have major impacts on water quantity and quality and processes of soil erosion. Therefore, land use planning and interventions on land should be undertaken in the context of water resource management.

For instance, tree growing has high potential due to availability of land and high demand for fuelwood. Due to the presence of saturation overland flow in the lowlands, the growing of trees should start from the uplands and the midlands due to their potential to intercept rainfall reduce lateral flow and maintain water resources during dry periods. In addition trees can further provide employment opportunities through bee keeping.

Cattle and human traffic in the watershed is closely linked to the water resources degradation. Therefore, land use interventions that will restrict cattle and human movement will result into improved water resources management. Controlled grazing and establishment of cattle fodder can improve land cover thus reducing runoff generation.

On the other hand, improvement of water availability and access to local people for livestock production, domestic use and irrigation, offer very high potential for improved water resources management. Springs in the uplands such as Chereres and Chalulu should be tapped through a gravity water distribution system and supplied to homes. Another strategy is the implementation of series of professionally designed and supervised water pans in the landscape. These structures have environmental benefits in that they impound and regulate runoff flow hence reducing gully erosion. Currently a number of water pans exist in the landscape although some are not operational due to lack of maintenance. Interviews with the local people suggest that on the implementation of these structures in the early 1980' s , the gully development process was greatly slowed down. *The table below gives the details of the proposed and existing water pans, their status and financial requirements for either implementation or rehabilitation.*

Harvested water from these water pans can be used to promote supplemental irrigation for horticulture, fruit trees and cattle fodder. There will be need, however, to design efficient irrigation systems that match crop water requirement to the available water in the water pans.

The environmental impacts of high runoff scenario should be addressed. In order to check the prevailing gully development immediate steps should be initiated curb serious erosion. Degraded areas need to be enclosed and revegetated. Rainwater harvested in water pans and at household level could be utilized to raise tree seedlings for revegetation. At the watershed level, this will call for collective community action. There will be need for the stakeholders to facilitate the formation of water users association that can legally register with Water Resource Management Authority. Such community could also a custodian of the environmental conservation measures.

4.4 Adopt a Best mix of strategies

An implementation approach that is based on the combination of a best mix of strategies will be optimal for water resources management in Katuk Odeyo given the socio-economic conditions, climatic and catchment characteristics. Structural measures should be combined with non-structural measures that empower the local people socially and economically. Implementation of structural measures should be done in the context of the national water resources management strategy and flood management strategy for Lake Victoria basin. Besides the implementation of small and medium water harvesting structures, possibility should be explored for construction of a large dam that can be used for large-scale irrigation.
The implementation process should adopt a resilient response that is flexible and can be adapted to changing recommendations obtained from a learning process. For planning purposes, systematic implementation, long term and short-term measures should be used.

4.5 Ensure a Participatory Approach.

Sustainable water resources development in Katuk Odeyo should involve the local community at all levels of decision-making and recognition given to the role of women and the youth.

An approach that is open, transparent, inclusive, communicative and decentralized in decision making with full local community consultation and involvement of the active stakeholders in planning and implementation is necessary.

In ensuring community participation, associations that draw members from uplands, midlands and lowlands should be formed and strengthened. Although Katuk Odeyo sub-watershed is a home of two ethnic communities with several clans and has in the past experienced ethnic hostilities, this should be circumvented and unity strengthened for watershed management.

It should be noted that Katuk Odeyo community has had a long history of working with external development partners. As a result associations have evolved with members that are professional and have interests for mainly monitory gains and not participative development. These associations should be circumvented and new ones formed that draw membership from

the vulnerable sections of the society.

Associations that are based on key water sources in the area with an umbrella body that draws membership from these associations for the co-ordination of watershed management will be an optimal arrangement. The umbrella body should register as a Water User Association (WUA) under the current national legal framework of water resources management.

CHAPTER 5.0

Recommended Interventions

5.1 Introduction

As outlined above, the problems of Katuk Odeyo and the Nyando river basin at large are numerous. It was also noted that there have been numerous previous efforts in trying to address these problems. It was therefore felt necessary that wide consultations had to take place. To avoid the duplication of efforts and possibly reinvention of the wheel that could lead to waste resources. A technical team of experts from key ministries was formed to gather information and make recommendations on the way forward. Consultation were made at the local level (those affected), and those who been involved previously. Visits to the sites were made to have first hand information on the nature of degradation and its effects. The experts made extensive literature search on previous efforts and related works.

5.2 Key areas for intervention

In order to address the key problems facing the local communities in the target areas, areas of intervention were guided by the project objectives. The following are identified as key areas for intervention

5.2.1. Income generation and food security

Linkages exist between environment, poverty, and investment in natural resource management (NRM). The low incomes, limited livelihood options compounded by HIV/AIDS menace constrain the communities' ability to invest in NRM.

Despite the scenario, huge potential exists for the development of income generating activities (IGAs) and promotion of food security crops especially the root crops that are drought tolerant and perform in poor soils, and value addition.

Baseline surveys undertaken in the area reveal that the following opportunities for exploitation in the promotion of income generating activities (IGAs) and food security crops

- Cohesive registered groups

- Groups already undertaking various activities despite the attendant constraints

The following constraints have also been identified:

- Groups have limited access to extension services
- Groups lack technical skills
- Groups undertaking tree/fruit nursery highlighted limited access to exotic seeds and scions for fruit tree grafting as a serious constraint hence low fruit tree seedling population.
- Inability of groups around the dams to exploit the structures for irrigated horticulture production

The following IGAs have been identified as having potential significant impact in the area:

- Improved dairy cow production
- Beekeeping
- Local poultry production
- Dairy goat production
- Tree/ fruit nursery development
- Value addition in preservation and processing of fruit products

5.2.1.1 Beekeeping enterprise

Groups undertaking beekeeping activities have either traditional loghives, which have limited potential or Kenya top bar hives (KTBH). The following activities are proposed:

- Introduction of the Langstroth hives (which have higher yields hence returns)
- Conduct training on beekeeping, honey harvesting, processing and marketing
- Acquire harvesting kit for demonstration purposes
- Follow up on the Kolongei farmers group, which ordered for hives from Africa Now, an initiative yet to be accomplished.

5.2.1.2 Local poultry production

Group members have an average of 10 hens per household. The major constraints experienced by the groups are:

Poor housing, inadequate feeding, disease control especially New castle disease (NCD) whose occurrence is very regular occasioning heavy economic losses or complete decimation of birds. The following activities would greatly enhance economic and nutritional needs of the groups;

- Carry out demo on improved housing
- Carry out demo on vaccination and control of NCD
- Carry out training in poultry management
- Facilitate farmer exchange visits

5.2.1.3 Dairy Goat development

The Luo and Kipsigis communities in the Katuk Odeyo sub catchment are known indigenous goat keepers. The challenges facing this livestock keeping activity are;

Low genetic potential, inadequate feeding regime, smaller individual land sizes and poor husbandry techniques. To address these challenges the target communities through their community action plans (CAP's) have expressed a desire to introduce improved high yielding goat breeds. These improved breeds have significant impact in enterprise return (higher milk prices 40/- litre), higher nutritional value and the management system less destructive to the environment.

To achieve and address these challenges the following activities are proposed:

- Establishment of model housing unit as demonstration
- Fodder establishment
- Training on various aspects of dairy goat management
- Purchase 1 buck and 5 does for target groups **

**NOTE; The purchased animals will form breeding stock whose offspring will be passed over to other group members.

5.2.1.4. Establishment of food security crops

Although maize and sorghum are the staple food crops in the area, erratic rainfall patterns, poor soils, and striga weed infestation severely limits crop production, reinforcing food insecurity and high poverty levels. Minimal food crop diversification further compounds the situation. Root crops such as cassava and sweet potato which are drought tolerant and do relatively well in poor soils would greatly enhance food security and alleviate poverty.

5.2.1.5 Cassava Mosaic Virus tolerant variety multiplication

Traditional cassava varieties grown in the area have been decimated by the Cassava Mosaic Virus. There's need to establish Cassava Mosaic Tolerant Varieties (CMTV) multiplication sites in the target area. Currently setts are sourced from KARI-Kakamega and limited access has been identified as a limiting factor. It is proposed that three demo sites (each 1.0 acres) be established in the upper and middle catchments.

Actions:

- Identifying the host farmers (must have prior experience with the target crop production)
- Sourcing for the cassava sets
- Training on cassava production and value
- Facilitate farmer exchange visit

5.2.1.6 Orange/ Yellow fleshed Sweet Potato Production (Zapalo and SPK/004)

This is a variety that is high yielding, highly nutritious (high vitamin A content) and high value addition potential (making cakes, *mandazi*, crips etc). Limited access to the sweet potato vines and drought experienced in the short rains of 2005 have acted as impediments to the promotion of this crop. It is proposed to have 3 demonstration

sites on both sides (i.e. Kericho and Nyando) of quarter acre each to facilitate acquisition of vines.

Proposed Activities:

Identify host demo farmers (must have prior experience with crop)

- Acquire vines for multiplication
- Undertake farmer training on crop production and value addition
- Facilitate farmer exchange visits

5.2.1.7 Development of model farms

Poor land use manifested in improper land preparation activities (which facilitate soil erosion processes), choice of crop varieties, crop and livestock mgt systems limit the potential return to agricultural investment. There's need to develop model farms as farmer learning / demonstration centers which can host farmer field days. Emphasis will be on the following;

- Development of a farm plan
- Promotion of farming as a business through enterprise selection/analysis, record keeping etc
- Soil fertility improvement
- Soil and water conservation
- Striga weed management
- Integrated pest management strategies (IPM)

Proposed activity

- Develop 3 model farms in each block during the start up phase

5.2.2 Soil and water conservation

5.2.2.1 Development of sub watershed wide soil and water conservation plan

There's need to promote land use systems that ensure water infiltration into soil for crop production and limit the surface runoff generation causing gulley erosion down stream at sub

catchment level. The entire Katuk Odeyo sub watershed will be sub divided into smaller catchments for specific soil and water conservation measures. It is proposed that Onyuongo sub catchment area which has serious soil degradation challenges of its own be delineated as a focal area to show case soil and water conservation interventions. The sub catchment area has a sensitized community with an empowered community based organization (CBO) called Jimo Onyuongo soil and water conservation group (JOSECO). This CBO has already identified proposed water pan sites and established check dams with sisal, aloe, brushwood etc.

Activities

- Focal area will be mapped
- Farm specific soil & water conservation plans be developed
- Enhance capacity of JOSECO and other common interest groups (CIGs) for environmental conservation.
- Survey and design water pans to impound surface runoff.
- Fence off gulley to limit human and livestock activity in the gullied and fragile areas.

5.2.2.2 Gulley Rehabilitation

Katuk Odeyo gully, which is currently developing at a high rate, will have to be addressed through the following measures.

- Diversion and harnessing of the surface runoff in the gully catchment area. This will be done at both farm level and sub watershed level using water harvesting and runoff conveyance techniques such as cut off drains, roof water harvesting, water dams and negarims.
- Fencing off the gully to ward off human and livestock activities. However this will require discussion with the local community so as to own the activity.
- Reforestation of the enclosed area and the surrounding farms.
- Establishment of institutional and legislative community framework to enhance sustainability of the rehabilitation initiatives.

5.2.2.3 Cut off drains

The existing Cut off Drain requires re-designing and silt traps placed along the course.

5.2.2.4 Water management for food security and poverty reduction

At sub watershed level, a number of water pans already exist and several have been proposed for construction. These water pans need to be implemented and micro irrigation promoted for food security and poverty reduction. At farm level, household water harvesting using techniques such as roof water harvesting and micro catchments (semi circular bunds, water holes, negarims) will be promoted both for domestic purpose and micro irrigation.
In development of water pans, roof water harvesting systems and micro catchments at household level, the following activities will be undertaken.

- Survey and design all the water pans.
- Rehabilitate the silted water pans.
- Implement the construction of the proposed water pans
- Fence off the constructed water pans.
- Ensure the development of guidelines for operation and maintenance of the water pans.
- Ensure the development of by laws for management of the water pans.
- Redesign and rehabilitate the cut off drain.
- Promote water harvesting and utilization along the cut off drain.
- Community capacity building for water resource management and utilization for food production.

The table below shows the proposed and existing water pans that are perceived necessary to harness the surface and subsurface runoff in the area to curb gully erosion in Katuk Odeyo sub watershed. The rehabilitation and implementation of water pans will require funding from various donors. The water pans have been prioritized for interventions according the following criteria.

1. High storage capacity.
2. High Potential for Income Generating Activities.
3. Number of households being served.
4. Minimum conflict.

Table 5. 1: List of proposed and existing water pan in Katuk Odeyo Sub-watershed

Waterpan	**Type**	**Capacity M^3**	**Status**	**Proposed works**	**Approx. Cost (Kshs)**	**Priority Ranking**
Ngeny B	proposed	100,000	Sited in a depression	Implementation	450,000	
Daniels'	Existing	40,000	Heavily silted	Rehabilitation	300,000	***
Kapsiti A	Existing	50,000	silted	Rehabilitation	250,000	**
Kapsiti B	proposed	50,000	Sited in a waterway	Implementation	600,000	*
Kapsiti C	proposed	50,000	Sited in a waterway	Implementation	400,000	*
Kipsaksak	proposed	70,000	Sited in a waterway	Implementation	300,000	*
Tuiyobei	Proposed	45,000	Sited in a waterway	Implementation	449777	*
Chereres	proposed	50,000	Sited in a waterway	Implementation	1,500,000	*
Mogoyuet	Proposed	200,000	Sited in a waterway	Implementation	150,000	*
Mogoyuet B	Proposed	100,00	Sited in a waterway	Implementation	150,000	*
Tabaita	Existing	40,000	silted	Rehabilitation	1000000	*
Kamchura	Existing	50,000	silted	Rehabilitation	300,000	*
Koyombe	Existing	100,000	silted	Implementation	300,000	**
Koyombe B	Proposed	45,000	Sited in a waterway	Implementation	450,000	*
Kamula	Existing	50,000	silted	Rehabilitation	200,000	***
Kokoto	Existing	50,000	silted	Rehabilitation	200,000	*
Kokoto B	Proposed	50,000	Sited in a depression	Implementation	450,000	*
Kobam A	proposed	100,000		Implementation	500,000	*
Kobam B	proposed	50,000		Implementation	300,000	*
COD	Existing	2.9 M^3 /s		Rehabilitation	400,000	
COD EXT.	Proposed	2.9 M^3 /s			750,000	
Total					**11,447,777**	

* Low priority ** Medium priority *** high priority

The indicative budget for ensuring sound environmental and water management for improved food production and poverty reduction as outlined below.

Table 5.2: Indicative budget for water management

Components	**Sub-components**	**Indicative Cost (Kshs)**
Survey and Design of waterpans	Toposurveys, Profile surveys Quantity survey Embankment design Spillway design Soil infiltration tests Preparation of bill of quantities	1,000,000
Rehabilitation/Implementation of water pans	Construction activities Technical supervision Fencing of waterpans	10,000,000
Survey, Design and Rehabilitation of Cut Off Drain	Toposurveys, Profile surveys Quantity survey Embankment design construction Technical supervision	1,560,000
Capacity building	Irrigation water management. Water harvesting. Runoff farming. Environmental conservation and management. Exposure tours. Organizational development. Development of operation and	1,200,000

	maintenance guidelines and bylaws. Development of water resource management and training manual for the community.	
Irrigation Development	Design of Irrigation systems. Supervision of installation of irrigation systems. Support to the community for purchase of irrigation equipment.	500,000
Household water harvesting	Assessment of water needs for roof water harvesting. Survey of and design of micro-catchments. Supervision of the construction of household water harvesting activities. Support to households for roof water harvesting.	2,500,000
Gulley rehabilitation	Afforestation Fencing Management	

5.3 Biodiversity Restoration and Conservation

5.3.1 Agroforestry development

Agroforestry is a dynamic, ecologically based natural resource management system that through integration of trees in farm and range land diversifies and sustains small holder production for increased social, economic and environmental benefits (Leakey, 1996). Traditional and innovative agroforestry technologies hold considerable promise for alleviating three critical problems facing many regions-rural poverty, natural resource conservation and sustainable development. Agroforestry in various forms has a big potential of addressing the key problems facing people in Katuk odeyo namely (i) fuel wood scarcity (ii) scarcity of timber and poles for construction (iii) scarcity of dry season fodder (iv) scarcity of fruit (v), environmental degradation and (vi) soil fertility replenishment. In view of the above the following agroforestry options are proposed.

It is important that the project keeps in mind social economic and biophysical factors that may influence afforestation in the lower Nyando basin (Katuk Odeyo)

1. Drought (little or unreliable rainfall)
2. Damage to trees by livestock (free grazing dry season)
3. Attitude (tree planting culture)
4. Lack of desired tree/shrub seeds and seedlings
5. Small land sizes
6. Shallow soils
7. Pests and diseases (Eucalyptus and fruit trees)
8. Cultural issues (women)

It will be particularly important that training on water harvesting for trees as the dry season sets in carried out. Protection of trees against livestock destruction will be very important through fencing, and controlled grazing. Fast growing trees for fodder, fuel wood, soil fertility (improved fallows) and fruits will be encouraged.

Training on tree integration in croplands will be important in the upper parts of the catchments and identification of proper niches on the farmlands. Tree planting along soil conservation structures will be encouraged in all areas. Use of trees that pose

minimal completion with agricultural crops and those that do not habour pest and diseases will be encouraged.

5.3.2 Woodlots establishment

Working closely with enterprising farmers in the four areas the project should establish wood lots in their respective farms. These woodlots could cater for provision of timber and fuelwood. This should be a participatory activity in that farmers prepare their land for and project provides the seedlings for planting. It will be necessary that farmers are trained in land preparation, site selection, species/site matching, tree establishment and management techniques. This is particularly important in ensuring survival and growth of planted trees. It will be necessary that fast growing and multipurpose trees that occur naturally and/or exotics of high priority are promoted. These are trees that are currently in high demand.

5.3.3 Timber (Poles and Posts)

Trees for poles and posts should have the following characteristics: should be generally straight, light in weight, durable, resistant to termites and borers, resist bending, have few branches and should be self-pruning. Those for timber should have larger diameters. Some of the tree species that may be preferred for the above are:
Acacia spp (*polyacantha, albida, gerradii, xathophloea), Balanites aegyptiaca, Cassia siamea, C. spectabilis, Croton megalocarpus, Eucalyptus camaldulensis, Tamarindus indica, Azadiracthta indica, Terminalia brownii, Maesopsis eminii, Grevillea robusta, Acrocarpus flaxinifolia, Markhamia lutea, Albizia* spp etc. *Cupressus lusitanica, Eucalyptus grandis, Pinus patula, Prunus africana* are appropriate in the upland areas of Sigoet. Given that farmers here have larger pieces of land, and that biophysical conditions are more favourable, it will be appropriate that they are encouraged to plant more trees to take advantage of the existing markets-Tea industry.

Niches for wood lots include homesteads or some degraded parts of the farm, hilltops, or rocky areas. Niches in which trees may pose competition with agricultural crops should be avoided

5.3.4 Woodfuel

Trees for wood fuel should have the following characteristics:- the trees should have fast growth rates, should be able to coppice, should be easy to cut, should be less thorny, easy to split, easy to dry, low water content, less and non-toxic smoke, high calorific value.
The tree species that may be planted for the above use include:-
Acacia spp (*gerrardii, nilotica, polyacantha,senegal, seyal). Others are Eucalyptus camaldulensis, E. tereticornis, Casuarina equisetifolia, Azadirachta indica, Croton megalocarpus, Acacia mearnsii(wattle),, Grevillea robusta, Acrocarpus flaxinifolia*, etc. *Pinus patula, Eucalyptus grandis, Maesopsis eminii* are appropriate in upland area.
Niches for fuelwood include homesteads or some degraded parts of the farm, hilltops, or rocky areas. Trees may also be planted along farm boundaries. In this case they may also act as windbreaks.

5.3.5 Browse and fodder

Livestock is a dominant activity in most parts of the Nyando river basin. Trees and shrubs happen to be the only available feed during the dry seasons.
The trees for this purpose should be fast growers, resistant to drought (retain their foliage during dry seasons), sprout profusely, should be palatable, their seed should be able to germinate after passing through the digestive systems of the animals.
Trees in this category include Acacia spp (*albida, tortilis, polyacantha, Seyal), Azadirachta indica, Balanites aegyptica, Leucaena leucocephala, Glicidia sepium, Grevillea robusta, Calliandra calothrysus, Sesbania sesban, Morus alba*.
A wide range of niches for fodder exists within a smallholder farm. These include: external boundaries, internal boundaries, contour bands, homestead, and driveway hedge reserves and widely spaced rows within fodder grass blocks. Degraded parts of the farm

where trees may also help rehabilitate the landscape. Some species such as Morus alba can also be planted as isolated trees within croplands while others like *Calliandra calothyrsus* can be planted as understorey within rows of boundary trees such as *Grevillea robusta*.

There is need for under sowing improved grass species under wood lots in earlier stages to optimize land utilization and provide livestock feed for dry season. Farmers will be trained on harvesting and conserving the forage for dry season livestock feeding.

5.3.6 Fruit production

Fruit and nut trees are important components in agroforestry systems and have been found to play a crucial role in sustaining livelihoods. Fruity/nuts in smallholder farms in Kenya play a crucial role in production systems through provision of food and contribution to diversification of cash sources. A part from food and cash they also provide other benefits/products such as fuel wood and contribute to soil amelioration and conservation, depending on where they are planted

Promotion of fruit/nut trees species as high value trees for smallholder farms is an attractive option due to economic benefits which can be achieved within a relatively short time compared to timber trees.

Trees for fruit production include *Carica papaya* (pawpaw), *Persia americana* (avocado), Mangifera indica (mango), Passion fruits, *Psidium guajava* (guava), *Tamarindus indica* (Tamarind), *Balanites aegyptica*, *Zizygium cumnii*,*Carrisa edulis*, *Zizypus Mauritania* etc.

It will be particularly important that high value fruit trees e.g. grafted mangoes, avocados and tissue culture bananas are promoted. The capacity of the local community in production of the same should be build through trainings in grafting and budding techniques.

There are many niches on the farmland on which fruit trees could be established. Soil conservation structures will be particularly important. Fruit trees could also be planted along common boundaries and in homesteads.

5.3.7. Tree nurseries

For project sustainability in terms of seedling production, it will be necessary that tree nurseries are promoted. Need to undertake an inventory of all existing tree nurseries. Need for identification of common interest groups (CIGs) interested in tree nursery establishment at both the private and community levels. Need to conduct trainings in nursery establishment and management. Identify requirements and provide necessary assistance (seeds, tubes etc). Preparation for nursery establishment should start in July. Efforts should be made to utilize water from the dams for nursery activities (income generation) and for rehabilitation of sections close to the dams.

There will be need to train nursery operators on seed collection and handling. Promotion of private seed vendors is recommended for sustainability purposes.

5.3.8. Agroforestry for soil fertility improvement (improved fallows)

Improved fallows entail the planting of one or a few trees species as a substitute to natural fallows to achieve the benefits of the latter in a shorter time (Young, 1997). Planted improved fallows have the potential to ameliorate soil fertility and increase carbon pools although the magnitude of improvement depends on several factors including the fallow species, length of the fallow and climatic conditions.

The communities will need to be trained on establishment and management of various improved fallow species. Those with a potential to improve soil cover and provide other benefits (fuelwood and food) should be given priority. Species` such as *Cajanus cajan, Leucaena tricandria, Calliandra, Sesbania sesban, Crotolaria and Tephrosia candida, Dolichos lablab* should be promoted.

There is need to establish improved fallows immediately (second weeding) this is to be able to be ready for harvest and incorporation in the next heavy rains.

5.3.9. Establishment of demonstration plots

It will be particularly important that demonstration plots showing different technologies are designed and established in the four areas. Technologies here are those that have been tried and found to work. Technologies that have shown success in COSOFAP working

areas are recommended. These include orange-fleshed potatoes, grafted mangoes, tissue culture bananas, Moringa, etc. Such technologies should be easy to establish and manage to enhance adoption.

CHAPTER 6

6.0 MONITORING AND EVALUATION

For effective implementation of the recommended interventions, continuous and focused monitoring and evaluation at various levels is essential. However, it would be prudent to involve various stakeholders, including the community in the monitoring and evaluation activities so as to provide the necessary checks and balances.

The following stages are viewed necessary to accomplish the monitoring and evaluation process;

1. Sensitization of stakeholders
2. Mobilization of the community
3. Baseline data collection
4. Interventions/implementation of the recommended options
5. Dissemination of the findings/results
6. Feed back from stakeholders

MONITORING AND EVALUATION FRAMEWORK

	ACTIVITY	**MONITORABLE INDICATORS**	**RESPONSIBILITY**	**TIMEFRAME**
1.	Sensitization of stakeholders	• Listing of key stakeholders and past efforts by the same • Number and gender composition in attendance. • Number of stakeholder groups involved	WKIEMP	
2.	Community mobilization	• Number of CBOs sensitized and their gender composition. • Number of participatory action plans developed.	WKIEMP Technical committee	
3.	Baseline data collection	• Sources of information • Mode of information packaging • Structures for storing historical data/information generated	WKIEMP, Community, Technical committee	
4.	Project proposals	• Number of proposals developed and accepted and activity composition.	Community, Technical committee	

5.	Afforestation and fruit tree farming	• Number of tree/fruit nurseries • Number of tree. • Planted and survived. • Number of species planted	Community, WKIEMP, relevant technical departments	
6.	Crop development	• Number of model farms reached/planned. • Number of demonstrations set up. • Yield levels achieved	Community Relevant technical department, WKIEMP	
7.	Livestock development	• Number of enterprises initiated. • Number of livestock demonstrations/bulking units. • Yield levels achieved	Technical committee, Community Relevant technical department, WKIEMP	
8.	Water Management	• Number of water pans designed and laid out. • Number of water pans constructed/desilted. • Number of on farm water harvesting structures. • Number of roof water harvesting setup. • Number of micro irrigation projects and enterprises. • Length of cut-off drain excavated.	Technical committee, Community, Relevant technical department, WKIEMP	
9.	Gully rehabilitation	• Length of gully fenced off. • Number of trees planted and survived. • Length of gully healed	Community, Relevant technical department, WKIEMP	
10.	Information dissemination	• Number of field days held. • Number of barazas held • Number of farmers reached. • Effectiveness of the media used	Community Relevant technical department, WKIEMP	

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APPENDICES

ANNEX 1: BUDGET FRAMEWORK FOR ENTERPRISE DEVELOPMENT

1. LOCAL POULTRY IMPROVEMENT

Training on poultry management: 30 people @ 200/- per person x 5 days =42,000/-

Construction of model housing unit: 15,000/-

Disease control estimated at 2,400/- per unit

Feed supplementation: 2 bags commercial feed @ 900/- = 1800/-

Total: 59,400/-

- **NOTE:** training budget inclusive of stationery requirements
- Max utilization of locally available resources will be made of in the construction of model housing unit

2.0 DAIRY GOAT PRODUCTION

Training on Dairy goat production: 42,000/-

Model dairy goat house: 35,000/-

Fodder establishment: 25,000/-

Purchase of 5 does @18,000/- = 90,000/-

Purchase 1 buck @ 15,000/- = 15,000/-

Subtotal: 207,000/-

NOTE:

- training is scheduled for 5 days for 30 persons
- Maximum use is made of locally available materials in the construction of model house

3.0 BEEKEEPING

Training: 30 people x 5days @ 200/- = 42,000/-

Purchase of 20 langstroth hives @ 4000/-

Purchase of beekeeping equipment an harvesting kits @ 7000/-

Subtotal: 51,000/-

IRRIGATED AGRICULTURE
Motorized pump and accessories – 5,000/=
Assorted seed – 7,000/=.
Pest an disease control chemicals 10,000/=
Training 30 people for 4 days @ 200/= each – 24,000/=
Sub Total = 81,000/=

ANNEX 2: THE LUO VILLAGE

Information gathered from the community meetings (2) and focus groups (8) indicated that in the Luo village there are five groups villagers can choose to join. With the exception of the Clan group, which was started in 1989, all the other groups started between 2002 and 2003. The village elders informed that all members belong to the Clan group by virtue of belonging to the clan. The purpose of the Clan group is to unite the clan by creating order as well as organizing funerals. Members can choose to join more than one group as long as they can afford to pay the membership fees and observe the regulations governing the groups.

The members in this village tend to lean more towards the traditional clan expectation as evidenced by the inclusion of the clan as a separate group. Some groups have been formed along the sub-clan lines. This village is one of the eleven clans in this area. There are four sub-clans and until recently, the Mwenge group membership was strictly for one sub-clan only. At the time of the interview, it had admitted two members from other sub-clans. Table 3 details the characteristics of the groups in the Luo village. The group name and the date of inception are included. With the exception of the clan group, all the other groups were started in the last five years.

Most groups indicated that their main objective was to offer and obtain assistance in times of hardships such as; sickness, medical and funerals expenses. The reasons were similar for most of the groups with the exception of Rita women group, which listed agricultural production and poverty reduction as their objectives. With the exception of the Clan group, all the other groups had a Kshs.50.00 membership fee as well as a monthly contribution agreed upon by members. A member must attend all meetings. Failure to attend three consecutive meetings results in the committee summoning the person and deciding on a course of action which may range from a warning to dismissal from the group. This requirement creates a problem of access for the sick members that cannot make it to the due to illness.

An elder from this village stated that the government encouraged both, formation grassroots groups and more women to participate. Rita and Mwenge groups elevated women in strategic leadership positions with the hope that non-governmental or other government organizations would work with them. Although women were in charge they

consulted the male members on matters related to the group. The groups seemed to function well. Perhaps without the external emphasis and encouragement on women's involvement in development, women would not otherwise have been involved. In this respect, externally motivated collective action favored and elevated women to leadership positions within the groups. The Elder's group was internally motivated whose main role was to deal with problems within the clan and maintain order. This group did not have any women memberships, indicating that clan-based some internally motivated groups do not favor women.

Annex 3: sketch showing all dams