

Assessment of Ecological Status and Socio-economic Dynamics of Upper Ewaso Ng'iro Basin Wetlands

(Volume 1: Summary of findings)

Search for Sustainable Use of Wetlands in Ewaso Ng'iro North River Basin

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2.0 Executive Summary

Upper Ewaso Ng'iro Basin stretches from a semi-humid area at the foot of Aberdare ranges and Mt Kenya through the arid regions of Laikipia County (eco-climatic zone 3), to the more arid Shamburg and Isiolo regions (eco-climatic zone 4). The nature of the physiographic features that are characterised by plateau formation has encouraged wetland formation along the Ewaso Ng'iro river artery. The upper most wetland is the Ol Bolossat which forms the headwaters of all important Ewaso Ng'iro river, which receives water from rivers draining from both Mt Kenya and Aberdare ranges.

Historically, this basin has been used by nomadic pastoralist up to the early part of the 20th century, when the area was occupied by white colonial farmers. Upon independence in the 1960s, the land was sub-divided into small scale farms which were mainly bought by farming communities from central Kenya. Due to the aridity of the region, this set the stage for wetland conversion since the adjacent area is too dry for farming. Currently the wetlands form important livelihood support system mainly for the farming communities. Farming is mainly geared towards meeting a combination of domestic food and income generation through horticultural crops, the later a recent development. Cultivation is done through irrigation using open canal and facilitated by loosely connected pipes with water pumping being done by pumps of various horse power. Horticultural farming is mainly characterised by huge losses throughout the year with middlemen controlling over 80% of market access. This scenario is evident from the poor livelihood status in terms of types of housing and wide spread poor health conditions related to poor sanitation and water contamination. The farmers are banked rolled by horticultural companies and banks hence high presence of liquid cash but low or no profits. Apart from farming the wetland area form an important grazing area for both the local community and outsiders especially from the arid northern region who come to the south for pasture in the dry months.

Although some of the wetlands were not initially allocated as farming area, all the wetlands have been parcelled out with the exception of Ol Bolossat. This is the only wetland with a management plan in the basin. For example, land allocation in Ewaso Narok has been undertaken by the provincial administration, while in Marura, the earliest (1970s) occupied wetland settlement was done by central government and titles have been issued. Similarly in Pesi, Mutara and Moyok, the people alleged that land buying companies allocated land in the wetland and some people have titles.

The impact of several years of farming in the wetland is visible in the dramatic change in the land cover with all the wetlands having recorded at least 50% increase in built up / cultivated areas between 1986 and 2010 with the exception of Ol Bolossat, which has remarkably recovered from 1990s encroachment. This increase in human activities is confirmed by decrease in sedges vegetation, which represent natural wetland ecosystem. Although the ecosystems indicated minimal change in

soil fertility and water quality this can be associated with high dynamism in terms of water flow from the humid Aberdare and Mt Kenya ecosystems. During the wet season these wetland are heavily flooded and human activities are totally curtailed resuming again in dry season, which allow ecosystem self recovery. However, the wetlands lack management plan systems apart from Lake Ol Bolossat which has an approved management plan. In addition Water users association are almost absent with the exception of Marura area and Pesi. In all the other wetlands they have been a non-starter but the farming community have a stronger desire for some effective water management system. At the same time, they would like to continue living in the wetland where farming is conducive because of availability of water. A wholistic government intervention in form of participatory planning on wetland utilisation and conservation is required.

Considering that more than 50% of the wetland has been converted into farming area, three management scenarios are proposed;

- No intervention at all and the status continues, which will gradually transform wetland into farmland and grassland
- Total exclusion of people from the wetlands, a momentous task and unpopular decision considering that the adjacent area is too dry for any viable farming activities
- .Coordinated intervention of wetland restoration and management as joint venture that will allow multiple sustainable utilisation

Acronyms

ASALS	- Arid and Semi Arid Lands
ASL	- Above Sea Level
CBOs	- Community Based Organizations
CEC	- Cation Exchange Capacity
CETRAD	- Centre for Training and Integrated Research for ASAL Development
ESAPP	- Eastern and Southern Africa Partnership Programme
FGD	- Focus Group Discussion
GIS	- Geographical Information System
GoK	- Government of Kenya
KFS	- Kenya Forest Service
KWS	- Kenya Wildlife Service
KWWG	- Kenya Wetland Working Group
LTM	- Landsat Thematic Mapper
LWF	- Laikipia Wildlife Forum
NDVI	- Normalised Difference Vegetation Index
NEMA	- National Environment Management Authority
NGOs	- Non Governmental Organisations
WRMA	- Water Resources Management Authority

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3.0 Introduction

Wetlands are areas oversaturated with water either temporarily or permanently in the non-capillary pores of the upper layers of the soil. These ecosystems are also characterised by emergent, submerged or floating vegetation of various form and diversity. The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat defines “wetland” in its Article one of 1972 as “Areas of marsh, fen, peatland or water whether natural or artificial, permanent or temporary with water that is static flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters” (Dugan, 1990)

In Kenya wetlands are defined as “Areas of land that are permanently, seasonally or occasionally waterlogged with fresh, saline, brackish or marine waters including both natural and manmade areas that support characteristic biota” This definition was adopted by Regional Wetlands Biodiversity Group at Mbale, Uganda, in May 1996.

Wetland ecosystems provide great economic, social, recreational, scientific, and cultural values; ecological habitats for various flora and fauna, and perform crucial ecological functions through carbon storage, water purification and waste detoxification. In Kenya's ASALs, wetlands occur in relatively small but widely distributed patches providing critical watering points for pastoral communities, and grazing areas for both wildlife and livestock.

4.0 Rationale

The issue of wetlands in Kenya has not been consistently documented. Although the National Environmental Management Authority (NEMA) and Kenya Wildlife Service (KWS) have the mandate over crucial environmental issues including wetlands. Little has been undertaken in the Ewaso Ng'iro basin to ensure sustainable management of wetlands. This is the main cause of the deteriorating conditions as information to govern their management is lacking. This research therefore intends to generate information that will guide the development interventions in the the upper Ewaso Ng'iro basin especially with regard to where wetlands exist. This will be a major step towards assisting the country restore its natural heritage.

This project is geared towards fulfilling this need by availing the much needed information for planning through the assessment of current situation in basin's wetlands. The aim of this project is to map wetlands and assess their socio-economic uses, values and functions, ecosystem services they render and threats to their sustainable management. This is an effort to generate information for guiding the appropriate interventions measures that will facilitate sustained management of these resources for the benefit of local economies.

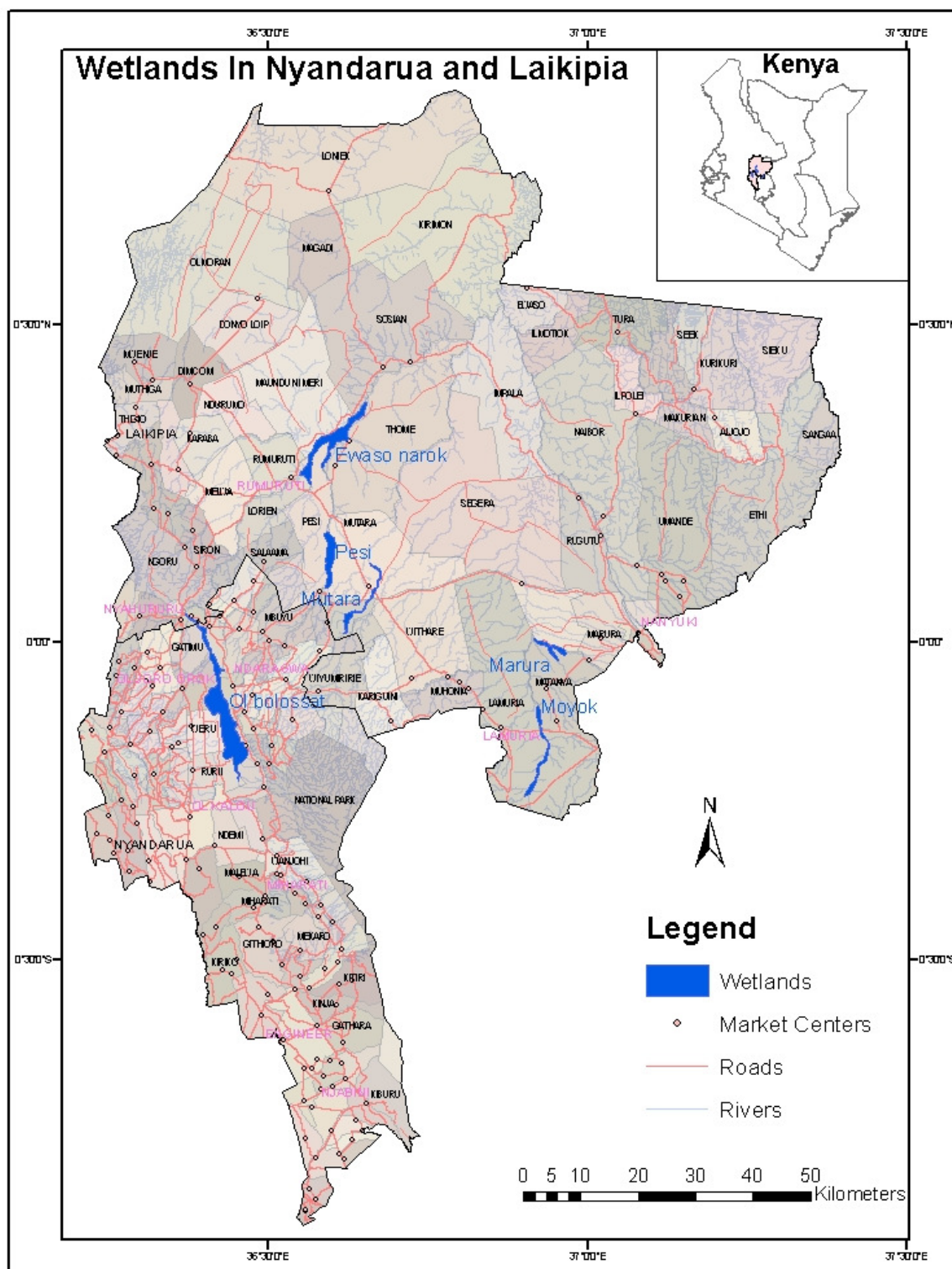
5.0 Wetlands in Upper Ewaso Ng'iro Basin

Ewaso Ng'iro drainage basin rises to 2600 m Above Sea Level (ASL) in the south and falls to below 1000 m ASL in the north. Annual rainfall ranges between 500-1000 mm with bimodal occurrence while temperatures vary between 20-37 °C annually. High rainfall occurs in the south gradually reducing to the north with drier parts receiving slightly over 400 mm per annum (GoK, 1994). Long rains occur between March to May and short rains from October to November. A significant part

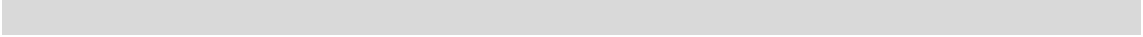
of this basin is used for ranching mainly due to water limitations and has been used by nomadic pastoralist for a long time. However, there has been increasing incidences of cultivation with farming being restricted to areas along river systems, although this is shifting to drier areas with population increase (Thenya, 1998, Thenya, 2001).

In terms of hydrology, few permanent surface streams exist in this basin most of them being seasonal usually drying up during the dry season. River Ewaso Ng'iro is the major permanent river, receiving all tributaries in the basin and it draws its head waters from Lake Ol Bolossat through Nyahururu falls (former Thomson Falls). It has a minor contribution from Oraimutia River from Sabugo highlands in Nyahururu, which is now heavily deforested. Other important rivers from Mt. Kenya include Nanyuki, Burguret, Likii, Ontulili, Sirimon and Timau while those from the Aberdares include Eng'are Ngobit, Moyak, Pesi, and Mutara rivers. Streams' seasonality coupled with high evaporation causes a major water deficit in the basin.

In spite of the aridity that characterise the region, Ewaso Ng'iro North Drainage Basin has numerous wetlands, which are partly attributed to geology, tectonic earth movements and topography. The wetlands found in this region are all riverine permanent wetland, with a total area over 50 ha (Thenya 1998, Mathuva and Kiteme 1997), but the total area could be higher. Most of them are concentrated on the drier western part of the drainage basin, where land gradient is also low. Dryland wetlands, like these ones found in Ewaso Ng'iro North Basin represent unique ecosystems, which closely depict the concept of 'Island biogeography' of isolated ecosystems. They have a unique flora and fauna very distinctively different from adjacent dry ecosystem, for example they are mainly dominated by macrophytes such as *Cypress species such as C. papyrus, C. dives. C. exaltatus* and allied genera, except for the Lorian swamp, which is *Typha*, dominated (Pratt *et al* 1978). The main swamps that are found in Ewaso Ng'iro North drainage basin are Ol'Bolossat, Ewaso Narok, Pesi, Marura, Moyok, and Lorian swamps. Other smaller swamps include Mutara, Ngare Nything that have little documented information (Thenya and Gichuki, 2001) (Fig. 1).



In the early 20th century, the plateau was home to the pastoral Maasai communities. By following the rains and utilizing the vast expanse of grazing land to support their cattle, the Maasai were able to support themselves sustainably. During the colonial era, most of the plateau was converted to large commercial ranches pushing the Maasai into the northeast corner of the plateau. The population of Laikipia District has grown rapidly since the 1960s with an annual growth reaching over seven per cent between 1967 and 1979. Much of this growth was in the arable southwestern corner. In the central plateau, the large, sparsely populated ranches enjoy the luxury of balancing their use of the land to match the land's regenerative capacity. In the District's southwest and northeast corners, however, pressures from growing populations are forcing people to the much drier northern side.



6.0 Specific wetlands

Lake Ol Bolossat is the highest altitude lake within the Kenyan rift valley, lying on the tilted Kinangop plateau at the base of Satima escarpment in Nyandarua district. It lies at an altitude of 2,340 m above sea level in a wedge shaped fault and covers an area of 23 Km². It is a shallow slightly alkaline lake surrounded by extensive swamp land vegetation and has a maximum depth of 4 meters. In terms of hydrological functions; Lake Ol Bolossat is an internal drainage basin and plays an important role in containing the excess water from Satima and Maruai escarpment to the East and the Dodori Tumaini escarpment to the west. The faulted zone to the west of Ol Bolossat valley acts as a channel for feeding springs in the mid catchment thus adding to the volume of flow in River Ewaso Narok, which is a major tributary to the Ewaso Ng'iro River, where it acts as the head waters that eventually forms Ewaso Narok swamp.

Ewaso Narok is the largest wetland in Laikipia district and is located in Rumuruti division. It covers about 23km² with a linear stretch of 12km. The wetland is an important fallback grazing ground for various fauna species. Pesi wetland is the second largest in Laikipia district and is located in the southern parts of Rumuruti division. It covers about 11.4km² and has formed within Pesi river valley.

Other small wetlands such as Moyok (7.7 Km²) and Mutara (5.5 Km²) have also had significant human impact. Marura wetland is also known as Burguret-Rongai and is located about 12km southwest of Nanyuki town in Matanya area falling in Central and Lamuria divisions. It covers about 4.4km² occasioned by minimal changes over the years.

Objective and Scope

The aim of this project was to map wetlands and assess their socio-economic uses, values and functions, ecosystem services they render and threats challenging their sustainable management. This was effort to was geared to generating information guide appropriate interventions measures that will facilitate sustained management of these resources for the benefit of local economies.

The specific objectives of the project:

- 1) To undertake an inventory of Upper Ewaso Ng'iro basin wetlands detailing their bio-physical components and map land use/cover changes overtime
- 2) To assess the socio-economic value attached to these wetland, utilisation and conservation initiatives among local community and other stakeholders in the basin
- 3) Develop a detailed spatial and non-spatial database for the upper Ewaso Ng'iro basin wetlands
- 4) Create awareness on socio-economic, ecological, and conservation status of the wetland and formulate a conservation strategy for the upper Ewaso Ng'iro basin wetlands

7.0 Methods

Various types of data were collected to facilitate assessment of wetland ecology and socio-economic status. A multi-faced approach was used in data collection. Specific methodology for each component included a combination of: socio-economic - questionnaire, focused group discussion (FGD), key informant interviews and field visit; ecological assessment on vegetation-water-soil-sample collection, *insitu* (field) measurements laboratory analysis; and use of change detection technique and

geographical information system (GIS) technique. Landsat Thematic Mapper (LTM) images downloaded from the USGS Glovis website were used covering the period between 1980 and 2010.

8.0 Results

The survey covered the upper Ewaso Ng'iro basin with a focus on wetlands in Nyandarua County as head waters and Laikipia County where several wetlands are located.

9.0 Ol Bolossat Wetland

Settlement around Lake Ol Bolossat has been rising gradually from an initial settlement in 1960s of 15%, dropping in 1970s but followed by a fast rise to a high of 32% in 2000 (Fig. 2). The gradual rise over the decades might explain to some extent the rise in changes within the wetland. While this forms an important proxy for wetland utilisation pressure it might be critical to find out the form of pressure exerted on the wetland by the rising population density. The main source of income is farming with education taking 80% of the generated income.

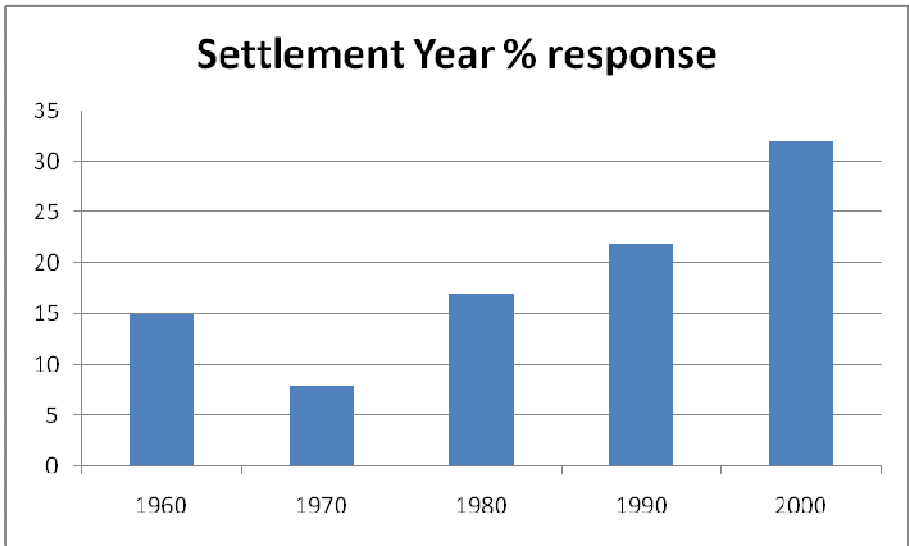


Figure 2: Settlement Trends around Lake Ol Bolossat

There are various types of land tenure systems around the wetland, which include trust land, family/inherited, rented and settlement schemes/ purchase land system. About 48% of the land in the study area is recognized as trust land. Land holdings vary but for the majority of the household land holding is relatively small with 52% of the households interviewed having up to 3 acres; 20% have 3.5 - 5 acres; 22% have 6-10 acres and 6% have 11 – 16 acres, most of which have been acquired through land buying company upon sub-division of the former white farmers land. Most of the respondents (85%) say they do not own land outside the wetland, which correspond well with 68% settlement within the wetland. It is possible some people have titles for land holding within the wetland but specific details needs to be verified. Kenya political disturbance in 2008 triggered increased flow of people to the wetland area mainly in search of settlement.

The main land use according to 98% of the people is crop farming with maize beans and Irish potatoes being the main crops but with crop production dropping in the last 45 years. Crops are mainly grown under rainfed farming with limited irrigation mainly under sprinkler system, which is different from the other wetland in the basin where open canal system is used for irrigation. The main markets for the farm produce are mainly local markets such as Nyahururu, Ol Kalou and Ol Jororok. Challenges facing crop production include minimal use of fertiliser accompanied by low extension services in the area. Other challenges include crop damage by wild animals such as hippopotamus and porcupines with wildlife damage having come down after the fencing of Aberdare through the initiative of Rhino Ark, KWS, KFS and other partners. Livestock farming is common among the local resident with wetland providing ideal dry season grazing area, although livestock watering in the wetland goes on throughout the year. Sale of both crops and animals products is largely controlled by brokers, which means that the farmers get a lower deal on value of their crops.

Fuel wood make over 80% of the sources of domestic energy around Ol Bolossat. There are various sources of fuel wood with on farm contributing approximate 43%; followed by buying from neighbours (35%); buying from the market (13%); Aberdare forest (4%); Ndaragwa Forest (4%); and being given by the neighbours (1%). The main source of domestic water at household level around Ol Bolossat is from rivers according to 64% respondents. However, according to the local community rivers flows from Ewaso Ng'iro and Shamuka have been reducing from 1970s to 2000s. Other sources of water include piped water (33%); springs (1.5%) and rain water (1.5%). Living close to the wetland is associated with several challenges among them is water related diseases with some of the common diseases around Ol Bolossat, being;

- Malaria (34%)
- Diarrhoea (25%)
- Typhoid (14%)
- Common cold (12%)

The main institutions that are responsible for management of Ol Bolossat include mainly government (86%) with KWS singled out as government department involved in management of the wetland. The role of local community is perceived as being low with only 8% acknowledging local community involvement.

Proposed Management by the community

- The Lake Ol Bolossat should be de-silted and the vegetation inside the lake cleared so that it can deepen and hold more water.
- The water springs around the lake area should be well protected and managed because they act as the water inlets of the lake.
- The boreholes in Githunguchu area should be improved and protected because it is the source of water for domestic and livestock use in that area.
- Farmers should be encouraged to plant more trees and especially indigenous trees but not trees that use a lot of water.

- Open grasslands near the lake should not be overgrazed because these are the grazing areas of animals like hippopotamus.
- The Lake environment should be protected and reserved as a tourist site which can collect revenue since there are animals like hippopotamus and different species of birds for watching.

10.0 Ewaso Narok Wetland

Settlement around Ewaso Narok has been rising gradually from an initial settlement in 1950s of 3%, with increased migration from 1990 to 2000s (Fig. 3). The gradual rise in settlement over the decades might explain to some extent the changes in land cover within the wetland. This forms the source of an important proxy for wetland utilisation pressure and hence it might be critical to find out the form of pressure exerted on the wetland by the rising population density.

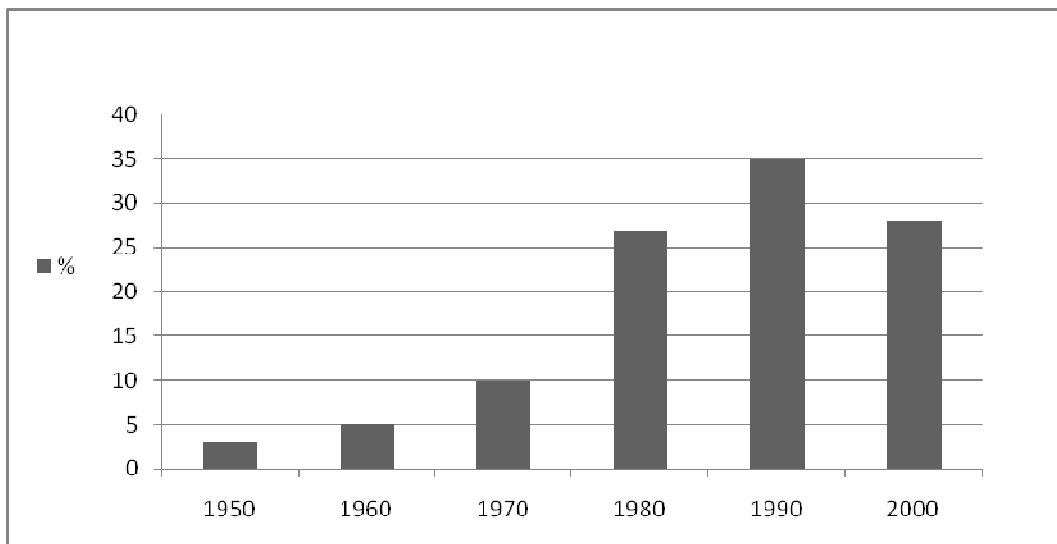


Figure 3: Settlement Trends around Ewaso Narok

The households are very near to the wetland boundary with 80% of the households being inside the swamp. The main driving force for the settlements over the years is inadequate land in place of origin according to 50% of respondents. Other reasons include;

- Tribal/ethnic conflict (13%)
- Lack of employment (10%)
- Insecurity (6%)
- Drought (5%)
- Inadequate water/rains (5%)
- Lack of pasture (3%)
- Poverty (3%)
- Transferred professionally (3%)
- Lack of water (2%)

There are various types of land tenure systems with 65% of the land in the study area being described as government land; 22% is recognized as trust land; 7% is rented; 3% is referred to as family land/inherited; 2% is settlement schemes and 2% is bought. This means that almost 90% of the landholding is government land. Land holdings vary from household to household with the smallest parcel being 0.25 acre while the largest is 7 acres. About 85% of the households interviewed have up to 3 acres; 12% have 3.5 - 5 acres and 3% have 6-7 acres. Land acquisition has been through different ways with 58% of the land alleged given by the government/member of parliament or provincial administration, 20% acquired through buying, 8% through self allocation, 7% through renting, 3% through balloting and 2% through inheritance. Over 80% of the respondents do not have legal documents on land ownership mainly because this is mainly government land.

The three main crops grown in Ewaso Narok are maize, beans and tomatoes. The crops are grown under varying proportions but most of the famers grow maize and beans on 0.25 acre each and tomatoes on 0.5 acres. Although crop production has been declining, the farming activities are important for raising cash for education purposes (40%) and household income. Sale of farm produce is largely (over 50%) controlled by brokers meaning that farmers get low returns for their labour both at the local market and distant markets like Nairobi. At the same time, extension services around the wetland are low to moderate with only 7% of the farmers having been visited by government extension services, which contribute to low crop production. Services offered by the extension officers include dissemination of new technologies on farming (36%), tree planting techniques (16%), development of compose manure (16%), use of agro-chemical and crop protection (16%) and livestock husbandry (16%).

There are a number of challenges in crop farming around the wetland. About 93% of the respondents say they experience crop damage by wildlife although damage varies depending on crop type. Although there have been increased efforts in fencing of wildlife areas within Laikipia, crop damage is still a big challenge mainly emanating from elephants and buffaloes. Other challenges associated with crop production around Ewaso Narok include flooding / water logging since most of the farming takes place in the wetland. However, there is increasing irrigation of the adjacent dryland. About 95% of the respondents undertake irrigation in their farms in the adjacent dryland areas. The type of irrigation in Ewaso Narok is flooding (74%) and furrow (26%) with the major crops and area under irrigation varying. The crops grown under irrigation are mostly for horticultural commercial purposes with products being transported to large distant markets like Nairobi and Mombasa. Farmers do not pay for water which is treated as a free commodity.

Livestock rearing is also a major undertaking by farmers around Ewaso Narok with about 83% of the respondents indicating involvement in livestock rearing. The types and numbers vary from household to household with cattle and sheep rearing taking the lead, which is mainly done under free range system. The wetland provides an important source of forage for livestock especially during the dry season.

The main source of household water in Ewaso Narok is from rivers according 93% of the respondents. Other minor sources include well/borehole (5%) and canal/ furrows (2%). According to the local community the two main rivers serving Ewaso Narok

swamp that is Ngare Narok and Aiyam have over the years experienced reduction in water flow between 1970s and 2000s with Aiyam having extremely low flows in 2000s. Some of the problems associated with water in the area include Contamination/ siltation/ pollution/ odour (52%) (associated with farming and poor sanitation), diseases (16%) and salty water (2%). About 50% of the people practice rain water harvesting so as to help in tackling water related problems. In Ewaso Narok, the common and frequent human diseases among the households that are associated with wetlands include malaria (38%), typhoid (36%), pneumonia (10%), common cold (7%) and amoebiasis (2%), which are common on wet areas with poor sanitation.

There are various sources of domestic energy around Ewaso Narok swamp with wood fuel and charcoal being the two major sources (over 90%), which have moderate availability. Sources of fuel wood include Narok forest (28%); unsettled land (28%); ranches (21%) and on farm (14%). The main institutions that are responsible for management of Ewaso Narok swamp management are; government departments (78%), the local people/community (15%), Individuals (4%) and provincial administration (Chiefs) (3%). The most mentioned visits are from the Provincial administration (chiefs/DO/DC/ police). The area has no water user association as the farmers claim that they were refused registration since most of them have settled in the swamp and are bound to be evicted.

Proposed Management by the community

- Dam construction to store run offs from farms and overflows from the swamp which would be used during drought.
- To keep the furrows clean so that water can flow with ease, currently the furrow has been neglected.
- Farmers should be encouraged to plant more trees or forestation in the swamp and deforestation in the swamp should be discouraged.
- There should be piped water projects for domestic, livestock and irrigation users from the upstream of the river which is the Aberdares
- The place is rocky so rock or valley catchments are possible and should be constructed to tap water from the nearby hills to be used for irrigation far from the swamp.
- Improved irrigation practices such as uses of sprinklers, drip tapes should be promoted since they use minimum water.
- Avoid overgrazing in the swamp; people should be educated on controlled stocking. Also promote of practices like zero grazing, poultry, beekeeping and fish farming.
- Avail extension services in the area as there are no extension officers to advice farmers.
- Human settling in the catchments areas should not be allowed due to destruction of forests like the Aberdare.

11.0 Pesi Wetland

Settlement around Pesi swamp has been rising gradually from an initial low settlement in 1950s of ca. 2%, with major movement to the swamp in 1980s and 1990s (Fig. 4). The gradual rise over the decades might explain to some extent the

rise in changes within the wetland. While this forms an important proxy for wetland utilisation pressure it might be critical to find out the form of pressure exerted on the wetland by the rising population density.

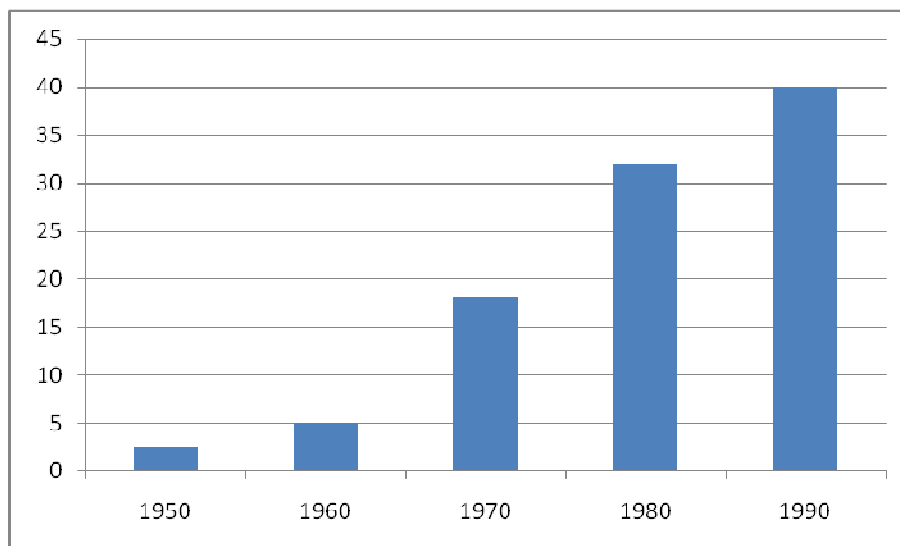


Figure 4: Settlement Trends around Pesi

The reasons for leaving the original homes are many but the search for settlement land due to inadequate land in original home area has been an important push factor. In addition the recent disturbance after 2007 general election has also been a major contributing factor to settlement around the wetland most inhabitants coming in 2009 (20%). Over the years 21% of the households have settled in the swamp.

There are various types of land tenure systems with 53% of the land in the study area being recognized as trust land. About 31% is referred to as family land; 13% is rented and only 3% is described as government land. The land holding vary from household to household about 74% of the households interviewed have up to 3 acres indicating small land holding sizes.

In terms of the legal status, 91% of the respondents say they have title deeds, which contrast with the large percentage of land recognised as trust (53%) or government land (3%); 3% say they have an allotment letter, 3% say it was self allocation and while 3% lack any legal documentation for the land. Wetland occupation is high with 53% of respondents saying that they do not own land outside the wetland, meaning they occupy wetland land where they are not supposed to be holding legal occupation document. Water availability and cultivatable land has been two major reasons for settling in the wetland. The three main crops grown in Pesi are maize, beans and tomatoes, with the former two crops being most important. While part of the crops are sold to raise income, unlike in the other two swamps, in Pesi a higher percentage of farmers (36%) are able to access the markets although brokers equally take a significant proportion about 33.4%. Farming in Pesi has been there for a long time, thus the farmers have developed marketing channels and skills in farm produce.

Most of the farming activities are under irrigation with about 84% of the respondents undertaking irrigation in their farms. The type of irrigation in Pesi is flooding (56%) and furrow (44%). However only a small percentage of about 13% of the respondents say they pay for irrigation water while 87% say they do not pay. Extension services around the wetland is low to moderate with only 24% of the farmers having been visited by government extension services, which is higher than in the other wetlands that is Ol Bolossat and Ewaso Narok. Services offered include use of chemicals/ crop protection (33%), animal breeding (AI) (33%), new technologies in farming (17%), general farming advice (8%) and livestock rearing (8%).

Wildlife related damage is high with elephants, monkeys and birds being a major menace in Pesi causing damage to the three main crops. The cost of damage varies depending on the type of crop with tomatoes incurring the highest losses maybe because tomatoes are grown as cash crops. Apart from wildlife damage (36%) the other challenges that are common in the area is flooding (30%), which is common in all upper Ewaso Ng'iro basin wetlands. In Pesi wetland grazing is low which can be attributed to high level of cultivation with a large majority (83%) indicating that pasture in the swamp, is supplemented by napier grass/ reeds/ sweet potato vines (60%) or renting uncultivated land for grazing (20%) or buying animal feeds such as hay (20%). However, it is an important water area with over 80% watering their animals in the wetland mainly along the rivers feeding the wetland and along the irrigation furrows. At the same time there are a number of challenges associated with livestock production in Pesi, which include insecurity / cattle rustling (54%).

The main source of household water according to 95% of respondents is Pesi river with minor contribution from well/borehole (2.5%) and rain water harvesting (2.5%). However, river Pesi flow has been on decline from high flow in 1970s to low in 2000s. Some of the challenges associated with water include contamination and long distances travelled to fetch water. About 77% of the respondents practice rain water harvesting so as to assess clean and safe domestic water; reduce workload of water fetching (20%); and for irrigation (3%).

The main source of domestic energy is fuel wood, which is mainly sourced from on farm (30%); unsettled land (24%); forest (23%); and buying from neighbours (23%).

The main institutions that are responsible for management of Pesi are ministry of water / WRMA (56%) along with provincial administration (22%), local community and KWS. About 92% of the respondents say that there are set rules and conditions on how to utilize Pesi swamp resources. These rules/ conditions include

- Water rationing during dry season (72%)
- Must have a water permit (18%)
- Maintaining hygiene (7%)
- How to conserve water (3%)

These rules and conditions have been set mainly by the ministry of water/ WRMA/ RWUA (79%) in collaboration with community (16%) and provincial administration (Chief/ DO/ DC (local administration) (5%). Those who contravene these regulations are either arrested/ fined/ jailed (52%) or their machines are confiscated (43%).

Some of the conflicts that exist in utilisation of the wetland and managers of the ecosystem include non-compliance with water usage (82%), or poaching. The people around the swamp have a registered water users association, which has a management plan under implementation.

Proposed Management by the community

- Construct a Dam along Kanyagia and Pesi rivers that would be used to store water during the wet season, which farmers can use for irrigation in the drier parts of the area during the dry periods. This would relieve the heavy utilisation of the swamp.
- Pesi farmers should use the canals water only and not tamper with the main river since the canal is not close to the swamp.
- To have piped water projects for irrigation, which can be used by upstream farmers instead of depending always on the swamp area.
- Use of other better methods of irrigation instead of flooding such as sprinkler, drip because the flooding method uses a lot of water and latter spoils the soil texture.
- Avail extension officers who can give better ideas and educate the farmers on issues like conservation, water use, environmental issues and farming techniques since often farmers use adhoc adopted technology
- Avail loans to farmers to start projects like fish farming, which is not water consuming and is environmental friendly as well as income generating.
- Security in the area should be improved. For example, cattle rustling in the last twenty four years have been a major issue that reduced cattle keeping and forced many would be livestock keepers to irrigation farming. This means that if there is maximum security the farmers would keep livestock and poultry hence keep off the swamp as before.

12.0 Moyok Wetland

Settlement around Moyok Swamp has been rising gradually from an initial settlement in 1980s of 5%, to a high of over 80% in 2000s (Fig. 5). The sudden rise in the 2000s might explain to some extent the rise in changes within the wetland. While this forms an important proxy for wetland utilisation pressure it might be critical to find out the form of pressure exerted on the wetland by the rising sudden population density.

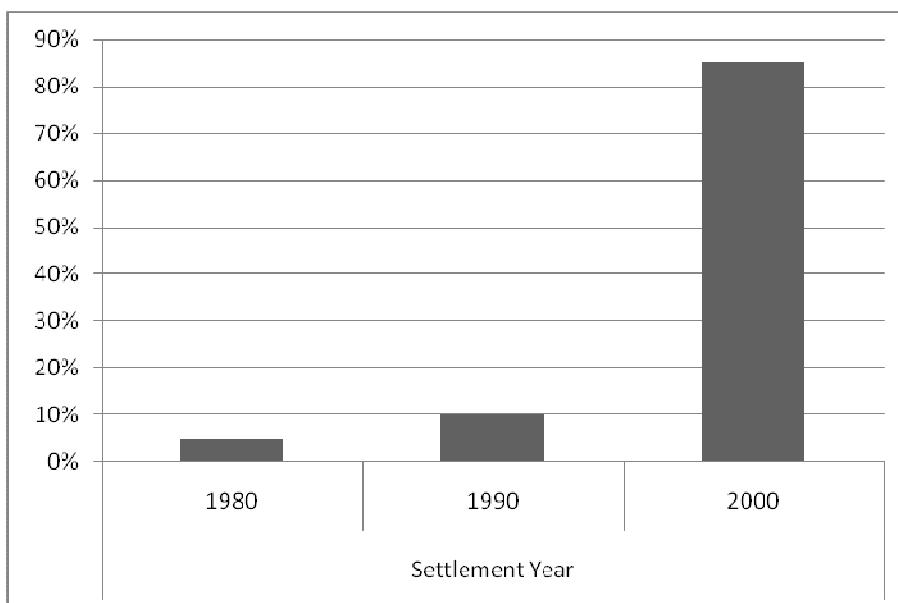


Figure 5: Settlement Trends around Moyok Swamp

The main driving force for the settlement trends over the years are several these include;

- Lack of enough land/landlessness (70%)
- Inadequate water/rains (10%)
- Lack of employment (10%)
- Tribal/ethnic conflict (5%)
- Lack of pasture (5%)

Settlement has varied over the years with some households being very near to the wetland boundary or within the wetland. For example, 59% of the households were within the swamp and 41% were 0.5 – 2km away. About 30% of the land in the study area is recognized as trust land; 45% is settlement schemes; 15% is rented and 10% is referred to as family land/inherited. About 60% of the households interviewed have up to 3 acres; 30% have 3.5 - 5acres and 10% have 6-10 acres. About 75% of the land was acquired through buying, which can partly explain the settlement scheme, 15% through renting and 10% through inheritance. In terms of the legal status, all the respondents say they have title deeds for the land they hold but which raise some questions since individuals cannot hold title for trust land or wetland areas. This is further complicated by the fact that most of the respondents (70%) say they do not own land outside the wetland. Those with land outside the swamp are in different land tenure such as trust land (17%); settlement schemes (17%); family land/inherited (33%) and rented land (33%). All of the new settlers which have taken place in the year 2000s especially in 2009/10 (70%) has been partly attributed to post election violence.

The three main types of crops grown in Moyok swamp are maize, beans and cabbages, which are mainly grown to meet basic household demand. All the farming activities are under irrigation in form of flooding and use of open canal with only 5% of the respondents indicating that they pay KSh 33 per month for the irrigation water. However, like in the other wetlands crop production has been dropping in the last 20

years. The sale of farm produce such as kales, arrow roots, livestock, capsicum, French beans, eggs and sweet potatoes is largely (over 80%) controlled by brokers. Extension services around the wetland are low to moderate with only 25% of the farmers having been visited by government extension services. Services offered include general farming advice (43%), new technologies/ Farming (28%), use of chemicals/ crop protection (14%), fertilizer application (14%). There are a number of challenges in crop farming around the wetland. About 95% of the respondents say they experience crop damage by wildlife although damage varies based on crop type. Elephants, monkeys, hare, porcupine and wild pigs seem to be a menace in Moyok causing damage to the crops.

Livestock rearing is also a major undertaking by farmers around Moyok, with about 95% of the respondents indicating involvement in livestock rearing. About 85% of the respondents say the pastures in the swamp are adequate and any variation of pasture is handled by buying animal feeds such as hay. Livestock from outside the wetland areas are also brought to the wetland especially during the dry season. The wetland is particularly important as dry season watering points by both local people and outsiders. Influx of livestock herders especially from the arid north is common during the dry months, which are also the critical months for crop production.

The main source of household water in Moyok is the river according to 95% of the households along with well/borehole (5%). A large percentage of the local people practice rain water harvesting according to 90% of the respondents with the main aim being to access clean and safe domestic water. The most common form of water related conflict is associated with water inadequacy especially during dry season or drought period (86%). Others are associated with upstream – downstream conflict (14%), which is common again during the dry period when water does not reach downstream users especially due to abstraction for irrigation. Like in the other wetlands the most common and frequent human diseases amongst the households include malaria (40%), typhoid (24%), common cold (19%) and amoebiasis (10%).

Domestic energy around Moyok swamp is largely sourced from wood fuel and charcoal being the two major sources, which have moderate availability. An overwhelming 90% of the respondents do not practise farm forestry with only very small proportion of land being under farm forestry. Sources of fuel wood were mentioned as; on farm (46%); buying from neighbours (29%); unsettled land (17%) and buying from the market (7%).

All the respondents say that there are set rules and conditions on how to utilize Moyok swamp resources, which touch on various aspects. According to the local community, the perceived regulations touch on; Water rationing during dry season (78%), No irrigation during dry season (9%), Clearing and cleaning the river banks (9%) and How to conserve water (4%). A Water Users Association for Moyok was started in year 2006 and farmers registered although the Association has not been active.

Proposed management by community

- Uproot all the eucalyptus trees in the swamp since they consume a lot of water and plant indigenous trees instead.
- The government should support construction of big dams inside the wetland to store water when there are floods but this can only be done by relocating some farmers and compensating those that their farms occupies the swamp.
- People in the area should be encouraged to harvest runoff water during rains in their individual farms through digging small pans, dams and wells. This water can be used in the dry seasons for irrigation.
- Farmers should also start practising roof catchment and install tanks and this water can be used for kitchen gardening, domestic and livestock.
- The government should think of drilling boreholes in the upper drier areas to relieve pressure on wetland water especially for livestock and domestic needs.
- Farmers should also protect the riparian by planting suitable trees with advice from environment experts and agricultural extension officers
- The farmers also need to be trained on the right species of trees to plant that do not consume a lot of water. They said that since the farms are small, it would be advisable to plant these trees along the farm boundaries.
- There are no extension officers in the area and farmers only operate with their farmer gained knowledge and the government should avail extension officers in the area
- Farmers need to be trained in values of WRUAS and legal provision in the water Act so that they can revive the non-functioning Moyok WRUAs

13.0 Mutara wetland

Settlement around Lake Mutara swamp has been rising gradually from an initial settlement in 1970s. The gradual rise over the decades might explain to some extent the rise in changes within the wetland (Fig. 6). While this forms an important proxy for wetland utilisation pressure it might be critical to find out the form of pressure exerted on the wetland by the rising population density.

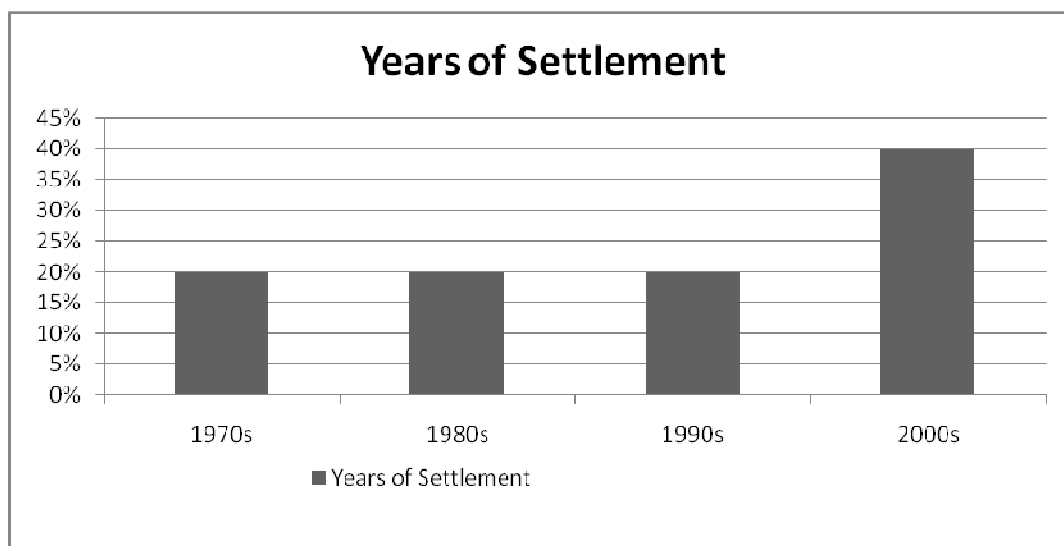


Figure 6: Settlement Trends around Mutara

The main driving forces for the settlement trends over the years are lack of enough land/landlessness (90%) and frequent drought (10%). For example, 60% of the households were within the swamp and they do not have land outside the wetland. There are various types of land tenure with about 35% of the land in the study area being recognized as trust land; 35% is settlement schemes and 30% is referred to as family land/inherited. The land holdings within the swamp vary from household to household with the smallest parcel being 0.25 acre while the biggest is 12 acres but on average about 65% of the households interviewed have up to 3 acres. In Mutara swamp all the new settlers have settled in the year 2000s with most coming in 2009/10 (75%) this may be attributed to the post election violence.

Crop farming is practised by all of the respondents on varying levels of proportions with the wetland being ideal because of water availability and fertile soils. The three main crops grown in Mutara are maize, beans and cabbages. About 95% of the respondents indicated that they undertake irrigation in their farms. The type of irrigation in Mutara is flooding and open canal (100%). However, crop production exhibit perceived high dynamics over the decades with crop production dropping during the last 30 years. Use of fertiliser and manure is relatively high with 95% of the respondents saying they add manure or fertilizer unlike in the other wetlands in the basin. Like in other wetlands within the basin, extension services around the wetland are extremely low with only 15% of the farmers having been visited by government extension services. Services offered include soil and water conservation (49%), general farming advice (17%), fertilizer application (17%) and use of chemicals/ crop protection (17%). Like in other wetlands within the Ewaso Basin brokers control over 80% of the sale of produce to the various markets, which include Mombasa, Nakuru and Nyahururu.

About 75% of the respondents say they experience crop damage by wildlife although damage varies based on crop type. Elephants seem to be the main menace in Mutara along with wild pigs. Thus, residents spend long hours guarding crops in their farms. The erection of electrified fence in parts of Laikipia has helped in reducing the long hours spent guarding crops.

Livestock rearing is also a major undertaking by farmers around Mutara swamp with about 95% of the respondents indicating involvement in livestock rearing. The types and numbers vary from household to household with cattle and sheep rearing taking the lead which is mainly done under free range system. Although a large proportion of the people engage in livestock rearing, there is very minimal land that is devoted to grazing. The dependence on the wetland is indicated by 100% of the respondents who say that the pasture in the wetland is adequate for the livestock, which is also shared with outsiders especially during the dry months.

The main source of household water in Mutara is the river with the amount of water consumed ranging between 60 – 100litres per day. However, the discharge of the two main rivers that is, Mutara and Suguroi (Thukuroi) has been reducing over time with the later almost disappearing in 2000s. At the same time high numbers of the local community approximately 95% practice rain water harvesting with the aim of minimising contaminated water. A large number of people approximately 80%

indicated that there are water related conflicts in Mutara such as between upstream – downstream conflict (94%) and water rationing complaints (6%) on availability. In Mutara, the most common and frequent human diseases among the households within the swamp include typhoid (31%), malaria (28%), common cold (8%) and Amoebiasis (6%), which are common in wet environment, related with poor sanitation facilities.

There are various sources of domestic energy around Mutara swamp with wood fuel and charcoal being the two major sources, which have moderate availability. They are sourced from different areas which include on farm (46%); buying from neighbours (32%) and unsettled land (22%). In spite of this dependence on fuel wood, about 75% of the respondents do not practise farm forestry with some few farmers planting grevillea and blue gum.

Several stakeholders are involved in issues affecting Mutara wetland with various roles and responsibilities. About 95% of the respondents say that there are set rules/ conditions on how to utilize Mutara swamp resources. These rules/ conditions include;

- Water rationing during dry season (54%)
- No irrigation during dry season (27%)

The farmers acknowledge having a Water River Users Association (WRUA) for Mutara River that was started in year 2006. The need of the River Water Users Association was to ensure that the Mutara River flowed all year around and also minimise water conflicts by ensuring equal sharing.

Proposed Management by community

- To have piped water projects for irrigation. These can be used by upstream farmers instead of depending always on the swamp area.
- Use of improved irrigation systems such as drip tapes and sprinklers and green houses.
- Planting of indigenous trees along the river bank
- Construction of dams and boreholes to be used by farmers in the drier parts for irrigation, domestic and livestock use.
- Government policies should be improved especially on water management, preservation and harvesting.
- Farmers should be encouraged to change their lifestyle and attitudes. To be engaged in other type of activities e.g. keeping dairy goats, cows, poultry so as to reduce pressure on use of river water. In addition introduce new projects like fish farming.
- Insecurity should be improved. This is the reason farmers are relying heavily on cultivation because their animals are usually stolen.
- Improve infrastructure which will improve the economic activities in the area e.g. electrification and transport system (roads) and water.
- Avail markets for the products from the area.
- Avail extension officers who would advice farmers on different aspects of wetland management and farming
- Loans should be available for the farmers, e.g. youth & women loans.
- Introduce agricultural home based industries and factories

14.0 Marura Wetland

Settlement around Marura swamp has been rising gradually from an initial settlement in 1950s of 5%, gradually rising from 1980s up to 1990s when incoming number started dropping (Fig. 7). The gradual rise over the decades might explain to some extent the rise in changes within the wetland. While this forms an important proxy for wetland utilisation pressure it might be critical to find out the form of pressure exerted on the wetland by the rising population density.

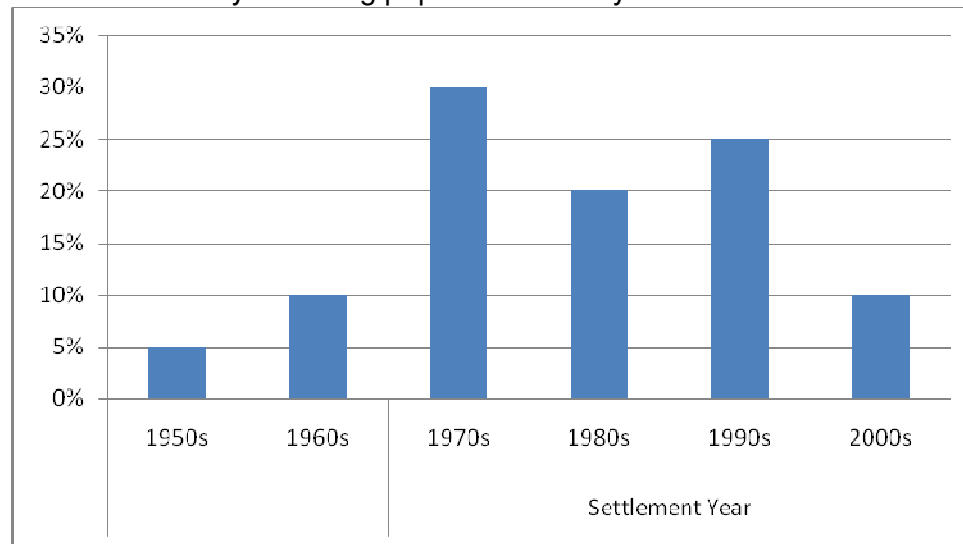


Figure 7: Settlement Trends around Marura Swamp

The main driving forces for the settlements trends over the years are several and summarised below. These include;

- Lack of enough land/landlessness (71%)
- Lack of employment (19%)
- Insecurity (5%)
- Transferred professionally (5%)

Settlement areas have varied over the years with some households being very near to the wetland boundary. For example, 56% of the households are within the wetland area. There are various types of land tenure systems with about 27% referred to as family land/inherited; 40% is settlement schemes; 10% is rented; and 5% is recognized as trust land. About 40% of the households interviewed have up to 3 acres; 50% have 3.5 - 4 acres and 10% have 6-10 acres. About 45% of the land was acquired through buying, 25% through inheritance, 20% of the land was given by the government/MP/DC and 10% through renting. In terms of the legal status, 95% of the respondents say they have title deeds with 5% having allotment letters for the land. Most of the respondents (65%) say they do not own land outside the wetland, which corresponds well with people who have settled in the swamp.

There were varied reasons for settling in the wetland with over 50% stating that alternative available land was a major driving force. These reasons area

- Land availability/ low land prices (55%)
- Water availability (25%)

Most of the new settlers have settled in the year 2000s with most coming in 2009 (67%) maybe due to the 2008 post election violence respectively.

Crop farming is practised by all the respondents on varying levels of proportions. The three main crops grown in Marura are maize, beans and Irish potatoes. Crop production has been deteriorating over time with the performance particularly bad for the crops in the last ten years. Most of the farming activities are under rainfed farming with about 65% of the respondents undertaking irrigation in their farms. The main type of irrigation around Marura is flooding (77%) and furrow (23%). All the respondents say they do not pay for the irrigation water. When planting all the respondents said they add manure or fertilizer. Extension services around the wetland are low to moderate with only 15% of the farmers having been visited by government extension services. Services offered by the extension officers mainly dwelt on livestock management. There are a number of challenges in crop farming around the wetland. About 80% of the respondents say they experience crop damage by wildlife although damage varies based on crop type. Some of the animals that are major menace include elephants, birds and gazelles. The main markets where these farms produce are sold included Karatina (24%), Nanyuki (24%), Naro moru (24%), Nairobi (16%), Nyeri (8%), Mombasa (2%) and Thika (2%). This is done to a large extent using brokers (45%) although there is also sale directly to the local communities/ neighbours (27%).

Livestock rearing is also a major undertaking by all farmers around Marura. The types and numbers vary from household to household with cattle and sheep rearing taking the lead which is done under free range system. About 80% of the respondents say the pasture in the swamp is adequate and they cope with the inadequacy by buying animal feeds such as hay (75%) and looking for pasture along the river banks (25%). Unlike in the other swamps within the Upper Ewaso Ng'iro basin, there are no outsiders who bring livestock for grazing in the swamp. Similarly brokers have an upper hand in sale of livestock and livestock products although at a lower level unlike western Laikipia.

The main source of household water in Marura is the river mentioned by all the households. River flow discharge has been declining overtime from a high of 1970s to low volumes in 2000s. Some of the domestic water problems that are experienced by local community include mainly contamination/ siltation/ pollution/ odour (48%). Approximately 95% of the respondents practice rain water harvesting so as to assess clean and safe domestic water and reduce workload of water fetching. In Marura, the common and frequent human diseases among the households within the swamp include malaria (38%), typhoid (18%), arthritis (12%), common cold (10%) and amoebiasis (6%), which are all wet environment related.

There are various sources of domestic energy around Marura swamp with wood fuel and charcoal being the two major sources, which have moderate to high availability. Sources of fuel wood are diverse and these include on farm (56%); buying from neighbours (25%); unsettled land (16%); and buying from the market (3%).

Several stakeholders are involved in issues affecting Marura swamp with various roles and responsibilities. About 80% of the respondents say that there are set rules

/ conditions on how to utilize Marura swamp resources. These rules/ conditions include;

- Water rationing during dry season (44%)
- No irrigation during the dry season (28%)
- Not to apply furrow irrigation (17%)
- No altering other peoples' pipes (5%)

About 30% of the respondents say there are conflicts between the users and the earlier mentioned stakeholders (managers of ecosystem). These are;

- Water usage (50%)
- Machine confiscation (33%)
- Law breaking (17%)

About 90% of the respondents say there are conflicts between the upstream and downstream users that are attributed to;

- Overuse of water by upstream users (89%)
- Conflict over insufficient water in dry seasons/ drought (11%)

The farmers acknowledged having a Water Users Association for Marura wetland called Burguret River Users Association (BRUA) which was started and registered in 1999. The association makes sure that the water is managed properly and water is not used for irrigation during drought so that the flow is constant and everybody and wild animals in Ol Pajeta ranch get water.

Impacts

Land portions in the swamp have been over-subdivided and given or rented to farmers from drier parts so that they can at least get some food through minimum irrigation.

Water levels were high in the streams and in the swamp in 1970s but this have changed due to clearing of reeds for irrigation and cultivation. The riparian and ecotone indigenous vegetation has also been cleared for settlement or farming. Water intakes upstream are so many and only little water is released downstream. Farmers have also planted a lot blue gum trees inside the swamp which consumes a lot of water.

Proposed Management by community

- To uproot all the blue gum trees in the swamp since they consume a lot of water and plant indigenous trees instead.
- The water intakes upstream the Burguret river are so many and they should be reduced since they take too much water outside the river which feeds the wetland. The water intake should also be regulated by the government.
- Government should introduce alternative projects which can profit farmers than irrigation of crop e.g. profitable uses of Marura (reeds) and fish farming.
- Construction of dams and boreholes to be used by farmers in the drier parts for irrigation, domestic and livestock use. Flood water during the rains can be stored for use during the dry period.

15.0 Upper Ewaso Ng'iro Basin Wetland Land Cover Changes

Land cover changes in the wetland have been dramatic with all the wetland having recorded at least 50% increase in built up / cultivated areas with the exception of Ol Bolossat, which has remarkably recovered from 1990s encroachment. This increase in human activities is confirmed by decreased sedges vegetation, which represented natural wetland ecosystem. These two land cover classes gives a good trend of the land cover changes in the wetlands within the basin especially when viewed between 1986 and 2010 (Fig. 8 and 12). A summary of these two wetland ecosystem land cover classes are presented below;

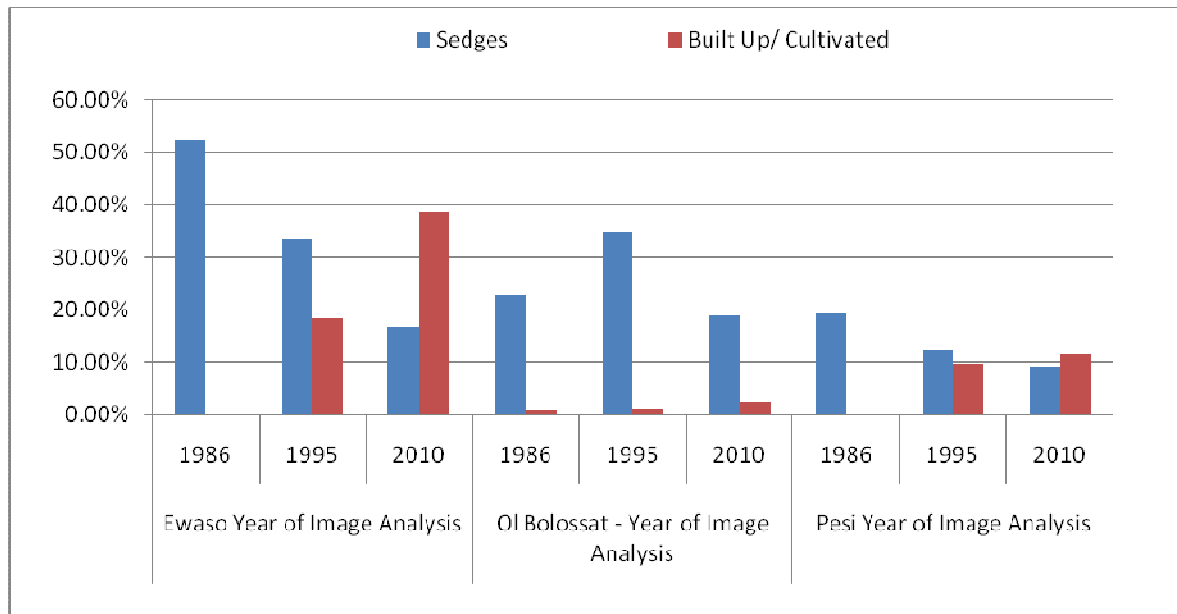


Figure 8: Land Cover Changes - sedges and Cultivated areas

Relatively more land cover changes were observed in Ewaso Narok particularly between 1995 and 2010, followed by Pesi (Fig. 9).

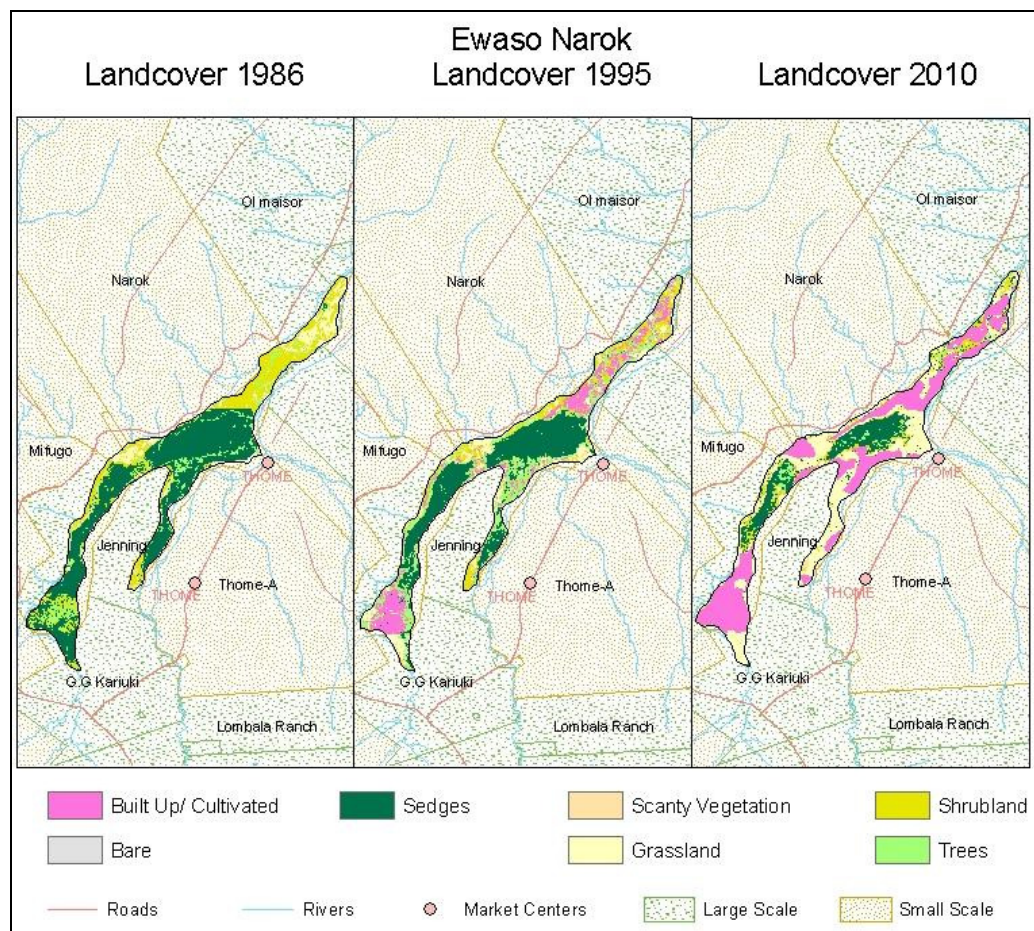


Figure 9: Ewaso Narok Classified Land Cover 1986, 1995 and 2010

The heightened conservation activities are visible with less human related cultivation but at the same time sedges have gone down. Ol Bolossat has huge grass coverage which has over time increased. At the same time open water has also increased which has contributed to reduced sedges coverage (Fig. 10).

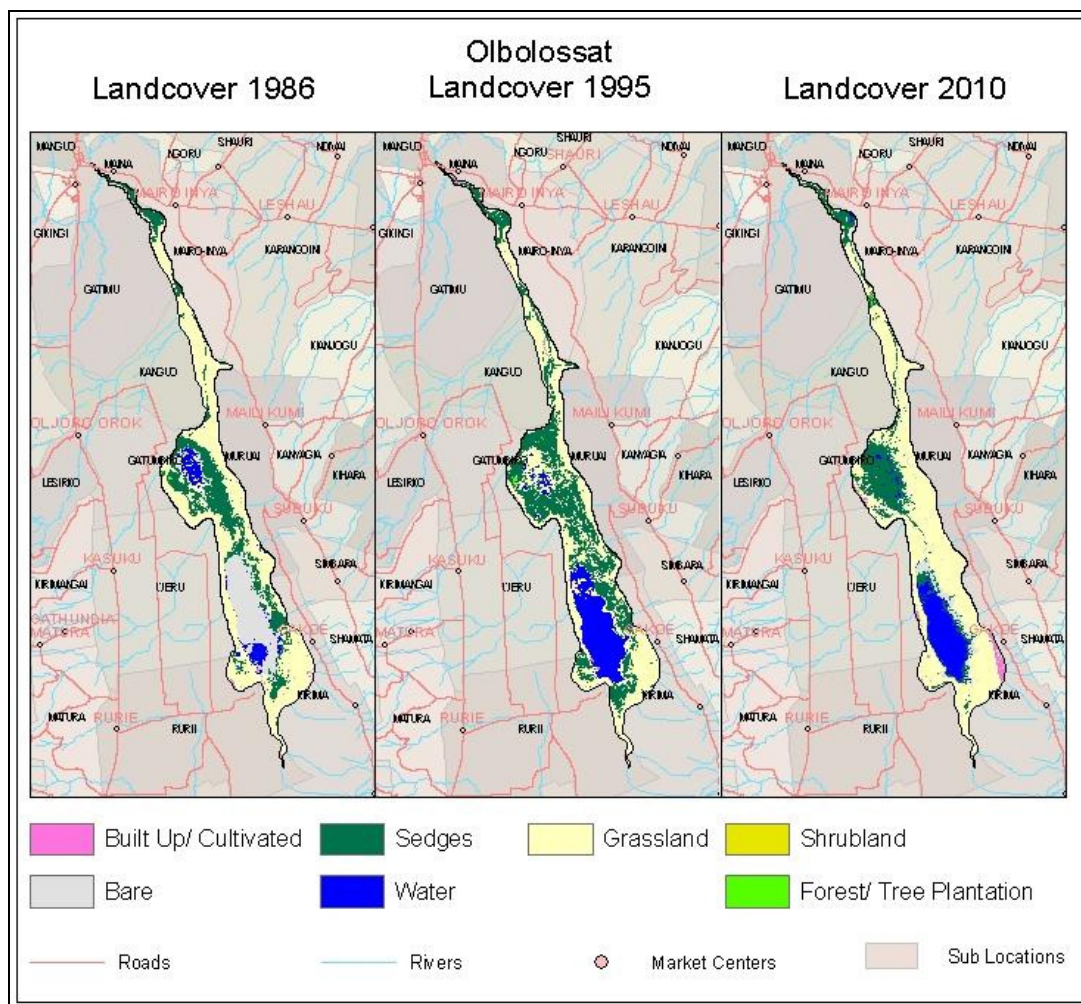


Figure 10: Ol Bolossat Classified Land Cover 1986, 1995 and 2010

Pesi like Ewaso Narok is characterised by high human settlement, which has been increasing over time. Like Ewaso Narok, Pesi also lacks any conservation status and has uncontrolled access to the wetland with provincial administration allocating land to individual who in turn extend to the wetland (Fig. 11).

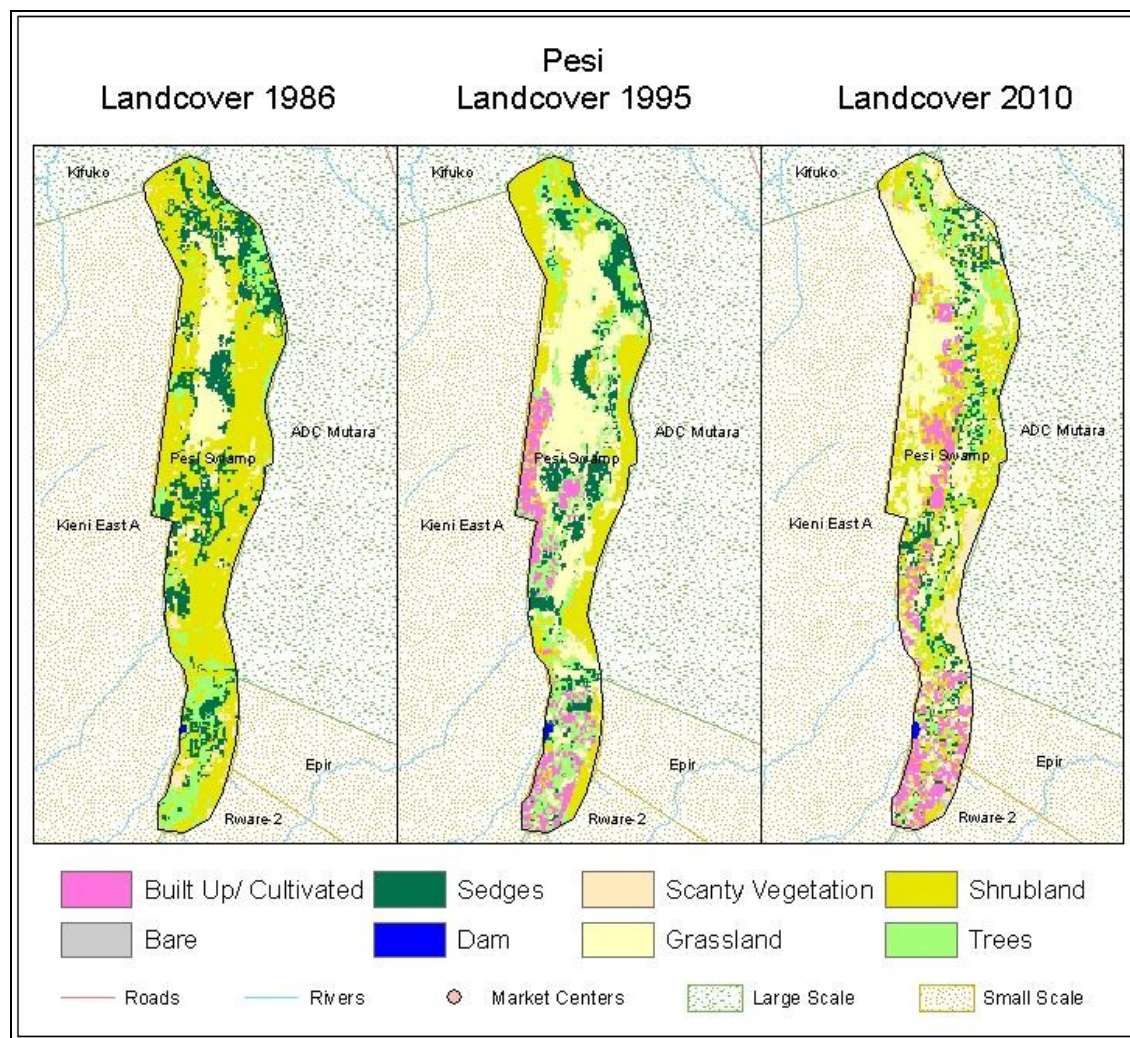


Figure 11: Pesi Classified Land Cover 1986, 1995 and 2010

The scenario in Lake Ol Bolossat, indicate the effect of intervention, which has contributed to low human encroachment and high recovery from disturbance in the 1990s. The slight increase of human activities within the wetland should be followed up and stopped at the earliest possible time.

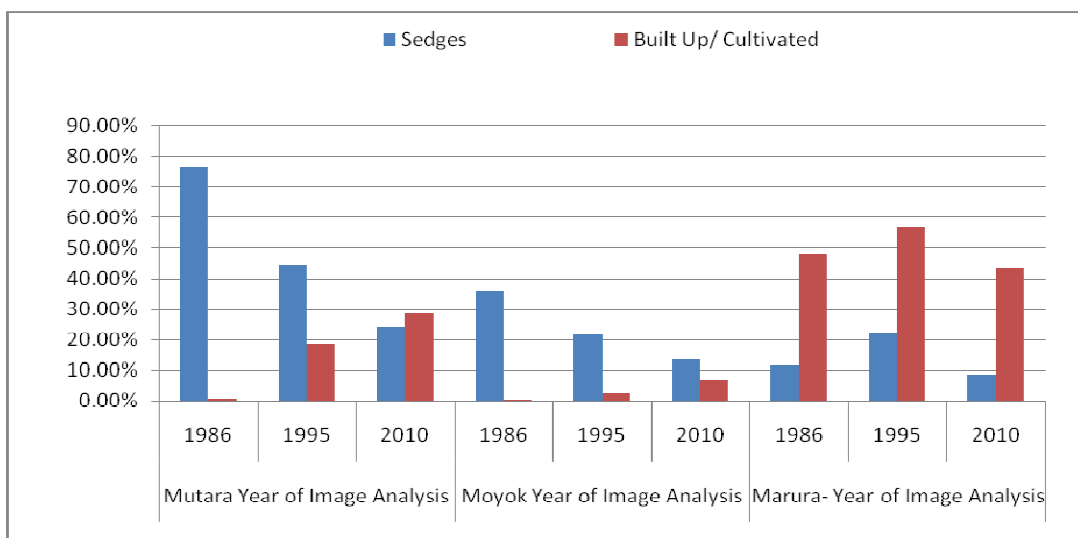


Figure 12: Land Cover changes- sedges-cultivated areas

The status and trends of the three other wetlands in the basin represent a scenario of no intervention. Marura wetland has a history of long human encroachment, having been allocated in the early 1970s as settlement area for a women group from central province (Fig. 13).

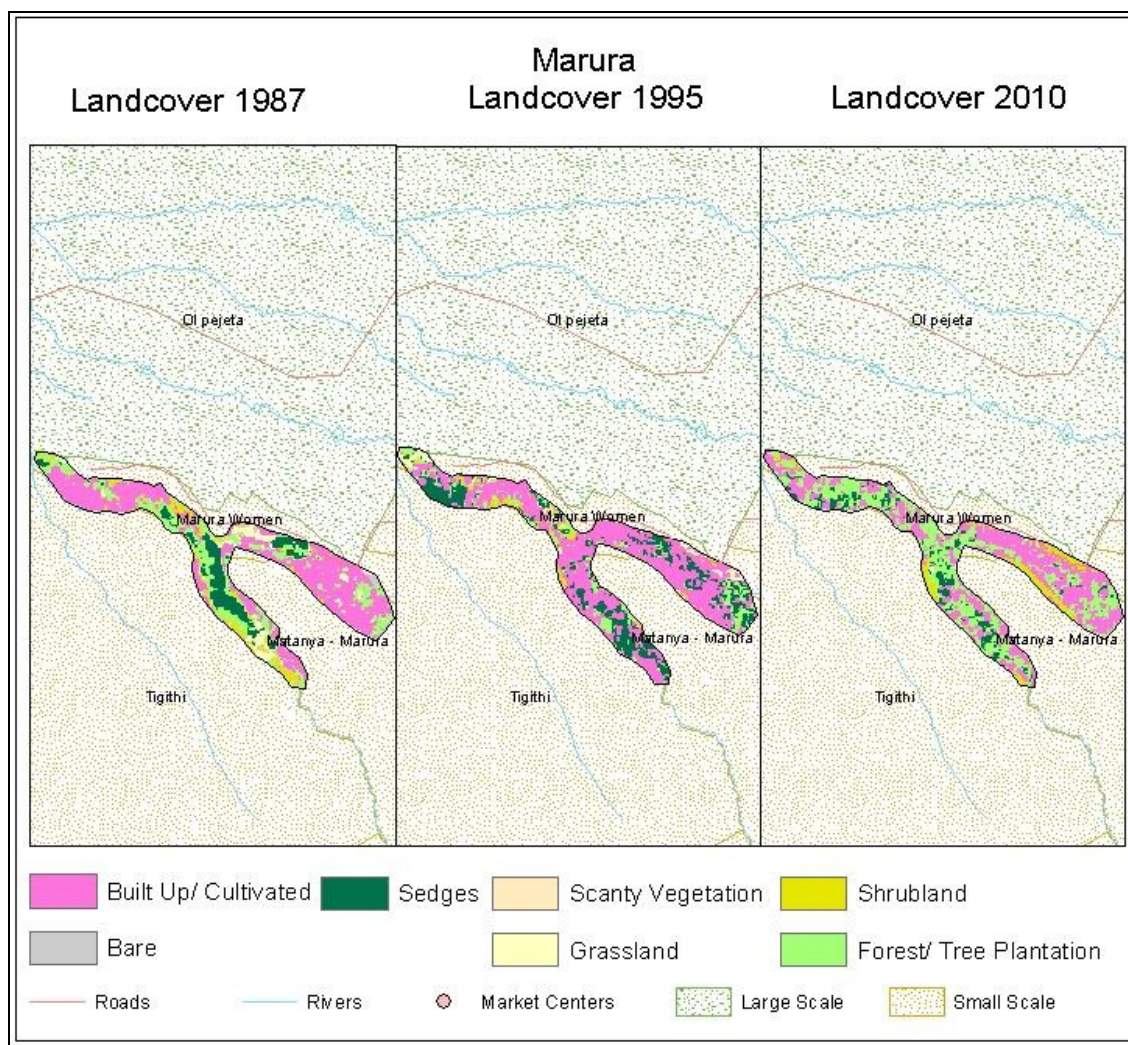


Figure 13: Marura Classified Land Cover 1987, 1995 and 2010

Over the years, the wetland has been almost completely drained except for river canal edge macrophytes mainly *C. dives* and *haploclada*. The other two wetlands that is Mutara and Moyok are of recent invasion and cultivation like in other parts of the basin is encouraged by the dry ecosystem (Fig. 14 and 15).

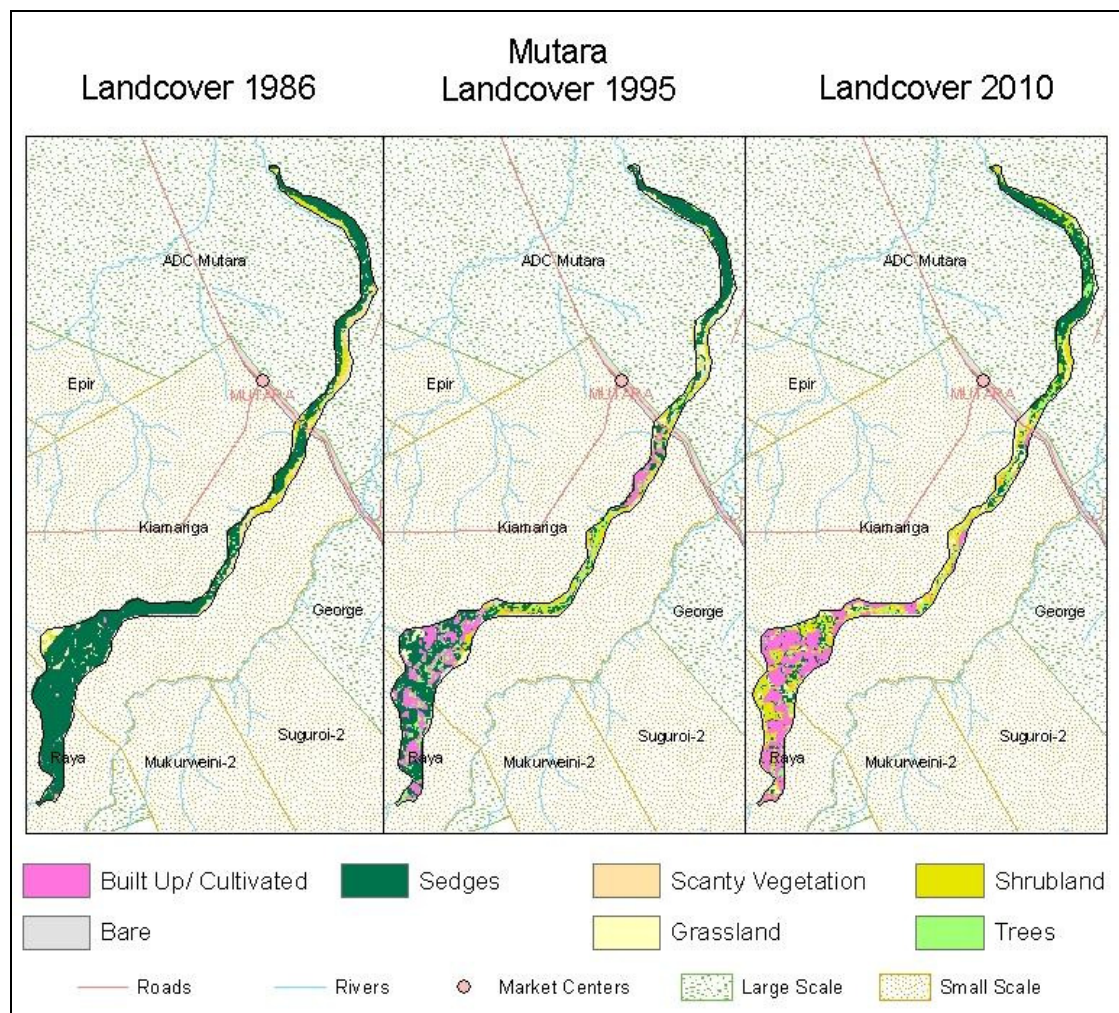


Figure 14: Mutara Land Cover Change - 1986, 1995 and 2010

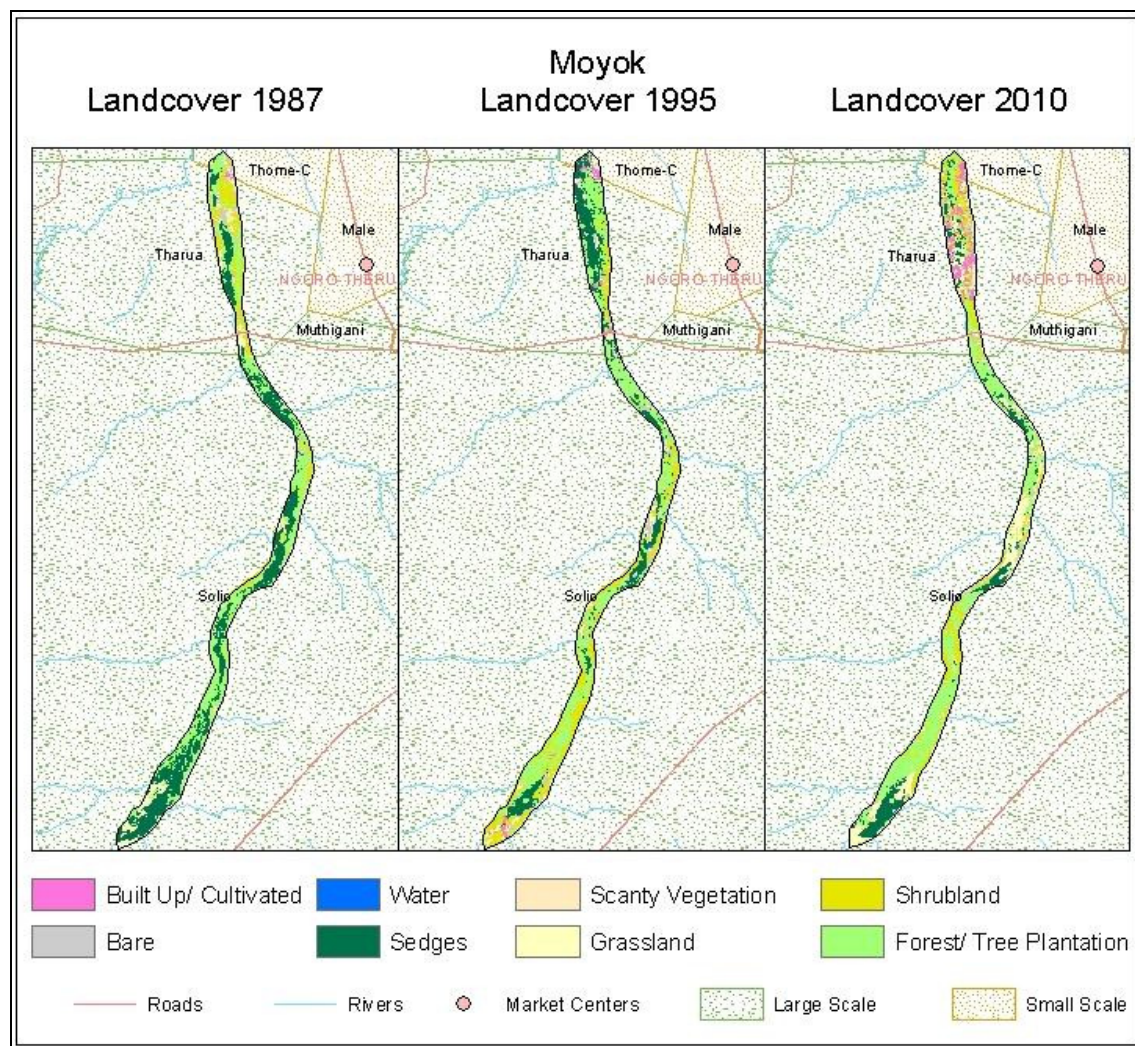


Figure 15: Moyok Classified Land Cover 1987, 1995 and 2010

At the same time, people were allocated land by the land buying companies thus providing justification for farming there. The three wetlands represent a scenario of no intervention, which provides ideal ground for draining the wetland. The real facts on the extent of the allocation can only be verified using survey maps for the wetland and land sub-division next to these swamps.

Due to the good catchment of all these wetlands in the basin, these wet ecosystems have good recovery during the wet season and with protection they can easily recover. However, the question of food security for the large people settled in the dry ecosystem raises important intervention questions. To achieve sustainable utilisation a balance between utilisation and conservation can be achieved through zoning of the ecosystem after development of management plan in a participatory way.

These changes have been accompanied by increase in tree cover mainly exotic, which reflects anthropogenic activities that have been on increase in the wetland ecosystem. The pressure to cultivate in the wetland have been due to the fact that the surrounding area is dry and people who bought land in the area that originally came from humid region transferred land use practice of cultivation to the wetland.

Ecological status of the wetlands

Wetland Vegetation

Vegetation composition in Upper Ewaso Ng'iro wetland basin wetlands vary but are mainly composed of extensive coverage of sedges mainly *C. dives* and *C. exaltatus* mixed with *Polygonum spp* *Ipomea* with *C. papyrus* and *Typha domingensis* in areas with open water especially along river canals. Several grass species are found especially along the edges and low water areas such as grass like *Echinochloa haploclada*, *Eragrostis*, *Cynodon paspalidium* and *Sporobolus helvolus* among others. While areas that have been converted for some time are covered by species like *Aschynomena schimperi*. The adjacent dry ecosystem area mainly covered by *Croton dichogamus*, *Chloris gayana*, *Cynodon dactylon*, *Aristida indigofera* and *Acacia seyal*.

Water characteristic exhibit strong geological influence with relatively higher alkalinity in upper catchment of Ol Bolossat with average pH of 7.68 and Ec in the range of 180-273uS. This reduces slightly downstream with pH moving towards acidity and with lower conductivity. However soil characteristics remains relatively the same with pH on average 6.5 and CEC of approximate 29 Cmol/Kg. These values are within tropical wetlands and previous studies which indicate the ecosystem ability to recover during the dry wet season like when this study was undertaken. (Thenya, 1998)

16.0 Wetland Impacts

Human activities have over time increased in the wetland, which has in turn contributed to several changes in wetland ecosystem. At the same time there has been minimal intervention with free access with the exception of Lake Ol Bolossat. The impacts on the wetlands can be divided into two, proximate effects and their underlying causes

Proximate effect

- There have been increased farming activities in all the wetland over the last 30 years starting with Marura, which has been occupied since the early 1970s
- Over 50% of the wetlands have been converted into farming area. Marura wetland the earliest occupied has been converted to almost 90% with only thin riverine macrophytes
- While cultivation and settlement areas have been increasing, areas occupied by macrophytes have been reducing at the same rate
- Increased horticultural activities have contributed to increase in irrigation activities (open canal and flooding) contributing to water flow reduction downstream
- Riparian trees such as *Acacia xanthophloea* Benth. have been cleared to provide building material and domestic energy
- The reduction in river flows can also be catchment degradation but the impact of just concluded Aberdare electric fence may positively improve river discharge
- Flood irrigation, is making the soil poorer within the irrigate dryland ecosystem by promoting salinisation
- Areas that have been cultivated indicated increased coverage of secondary vegetation such as *Aschynomena schimperi*

Underlying causes

- Increase in population number and density in the area has contributed to demand for farming land
- Lack of defined management system within the wetlands
- Land allocation by both government arms in adhoc manner in places like Ewaso Narok swamp
- Land buying companies have allocated land in wetlands in places like Pesi, Moyok and Mutara. In the last two title deeds have been issued to the land owners
- Adjacent ecosystem to the wetland too dry for rainfed farming and with land allocation by migrants being too small for livestock farming, the wetland provide the inevitable opportunity for farming.
- Livestock rearing promote insecurity from cattle rustlers thus only cultivation provided secure source of livelihood support
- Only a small percentage pay for water both irrigation and domestic use which contribute to high wastage especially during irrigation
- Rain water harvesting is done at a minimal scale and this has put a lot of pressure in abstracting from the rivers feeding the swamp hence contributing to decline

Ecosystem resilience and opportunities

- pH measurements and soil fertility indicate minimal or no change since the wetlands in the basin have good humid catchment that contribute to heavy flooding enabling ecological recovery
- all the wetland experience heavy flooding during the wet season that last for about 3-4 months

- with WRUAs function in some wetlands like Marura and Pesi this could provide entry point for organised utilisation
- Irrigation system can be improved and marketing of farm produce enhanced to reduce profit loss through brokerage
- Ol bolossat wetland has in the past exhibited changes attributed to human activities but there is visible ecosystem self recovery associated with initiatives such as the Aberdare fencing and lake Ol Bolossat management plan initiatives Again the limited irrigation practised through sprinkler system contribute to better water use

17.0 Scenarios for wetland resources management

The current problems facing the North Ewaso Ng'iro drainage wetlands can be viewed in three scenarios. These are;

- **a) Scenario ONE - no intervention at all;**

Considering the present situation if there is no deliberate intervention either from the community or local authority and in default central government these dryland swamp will eventually disappear. While Ol'Bolossat and Lorian may stay for some time but eventually disappear due to siltation, water abstraction and reduced water flow. Other swamps like Ewaso Narok, Pesi, Marura, Moyok, Mutara and Ngare Nything will gradually be turned into farming area and grassland areas.

- **b) Scenario TWO - total exclusion of people from the wetlands;**

This would involve the enforcement of the existing legal and institutional arrangement to all un-authorized persons. Implementation of this scenario would involve adequate resources allocation to all concerned government departments. While this may present a situation that gives hope to restoration of multiple uses in line with, "The Environmental Management and Co-ordination Act (Legal Notice No. 8 of 1999)." This will definitely prove a momentous task that may be very difficult to implement. Due to the duration, which the farmers have been in the swamp, they have come to identify themselves with the swamp; hence they will not take it very kindly. It will be a very unpopular decision considering that the adjacent area is too dry for any viable farming activities.

- **c) Scenario THREE - co-ordinated intervention of wetlands restoration and management;**

This would involve a joint venture between the local community and the authorities to reduce the threat facing respective wetlands. Considering the environmental condition and the changing landuse, the community would have to identify the benefit they draw from the wetland, while the government department give guidance on technical aspects like what area to be protected. The wetland could be zoned to allow multiple uses by different communities. Like a zone for controlled cultivation, grazing and total exclusion of human activities. This would also involve setting up of water abstraction quotas by the community with assistance of the water technical officer. This gives room for dialogue, community management and wetlands restoration.

18.0 Strategies for action

Community and Individual actions required: If realistic, cost effective utilization and conservation of wetlands natural resources is to be realized then community involvement is a must in the management and monitoring of the wetlands resources in the Upper Ewaso Ng'iro North drainage basin. This could be achieved through the following:

- Formation of Community-Based Organization (CBO) that could act as watchdogs over their resources as well as policing on each other and as a channel for building capacities for wetland conservation and management. Different interest groups like water abstraction, conservation and charcoal burning could be more effective in regulating natural resources use in the face of reducing government expenditure on such activities.
- Activities of such groups could encourage establishment of woodlots at individual farmers' plots to ease pressure on riverine wetland. Local education programmes on wetland management and resources facilitated by local NGOs. Encouragement of dryland irrigation using the wetland water so as to preserve the wetland in natural state for flood control and dry season grazing.
- Form a Joint committee of farmers and pastoralist to handle the issue of dry season grazing. Establishment of natural resource district committee comprised of all CBOs, NGOs, local authority, schools and all parties involved in natural use, planning or utilization would help to realize this dream of common resource use and minimize corruption. This could also act as the central regulatory body on issues concerning natural resources use, where all organization operating in the district would have a chance to share their ideas, plans and experience.

Technological: While the local community may have the will to utilize and conserve natural resources, in the area technical aspects could obviously limit their success. Between 1994 and 1995 the Arid and Semi-arid Lands (ASAL) Programme Laikipia received three proposals on wetland drainage and water supply. Although the proposal all written and submitted by local communities especially those on drainage targeted the wetland for farming activity solely, these could be adjusted to include aspects of biological conservation. These projects included Thome irrigation scheme received on 2nd December 1994; Ewaso Narok Proposed Drainage scheme received 19th June 1995; and Pesi irrigation water project received 24th June 1994. Some of these activities and adjustment may include;

- Better means of getting water to their farms from the rivers, wetlands or constructed dams. Water for irrigation is often limited during the dry season when the demand is high. This could enhance through construction of earth dams where machinery and technological input would obviously be necessary from either local NGOs or government departments.
- Advice on crops that can do well and boost food production in the area and help to diversify the crop variety hence reducing incidences crop failure.

- Give guidance in the zonation of wetlands for multiple uses, levels of water abstraction.

Legal and Institutional Support: There are a number of policy and legal measures that are used to promote biodiversity conservation at national and district levels in Kenya. For sometimes now these regulations have been scattered in various official documents and statements. These include development plans; sessional papers official economic survey papers, ministerial statements and presidential decrees, Water Acts, Fisheries, Wildlife Act among others. However, the recent “Environmental Management and Co-ordination Act, Legal Notice No. 8 of 1999” has helped to consolidate the various scattered regulation, which is easier for implementation. Part II - Management of wetlands and wetland resources clearly outline the legal action and processed to be followed. The Act further provides for development and management plans for the protection of wetlands.

As the community is encouraged to take charge of the resources it is necessary to have a backstop since not everyone is likely to comply with the community regulations. It is necessary to build the capacity of the community to take legal action on people going against the agreed procedure. NGOs, government department and other organization operating in the area should have the responsibility to educate the community on legal issue governing natural resource. To enable community empowerment, communities living adjacent to the wetlands should be encourage to establish wetland management committees in their respective wetlands and the involvement of all stakeholders in the area concerned. For effective resource use and conservation the local institutional support is necessary. Such institutions include government departments, provincial administration as well as local authority support from NGOs to local communities. The institutional support should go into facilitating and enabling the organization of the local community into groups that could assist in marketing their products so as to fetch better prices and improve their livelihood. This could also be in educating the community about alternative sources of livelihood like *bee keeping so as to ease pressure on the wetlands*. To assist in the integration of the management support of research that is geared towards natural resources use and management should get institutional support so as to generate the necessary data for experts in various fields of natural resources.

Policy: According to government development plans reclamation of wetlands has been floated previously as a way of boosting food supply in the district. While this in itself will result in increased farming activities and food at household level it will in no way translate to food sufficiency in the region since farming is at small scale level, which is geared towards survival rather than food sufficiency. Even those farmers engaged in horticultural farming making huge losses with brokers controlling more than 80% of the market access. This is also accompanied by crop destruction by wild animals, flooding during the wet season which is often heavy, pest, and poor extension services (Thenya, 1998).

The government lacks clear policy to guide resource use in dryland, which is currently threatened by landuse transformation due to the immigration of agrarian population into these dryland areas (Thenya, 1998). Vital common resources like wetlands should be protected from uncontrolled utilization, hence remaining

available both for people at local level and for national importance. The initial land allocation in settlement scheme was 35 acres both through government and land buying companies (Omoke, 1998). However, much of this has been reduced through sub-division to an average of 20 acres and this is bound to go lower (KFWG, 2000), but in the swamp area plots are at uneconomical size of one to two acres per household inadequate to contribute to food deficit in the district. Such sub-division should be restricted especially in dry areas to economically manageable units for agricultural purposes. While the force to utilize such resources look inevitable due to rising population, inadequate and adhoc enforcement, some of them should be conserved as a national policy for grazing and watering points in dry season, while enhancing the productivity of the drained ones (Thenya, 1999). Such a move should appear to take into consideration the downstream users, currently not considered especially in the face of water abstraction upstream. The most effective approach should ensure participatory resource planning and enforcement, which should be guided management plans currently absent in all wetlands in the basin apart from Ol Bolossat. Urgent steps should be taken to ensure effective formulation of management plans for these ecosystems.