

Management Challenges of Freshwater Fisheries in Africa

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1. Economic and Geographic Setting of the Lakes

1.1. Economic Setting of the Lakes

Many African countries are among the poorest in the world and as a result, the development objective of most African countries is to reduce or even eradicate poverty through modernising agricultural production including fisheries. In countries around Lake Victoria, fisheries contribute 3-5% of GDP. Fisheries also contribute significantly to export earnings of a number of African countries. On a global scale, the values of lakes are similar. However, the relative importance of the values (e.g. fisheries, recreation, water abstraction) varies from one region to another. In Uganda, fish exports are among the two most important export commodities. The inland fisheries production grew from 250,000t in 1950 to 2,000,000t by 1999 (Geheb & Sarch, 2002) representing about 50% of total catches from Africa (FAO, 2000). The other avenues of Agricultural production are crop agriculture, livestock and forestry.

1.2. Background to the African freshwater lakes

Africa is rich in freshwater systems comprising natural lakes, man-made lakes or reservoirs and rivers (**Figs 1 & 2**). The major lakes include in alphabetical order Albert, Bangwuelu, Chad, Chilwa, Edward, George, Kivu, Kyoga, Malawi (Nyasa), Mweru, Tanganyika, Turkana, and Victoria. The major manmade lakes include: Cahora Bassa, Kariba, Kainji, Nasser-Nubia and Volta. The larger natural lakes of the rift valley include Albert, Edward, George, Kivu, Tanganyika and Turkana (**Fig. 2**). In addition the rift valley has a number of smaller lakes including Baringo, Bagotia, Nakuru, Naivasha, Magadi, Natron, and Manyara. The African Lakes include Victoria which is the second largest lake in the world, Lake Tanganyika which is the second deepest lake in the world, Lake Malawi (Nyasa), Lake Turkana, Lake Albert, Lake Kyoga, Lake Kivu. Other smaller lakes such George, Nakuru, Naivasha have been useful in understanding the production processes in African lakes.

The African lakes such as the Rift valley are amongst the oldest on earth (e.g. Lake Tanganyika: 2-20m years BP) but are sensitive to climatic and physico-chemical changes. For example, Lake Victoria is reported to have dried up about 12,500 years ago (Kendall, 1969; Johnson *et al*, 1996) while 6000 years ago Lake Chad was 20 times larger and its maximum depth was 154m compared with about 4m today (ILEC, 2003). As recent as the 1960s, the environments (particularly water level) of Lakes Victoria, Kyoga, Tanganyika and

Malawi have changed in response to el-nino rains, and in case of the shallower Lake Victoria, the chemical composition of the water.

The African lakes contribute significantly to poverty reduction and food security. They are a source of dietary proteins and water, they provide revenue through fish harvest, export and tourism, and are used as avenues for transport. The lakes also provide water for irrigation, agriculture and hydropower projects. Lakes Malawi, Tanganyika and Victoria harbour diverse endemic fish fauna of ecological and scientific importance. During this century, African lakes have experienced declines in fish catches, reduction in fish species diversity and deterioration in water quality. Much effort has already been put in mitigating these threats but there is still need to strengthen these efforts.

1.3. Biophysical Features of African Lakes

The lakes covered in this study (Victoria, Tanganyika, Malawi, Chad, Baringo, Naivasha and Nakuru) provide a representative sample of African lakes that can be used to analyze the challenges facing African freshwater systems, the interventions undertaken to manage the challenges, the inputs that have been required and the lessons learnt to guide further actions. The lakes vary considerably in the geographic and biophysical characteristics. The larger ones (>1000 km²) are shared by at least two countries. Lakes Malawi, Tanganyika and Victoria are among the “Great Lakes of the World” on account of their size unique biodiversity, and high population densities in their catchments. Lake Tanganyika and Malawi differ from Lake Victoria in terms of depth, volume and residence time with Lake Victoria being the shallowest of the three and having the shortest (23 years) residence time.

Three of the lakes (Victoria, Malawi, Tanganyika) have received GEF and other support over the last decade; Lake Chad had UNDP support while the other lakes have been supported mostly through bilateral arrangements. Irrespective of source of support, the main objectives of such support have included mixtures of biodiversity and environmental conservation, fisheries management, water resources, planning, development and assessments. As a result, the project support has had a multiplicity of government-driven machinery in form of different Ministries for water resources, environment, fisheries, agriculture, energy development, etc.

1.3. 1. Lake Victoria

Lake Victoria is a large lake (68,800 km²) second only to Lake Superior in the world; has a long shoreline of 3450 km; a large catchment area of 193,000 km², a mean depth of 40 m and maximum depth of 80 m. The lake is shared by Kenya (6%), Uganda (43%) and Tanzania (51%). The Lake basin is estimated to have a population of 30 m people which is growing at > 3% per annum. Lake Victoria had a native fishery of tilapiine species which collapsed. Lake Victoria supports the most productive freshwater fishery in the world with annual fish yields in excess of 500,000 tons worth USD 600 million annually. The lake’s fisheries are dominated by two introduced species Nile perch *Lates niloticus* and Nile tilapia *Oreochromis niloticus* and one native cyprinid *Rastrineobola argentea*. Nile perch is the basis of a lucrative export industry supporting about 30 fish processing factories in the three countries. Other economic activities in the lake basin include agriculture, floriculture, hydropower generation and transport. Three major cities (Kampala, Kisumu and Mwanza)

with a combined population of at least six million people depend on the lake for domestic and municipal water supply and waste disposal. Recent data shows that the lake is eutrophied.

1.3.2. Lake Tanganyika

Lake Tanganyika is second largest in Africa and the second deepest in the world. 11 million people live in the Lake Tanganyika watershed which spread across four countries (Burundi, Democratic Republic of Congo - DRC, Tanzania, Zambia). Up to one million people live in the immediate vicinity of the lake with two major cities (Buyimbwa and Kigoma). The lake supplies 25-40% of animal protein (fish) for the communities around it. It is a transport link between the riparian countries. 95% of total fish catch from Lake Tanganyika comprise of two small endemic pelagic (dagaa and Kumpu) clupeid species (*Stolothrissa tanganicee*) and *Limnothrissa ruiodon*) respectively (Deelstra, *et al* 1994). The third important species in the catch is the predatory *Luciolates stepperssi* (mukeke). The annual fish yield of 118,000t is dominated by the Tanganyika sardine (*Stolothrissa tanganikae*). Other economic activities in the drainage basin include agriculture, (maize, cotton, tobacco, sisal, coffee), livestock and mining (tin, copper, coal).

1.3.3. Lake Nakuru

Lake Nakuru has a surface area of 40km², catchment of 1800km² with a population of about 400,000 estimated to grow at 10% per annum. 98% of Nakuru's population depends on agriculture. 50% of urban farmers draw water for irrigation from the lake. Lake Nakuru National Park is a major tourist destination and a Ramsar site because of its bird populations comprising mainly of Flamingoes.

1.3.4. Lake Chad

The Lake Chad basin of 967,000km² supports a population of 22m people in four countries (Cameroon, Chad, Niger, Nigeria). The lake has a fishery that is over-exploited, a center of cross boarder trade, a pastoral area, with irrigation dams and mining operations. 6000 years ago, Lake Chad (area 1600 km²) was 20 times larger (about half the present size of Lake Victoria) and had a maximum depth of 154m, compared with 4 m today. The Lake Chad Basin Commission (LCBC) established in 1964 is working to establish a monitoring and water management systems under a Watershed Action Plan. Conservation plans include designation of Ramsar site and biodiversity priority status. However, due to large-scale deforestation and changes in rainfall, large number of people and their livestock are migrating.

1.3.5. Lake Malawi

Lake Malawi has a surface area of 25,000km² and a catchment 97,500km². The lake is shared between Tanzania, Mozambique and Malawi. The lake is a source of fish for food and water for domestic use, irrigation and hydro-electricity. The lake has high fish species diversity. Annual fish yield declined from 21,000t in 1971 to 9000t in 1983. The narrow 1.0 to 2.5 km wide coastal zone from the shoreline has a wide range of activities including fishing settlements, towns, transport, tourism, and recreation: the lake has a National Park. A Lake Management Plan has been drawn up and is being partially implemented. Lake Malawi

National Park has been designated a Natural World Heritage Site. Traditional fishing methods are regulated, and in some areas of the lake, fish habitats are protected.

1.3.6. Lake Baringo

Lake Baringo has a surface area of 150km², an average depth of 6.0m and a catchment of 6820 km². Up to 10,000 people depend on the fishery of the lake comprising Tilapia, *Protopterus* and *Clarias*. Fishery yield dropped from 240 tons in mid 1970s to 14 tons by 1995. The number of fisherfolk reduced from 4600 to 200. About 220,000 people living around the lake depend on it for employment, water for irrigation, agriculture and tourism. Has four inflowing rivers but no outflow although suspected to have an underground outlet. The lake has symptoms of eutrophication with frequent algal bloom and low secchi depth.

1.3.7. Lake Kariba

Lake Kariba (5,364km²) is one of the largest man-made lakes in the world. The lake is located along the Zimbabwe/Zambia border. The primary use of the lake is to generate hydroelectricity for the two countries. The lake was created by a dam constructed on the Zambezi River in the 1950s. About 55% of the lake area lies within Zimbabwe and 45% in Zambia. The Zambezi River contributes about 70% of the inflow. The lake has two distinct fisheries: the artisanal and the semi-industrial. The artisanal fishery which targets 15 out of 50 species in the lake is conducted nearer to the shoreline in areas not more than 20m deep (Geheb & Sarch, 2002). About 10,000t of *Kapenta* is harvested annually. In recent years, Tilapia cage culture has been introduced. Other economic activities include agriculture and tourism.

1.3.8 Lake Naivasha

Unlike most of other small Rift Valley Lakes, Naivasha is a freshwater lake. It has a surface area of 100km². The lake provides drinking water for approximately 250,000 people (50,000 in 1977) within its (5km) urban centers such as Nakuru and Naivasha towns. Tourism accounts for at least 50% the area's GDP besides the lake is Ramsar Site. The fishery (Tilapia, Bass) provides food and income (as a sport fishery) while lake water is used for irrigation in floriculture.

1.4. Key Questions

For all their fisheries potential as a dominant economic good, the degradation of the lakes through population expansion, over-fishing, agricultural production with irrigation water, biodiversity loss and pollution are among the major but diverse challenges that have arisen. What then are the management challenges of the fisheries of the different lakes?

How have they come about? How have they been handled?

What lesson have we learnt from the different efforts, and how can these lessons guide further action?

How has GEF support contributed to resolving the challenges?

2. The History of Degradation of the Lake Resources

2.1. Introduction

Ecosystem changes in most of the lakes apart from Lakes Victoria, Tanganyika and Malawi are not well documented because basic data linking biological production to water quality and hydrological variability had not been acquired or is not well documented. For the fisheries, it is uncertain during which periods year-class strengths had translated into catch variability and what the root causes had been. In addition, the transformation of the fisheries through species introductions was partly affected by fishing pressure and water quality deterioration.

Degradation of fisheries and the lake resources normally starts with over-population followed by over-exploitation of the resources, which leads to a decline in fish stocks. This can be followed by introduction of new fish species to improve catches (Ogutu-Ohwayo & Hecky 1997). Increase in human and livestock population increases pressure on land, which increases waste production, and contamination of aquatic systems, loss of the fish habitat and fisheries. If these factors are not controlled, they can lead to total loss and abandonment of the fishery. Many of the freshwater fisheries resources and the fish habitats of African freshwaters are at different levels of resource and environmental degradation and some could diminish if no interventions are made. The major challenges to fisheries resources in Africa include: High populations in Lake basins; Unsustainable fishing practices; Species introductions; Loss of aquatic biodiversity; Pollution and eutrophication; Invasive weeds; Inadequate policy and legal regimes; Inadequate institutions, institutional mechanisms and governance including stakeholder commitment and participation; and Inadequate and unsustainable funding mechanisms.

2.2. Population Growth in the lake basins

Population growth is one of the main challenges to management of the fisheries resources of African lakes. The rate of population growth in the countries in the Great Lakes region is between 3 to 4% compared to about 0.5% in many developed countries. In addition, the population of livestock around the lakes is similar to that of humans (Bootsma and Hecky 1993). High human population enhances fishing pressure and increases the demand for agricultural and domestic water supply and discharge of wastes. The high human and livestock population accelerates rates of deforestation, erosion, sedimentation, siltation and nutrient loading into the lakes, which degrade the fish habitats (Hecky 1993, Bootsma & Hecky 1993). The high human and livestock population is thought to have contributed to the deterioration of Lake Baringo (Odhiambo and Gichuki, 2000). Human and livestock population growth need to be contained within the carrying capacity of the lake basins.

2.3. Unsustainable fishing practices

One of the key challenges to the fisheries of most freshwater fisheries in Africa has been how to sustainably manage the fisheries resources. The fisheries policy of most government in Africa is to ensure increased and sustainable fish production and utilization to reduce poverty. Unfortunately, most fisheries in Africa have declined and others completely collapsed. Fishing effort on most of the African lakes was originally low due the low number of fishermen, poor fishing crafts, inefficient traditional fishing gear and limited markets.

Fishing effort on virtually all the lakes has increased with increase in human population, improvement in fishing crafts to types that can move faster and venture further offshore, introduction of more efficient and in some cases destructive fishing gears and methods and expansion of markets with improvement in communication. The decline in the fish stocks on some of the lakes has been attributed to: excessive fishing effort; use of destructive fishing gears and methods; capture of immature fish; weak management and extension systems; inefficient packaging and dissemination of management information; outdated fisheries laws and regulations; inadequate capacity to enforce laws and regulations and limited commitment and involvement of stakeholders in management of fisheries resources and the fish habitats. On Lake Victoria, the fishing effort in the Uganda part of the lake increased from 3200 canoes in 1972 to 8,674 canoes in 1990 to 15,452 canoes in the year 2000. Destructive fishing gears including gillnets of mesh sizes which can catch immature fish were encountered during a frame survey of the lake in the year 2000. Although there have been efforts to eliminate the destructive fishing gears and methods, the number of fishing canoes on the lake has continued to increase and policies still emphasize increased fish production. As the fisheries are still open access, this needs to be controlled through restrictive measures while urgent steps are taken to address employment options. The over-fishing and fishing malpractices as a result of unemployment has to be addressed not only from a population pressure point of view but also based on alternative livelihood strategies away from fishing.

2.4. Fish species introductions

Fish species introductions have been used to enhance fish production of lakes whose fisheries have collapsed or to create a fishery in a lake where no such fishery existed as in the Lake Kariba. Such introductions have had both positive and negative consequences. Lake Victoria and Lake Kariba provide some of the best examples of utilisation of fish species introductions in management of fisheries resources. Nile perch and four tilapia species were introduced into Lake Victoria and in two other lakes (Kyoga and Nabugabo) to improve the fisheries that had declined due to over-fishing. The Lake Tanganyika clupeids, *Limnothrissa miodon* and *Stolothrissa tanganyicae* were introduced into Lake Kariba in 1967 and 1968 (Balon 1974, Marshall 1988) to create an open water fishery of a man-made lake. Fish have also been introduced in Lakes Naivasha, Baringo and Nakuru. There were also proposals to introduce other fishes in Lake Malawi. In Lake Victoria fish catches increased about six times following establishment of Nile perch and this created a lucrative fish processing and export industry that increased from zero prior to establishment of Nile perch to US\$ 600 million annually. The introduction of the clupeids in Lake Kariba resulted in an increase in the quantity of fish landed from 1000 tons in 1974 to 24,000 tons by 1985 (Marshall 1988). Unfortunately, the establishment of Nile perch in Lake Victoria was accompanied by a decline and in some cases total disappearance of most of the native fish species. Stocks of haplochromines which were the most abundant fish in Lake Victoria and formed 80% of the fish stocks (Kudhongania & Cordone 1974, Okaromon *et al* 1985) comprising of over 500 species (Seahausen, 1996) declined and 60% of the species are feared to have become extinct due to predation by Nile perch (Witte *et al* 1992a, b). Introduction of the clupeid in Lake Malawi was opposed and abandoned on the ground that its impacts on the complex fish fauna of the lake could not be predicted. The challenge that has faces the fisheries managers on Lake Victoria is how to sustainably manage the lucrative fishery that emerged out of the Nile perch introduction, and how to restore and conserve stocks of those species affected by Nile perch introduction.

2.5. Loss of Aquatic Biodiversity

African Lakes especially Victoria, Malawi and Tanganyika are very rich in aquatic biodiversity and most species are endemic to specific catchments. Introduction of exotic fish species as in the case discussed above and loss in fish habits due to habitat degradation have affected aquatic biodiversity. It is now recognised that fish introductions can have positive and negative effects. The conflict between using lakes for biodiversity conservation as in Lake Malawi or fish production as in the case of Lake Victoria needs to be resolved especially in Africa where poverty eradication, export earnings and the need for dietary protein are priorities for the riparian countries. However, it is important to recognise that biodiversity integrity is the basis of sustainable biological production and therefore fishery potential and should be protected.

Apart from awareness campaigns, there is need to protect endangered fish species as is the case for some wildlife and to apply indigenous knowledge and community participation. Biodiversity conservation in African lakes is thus a local, national and global issue.

2.6. Pollution and Eutrophication

Until recently, management of the lake environment was not considered to be an important component of fisheries management. Changes in physical, chemical and biological processes in Lake Victoria over the last three decades (Talling, 1966; Hecky, 1993; Mugidde, 1993) show that physical, chemical and biological factors of the lake effect fisheries and the functioning of the whole aquatic ecosystem. In Lake Victoria, the algal biomass increased four times, phytoplankton production doubled, the algal community changed from dominance of diatoms to blue green algae as the concentration of phosphorus doubled and that of silicon concentration decreased ten times (Mugidde, 1993; Hecky, 1993). These changes were accompanied by a four times decrease in water transparency, a decrease in oxygen concentration in the hypolimnion during the period of stratification and elevation of the anoxic layer in the water column leading to loss in fish habitat. The invertebrate community changed from a dominance of calanoid to cyclopoid copepods and the benthic invertebrate community to *Caridina nilotica*. Since these changes, the fish communities have become dominated by Nile tilapia which can ingest the blue greens, Nile perch which feeds on *Caridina* and *Rastrineobola argentea* which feeds on zooplankton and insects. The increase in eutrophication in Lake Victoria has been attributed to nutrient enrichment from human activities in the catchment areas, industrial and domestic sewage inputs and from combustion processes (Hecky 1993, Bootsma & Hecky 1993). Since fish production and sustainability depend on the health of the fish habitat, there is need to consider management of pollution and eutrophication along fisheries management. However, since the bulk of P input is of atmospheric origin, there is also need to consider not only direct water discharges into the lake but the diffuse sources of catchment origin by incorporating sustainable land especially wetland use practices into lake management.

2.7. Sedimentation

Another factor that has contributed to loss in fish habitat, fisheries and biodiversity is sedimentation. In the 1970s, the mean depth of Lake Baringo was 5.6m but currently, the total depth of the lake has been reduced from 8.9m in the 1970s to less than 1.9m by 2003 due to growing human and livestock population accompanied by deforestation. Of the seven

rivers that were flowing into the lake in 1970s only one river currently flows into the lake. Sedimentation has resulted into a loss of many fish species such as *Labeo* that contributed to the livelihood of local people. On Lake Tanganyika sedimentation reduced the diversity of invertebrate and fish fauna (Cohen *et al*, 1993). Sedimentation is primarily caused by inappropriate land use practices especially on sloping land.

2.8. Invasive weeds

Major challenge to fisheries managers of African lakes has been the invasion of the lakes by aquatic weeds, the most outstanding being invasion of water hyacinth (*Eichhornia crassipes*) in East Africa since the 1980s. Water hyacinth has invaded many lakes in Africa including Lake Naivasha in 1988, and Lake Victoria in 1990 (Harley 1991, Twongo 1996) and has been reported in other lakes and rivers systems including River Shire which connects to Lake Malawi (Tweddle 1992). Water hyacinth covers shallow sheltered bays which are the most suitable breeding and nursery grounds for fish. The weed impedes boat traffic, blocks irrigation channels, interferes with hydropower generation and water treatment plants. The areas below water hyacinth are devoid of oxygen which reduces fish breeding and nursery grounds. The appearance and proliferation of water hyacinth has been associated with nutrient enrichment of the water bodies and its control should include reduction in nutrient inputs. Other weeds such as *Salvinia mollesta* invaded Lake Kariba in 1970s and Lake Naivasha in 1980s. Certain alien aquatic plants including *Pistia stratiotes* (Nile cabbage) *Azolla filiculoides* and *Myriophyllum aquaticum* have the potential to bloom explosively and become weeds especially when the nutrient regimes in the lakes change.

2.9. Lake and Drainage Basin Resource Use Conflicts

A number of economic activities in the catchment area of the lakes including crop agriculture, livestock, urban development, utilization of wetland resources and mining affect the health of the fish habitat and have to be considered in lake management planning. Increasing human populations and increasing food demands lead to intensive farming practices that require more water, use fertilizers and pesticides. In addition, forested catchments and lakeshore wetlands are cleaned and drained to create more farmland. Around Lake Victoria, 80% of the population are involved in agriculture, and in most parts of the catchment, deforestation is extensive and soil erosion is a serious problem (Crisman *et al*, 2003). Increased runoff washes silt and agrochemicals into the lakes. In Lake Victoria, the increase in nutrient (N & P) which have altered in water quality (Hecky, 1993) are thought to originate from the catchment.

High densities of livestock (cattle, goats, sheep including wild animals) are characteristic of lake drainage basins. In the southern part of the Lake Victoria basin pastoralism is the main economic activity. Both wildlife and livestock put enormous pressure on the rangelands increasing problems of soil erosion and silting. In the Chad basin, large numbers of people and their livestock have migrated to the lake basin due to the changes in rainfall.

The shallower lakes (Victoria, Chad) have extensive wetland systems and smaller satellite lakes which are normally enclosed by wetlands. The wetlands buffer and regulate the quality of water entering the lakes and are critical habitats for fish and other biotic communities. The harvesting and burning of wetlands lead to changes in structural components in surface water (Balirwa, 1998; Hecky, 1993). The water quality deterioration in Lake Victoria is partly

attributed to encroachment on wetlands. Some lakes or parts of lakes have been designated Ramsar sites (Chad, Naivasha, Nakuru), National Parks (Lakes Malawi, Baringo) but it is the threats and rate of deterioration of the habitats that has been a factor in recognizing the ecological importance of wetlands.

Mineral deposits in the drainage basins can trigger economic development associated with urban growth. However, the current status regarding heavy metal contamination of African lakes indicates the localized nature of pollution. A survey of East African lakes to evaluate the importance of Total Mercury (THg) concentrations in fish found that sources of THg may be more diffuse than previously thought even though gold mining is a major activity to the south of Lake Victoria. For the much smaller Lake Nakuru (surface area: 40km² with a catchment/lake surface ratio of 45:1), the presence and leaching of heavy metals (Lead, Zinc, Mercury, Copper and Arsenic) have been linked to massive deaths of flamingos which is a major tourist attraction. The leaching of the heavy metals into aquatic systems and their bio-magnification renders the fishery resources more vulnerable and may render the fish unsuitable for human consumption. A related pollution source is the growth of urban centres around the lakes. While this is inevitable, the discharge of untreated or semi-treated industrial and municipal wastes that may contain heavy metal residues is a threat to most of the African lakes. In addition, oil and mineral exploration, and powered boat transport across the lakes pose threats (e.g. oil spills) that need urgent mitigation. The above conflicts in lake basin resource use require proper planning for the different users of the lake basin. There is need for spatial planning to define and allocate the land and water surface to the different uses.

Management Plans and Efforts

Introduction

Actions are required to address the management challenges and to reduce threats to African fisheries include: control of population increases in lake basins; Manage fisheries resources sustainably (including control of effort, elimination use of destructive fishing gears and methods and capture of immature fish); Develop guidelines on species introductions; Conserve and sustainably use aquatic biodiversity; Prevent and Control eutrophication and pollution; Control invasive weeds; Manage water withdrawal; Manage health issues related to aquatic systems; Manage Climate change; Set up and enforce appropriate policies, laws and regulations; Develop efficient and effective institutions and institutional processes and governance which involve stakeholders in planning and implementation; and Develop sustainable funding mechanisms for implementing fisheries programs.

A number of projects have been initiated on the lakes to address the above issues. Some of the lakes have had support from GEF either individually or alongside other donor supported projects. This part of the paper analyses, the efforts and outcomes of the management efforts towards ensuring healthy and productive aquatic freshwater ecosystems and the contribution of GEF to these efforts.

Controlling the Population

The degradation of freshwater fisheries in Africa can be traced to rapid population growth and changes in livelihood systems in the drainage basins. A doubling in population since the

1960s has led to pressure on the diverse natural resources of which fisheries are part. As most of the African countries are among the poorest in the world, it is to be expected that poverty is a key driver of the exponentially increasing population that seeks to maximize on socio-economic development objectives. This leads to increasing deforestation, intensification of agriculture and urbanization. Most African governments receive support from UN agencies such as UNICEF and UNFPA aimed at educating communities in family planning, encouraging widespread of immunization and handling of preventable diseases. While there have been some positive impacts, the population in many countries is still high.

With severe droughts and floods that characterize many parts of the drainage basins and low agricultural prices, declining soil productivity, and unemployment, entry into the usually open access fisheries provided options for poverty alleviation and sustaining of peoples livelihood. Therefore, measures to control population growth should be accompanied by improved livelihood patterns in the communities and practical education programmes in resource use.

Sustainable Management of Fish Stocks

Sustainable management of the fishery resources is being undertaken through: Control of fishing effort; (Boats, gears, No of fish processing plants); Controlling fishing gears and methods. On Lake Victoria the European Union has over the last decade provided support to generate information for management of fisheries, which culminated into preparation of a Fisheries Management Plan for the Lake. EU has provided additional funds to implement the fisheries management plan. This will assist LVFO to: Develop, harmonise fisheries policies and legislation; Implement a monitoring control and surveillance (MCS) program to enforce the laws; Promote participation of stakeholders in management of the fishing through support to BMUs; Provide additional information on the fish stocks, the environment and socio-economic factors; Establish databases; Improve information, communication and outreach; and Improve infrastructure and human resources capacity.

3.4. Conservation of aquatic biodiversity

There have been efforts to conserve ecosystems, species and genetic diversity especially in Lake Victoria with support of GEF through the Lake Victoria Environmental Project (LVEMP). This has been done by identifying and protecting satellite lakes and refugia in main lake; identifying and protecting areas with high species and trophic diversity; selecting suitable areas and setting up marine parks. Conservation of ecosystem, species and genetic diversity was to be achieved through: Keeping representative samples of aquatic fauna & flora in zoos, aquaria and museum; Determining genetic status of endangered species and proposing mechanisms for protection; Enhancement of stock of originally important commercial species through aquaculture.

3.5. Reduction and Control of Pollution and Eutrophication

The high population growth rates (2-3% p.a), high livestock densities, accelerating urbanization and industrialization accompanied by water extraction and waste disposal, intensification of agriculture, soil erosion and use of agro-chemicals are primary factors in the increasing pollution and eutrophication of the lakes. As many of the African lakes straddle several national jurisdictions, regional harmonized approaches are the most appropriate. This

has generally been difficult to achieve without external support as different countries with divergent priorities may pursue different economic models of development. Moreover, the extent of dependence of communities in the drainage basins on the natural resources especially fishing and agriculture requires poverty relief programs that the poor countries with high population growth rates, low GDP, unsecured markets, etc, cannot afford.

The current attention and concern about pollution and eutrophication of African lakes has greatly benefited from research studies on the lakes. Individual scientists in national institutions working closely with international collaborators have greatly contributed to improve awareness of emerging issues. For example, in East Africa, ecological changes associated with species introductions in Lake Victoria were first studied through national institutions, and subsequently with IDRC, EU and GEF support larger programs such as the GEF-funded LVEMP were negotiated at regional level. The experience of Lake Victoria was transferred through GEF funding to Lakes Malawi and Tanganyika while smaller efforts to smaller water bodies (e.g. Lakes Naivasha, Baringo, etc) often on the basis of isolated concerns such as the establishment of Ramsar sites. On a much larger scale, a decade of investigations of the limnology and biodiversity issues of the East African Great Lakes culminated in improved scientific understanding of the diverse threats facing these lakes through the IDEAL program. It is clear that international awareness of the fragility of freshwater ecosystems and the various fora of the last decade (e.g. Rio, conventions etc) have created regional awareness about African lakes. However, it is still early to predict the direction of efforts to control the primary factors responsible for pollution and eutrophication will take in the longer term. Degradation and loss of fish habitat was implemented through: Improvement of land-use practices; Protection of wetlands; Ensuring adequate treatment of sewage; Promoting afforestation programs in the catchment.

3.6. Control of aquatic weeds especially water hyacinth

Biological control has successfully been used to control aquatic weeds especially *Salvinia* and Water hyacinth. Measures have been taken to control water hyacinth in those lakes invaded by the weed such as Lake Victoria. This involved biological control using two weevil types *Neochetina bruchi* and *N. eichhornia*, mechanical and manual removal at strategic areas such as the hydropower station, water extraction points and fish landings. Water hyacinth mats have also been displaced through ecological succession by native plants especially hippo grass, *Vossia cuspidate*. It has been observed that proliferation of water hyacinth is related to nutrient levels. Control of nutrient inputs to Lake Victoria is expected to contribute to control of water hyacinth. However, there is need to sensitize countries about accidental transfers of weeds within drainage basins.

3.7. Improving policy and legal regimes

The success of any interventions depends on availability of appropriate policies, laws and regulation to guide management. Most of the African countries have policies laws and regulations for management of fisheries and biodiversity. In some of the countries such as those around Lake Victoria, the fisheries laws and regulations are being reviewed and harmonized.

African countries are also signatories to a number of regional and international agreements, conventions and protocols for management of fisheries and the fish habitats. Regional

conventions include: The Convention for the Establishment of Lake Victoria Fisheries Organization (LVFO); and the Treaty establishing the East African Community (EAC). The International conventions include: the Ramsar Convention on Wetlands of International Importance; the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES); the Convention on Conservation of Biological Diversity; and the Code of Conduct for Responsible Fisheries. Some of the sites around the lakes are being developed into a Ramsar sites.

African countries each have fisheries policies whose overall goal is to ensure optimal and sustainable fishery production. The countries have Fisheries Acts specifically for management of the fisheries resources. There are also a number of other Acts which apply to management of other aspects related to fisheries. There are laws covering management of the environment, water quality and wetlands. Many African countries are implementing Environmental Action Plans (NEAP) which provides a framework for integrating environmental concerns in project design and implementation.

3.8. Improving institutional mechanisms including stakeholder participation

An important contribution to the 1992 UN Conference on Environmental and Development (UNCED) in particular its Agenda 21 was the preparation by the FAO of the Code of Conduct for Responsible Fisheries. Among its objectives, the code includes recognition of economic goals and conservation issues. However, very few governments cite this instrument as a principle in the regulation of use of aquatic resources. Follow-on declarations including the Convention on Biological Diversity and the development of the Millennium Development Goals have yet to be incorporated in National development plans. These concepts are still largely a presence of research and related institutions that block the principles to politicians. State-based management options that emphasize GDP and poverty eradication especially with respect to fisheries do not seem to be successful. There is therefore need to strengthen and deliberately empower grass-root stakeholders and other uptake pathways (e.g. schools and organized fisher/farmer groups with clear messages of the implications of the scientific results that have improved our understanding of the freshwater ecosystem of Africa.

3.9. Improving acquisition, packaging and dissemination of information

Creating an informed society has been recognized as a prerequisite to conservation efforts. On Lake Victoria efforts are being made to make information available to stakeholders at different levels. This involves production and distribution of books, booklets, charts, facts sheets, brochures, geo-referenced maps to be used in biodiversity conservation efforts. Other information dissemination activities are carried out through workshops involving extension agents, fisher communities, and educational institutions.

3.10. Developing Sustainable Funding Mechanisms

The fisheries sector has normally been funded from national budget. However, the allocation to the sector for its operations are usually low. This limiting the amount of work that can be done on the ground. Some countries have instituted a fish levy to collect funds for implementation of fisheries activities. This has particularly been successful in Tanzania and the other countries bordering Lake Victoria are trying to copy the Tanzania model. The

LVEMP project funded by GEF/World Bank provided support to the three riparian countries to carry out a fish levy study around and establish modalities for setting a Trust Fund. The study has been completed but operationalisation of the fund has been hindered by the revenue collection policy of individual countries. Whereas Tanzania allows for use of the fund directly in fisheries development activities, Kenya and Uganda require the money collected to be surrendered to the national treasury.

4.0. Lessons Learnt and Recommended Initiatives

4.1. Historical Focus of Fisheries Management Efforts

Historically, fisheries management efforts generally focussed on commercially important species. It is however clear now that the lake productivity processes and the health of the habitat determine fisheries production. The health of the habitat is in turn affected by activities in the watershed and the air shed. It is upon this realisation that a number of projects such as the LVEMP have taken on a whole ecosystem approach to management of the fisheries and environment of Lake Victoria. Future fisheries development and management efforts should, therefore, include environmental aspects.

4.2. Political Interest and Commitment: National Commitment, Regional Commitment and International Commitment.

The fisheries development objective in virtually all the countries is to ensure increased and sustainable fishery product and a healthy fish habitat. There is interest in sustainable management of fisheries and the fish habitats at international, regional and national levels. This has led to a number of international and regional conventions, protocols, and agreements. A few examples of these include the conventions of Biological Diversity, CBD, the Convention for International Trade in Endangered Species of Wild Fauna and Flora CITES, the Convention for Establishment of Lake Victoria Fisheries Organisation, the Code of Conduct for Responsible Fisheries, the International Plan of Action to deter and eliminate Illegal Unreported and Unregulated Fish, IPOA / IUU. At national levels, there have been efforts towards sustainable resource use and environmental project through setting up national environmental action plans and authorities to implement the plans. Despite all these efforts, fisheries stocks have continued to decline. This may be attributed to lack of effective action.

4.3. Policy and Legal Framework

The riparian states of most of the lakes have fisheries and environmental policies for management of lake ecosystems. Virtually all countries have fisheries laws and regulations. Some of the laws were however made during the colonial era and certain components have become outdated. It is also important that fisheries laws and regulations of the countries sharing a lake harmonized so that the riparian countries can take similar action. GEF through LVEMP initiated a process of harmonisation of the laws of riparian states of Lake Victoria but even this was not completed. The Policy and legal framework needs to be updated regularly to handle the situation of the day. There is also poor enforcement of available laws and regulation leading to continued resource degradation. There is, therefore need to have the laws updated regularly but more importantly, the laws need to be enforced.

4.4. Institutions, Institutional Mechanisms and Governance

Overall, there are institutions and institutions at international, regional and national levels with mandates to develop fisheries resources. At international level, there are institutions like FAO and Worldfish (formerly ICLARM) with interest in fisheries development and management. These institutions have existed and cooperative efforts have existed to many years. For instance, the three riparian states of Lake Victoria have co-operated in development and management of the fishery resources of the lake since 1929 and some of the other lakes have similar institutions. Lake Victoria has the Lake Victoria Fisheries Organisation, Lake Chad had a Lake Chad Commission, Lake Kariba has the Zambezi Rivers Authority and Sub-committee of the Committee for Inland Fisheries of Africa CIFA coordinates Lake Tanganyika and there are attempts to form an organisation similar to LVFO on Lake Tanganyika. In East Africa, the scope of regional cooperation in management of Lake Victoria and its resources has been strengthened through the East African Community EAC. The EAC has designated Lake Victoria Basin an economic growth zone and is forming a Commission to oversee development of the basin. A number of donors have put in place Partnership Fund and others are providing direct support to the basin activities. In addition each of the countries have national and in some cases grass-root institutions for development and management of fisheries resources. Many of these institutions have however faced challenges especially of financial sustainability and have had to depend on donor funding. For instance, GEF through LVEMP recently assisted the establishment of LVFO but this support ended before a sustainable funding mechanism was put in place. Donor support should have involved setting up a sustainable funding mechanism in a phased manner. Despite existence of these institutions, the fish stocks have continued to decline apparent due to lack of effective action. There is therefore need to organise the institutions and enable them to be more effective.

4.5. Stakeholder Participation

Fisheries and natural resource management in most of the countries in Africa have been through a top-down command and control systems under government control and as stated above, this has not been very effective. It is now recognised that for effective management, there is need to involve stakeholders in planning and management of natural resources. Co-management, an arrangement where resource users and government share the responsibility of managing the fisheries resources is being promoted on a number of lakes. Development of community institutions known as Beach Management Units (BMU) has been initiated on Lake Victoria with support from LVEMP and this will be improved during implementation of a fisheries management project on the lake with support of the EU. Similar institutions are being developed on other lakes such as Malawi. The BMUs will work with existing government institutions to prepare village bye laws, enforcing fisheries regulation, collecting fisheries statistics, ensuring beach sanitation and hygiene and conduction training workshops for beach members on sustainable fishery practices.

4.6. Funding Mechanisms

Inadequate funding at national and regional levels has been a major setback to effective implementation of fisheries programs. Many riparian government do not allocate adequate funds from their national budgets to fisheries programs and as a result many fisheries programmes depend on donor funding which in most cases stops when the project ends.

There is need to develop sustainable funding mechanisms for fisheries programs. Experience from Tanzania has shown that this can be achieved through levying taxes on fisheries and use the fish levy to fund fisheries activities. GEF through LVEMP supported a study of a fish levy to fund activities of fisheries on Lake Victoria and the principle is generally accepted by the three riparian states. These efforts should be concluded so that the experience from Lake Victoria can be applied on other lakes.

4.7. Linkages between Lake Management Programs

There are sometimes many donors and national and sectoral projects operating on African lakes. For instance on Lake Victoria, LVEMP was being implemented along a Lake Victoria Fisheries Research Project which was supported by EU. At the same time, there were many sectoral projects implemented by different ministries or departments within the same country. Some of these projects have planned and operated separately and duplicated activities. There is need to have clear linkages between the projects and to avoid duplication of activities and the accompanying wastage of resources.

4.8. Scientific Information and Databases for Lake Management

Information and database are very important as management decision tool. Many of the lakes have research institutes, which generate information to guide management decision. There has been considerable investment in research to provide the information for management of fisheries resources. The research institutes such as those on Lake Victoria have information on the Status of fish stocks, changes in biodiversity changes in lake productivity processes, pollution, eutrophication, invasive weeds and socio-economic aspects of the fisheries. However, much of this information is not available in usable forms and in some cases cannot be applied to real situations on the ground. There is need for a clear information strategy, which will ensure that the information collected is relevant and that the information available is packaged in appropriate forms and language for use by the stakeholders. There is also need to carry out an information needs assessment before research is conducted.

4.9. Conclusion

Africa is rich in freshwater resources, which are of value to the communities. The resources are under threat and have continued to deteriorate despite many effort by national and regional institutions with national and international support. The experience so far show that there has been lack of effective action due to, limited accessibility and application of scientific information; poor dissemination of management information; inappropriate and in some cases un-harmonised fisheries laws and regulations; inadequate enforcement of existing laws and regulations; Weak institutions and institutional processes; and inadequate funds to implement fisheries programs. There is need to: Make appropriate information and data available to guide decision and formulation of policies, laws and regulations for sustainable management of the fisheries resources and the fish habitats; Provide appropriate policies, laws, regulations, and standards to be used in management efforts; Establish and develop effective institutions, institutional mechanisms including community participation to provide the required data and information, promote sustainable use practices, and enforce laws and regulations; and to Provide adequate financial resources and human capacity to implement fisheries programs.

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Captions to the Figures

Figure 1. The main freshwater systems of Africa showing the lakes. Albert, A; Bangwuelu, B; Cahora Bassa, CB; Chad, Ch; Chilwa, Cw; Edward, E; George, G; Kariba, Kb; Kivu, Ki; Kainji, Kj; Kyoga, Ky; Malawi, M; Mweru, Mw; Nasser-Nubia, N-N; Tanganyika, T; Turkana, Tk; Victoria, V; and Volta, Vo.

Figure 2. Map of the African Great Lakes Region including Lakes Victoria, Tanganyika, Malawi (Nyasa), Kariba, Baringo, Naivasha and Nakuru.

Figure 1.

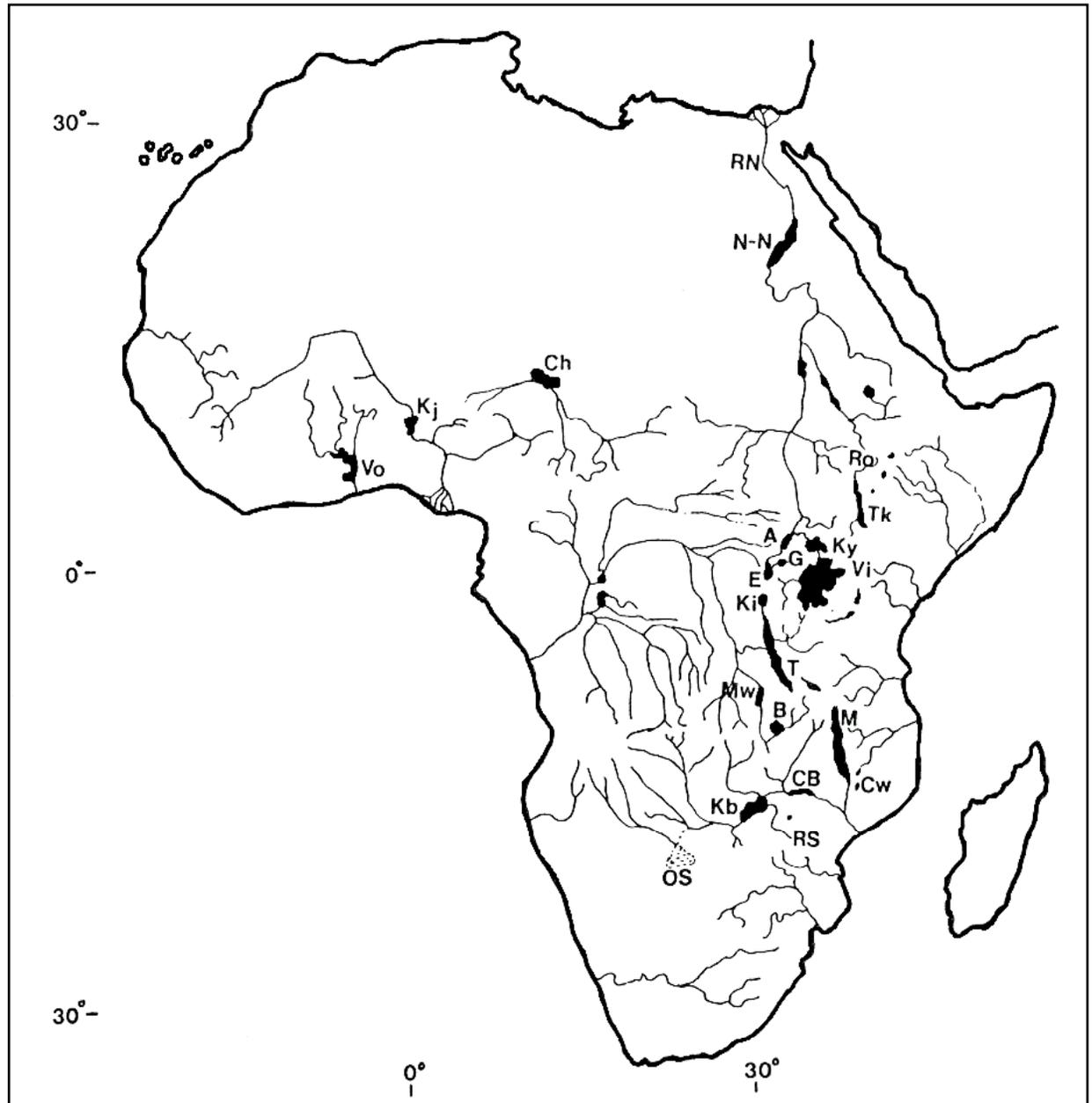


Figure 2

