Biodiversity and Sustainable Management of a Tropical Wetland Lake Ecosystem:

A Case Study of Lake Kanyaboli, Kenya

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Abstract

Lake Kanyaboli and the surrounding Yala Swamp wetland have been recognized as an important biodiversity hotspot. Recent population, genetic and phylogenetic studies confirm the evolutionary importance of Lake Kanyaboli in preserving the *cichlid* fish fauna of Lake Victoria. The adjoining Yala Swamp harbours the endangered swamp antelope Sitatunga (*Tragecephalus spekii*) and several papyrus endemic birds. The lake and adjoining swamp play a critical role in the livelihood of the local communities who heavily depend on the wetland resources.

Current ongoing large scale land use and changes within the swamp threaten the ecological integrity and functioning of this highly dynamic wetland ecosystem. It is therefore imperative that proper management and conservation measures are put in place to protect Lake Kanyaboli and the associated Yala Swamp.

This paper presents a review of the biodiversity of Lake Kanyaboli and the associated wetland and the threats this ecosystem has to face. Polycultural *finger-ponds* aquaculture (see Figure 3), tourism and papyrus based industries as well as an all-stakeholders-driven management plan is suggested as a step towards achieving sustainable management, utilization and conservation of the Lake Kanyaboli ecosystem.

Key words: Biodiversity, Conservation, Lake Management, Lake Kanyaboli, Land use changes, Yala Swamp.

Introduction

Most developing countries depend heavily on the exploitation of its natural-, especially biological resources. Most of these resources are found among very poor rural communities whose livelihood depends solely on the exploitation of these resources. Sustainable conservation and development depend heavily on strengthening the capacity of local individuals and communities to implement conservation initiatives (IUCN, 1996).

The Yala Swamp Wetland, located along the North-Western shores of Lake Victoria is one of the most extensive freshwater wetlands in Kenya. The wetland supports a large human population that derives its income directly from activities like fishing, hunting, construction material production and agricultural production. These economic activities, if not carried out sustainable, can lead to the destruction of the wetland. Therefore, the Yala Swamp Wetland is important as a source of livelihood to the local community; as a potential area which's agro–industrial exploitation could lead to increased national food production; and as an important biodiversity hot spot. How to reconcile and harmonize these three apparently conflicting interests, is a big challenge to the management of the wetland.

Currently, a large scale reclamation venture that will reclaim up to 40% of the swamp, mostly around Lake Kanyaboli is underway. The short and long term ecological and socio–economic costs of such an undertaking will be enormous. This paper presents suggestions for sustainable utilization, management and conservation of Lake Kanyaboli and the adjacent wetland.

Ecology and Biodiversity of Lake Kanyaboli and the Associated Swamp

The Yala Swamp is Kenya's largest freshwater wetland habitat (Otieno, 2004). The wetland covers 17,500 hectares along the North-Eastern shore of Lake Victoria in Siaya, Bondo and Busia districts in Kenya (Figure 1).

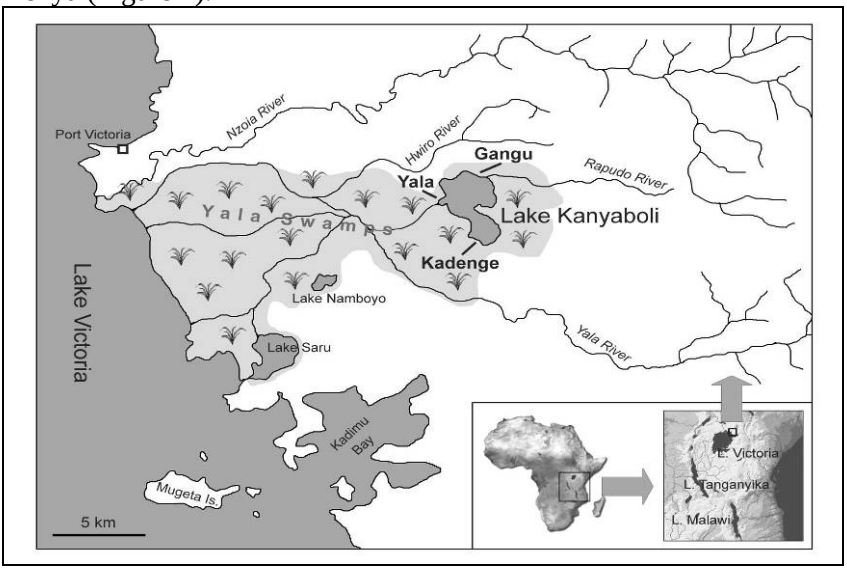

Figure 1: Map of Yala Swamp showing the position of Lake Kanyaboli and other associated lakes (*Crafter, 1992*).

Three sizeable peripheral lakes Kanyaboli (10.5 km^2), Nyamboyo, (2.0 km^2) and Sare (5.0 km^2) lie within the boundaries of the Yala Swamp as do at least a dozen other smaller bodies of water (Otieno, 2004). Lake Kanyaboli is the largest and most economically and ecologically important. A thick fringe of papyrus (*Cyperus papyrus)* completely surrounds the lake (Figure 2).

Figure 2: Part of the shore of Lake Kanyaboli. Note the dense papyrus fringed littoral zone. The lake is completely surrounded by such dense papyrus vegetation.

Lake Kanyaboli is of great conservational interest. The lake contains relic populations of *cichlids* that have been severely reduced and are almost extinct in Lake Victoria. Viable populations of the native Lake Victoria tilapias *Oreochromis esculentus* and *Oreochromis variabilis* that have virtually been eliminated from Lake Victoria due to Nile perch predation occur in Lake Kanyaboli. Secondly, Lake Kanyaboli acts as refuge for the following haplochromine species: *Lipochromis maxilaris*, *Astatotilapia nubila*, *Astatotilapia bigeye* (Kaufman), *Pseudocranilabrus multicolor victoriae*, *Xystichromis phytophagus* and *Astatoreochromis alluaiudi*. *L. maxilaris* and *X. phytophagus* are critically endangered haplochromines (IUCN, 2002). A recent molecular phylogenetic study uncovered a very high genetic variation in the Lake Kanyaboli haplochromines (Abila, 2004). This illustrates that Lake Kanyaboli can act as a 'genetic reservoir' for Lake Victoria's species flock. The fish fauna found in Lake Kanyaboli furthermore includes *O. niloticus*, *O. leucostictus*, *T. zilli*, *Clarias mossambicus*, *Protopterus aethipicus* and *Xenoclarias sp*. (Aloo, 2003). The adjoining Yala Swamp forms an important habitat to the

endangered Sitatunga (*Tragecephalus spekeii*) and the following bird species: the Blue Breasted Bee Eater, the Papyrus Gonolek, the Swamp Flycatcher, the Papyrus Canary, the White Winged Warbler, the Great Snapper and the Baillor's Crane.

Patterns of Utilization of the Wetland Resources

The major economic activities in Lake Kanyaboli and associated wetlands include the following:

Fisheries

In Lake Kanyaboli, the main method of exploitation is the use of *gill nets*. Other methods of fishing include the use of long lines, and, in areas bordering Lake Victoria, *seine nets*. Fish is the most important wetland product, and 98 – 100% of the residents are dependent on the fishing either commercially and/or for subsistence (Abila, 2002 and 2003). The average income per day per fisher ranges between 140 – 150 Kenyan shillings per day (approx. $1.8) (Abila, 2002 and Abila, 2003, see Table 1).

Table 1: Patterns of exploitation of the Yala Swamp Wetland (*Abila, 2002*) - * Subsistence

ACTIVITY	**% People involved**	**Mean monthly income (Ksh.)**
Grazing	49.3	*
Hunting	11.2	150, *
Fishing	80.6	5015, *
Fuel wood	66.2	984, *
Papyrus exploitation	21.0	1000, *
Agriculture	89.5	1263, *
Salt lick	35.0	*
Water for domestic use	97.0	*
Transport	70.0	3000
Brick making	5.6	2000
Papyrus building mat.	28.0	2100

Grazing

Gazing is carried out in the swamp, which is a free access property thus grazing is not controlled. The wetland is particularly important for grazing during droughts. A special kind of clay containing minerals required by animals and found only at particular spots is used by cattle as a salt lick.

Agriculture

Agriculture is the second most important activity after fishing. Agriculture takes place on privately owned farms, based on traditional methods of land cultivation, with little use of fertilizer or biocides.

Mats 'Industry'

Papyrus reeds are also used as a raw material to make a variety of products. Mats are used as bedding materials or drying surfaces. They can also be useful substitutes for roof ceiling materials. Papyrus is also used to make chairs.

Current Threats to the Biodiversity of Lake Kanyaboli and the Associated Yala Swamp

One of the major threats Lake Kanyaboli currently faces is over exploitation of its fish resources especially the cichlids. It is currently estimated that there are over 65 fishing boats in Lake Kanyaboli (Abila, 2003). This has exerted considerable pressure on the lake. The majority of fishermen use gill nets of between 1 - 2 inch mesh sizes. The result has been a rapid decline in the size of fish landed. The current fishing pressure in Lake Kanyaboli is certainly not sustainable.

Secondly, the on going swamp reclamation and conversion pose several environmental and socio-economic problems. The most immediate effect of reclamation is habitat loss and associated cascading environmental effects. Apart from directly destroying the habitats of the various swamp organisms, removal of swamp vegetation will result into several negative effects on the limnology of Lake Kanyaboli. The wetland has been shown to play an important role in the reduction of sediment loads and nutrients (Okungu and Sangale, 2003). The buffering effects of the swamp would be greatly reduced by the removal of the swamp vegetation. Excessive nutrient

and biocide loading to Lake Kanyaboli would greatly affect the water quality and functioning of the lake's ecosystem. In a nutshell, the environmental effects of swamp conversion will be wetland degradation, water quality change and pollution and biodiversity loss.

Socio–economically, conversion of the wetland will end the socio–economic activities of the local communities. A critical examination of the Environment Impact Assessment study carried out by the project developers reveals that issues associated with wetland conversion have not been adequately addressed.

Future outlook: Towards Sustainable Utilization, Conservation and Management of Lake Kanyaboli and Associated Wetland

The foregoing demonstrates that like most tropical wetlands, the Yala Swamp Wetland is important for its biodiversity and is of great socio-economic value to the local community. Long lasting sustainable utilization, conservation and management of this resource therefore hinges on addressing the seemingly conflicting demands of biodiversity conservation, community utilization and agro industrial development. The high economic potential of the Yala Swamp Wetland, the wetland being non-protected area and the lack of a proper wetland policy makes the Yala Swamp a vulnerable ecosystem.

While reclamation has received immense political support, past studies indicate that this has been a source of conflict with the local communities. Conversion of the wetland, while it may give short term gains, will lead to long term economic, social and environmental problems such as inflated costs and reduction of yields after irreversible soil fertility exhaustion. Evidence on the ground indicates that other problems associated with conversion such as resettlement, compensation, sedimentation, eutrophication and habitat loss have not been adequately addressed in the on going Yala Swamp irrigation development scheme.

In order to maintain the ecological integrity and environmental functioning of the Lake Kanyaboli Yala Swamp Wetland, the following alternative sustainable methods of wetland utilization should be pursued and if possible improved.

Papyrus based industry

This could involve formation of groups to make mats, baskets, seats etc. NGOs and development partners could be consulted to give technical assistance geared towards improving and diversifying the papyrus products and to explore better marketing strategies. Developments of papyrus based industry have been attempted in the Nyando Wetland of Lake Victoria, Kenya (Raburu, 2004).

Aquaculture

Aquaculture could be development through adopting the 'finger pond' techniques developed by Denny and Turyatunga (1992) for the Ugandan Lake Victoria Wetlands. This involves cutting wide channels into the swamp at right angles to the shore. The soil removed from the channels would be heaped between the channels to form raised beds (see Figure 3).

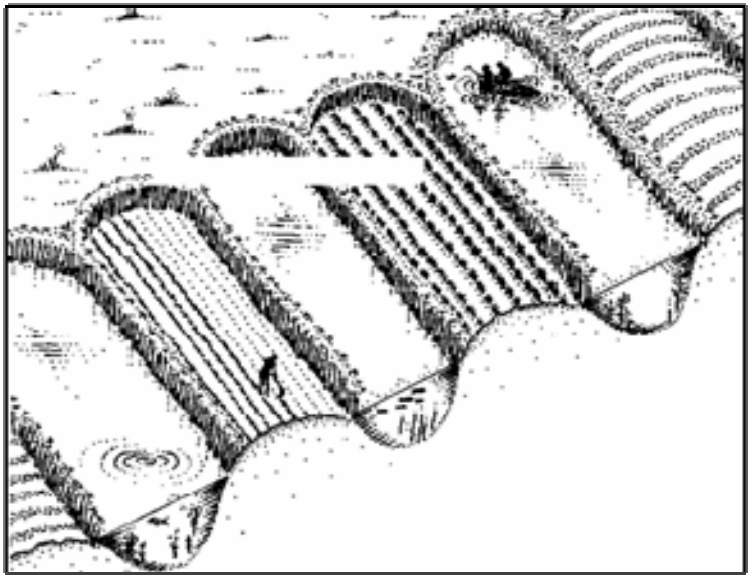

Figure 3: A proposed scheme for development of swamp fringes with finger-ponds. The fishponds will be based on polycultural management whilst raised mounds between the ponds will provide for horticultural cultivation (Denny/ Turyatunga, 1992).

These channels could be used to raise *Clarias, Oreochromis niloticus* and the two native *Oreochromis* species. The fringe of the ponds could be used to cultivate papyrus or for horticulture. Fish culture would be based on polycultural techniques successfully used in South East Asia and now being developed in Africa. This technique is currently being tried in the Ugandan wetlands (Ssanyu, 2004). Aquaculture development would greatly reduce pressure on Lake Kanyaboli.

Tourism

Tourism is the least developed activity at present. Potential tourist attractions include bird watching, sport fishing and boating. Further income could be obtained by charging the tourists visiting the wetland. The wetland could be promoted as a locally controlled, people–centred tourist destination and be included in Kenya's 'western circuit'.

Finally, the success of an integrated natural resource management depends on developing and implementing a comprehensive management plan drawn up by all the stakeholders. A major drawback to wetland conservation in Kenya has been the lack of clear policies guiding utilization. It is therefore important that the various stakeholders to Yala Swamp wetland be identified and their needs assessed. Such a management plan would identify the various interest group needs and will spell out how the resources will be utilized to ensure sustainability and minimize resource access and use conflict.

Acknowledgements

I am grateful to the organizers of the summer school 2005 for inviting me to participate in the 2005 edition and to DAAD, Nairobi for facilitating my participation.

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