

**Current Land use and trend analysis on the Tana River Delta Important Bird Area to evaluate on  
Bird Species, and Habitat Implications**



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Financial Support through the African Bird Club Conservation Grant to Joseph Mutahi Mwangi



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## **ABSTRACT**

Cases of deforestation in the Tana Delta have drawn significant concern due to the value of this forest resource, both ecologically and economically. The Tana Delta is one of Kenya's 60 IBAs and an important fisheries resource, providing a source of livelihood to a large proportion of neighboring communities. However, conflicting land uses has led detrimental land use types that threaten the resource. We used Landsat TM images to carry out visual analysis of land use systems between 1980 to 2012. A significant shift from traditional land use types (forests and grasslands) was observed, with most land changing to agriculture in the observed period. This has implications on the biodiversity of the resource, particularly migrant waterfowl. In order to mitigate the depletion of this and other vulnerable resources in Kenya, there is need for the country to implement relevant policies, resolve social strife and enforce legal instruments at the Tana Delta.

Key words: Deforestation, Remote Sensing, Visual Analysis, and Landsat.

## **INTRODUCTION**

The greater Tana River district of Coast province occupies an area of 38,782 Km<sup>2</sup> and has an estimated population of 232, 488 persons. It derives its name from the largest river in Kenya, which traverses the northern and eastern part of the district and drains into the Indian Ocean. Precipitation is low, bimodal and quite erratic, fluctuating between 300mm to 500mm annually. The extensive river delta created by Tana River as it enters the Indian Ocean presents great potential for agricultural development (Republic of Kenya, 2002a). The Delta, covering 130,000 hectares in total, is one of Kenya's largest and most important freshwater wetlands. It is a vast patchwork of habitats including savannah, forests, beaches, lakes, mangrove swamps, agricultural farms and the Tana River itself.

The delta supports uncounted plant and animal species and is home to endangered marine turtles, the Near Threatened restricted-range Malindi Pipit (*Anthus melindae*) and endangered Basra Reed Warbler (*Acrocephalus griseldis*) (Marsh, 1985). The wetlands, including the coastline and offshore islets, at times hold exceptional concentrations of water birds. Internationally important populations have been recorded here for no fewer than 22 species, making the delta one of the key sites in the country for waterbird conservation. The Tana delta also supports one of the very few breeding sites for colonial waterbirds in Kenya (Birdlife International, 2010) and other important and conservation sensitive flora and fauna (Ng'weno, 2008). Local people live by the seasons, adapting to the regular floods that keep the area fertile through the year. The site is under threat due to proposed agricultural conversion and thus the immediate

need to carry out research to counter this and propose ways of merging the desired development and conservation.

## **Goals and Objectives**

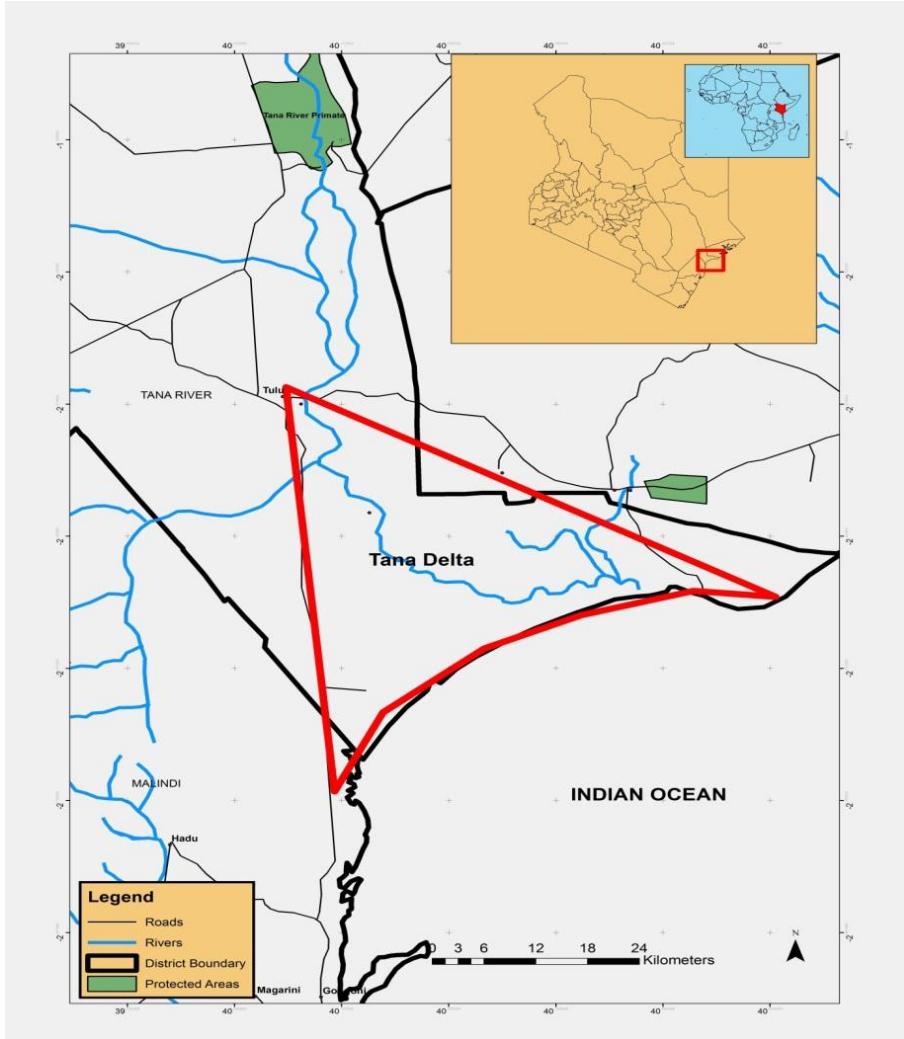
The project aims were to document current land use at the Tana River delta and monitor the rate of conversion through a thirty year time period. The project specific aims were:

- Quantify land cover change in a thirty years period at the Tana river delta
- Assessing land use dynamics and their implications to conservation of endangered fauna and flora
- Propose ecologically and economically compatible land use strategies that benefit the people's livelihoods and the ecosystem

## **METHODOLOGY**

### **Study Site**

The site is located at  $02^{\circ}30'S$ ,  $40^{\circ}20'E$  covering an area of 130,000ha at an altitude of 0-37m with its status being unprotected. The Tana River Delta is the name loosely given to the floodplain ecosystem of the lower Tana River, a vast wetland complex on the Kenyan coast. The Delta is roughly triangular in shape, with its apex at river Belisa (north of Garsen) and its base a 50 kilometers stretch of beach along Ungwana Bay, stretching from Kipini in the north-east to Mto Kilifi in the south-west (Birdlife, 2010). This low laying area is bounded by higher land to the east and west and to the south by a dune system bordering the Indian Ocean. It forms the interface between the ocean and the river, with fresh and blackish lakes and streams, fresh water and saline grasslands and wetlands, and successional stages of forest and woodland on the river banks and the dune ridges parallel to the shore (Robertson & Luke 1993).



**Figure 1: Map of the study area**

The expansive Tana Delta is located in Tana River District at the Kenyan coast (fig 1) characterized by wetlands, forests and grasslands. It provides grazing area during the dry season and is a tourist attraction. The district borders Lamu to the south east, Malindi to the southwest and Indian ocean to the south with a coastal strip of 35 km. The major physical feature an undulating plain interrupted in a few places by low hills. The district is generally sparsely populated mainly due to harsh climatic conditions like low and erratic rainfall and high temperatures with 5 person/km<sup>2</sup>. Rainfall is low, bimodal, and erratic with mean annual ranging between 300 to 500 mm. Long rains occur in the months of April and May while short rains occur in the months of October and November. The average annual temperatures are about 30°C and along the coast humid conditions are prevalent.

Over 100, 000 inhabitants use rely on the delta for their livelihoods (Kenya Population Census, 2009), from the Pokomo, Orma, Somali, Wardei and Wata communities. Communities rely on the delta for subsistence, including agricultural production, fishing and livestock keeping (Duvail et al., 2012) for subsistence.

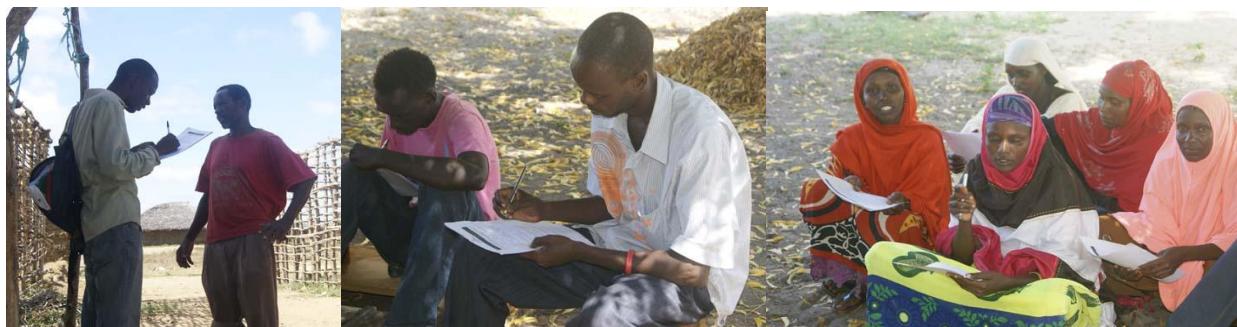
Despite the high productive potential of the delta, the region is among the poorest in Kenya, scoring poorly in poverty indices. Large irrigation schemes have been proposed and initiated in the area, which will deprive the local communities of essential land and water resources (Duvail et al., 2012). The area is also richly endowed with biodiversity (Hamerlynck et al., 2012).

The Tana River is approximately 1000 km flowing from Mount Kenya and the Aberdare Mountains to the Indian Ocean. Peak flows follow the bi-modal pattern of rainfall in Kenya, usually during the long and short rainy seasons. The mid and lower catchment of the river is largely semi-arid and the predominant livelihood type is livestock keeping. Subsistence farming is practiced along the river borders. Over the past fifty years, five major reservoirs have been built in the upper basins which have significantly modified the hydrological regime of the river, with a 20% decrease of the peak flow in May (Maingi and Marsh, 2002). Soils are characteristic of alluvial deposits from the river's hydrological processes. The main soil types are deep, well drained, dark brown and cracking vertisols and fluvisols 5 (Kenya Soil Survey, 1984a, b).

## DATA COLLECTION AND ANALYSIS

### Compatible and Potential Land Use Options

The study was carried out using a descriptive structured interviewer-administered questionnaire. Questionnaires sought to answer: what livelihood activities the community engaged in; the economic returns derived from these livelihood activities; the level of human-wildlife conflict in the area; indigenous conservation knowledge; and sustainable utilization options in existence.



**Figure 2:** Justus Ochon'g (first on the left picture) one of the research assistants during the study, guides the locals on how to fill the questionnaires during the data collection field work

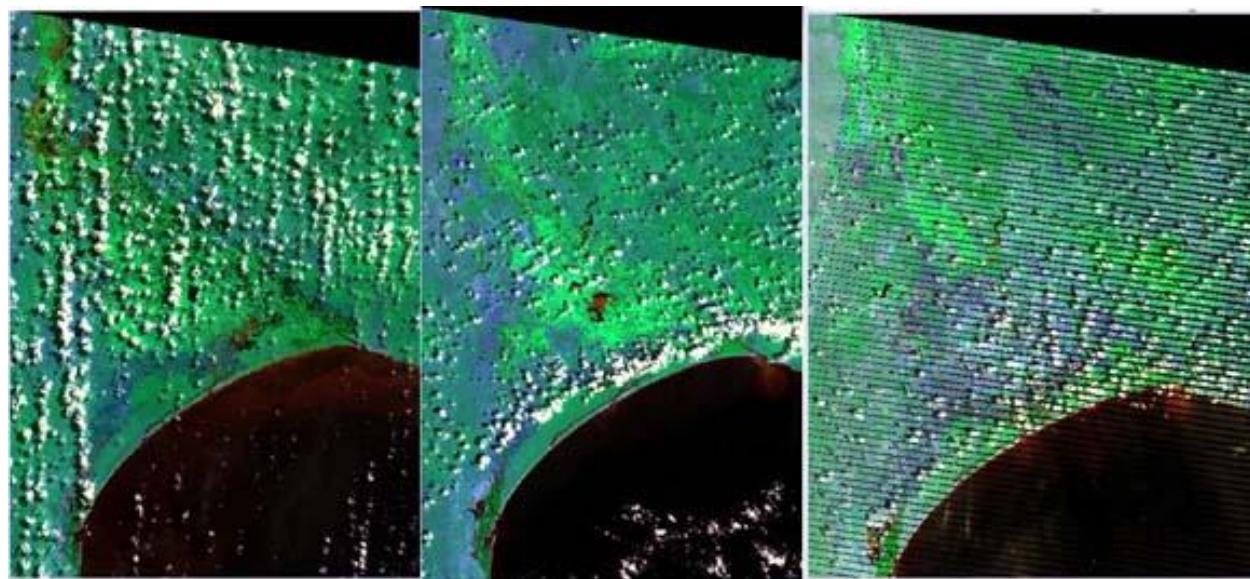
## Land use survey

Landsat satellite imagery for three epochs (1990, 2000 and 2011) were used in this analysis. False colour composites were created using bands 2, 3, and 4 for each of the three epochs. Using the 1990s image (geo-referenced in UTM projection, WGS84 ref. ellipsoid) as a base, the other image was registered to the base image using Idrisi's RESAMPLE module. Linear resampling was performed using 15 well defined and distributed control points. An Area of Interest (AOI) encompassing the entire delta was for each of the image sets.

## RESULTS

### Visual Analysis

Available image data had over 20% cloud cover, making it extremely difficult to achieve accurate classification. Acquisition of cloud-free Landsat data poses a difficulty due to the high humidity of coastal areas. In addition, the 2011 had an error due to stripping caused by a defect in the sensor. Therefore, a large proportion of the analysis relied on visual interpretation of the image data.



**Figure 3:** Landsat imagery used in the analysis (left to right, 1990, 2000 and 2011), showing a reduction in vegetation cover (from green to purple), suggesting an increase in human activities, largely farming and grazing.

NDVI differencing between 1990 and 2000 showed a negative mean (-5.447), which indicates an increase in biomass. However, the 1990 image had more cloud cover than the image of 2000, and might have implications on this result. Similar computations between the 2000 image and that of 2011 shows a positive mean (2.048), indicating a decrease in biomass within the period. We were not able to perform statistical cross tabulation due to cloud cover on the images to measure whether differences between time periods were significant.

## Questionnaire

A total of 85 questionnaires were administered and retrieved. Of the interviewed 52 were natives and 32 were residents who had settled there. All non natives who were interviewed had stayed in the delta more than 10 years. The respondents age bracket were 20 to 40 years (38), above 40 years (35), and less than 20 years (10). The higher majority had primary school education at 44, followed by 26 with secondary education, tertiary 7, adult education 2 and only two (2) had no formal education. Most of the people rely on the delta as farmers 56%, with only 20.7% in formal employment, 8.5% in business while 14.6% were unemployed.

Majority listed community as the owner of the delta at 62.9% while 28.4% said government and 8.8% said it was free access. Twenty five percent (25%) of those interviewed said they own land in the delta which they used mostly for farming (75.36%), followed by fishing rearing (10.14%), livestock keeping (8.7%) and other uses (5.80%). Most of the land owners indicated a high probability of changing their land use in future. The highest reason for the planned change was to increase productivity through improvement to modern mixed farming and adoption of technology. There was a high reporting of different conflicts within the delta attributed to land use. Conflicts between farmers and pastoralists were the most abundant (55%), human wildlife conflict (20%), internal conflicts (8%) with community conflict with government last (5%).



**Figure 4:** Most popular land use in the delta include livestock keeping, farming/irrigation, extraction of wetland materials for building and building of fishing boats

Major threats to the delta are human induced additively contributing to 61% of the threats and reflect intensive land use of the delta. Population increase (19%) is ranked as the major threat and can also be the key reason of the other threat identified i.e. overexploitation of resources (15%) cutting mangroves and trees (15%) and soil erosion (6). Other non-human induced threats to the delta are climate related (15%) in the form of drying of the delta, changing of the river course and unpredictable rainfall affecting annual cycles (fig 5).

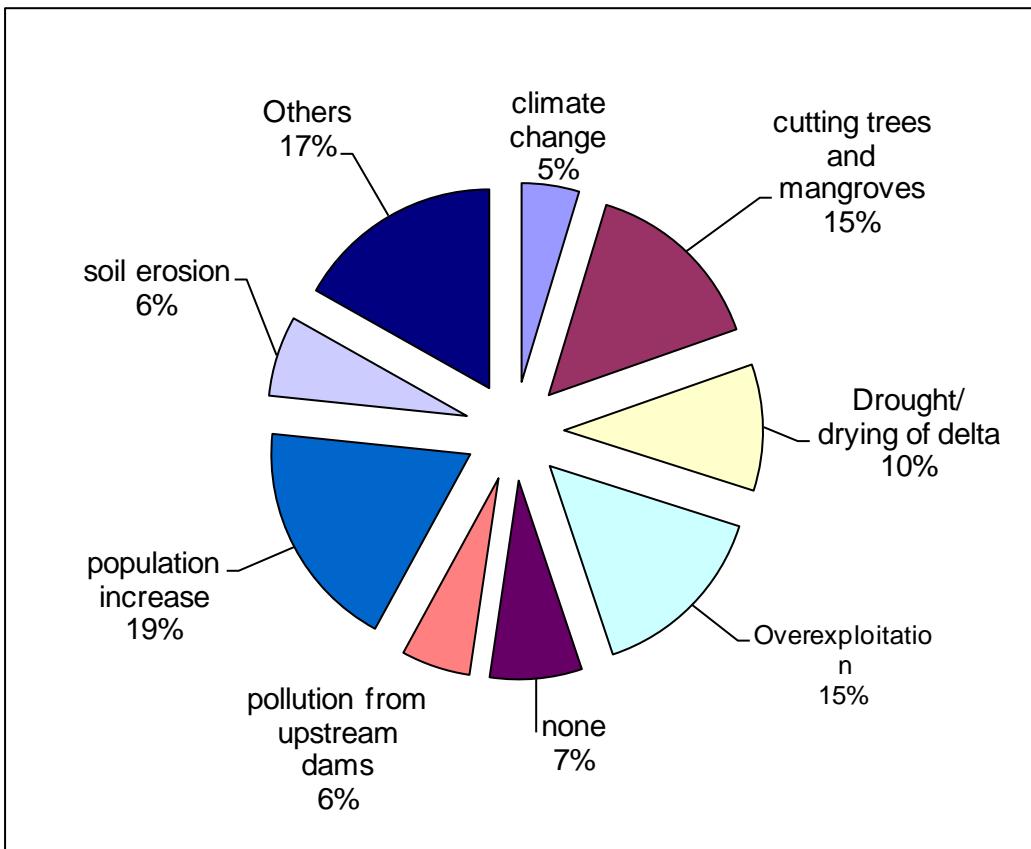
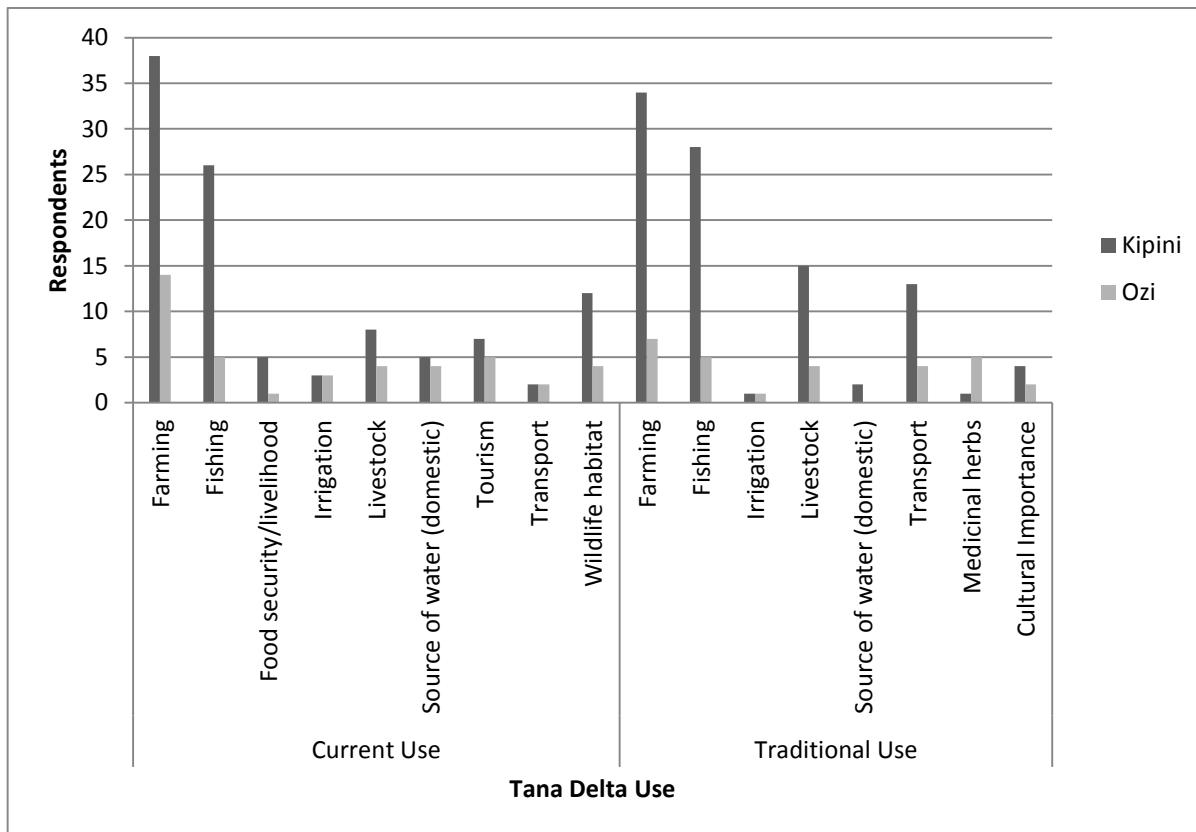


Figure 5: A pie-chart depicting the proportionate percentage threat of each category in the delta as listed by the local residents.



**Figure 6:** Changes in land use intensity and type between traditional use and current use showing an increase in farming and reduction of non-destructive land use types in both locations sampled at the Delta

## DISCUSSION

The study showed a shifting land use trend towards a more agricultural intensive livelihood in the delta. As observed in the shifting delta importance, there was complete disappearance of some delta use and reduction in others from the traditional use and the current use (fig 6). Of special note is the use of delta for medicinal herbs and cultural importance. All other uses have reduced with the exception of farming. Though the trends are not significantly high this reflects to some extent positive trends towards farming with time which is in agreement with land cover maps (fig 3). The additive reduction of fishing, transport and livestock (all less destructive than farming) reflects an increased threat to biodiversity. This trend may be attributed to increased population size and drying of the delta leading to overexploitation and clearing of trees and mangroves to create more land for farming as reflected in the threat pie chart (fig 5). The high level of land conversion to agriculture is a major threat to the conservation of the remarkable biodiversity of the Delta. This, together with the poor status of land protection, represents the major environmental problem facing this ecosystem. Land-use/land-cover changes and the associated habitat loss are a consequence of natural

and human driven processes and many studies indicate high rates of change associated to high human population growth rates, land-use intensification, and loss of natural habitat (Falcucci et. al. 2006).



**Figure 7:** The delta is an important migratory wetland and host large congregation of wetland birds and the endangered Basra Reed Warbler. From left top A-Mixture of Cattle, Yellow-billed and Great Egrets, B-migratory Carmine Bee-eater, C-migratory White-throated Bee-eater, D-Lilac-breasted Roller, E- Nightjar, F-Range restricted Malindi Pipit, G-Migratory Common Sandpiper and H- Double-toothed Barbet

Ownership of the delta was largely identified as belonging to the community during the survey making it imperative that the community get involved in the management and protection of the wetland. Though socio-economic developments are not usually factored in conservation oriented programmes, any conservation effort at the Tana delta should take socio-economic issues into account especially management related to biodiversity. This is largely due to the almost complete reliance on the delta for livelihood for majority of the locals. The community must however be examined in the context of development and conservation by focusing on the multiple interests and actors within communities, how these actors influence decision-making, and on the internal and external institutions that shape the decision-making process (Agrawal and Gibson, 1999). A high number of conservation group have multiple initiative geared towards conservation of the delta. However the fragmented and replication of effort lead to uncoordinated activities and thus poor efficiency of the efforts. One of the current avenues identified was a local site support group known as *Ozi site support group* (*Ozi SSG*). The group was started in 2009 by Nature Kenya and registered in the same year. It is an umbrella organization of 11 groups; Mulikani nyuki youth group, Mgomboni women group, Moto self-help group, Mafanikio women group, Tala giza women group, Shombe self-help group, Sin badi self-help group, Ozi forest conservation (afco), and Almuradi youth group. This community based organizations (though not all community groups present at the delta are listed above and more effort is needed to identify the others), these organizations can provide ideal entry point to initiate or compliment ongoing conservation initiatives.



**Figure 8:** Both the method of exploitation (left picture: wrong fishing method using mosquito net) and intensity of use (right picture: overharvesting of timber/mangroves) pose significant threats to the delta needing redress through community education on sustainable resource exploitation

The recent upgrading of the delta to a Ramsar site presents a first positive step in addressing these conservation challenges. As an international based agreement, this action will need national policies implemented and translated to action at the local level. Ongoing collaboration between county government , Non-governmental organizations ( e.g. Nature Kenya), research groups (e.g. KENWEB) national government institution (KWS, KFS, NEMA, NMK, Agriculture and Fisheries ministries) and other external stakeholders should adopt a more collaborative approach centered on community mobilization and empowerment to achieve the desired conservation outcomes.

## **CONCLUSION AND RECOMMENDATION**

Tana River Delta is an ecologically significant ecosystem while at the same time the major livelihood resource supporting the local people. This presents contrasting high priority opposing objectives for different stakeholders. However ecosystem integrity of the delta and continued sustainability of livelihoods can only be achieved through coordinated effort to create synergy and integrated management. The solution will lie in the concerted effort of all stakeholders and the support of the various government institutions to provide a working framework. Existence of community led conservation groups provides ample support of the willingness of the community to conservation oriented management. This will only be achieved and receive grassroots support if the community is involved from conception to implementation of the proposed interventions. There is however immediate need to address prevailing tribal conflicts resulting from different use and in particular farming and pastoralism's. There is also urgent need to conduct a large scale detailed rapid assessment on biodiversity to identify results of the land use changes to the delta.

## **ACKNOWLEDGEMENT**

I wish to sincere acknowledge the African Bird Club who provided the grant for carrying out these survey. I also wish to express sincere gratitude to the local community who were very welcoming and willingly took their time to answer the questionnaires. Special thanks go to the area administration and in particular the District officer and the area Chiefs for the administrative permission and for providing valuable advice during the survey. Last and not least I wish to thank Justus Ochon'g who assisted me during the data collection and Geoffrey Mwangi for help with the Landsat image analysis.

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