Lake Baringo

Experience and Lessons Learned Brief

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1. Introduction

Lake Baringo is named after the local word 'Mparingo', meaning lake. The lake is located in the Eastern Rift Valley in Kenya and is one of the seven inland drainage lakes within the Rift Valley drainage basin. The lake has a surface area of about 108 km² and drains a total area of 6,820 km² (Figure 1). The lake is located in the administrative district of Baringo at an altitude of 1,000 m above sea level, while its basin extends to the neighboring districts of Koibatek, Laikipia and Nakuru. Several seasonal rivers drain into the lake, including Ol Arabel, Makutan, Tangulbei, Endao and Chemeron. Perkerra and Molo are perennial rivers, although with significantly reduced water discharges during dry seasons. Lake Baringo experiences very high annual evaporation rates of 1,650-2,300 mm, compared to an annual rainfall of 450-900 mm. Thus, its survival depends on the inflows from rivers originating from the humid hillslopes of the drainage basin, where the annual rainfall varies between 1,100 mm and 2,700 mm.

As a freshwater body, Lake Baringo is important to the communities in its basin as a source of water for domestic use and livestock consumption. Other important uses are income generation through tourism, biodiversity conservation and fishing. The fish species composition of the lake include *Oreochromis niloticus*, *Protopterus aethiopicus*, *Clarias gariepinus*, *Barbus intermedius* and *Labeo cylindricus*. Three indigenous human communities live in the basin; namely, the Ilchamus, Pokots and Tugens. They earn their living through pastoralism and agro-pastoralism. As pastoralists, they keep large numbers of cattle, which overgraze the catchment vegetation leading to enhanced soil erosion, sedimentation in streams and the lake, and frequent flash floods. Other activities causing degradation are deforestation and conventional agricultural practices. Together with other forms of degradation, including loss of biodiversity and declines in fisheries, these activities have drawn the attention of the Government, non-governmental organizations (NGOs) and other stakeholders of the need to carry out management interventions with the aim of minimizing further degradation of the lake. Past interventions for resource management in the lake drainage basin include:

- Baringo Semi-Arid Project (BSAP) for land rehabilitation, 1980-1989;
- African Land Development (ALDEV) for grazing schemes and provision of water, 1940s;
- Kenya Livestock Development Programme (KLDP) for group ranches, 1960-1970; and,
- FAO project for Fuel and Fodder, 1982-1987.

The approaches adopted by the stakeholders for the sustainable management of the lake basin include empowering local communities for natural resource management, diversification of agriculture, agro-forestry systems, and micro-enterprises. In addition to these activities, fishing moratoria, and soil and water conservation practices also are in place in the lake and its basin. These practices tend to reduce degradation either

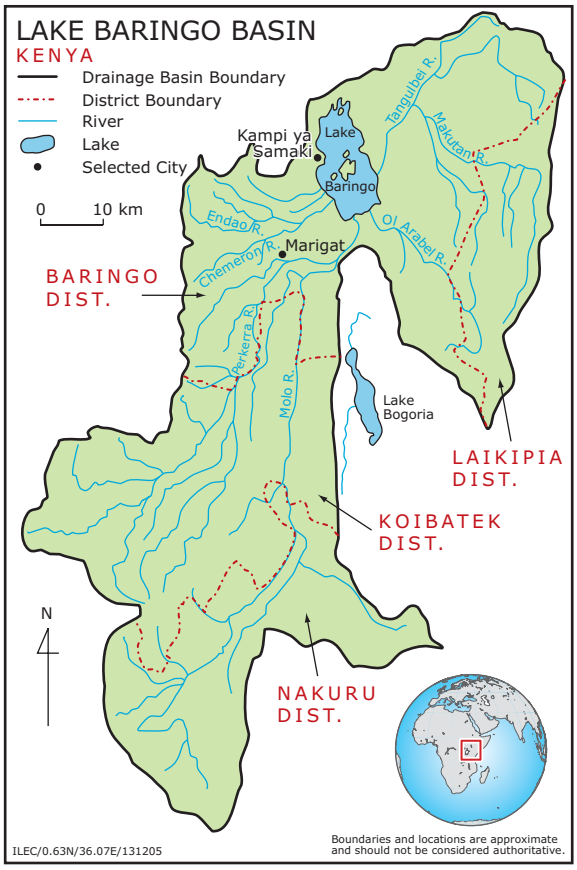

Figure 1. The Lake Baringo Basin.

by reducing pressures on certain resources, especially land, through the provision of alternative sources of income, or by effecting direct conservation measures. The institutions involved in carrying out these management activities include the following:

- **Public Institutions**. Kenya Marine and Fisheries Research Institute (KMFRI); Kenya Forestry Research Institute (KEFRI); Baringo County Council; Ministry of Agriculture (MoA); Ministry of Water Resources and Development (MoWR&D); Ministry of Environment and Natural Resources (MENR); Ministry of Livestock and Fisheries (MoLF); Kenya Agricultural Research Institute (KARI);

- **Private Organizations**. Block Hotels;

- **NGOs**. World Vision; Rehabilitation of Arid Environment (RAE) Trust; and,

- **Community-Based Organizations (CBOs)**. Honey Care; Women's Groups.

The management of the lake and its basin carried out by the above institutions in the past was mainly sectoral in nature. The need for integrated management was realized from lessons learned from past projects. Thus, the involvement of UNEP and the Global Environmental Facility (GEF) through the Lake Baringo Community-Based (LBCB) Land and Water Management Project has facilitated integrated management of the lake and its basin. In this program, capacity building and creation of awareness of local communities were undertaken, along with coordination and facilitation of the stakeholders, to facilitate sound management of Lake Baringo and its drainage basin.

2. Background

Lake Baringo is a freshwater lake with importance to the population of its drainage basin as a source of water for domestic use and for watering livestock. It is also a source of food to the community, especially fish. Currently, the species composition of the lake is as follows: *Oreochromis niloticus* (80.4%), *Protopterus aethiopicus* (7.95%), *Clarias gariepinus* (9.8%), *Barbus intermedius* (0.96%) and *Labeo cylindricus*. *Barbus* rarely appear in the fishermen's catches, while *Labeo* has almost disappeared from the lake since the damming of the inflowing rivers, which interfered with its breeding habits (Aloo 2002). The lake also is a source of vegetation products such *Aeshynomena elephroxylon*, which is used for boat construction, and water lily for making domestic bread (ugali). About 500 families live in Kampi ya Samaki, a center which has grown mainly because of fishing activities in the lake. Half of the population in this center are fishermen and 300 are fish handlers, while others earn their living through activities such as boat construction. Due to an over-dependence on fishing, there has been a remarkable fluctuation in fish production (Figure 2). The estimated economic value of the fishery for the year 2002 was based on experimental fishing, while that for 2001, the year of establishment of a fishing moratorium, was derived through interpolation.

Fish is a source of food, and the sale of fish to nearby urban centers also generates income for the local people. Through fishing, the lake provides employment to the fisher folk and the young tour operators who own boats. The boats are used by tourists for navigation in the lake. The lake also is an important tourist attraction because of its rich biodiversity, which comprises hippos, birds and crocodiles, among others. Its shoreline also is used as a grazing ground for livestock, especially during dry seasons when the catchment is dry and grass is scarce. The local people also use the lake for navigation to link the eastern and the western parts of Baringo District.

Records indicate that between 1969 and 1972, the average depth of the lake was 8 m. In early 2003, before the onset of the long rains, the average depth was 1.7 m. The current average depth is 2.5 m, with the deepest end of the lake being 3.5 m. This increase in water depth was due to prolonged long rains during 2003, especially in the humid upper catchments. The surface area of the lake has shown a decreasing trend. Studies by Onyando (2002) revealed that the area of the lake in 1976 was 219 km^2, in 1986 it was 136 km^2, in 1995 it was 114 km^2, and in 2001 it was 108 km^2. Based on these trends, the author extrapolated the lake's surface area into the future, suggesting that by 2025, the surface area will be reduced by 50% if the current trend continues (Figure 3).

The boundary of the drainage basin lies on the Tugen Hills to the west, the Eldama Ravine ranges to the south, and the Laikipia Plateau to the east. These hills rise as high as 2,800 m above mean sea level (AMSL), while the lake is at an altitude of about 1000 m AMSL. The geology of the area is mainly undifferentiated volcanic rocks, while the soils are of clay type. The landscape is characterized by steep slopes from the Tugen Hills and Eldama Ravine Highlands to the Perkerra River,

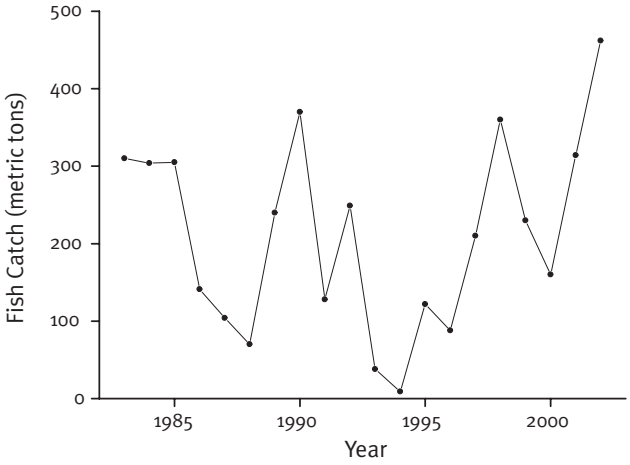

Figure 2. Trend of Fish Production in Lake Baringo (comprising *Oreochromis*, *Clarias*, *Barbus*, *Protopterus* and *Labeo*).

grading in to gentle slopes, and finally to the flood plains of Marigat and Lake Baringo.

Although Lake Baringo is located in a semi-arid zone, its catchment covers a range of climatic zones, from semi-arid through semi-humid and sub-humid, to a small portion in the humid zone. The mean annual rainfalls in these zones are 450 mm to 900 mm (semi-arid), 800 mm to 1,400 mm (semi-humid), 1,000 mm to 1,600 mm (sub-humid) and 1,100 to 2,700 mm (humid). The mean annual potential evaporation amounts for these areas are 1,650 mm to 2,300 mm (semi-arid), 1,450 mm to 2,200 mm (semi-humid), 1,300 mm to 2,100 mm (sub-humid), and 1,200 mm to 2,000 mm (humid). The risk of crop failure is 25% to 75% in the semi-arid zone, 5 to 10% in the semi-humid zone, 1 to 5% in the sub-humid zone and less than 1% in the humid zone. Similarly, the potential for plant growth in these zones can be classified as medium to low, high to medium, high, and very high, respectively. These figures indicate that the semi-arid zone, in which Lake Baringo is located, is a fragile environment with low natural life-sustaining properties, thereby requiring urgent conservation attention.

The rainfall characteristic of the basin is bi-modal, intense and erratic. The long rains occur in the months of April to August, while the short rains fall from October to November. Daily rainfall monitoring in the basin dates back to 1903. Since that time, a total of 101 stations have been installed in the catchment by various organizations, including the Kenya Meteorological Department, research organizations and individuals. However, only 66 stations are currently operational. This translates into a density of 97 km^2/gauge, which is less than the World Meteorological Organization's (WMO) recommendation of 17 km^2/gauge. Streamflow monitoring started as early as 1926, with a total of 26 river gauging stations having been installed at different times since then in various locations in the rivers flowing into Lake Baringo. Most of the above stations are not currently operational, due to poor maintenance of the gauges. Thus, the available data contain a lot of gaps, which is a drawback in managing the basin's water resources.

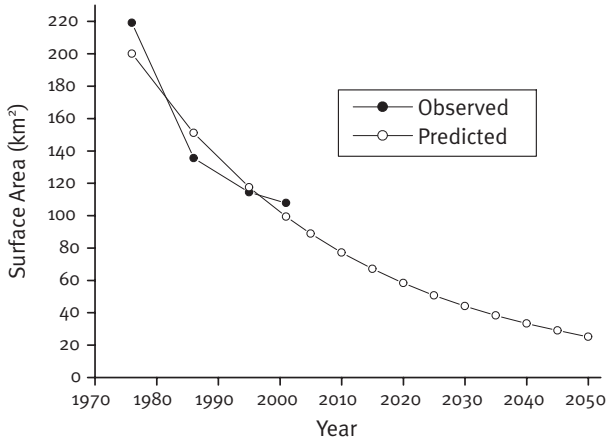

Figure 3. Observed and Predicted Surface Area of Lake Baringo.

Lake Baringo is the lifeline of the communities living in its basin, especially in the vicinity of the lake. These communities include the Pokots to the north, the Tugens to the east and the Ilchamus to the south and eastern sides. The Ilchamus form about 50% of the riparian population, and are mainly pastoralists. The Ilchamus and Pokots mainly practice agro-pastoralism, with emphasis on pastoralism, while the Tugens are primarily agriculturalists. These communities are politically marginalized, especially the Ilchamus and the Pokots. Thus, their poverty level is high and they have limited access to tap water, health facilities and other services. Livestock over-grazing is a major problem in this area, since the pastoralists are not willing to reduce the number of their herds to conform with the available food biomass. Their livestock is comprised of cattle, sheep and goats. Dry seasons are critical periods for raising livestock, since grass is rare at that time and most cattle graze along the lakeshore, thereby interfering with the lake's ecosystem. The land tenure system is group ranch, with grazing being communal. This accelerates soil erosion, as the cattle graze together and are driven together from place to place in search of pasture. Another area of conflict is cattle rustling, which creates friction between communities in the basin, hence limiting collective responsibility in the management of the lake and its basin.

The streams flowing into Lake Baringo originate from humid and sub-humid hillslopes, where the annual rainfall is more than 1,000 mm. These hillslopes are the major recharge areas, but belong to administrative districts that, while within the basin, are not riparian to the lake (the lake is surrounded by the Baringo District). This creates restrictions in river basin management, since the administration in every district is unique. Although some low level of interaction exists between the districts, it must be enhanced to facilitate effective management of the basin's natural resources. The hillslopes, which are in the water recharge areas, have undergone deforestation in the recent past, through land conversion to create more land for agriculture, and through harvesting of forest products for timber, wood fuel and charcoal. The forested areas of the catchment have decreased by about 50% since 1976. Consequently, groundwater recharge has decreased, with streams drying up more often during the dry seasons, while they cause flash floods during the rainy seasons. As a result of the floods, loss of property and displacement of people has been prevalent in the lower reaches of the basin.

The benefits accruing from the lake include water for domestic and livestock use, fisheries, tourism and biodiversity. Irrigated agriculture is another major benefit derived from the water resources of Lake Baringo basin, mainly through water abstraction from the Perkerra, Endao and Chemeron Rivers. The crops grown in the irrigation schemes include maize, water melons, tomatoes, onions, pawpaws and oranges, among others.

The Lake Baringo drainage basin is endowed with rich terrestrial and aquatic biodiversity, including natural vegetation, wildlife, birds and fisheries. For example, there

are about 400-500 different bird species (Gichuki 2000), most of which reside in areas with intact woodland and grassland and rehabilitated lands. Such areas also have a variety of plant species. Reports also have indicated there are about 40-60 hippos in the lake, while crocodiles numbering about 20 also occur there. In addition to the lake, the biodiversity offers a resource base for tourism attraction. Through tourism, the area has been opened to other regions, both nationally and internationally. This has promoted business enterprises and the interchange of knowledge and technologies through interactions between the locals and foreigners. By attracting foreigners, the lake and its basin have attracted markets for local agricultural and livestock products.

3. Biophysical Environment

3.1 Water Quality Conditions

The quality of water in Lake Baringo has deteriorated over time. The main concern is turbidity, which has increased because of high rates of sedimentation resulting from increased soil erosion in the catchment. The turbidity values recorded in recent analysis range between 350-900 NTU, which are rather high values. Related to the increased turbidity is reduced water transparency, which is less than 0.1 m as measured by Secchi disc. Physio-chemical analyses of the lake have been carried out in the past, with the most recent and reliable analysis done between June 2001 and May 2002 (Ballot *et al*. 2003). The parameters analyzed in this latter study are shown in Table 1.

As shown in Table 1, the physical conditions of Lake Baringo are characterized by high temperature and low transparency. The pH of the lake is relatively high because of the alkaline hot spring discharge from Kokwa Island, which is located in the lake. The conductivity and salinity indicate the sub-salinity of the lake (Hammer 1986) while the high total nitrogen and total phosphorus concentrations reflect the hypereutrophic condition of the lake.

3.2 Biomass Production

The turbid water of Lake Baringo is characterized by a greenish color related to the presence of the dominant cyanobacterium, *Microcystis aeruginosa*, which dominates the lake's phytoplankton community. Primary production in the open water is very low, due to the turbid nature of the lake water. Thus, the phytoplankton population is limited to only the positively-buoyant species, including *Microcytis aeruginosa*, *Melosira granulata* and *Anabaena carcinalis*. The lake's high turbidity limits light penetration into the water column, resulting in low biomass production. Recent analyses revealed the concentration of phytoplankton biomass to range between 1.5-8.2 mg/L (Ballot *et al*. 2003). The main phytoplankton groups in Lake Baringo are shown in Table 2.

Microcystis aeruginosa dominates in Lake Baringo, compared to the other phytoplankton, because it is able to develop gas vacuoles in its cells, allowing it to regulate its buoyancy. This ability to control vertical location enables it to locate itself in the water column where it can receive relatively more light in the turbid water of Lake Baringo. Other factors contributing to the dominance of *Microcystis* are temperature and nutrient loading. The growth rates of bloom-forming cynobacteria like *Microcystis* are optimal at 25°C, which falls within the temperature range measured in Lake Baringo (i.e., 23.7-26.3°C). The total phosphorus (TP) and total nitrogen (TN)

Table 1. The Physio-Chemical Conditions of Lake Baringo During June 2001 to May 2002.

Parameters	June 2001	November 2001	January 2002	May 2002
Water temperature (°C)	26.3	26.1	23.7	24.9
Secchi depth (m)	‹ 0.1	‹ 0.1	‹ 0.1	‹ 0.1
pH	9.0	8.8	9.1	9.1
Conductivity (mS/cm)	1.66	1.39	1.51	1.67
Salinity (‰)	0.7	0.5	0.6	0.7
Total nitrogen (mg/L)	8.0	1.8	1.0	0.5
Total phosphorus (mg/L)	1.3	1.0	0.6	1.0

Source: Ballot *et al. (*2003).

Table 2. Mean Biomass Production of the Main Phytoplankton Groups in Lake Baringo During June 2001 to May 2002.

Phytoplankton groups (mg/L)	June 2001	November 2001	January 2002	March 2002	May 2002
Cynopyceae	5.45	1.64	0.67	0.22	2.53
Bacillariophyceae	0.26	0.19	0.04	0.46	0.03
Chlorophyceae	1.84	0.52	0.34	0.8	0.17
Euglenophyceae	0.62	0.08	0.56	0.03	0.0
Cryptophyceae	0.0	0.04	0.07	0.03	0.05
Total Biomass	**8.17**	**2.47**	**1.68**	**1.54**	**2.77**

Source: Ballot *et al.* (2003).

concentrations of 1.0 mg/L and 2.8 mg/L, respectively, indicate high nutrient loading to the lake. However, the production of cyanobacteria at levels between 0.2 and 5.5 mg/L is not commensurate with the TP and TN concentrations in the lake. Hartebeesport Reservoir in South Africa, for example, with similar TP and TN concentrations, has *Microcystis* production levels between 20-50 mg/L (Zohar and Robarts, 1990). This latter production level is about 10 times that of Lake Baringo, thus illustrating the degree that high turbidity can limit lake production.

3.3 Land Use Changes

Although industrial and urban development in the basin have gradually increased over time, agricultural development has increased rapidly, particularly in the upper reaches, where the climate is conducive for such activities. The natural forest in this region also has been exploited for timber, wood fuel and settlement. The benefits being lost as a result of deforestation include the functioning of the forest as a moisture reservoir: forests store 100 times more water than grasslands, capture air moisture and increase the incidence of rainfall, regulate river flow and prevent flooding, reduce the sediment load in river water, and regulate rainfall patterns. In addition to these benefits, forests are a center for biodiversity and attract tourism. The Lake Baringo drainage basin has lost more than 50% of its natural forest cover, decreasing from 829 km^2 in 1976 to 417 km^2 in the 2001. Thus, the same proportion of the benefits derived from the forests also has been lost.

The undergrowth in natural forest cover, and the humus-rich soil, encourage groundwater retention and recharge. This feature ensures a regulated streamflow throughout the year, compared to deforested catchments with short durations of high magnitude flows during the rainy seasons and reduced low flows during the dry seasons. This phenomenon leads to faster drying of rivers, as observed in Lake Baringo drainage basin. It is worth noting that the tree species also is important; eucalyptus, for example, consumes more water and has little undergrowth, thereby leading to faster depletion of sub-surface water reserves. When cut, such trees can cause low flows to increase. Other species, such as *Luceana leucocephala*, use less water and encourage undergrowth, soil water retention, and groundwater recharge in a manner similar to natural forests. When cut, such trees and forests can cause low flows to decrease.

The effects of climate change in the region are evident from the decreasing snow coverage on top of Mounts Kenya and Kilimanjaro. This is attributed to global warming, which increases the temperature of the air. Deforestation facilitates the accumulation of greenhouse gases, such as carbon dioxide, in the atmosphere. These gases can cause global warming and, hence, higher atmospheric temperatures. Increased air temperatures can lead to increased evaporation from the lake, resulting in a reduced water level in the lake. Overall, the potential effects of climate change on Lake Baringo are not yet been well understood, due to a lack of reliable data.

3.4 Sedimentation

Sedimentation is considered to be the main environmental threat to the lake. It reduces both the depth and surface area of the lake, in addition to destroying the habitats of aquatic animals. The parts of the catchment that produce the most sediment are the steep slopes with erodable soils. Such areas include the footslopes of Tugen Hills around Cheberen and Tenges. The rates of soil erosion in these areas are as high as 205.79 metric tons/hectare/year. In other areas, soil erosion is quite low, being around 2.21 metric tons/hectare/year. The eroded soils are deposited on the flat lower reaches of the drainage basin and in the lake. The estimated sediment yield of the Lake Baringo basin, as extrapolated from erosion studies of the Perkerra catchment, is 10.38 million metric tons/year (Onyando 2003). Other estimates made three decades ago showed sediment yields of 13.5 million metric tons/year (Pencol Engineering Consultants 1981).

3.5 Water Abstractions and Impacts on Biodiversity

In addition to siltation, reduced recharge and damming of rivers also pose a threat to the lake. The dams are meant to accumulate water for irrigation, and for rural and urban water supply. For example, the Kirndich Dam, which covers an area of 2 km^2 on the Endao River, supplies water to the town of Kabarnet. Other dams include Chemeron Dam (area of 1 km^2), which is used for irrigation. Water diversions for irrigation also have been made from the Perkerra, Molo and Ol Arabel Rivers. These water abstractions also have contributed to reduced streamflows. Both the lake and its rivers have been used throughout their history to water animals at various points. Therefore, the decreased water levels have significant impacts, especially on the livelihoods of the communities living downstream. This problem is likely to continue as long as the population in the upper catchment continues to increase.

The reduced water inflows to the lake resulted in a low lake depth of about 1.7 m early in 2003. Only a limited number of aquatic animals can survive under such conditions. The fish community, for example, has been very much impacted by this situation, with over-fishing also threatening their survival. The mean size of *Oreochromis niloticus*, for example, decreased to 15 cm, necessitating a fishing moratorium in the 2001. Other fish species (e.g., *Barbus* and *Labeo*, which migrate upstream to spawn) are presently close to extinction in the lake.

3.6 Socioeconomic Factors

Socio-economic factors also have had both direct and indirect impacts on the lake. These include:

- Increased demands for developing and using lake resources such as fish, water, and tourist facilities;
- Limited public awareness and understanding of human impacts on the lake including low literacy levels, cultural beliefs, and stratification within communities;

- Insufficient governance and accountability systems which involves inadequate consultation, a lack of expertise, and insufficient mobilization of institutions to address problems;

- High poverty levels which compound disasters due to droughts and floods, low crop yields and low livestock returns; and,

- Finally, poor land management with cultivation of river banks and cultivation of steep slopes without conservation measures.

3.7 Other Problems

Other environmental and sustainability problems associated with the lake include invasive species, especially *Prosopis juliflora*, a fast-spreading shrub with hairy evergreen leaves. It was introduced in 1982 and has spread to cover much of the grazing land in Baringo District, especially around the lake. The shrub forms an extensive and impenetrable thicket that gradually chokes out other plants, including the acacia tree and grass, leaving much of the soil bare and prone to erosion. It has deep roots, and is likely to be linked to the lowering of the water table in the areas that it colonizes. It has aroused concern among the pastoralists, especially the Ilchamus, since it chokes out all the grass upon which their cattle depend.

4. Management Environment

4.1 Institutional Roles

The goal of management of the lake and its basin is its sustainability and that of its biotic communities, while at the same time benefiting the populace through wise use of its resources. For effective management of Lake Baringo's resources, a management plan is necessary, but has not yet been developed. The management efforts in the past have been sectoral. The involved institutions and their roles in managing the lake and its basin are outlined below.

Kenya Marine and Fisheries Research Institute. This is a public research institution, with the responsibility of carrying out research on fish production and the quality of the lake water as related to fish production. It provides statistics on fish trends and lake productivity, with its operation enshrined in the Fisheries Act.

Kenya Forestry Research Institute. This also is a public research institution, mandated to carry out research on agro-forestry systems, preservation of indigenous tree species and development of environmentally-friendly tree species. The trees are planted in the catchment and used for various purposes, depending on the species. Some uses include conservation of soil and water, as wind breaks, and as sources of fodder, wood fuel and timber, among others.

Ministry of Livestock and Fisheries. This ministry was created recently as part of government reforms to further streamline fisheries and livestock departments. The Fisheries Department in this ministry operates under the Fisheries Act. The department's role is to prevent illegal fishing and the use of illegal gear sizes. It also recommends provision of licenses to fishermen and transporters. The Livestock Department provides extension services on livestock management. It also is involved in re-seeding of degraded rangelands, livestock improvement and marketing. The ministry also has affiliated research institutions, both national and international, which are involved in livestock research.

Kenya Agricultural Research Institute. This is a public research institution under the Ministry of Agriculture. It is responsible for agriculture-based research, including developing drought resistant crops, fast maturing crops, and disseminating research findings.

Ministry of Water Resources Development. This ministry is responsible for water resources management and development within the lake basin. It operates under the Water Act, and provides guidelines on water abstraction and borehole development, among other topics.

Ministry of Environment and Natural Resources. This ministry is responsible for environmental conservation in the catchment, including its rivers and the lake. It advises the Government on the use of natural resources in such a way as to minimize environmental degradation. It also promotes environmentally-friendly management interventions. Its activities are enshrined in the Environmental Act.

Ministry of Agriculture. This is a public institution responsible for improving food production, while at the same time conserving the resources to ensure a sustainable supply of food needs. Its activities involve carrying out extension services on modern farming techniques, creating awareness on the sustainable use of resources, and educating farmers, among other tasks.

Kenya Wildlife Services. This is a public institution responsible for wildlife management. It controls, as necessary, the population of predators to minimize human-wildlife conflict.

Baringo County Council. This council is composed of elected leaders from the district. It owns the trust land where the lake is located. It collects taxes from revenue generated from the lake. The taxes are ploughed back, through facilitation of its personnel, who oversee the overall management of the lake.

Rehabilitation of Arid Environment (RAE) Trust. This is a non-governmental organization (NGO), which undertakes planting and regeneration of indigenous trees and grasses in badly-eroded lands within the basin.

World Vision. World Vision is an NGO, which provides famine relief to families affected by extended droughts, and which

have lost crops and other resources. Assistance also is given to those who have lost property due to floods. The objective is to enable them to recover from their losses and resume their livelihood activities as rapidly as possible.

Honey Care. This is a CBO responsible for promoting honey production and sale. Honey is an important resource in the Baringo District, providing an alternative source of income to the local people.

Women's Groups. These comprise CBOs composed of women, with a common goal of improving livelihoods. They operate micro-enterprises as alternative sources of income. Such enterprises relieve consumption pressures on the lake and its resources, thereby contributing to improved resource management.

Block Hotels. This is a private organization operating the three-star hotel, Lake Baringo Club, near the lake. The lake and its rich biodiversity attract tourists, from which the hotel generates income. As a direct beneficiary, the Block Hotels, in turn, participate in lake management, thereby also contributing to the sustainability of the lake, which also helps sustain their business.

4.2 Legislation

The lake management program operates on the basis of government legislation and policies. It is linked to other programs, such as the National Action Plan on Desertification, National Biodiversity Action Plan, Poverty Reduction Strategy Paper, and National Wetland Management. All these have a common objective of sustainable use of natural resources to meet livelihood needs. The legislative framework to enforce management initiatives operates under various acts of the Kenya Government, including the Fisheries Act, Water Act, Agriculture Act, Forest Act, Land Control Act, and Land Planning Act.

The enforcement laws are contained in the acts, which in the past have been implemented sectorally. However, the Environmental Management and Coordination Act (EMCA) was enacted in 1999 to harmonize all the environmental management laws scattered throughout the various existing acts. The implementation of this act is overseen by the National Environment Management Authority (NEMA). At the local level, District Environmental Committees and Village Environmental Committees have been established to ensure that environmental management initiatives are implemented. These committees operate by encouraging the local communities to participate in environmental management activities.

In cases where serious degradation is taking place, or where it is anticipated as a result of human activities, gazettment can be done by the minister concerned as a measure to stop the degradation. This has been done in forest areas following extensive felling of trees for timber, and recommendations made to the central Government for timber to be imported.

In other cases in which there is a deliberate illegal use of resources, law enforcers are encouraged to keep vigilance and arrest the involved parties. In cases of illegal fishing, scouts carry out surveillance in the lake and arrest poachers. The scouts are armed in order to eradicate forceful poaching. Apart from scouts, local chiefs, the administrators in the localities, have the mandate from the provincial administration to enforce legislation. Cases of arrests have been recorded in the Lake Baringo area, with illegal gear sizes of less than 4-inches being burned in public.

4.3 Research and Science

Research and science are prerequisites for effective resource management. Through research and scientific studies, inferences from analysis of statistics of natural phenomena and biodiversity can be made and incorporated in management plans. For example, provision of data on bird life, allowing the numbers of various birds of different species to be determined, is essential for establishing bird sanctuaries.

Research linkages have been made with both local and international universities. Examples include Egerton and Kenyatta Universities in Kenya and the University of Uppsala in Sweden. The research findings have been disseminated to rural communities through Participatory Rural Appraisal (PRA). Such research findings provide a basis for recommendations for sustainable resource management based on available resources and capacity. The fish ban, for example, was a recommendation based on research findings, resulting in improved quality and quantity of the fish catch. The improved catches made the practice readily acceptable to fishermen.

4.4 Management Strategies

Mitigation measures undertaken to control degradation in the basin include the control of soil erosion through terracing, contour farming and gully control, among other actions. Stone walls and desert plants (e.g., cactus) also are used to trap sediments in the flood plains. Construction of check dams and semi-circular bands to reduce overland flow rate also is undertaken. Afforestation and control of tree cutting are other control measures done to minimize degradation. However, these techniques are long-term interventions requiring time, up to a decade or more in some cases, to counteract the lake's degradation.

Other management measures include re-seeding with high-yielding pasture, conservation of wetlands around the lake, and agro-forestry practices in the lake catchment using fodder trees. In addition to these measures, water harvesting and groundwater supplies are undertaken to provide alternative sources of water. Diversification of alternative livelihood opportunities is encouraged to reduce exploitation pressures

on lake resources. One possible way to do this is through facilitation of micro-enterprises.

A fishing moratorium involving the local communities was implemented to improve fish stocks in the lake. The moratorium was instituted after recognition of dwindling fish stocks, based on monitoring efforts by Kenya Marine and Fisheries Research Institute (KMFRI) and the Fisheries Department. The fisherfolk were experiencing losses in income due to dwindling fish stocks; thus, it was not difficult for them to accept the moratorium in anticipation of better yields in the future. When a monitoring report was presented by KMFRI and Fisheries Department, they readily agreed to impose the moratorium, which involved instituting a fishing ban until the fish stock improved. The moratorium was enforced by the Fishermen Cooperative and the Fisheries Department. It involved regular surveillance to control illegal fishing, as well as ensuring the use of recommended gear ratios when the ban was lifted. Although fishing is a major income-generating activity for the communities around the lake, they are not entirely dependent on it, but also engage in agro-pastoralism and micro-enterprises. During the fishing ban, therefore, they concentrated on these other livelihood opportunities. However, regulated subsistence fishing, using hooks, was allowed to continue among the communities living on the island. Some opposition to the moratorium was noted from a few individuals, who continued to poach. This situation, however, diminished with time, following community participation in surveillance and education facilitated by the LBCB land and water management project.

The progress in increasing fish production during the moratorium was monitored by the Fisheries Department and KMFRI. The outcome of the exercise was disseminated to stakeholders through quarterly reports and stakeholder forums. Recent spot checks showed that the ban, instituted about two years ago, has allowed Tilapia (*Oreonchromis niloticus*) to grow to an average size of 29 cm, from the previous average of 15 cm. To prevent future moratoria, overfishing should be minimized by requiring use of the correct-sized fishing gear, regulating the number of licensed fishermen, and regular surveillance to prevent illegal fishing. In contrast to the fish moratorium, erosion control in grazing lands has had little success. This is because, when compared to the lake, a common resource, the cattle which cause overgrazing are individually owned by pastoralists, who are reluctant to control herd numbers to conform with the land's carrying capacity.

Wildlife conservation and community-based water projects also are being undertaken to further reduce degradation of the lake and its resources. Some of the biodiversity conservation activities are fish and bird counts, protecting endangered species, prohibition of illegal poaching, and establishment of a Ramsar site for Lake Baringo.

The current management initiatives in the Lake Baringo drainage basin are mainly sectoral. Activities currently receiving the most attention include fishing, soil conservation and agro-forestry, tourism development and biodiversity, micro-enterprises, and water resources management. Through its designation as a Ramsar site in 2001, Lake Baringo is now recognized as a wetland of international importance, therefore open to funding opportunities to conserve its resources, support livelihood opportunities and reduce land degradation. The management plan under development is aimed at integrating all the sectoral plans, and is in accordance with the Ramsar Convention. Lake Baringo itself is in trust land, with its management under the jurisdiction of the Baringo County Council. The council focuses on income-generating activities (e.g., tourism, fishing), however, with little attention given to catchment conservation. With the development and implementation of an integrated management plan, therefore, it is anticipated that the management of the lake and its basin will be diversified, and include both income and non-income generating activities, as well as incorporating all stakeholders.

4.5 Conflicts and Constraints

The institutions responsible for managing Lake Baringo are not devoid of constraints; this hinders the sound management of the lake. One constraint is the lack of resources, such as boats for surveillance. The Fisheries Department, for example, has been incapacitated and could not carry out regular surveillance for an extended period of time, due to lack of motorized boats. This has resulted in cases of illegal fishing during the period of the ban. Coordination of stakeholder activities is another constraint in managing the lake. This is because every stakeholder has a program of activities, which may not conform to others, in as much as they have a common goal of sustainable management of natural resources. Conflict of interest is another drawback in lake management. This is particularly so with the local communities, who exploit the resources of the lake and its basin to meet their livelihood needs. The fishing ban may conflict with the interest of the fishermen to meet their livelihood needs through fishing activities.

Grazing of cattle along the lakeshore, especially during dry seasons, is another area that has generated controversy. The pastoralists keep large herds of cattle, which cannot be sustained by the available biomass, especially during dry seasons. Consequently, they enter the lakeshore areas, where their cattle graze and destroy the habitats of other plants and animal species. Control of the number of the herds as a management strategy is a practice which is not acceptable to the pastoralists. As an alternative, a participatory range management plan that regulates access to grazing lands and movement of herds could be developed and implemented. The plan could be derived from traditional systems, with involvement of pastoralists and enforcement by elders. Through CBOs, rotational grazing can be introduced, in which herds are rotated to allow re-vegetation. This is likely to increase the carrying capacity of the rangelands, and will readily be accepted by the pastoralists. Lack of support, ineffective legislation, lack of transparent decision-making systems, lack of qualified personnel in environmental

management and lack of sufficiently trained personnel are additional drawbacks affecting the institutions.

The lack of a management plan for the lake and its drainage basin is another management constraint. Since the current management initiatives are sectoral, the negative impacts that may occur from an activity also are likely to influence other sectors. Such sectors may have difficulty in formulating solutions to problems whose origin they may not know. The construction of dams upstream for domestic water supply, for example, resulted in reduced flows downstream and into the lake. Consequently, the downstream population suffered from inadequate water supplies, which they need, not only for domestic use, but also for irrigation. Fish production also decreased partly because of reduced inflows into the lake. Siltation of Chemeron Dam is another side effect that has reduced the capacity of the dam and, hence, the reliability of the downstream water discharge to meet irrigation needs. Since there is interconnection between the activities of various sectors, however, involvement of all stakeholders is inevitable. This requires a management plan and a clear Government policy, especially on lake management, which is unfortunately still lacking.

Other constraints to the management of Lake Baringo and its drainage basin include the following:

- Lack of local expertise, lack of coordination, retrenchment of staff, especially in government institutions, and low incentives, which demoralize personnel responsible for effective management of resources;
- Inadequate understanding by the public and decision-makers on the effects of human activities on the lake and its drainage basin;
- Lack of data and information about the problems facing the lake and it drainage basin;
- Inaccessibility to information on past studies and research on the lake and its drainage basin;
- Lack of understanding by many lake basin inhabitants, especially among those who live on the hillslopes at a considerable distance from the lake, about their individual roles in causing lake problems;
- Lack of knowledge by most of the indigenous communities of what actions to take to help solve lake problems;
- Lack of feedback of information to government officials;
- Frequent droughts and floods;
- Inadequate accessibility to safe water;
- Livestock diseases;
- High land preparation costs;
- Limited market opportunities;
- Lack of public awareness; and,
- Land tenure system and cultural values.

Some constraints can be minimized through environmental educational programs. The conflicts, on the other hand, are resolved from two possible approaches. One way is through the Provincial Administration, whereby the District security teams from different districts organize roundtable discussions to find amicable solutions to the conflicts, or to enforce law and order among the conflicting groups. The other approach is through village elders from the conflicting groups. The elders usually can easily identify the root causes of the problem and help find solutions acceptable to the conflicting groups.

4.6 Capacity Building and Public Participation

Capacity-building efforts undertaken to manage the lake and its drainage basin include training of farmers to create awareness, so that they become receptive to resource management initiatives. These activities include the involvement of local communities in the tree-planting process, participation in programs such as the Kenya-Finland Livestock Development Programme Bull Scheme, which also entails empowering women's groups in land rehabilitation. Other activities include on-farm demonstrations by extension workers, village environmental committees to oversee the day-to-day implementation of the on-farm management practices, and training extension staff regarding new technologies. Strengthening institutions through facilitating support of micro-enterprises on income diversification and educational visits to demonstration sites are additional capacity-building initiatives.

As part of capacity-building activities, an excursion to Lake Bogoria resulted in passing resolutions that were to be used as guidelines to ensure good management of the lake. These were as follows:

- Formation of beach committees;
- Joint patrol and surveillance with the Fisheries Department;
- Supporting research to determine the rate of recovery of the lake's fishery;
- Participation in tree planting; and,
- Involvement of women groups in fodder farming and zero grazing.

One of the experiences of stakeholder involvement is that they tend to participate in activities in which they will get

direct benefits, or if the activities are linked to their livelihood needs. Creation of awareness among stakeholders on the importance and value of the lake, and the need to conserve it, has been made possible through training, sensitization and mobilization, using PRA methods. Such methods include field days, workshops, seminars and demonstrations in which the stakeholders learn through participation.

4.7 Financial Investment

Financial investments made to help solve the problems associated with the sustainable use of the lake and its resources include:

- Ministry of Livestock and Fisheries—US$30,000 between 1998 and 1999;
- Local Afforestation Scheme (LAS)—US$52,000 for 1.8 million seedlings for planting during 1999 and 2000;
- UNICEF and various NGOs—US$107,000 in 1999-2001 to undertake community-based water projects;
- Kenya-Finland Livestock Development Programme Bull Scheme for cow rotation—approximately US$74,000; and,
- UNEP/GEF, through LBCB project—approximately US$750,000 during 2001 to 2003 for capacity building and rehabilitation of degraded Lake Baringo basin areas.

4.8 UNEP/GEF LBCB Project

Environmental degradation was identified as a major constraint to development in the Lake Baringo basin. The increase in both the human and animal population beyond the land carrying capacity, and unsuitable land use activities, in the drainage basin resulted in a decrease in the natural resource base that supports livelihoods and biodiversity. The environmental status of Lake Baringo has been the concern of the Government of Kenya (GOK), NGOs and local communities for a long time. In 2000, the GOK forwarded a proposal to UNEP to fund the LBCB Project, with the main objective of building the capacity of the local communities and institutions to respond positively in addressing the impacts of land degradation, through demonstration of best land use practices. The project was formulated with line ministries, in consultation with the local communities and other stakeholders. The entry point to the communities was through PRA and socio-economic surveys, with the main problems focusing on land degradation, biodiversity conservation, and aquatic resources.

The approach adopted was to facilitate institutions to build their capacity for sustainable environmental management. The advantages of this approach include involvement of stakeholders in a participatory manner, strengthening of institutional partnerships/synergies, resource mobilization, and ownership.

The disadvantages of this approach include weak partners, little budgetary harmonization, ownership of credit concerns, lack of transparency, and high expectations from stakeholders.

The entry point of the UNEP/GEF Project was to build capacity for managing natural resources and improving income through facilitation of various stakeholders. One such activity to which UNEP/GEF funds were committed is micro-enterprise, which was introduced to assist organized community groups to engage in environmentally-friendly income-generating activities, in order to relieve land use pressures and, at the same time, raise people's livelihood standards. Other activities include environmental education and conservation programs, facilitation of stakeholder forums, and policies and facilitation of research.

4.9 Achievements of UNEP/GEF LBCB Project

The LBCB Project facilitated eight women's groups, two self-help groups, and a community-based organization. Financial grants totaling US$16,500 were allocated to fund micro-enterprise and conservation activities, including the purchase of zero-grazing animals, poultry-keeping, merchandise kiosks and market day trading, purchase and sale of livestock, agro-vet store establishment, food crop production, roof water catchment, and soil and water conservation measures. Overall, 294 households, with a population of about 1,000 people, were involved. The assessment results revealed that, out of the total grants released, US$10,000 (61.24%) had been utilized by end of June 2003, with a revolving fund build-up of US$7,000 generated by four groups.

The achievements brought by micro-enterprise support include the establishment of 70 acres of pastures, 25 acres of agro-forestry plots, 55 acres of food crops, and purchase of 16 dairy animals and 200 poultry birds. Others included 2,000 goats bought or sold, 16 roof water catchment tanks, and 60 energy-saving Jikos. The benefits accrued from these achievements included increased sources of income to the groups and individual members, on-farm manure sources from dairy and poultry units, group-managed credit facilities, up to 900 man-hours per month saved for other farm activities, technology transfer to neighbors, reduced water-borne disease incidences, and savings on wood fuel. Other significant achievements are listed below.

- Production of baseline information on Lake Baringo on land cover mapping, hydrological data, soil erosion assessments, socio-economics assessments and biodiversity inventories. The reports were produced in collaboration with consultants from local universities and research institutions. The information generated has been used to formulate project activities and disseminated to other stakeholders.

- Support of research institutions through procurement of scientific equipment and means of transport. The project procured scientific equipment for KMFRI worth US$5,000 and a boat worth US$3,000. The project also procured a boat engine for the Fisheries Department, worth US$3,000, for routine surveillance in the lake.

- The facilitation of dialogue and formation of partnerships among government, NGOs and community institutions on resource management.

- Creation of increased project awareness, which has caused the local people to establish four community-managed wildlife sanctuaries in Kaptuya, Kichirtit, Rugus and Kampi ya Samaki. The Ilchamus community is currently negotiating with the Giraffe Centre for the return of the Baringo Giraffe to its original habitat in Baringo. The Kenya Wildlife Service and LBCB project are currently assisting this community to make the sanctuaries operational.

- Facilitation of extension agents from the Department of Agriculture to assist farmers to develop soil and water conservation structures. Over 30,000 m of terraces have been constructed to date. An encouraging outcome of this effort, which will act as an incentive for conservation, is the successful harvest these farmers got after previous years of crop failure.

- A successful lobby with the Baringo County Council to establish a management committee for the Lake Baringo ecosystem. The committee draws its membership from the Baringo County Council, District Administration, other government departments, community leaders and NGOs. It is responsible for the management of the lake ecosystem, and is currently working on developing an integrated management plan. A major outcome of this initiative is the designation of Lake Baringo as Kenya's fourth Ramsar site. Through this initiative, the management committee, in consultation with the local fishermen cooperative and other stakeholders, unanimously agreed to a moratorium on fishing in Lake Baringo to allow the depleted fish stock to recover.

- Assistance to the Baringo County Council, Samburu County Council and the District Security teams in the two Districts to re-open the Samburu-Baringo component of the northern tourism circuit, which had been closed since 1991. The project procured communication equipment for monitoring the movement of tourists and their security along the route. The communities along the circuit were also trained to generate income, through the sale of artifacts and the establishment of cultural centers.

- Participation in the review of government policies in the wetlands, livestock marketing and tourism sectors. It also includes participation in the regional wetlands policy formulation workshop, and input of significant contributions subsequently incorporated into the draft policy. In livestock marketing, the project contributed to the National Poverty Reduction Strategy Paper (PRSP), through the Pastoralists thematic group. On tourism policy, the project presented its recommendations to the review committee during the regional workshop in Eldoret. The project also is pursuing forest policy development.

- Facilitation of the rehabilitation of degraded lands was achieved. Relevant efforts included grass reseeding of 32 individual plots, promotion of agro-forestry practices in seven schools, protection of ten water springs, promoting water harvesting techniques for dryland farming in 20 farms, support for the establishment of four demonstration sites for alternative livestock fodder, and promotion and construction of 40 energy-saving stoves.

- Participatory management and conservation of biodiversity also was undertaken. In the process, eight locational environmental committees were established, and four community conservation groups registered. Further, 20 government officers were trained in short courses on gender and agro-meteorology. Community workers also were trained in participatory agricultural extension methodologies. The project also integrated various Locational Environmental Action Plans (LEAPS) and sectoral plans into a management structure for the entire Lake Baringo ecosystem.

- Facilitation of capacity-building and sustainable livelihood security also was achieved. Relevant activities included facilitation of seven groups of micro-enterprises, planting of 1,546 mango and 867 macadamia seedlings, recruitment and training of farmers, procurement and distribution of seed varieties of drought resistant pulses worth US$4,000, and training of 60 pastoralists on livelihood risk management.

- Awareness creation programs, including environmental education, using video shows in 16 schools, eight exchange visits between communities and opinion leaders, and several study tours and exchange visits by the community to rehabilitation sites. The project also organized one joint meeting between District Environmental Committees from the four districts (Nakuru, Laikipia, Koibatek and Baringo) of the Lake Baringo drainage basin.

- Funds from other organizations for community-based projects were mobilized. These include a pledge of US$50,000 from UNDP Kenya for land adjudication in Salabani location, and US$50,000 from Tourist Trust Fund Kenya to facilitate development of tourism area plan for the Lake Baringo circuit. The project also negotiated for US$2,000 from the UNDP Kindelevu

Project for the Marti water pan, and US$3,000 from World Vision for construction of the Lomunge water pan.

5. Lessons Learned

5.1 Stakeholder Involvement

Lake management programs should involve all relevant stakeholders and all other parties interested in the sustainable use of a lake and its resources. This practice will not only minimize the duplication of activities, but will also ensure wise and efficient use of resources. Through the sharing of information, knowledge will be generated and appraised. The interests of the community, preferences and values also will be taken into account in the management plan, thereby minimizing conflicts of interest. This approach also makes the community more receptive to lake management efforts. Care should be taken to involve members of the community from all strata in the management efforts, to ensure their interests are adequately considered.

5.2 Improvement of Livelihood Security

Local people will tend to support those interventions that they perceive to favor their aspirations, especially those that improve their livelihood security. For example, most farmers in the lake basin were not willing to construct terraces and other water conservation structures until they saw the successful harvest obtained by those who did so. Similarly, they do not see direct gains in natural resource conservation and management. This is exacerbated by the lack of critical mass with interest in resource conservation, communal land ownership and high poverty levels. Thus, it is important to develop environmental awareness packages with incentives, in order to build a conservation constituency at a grassroots level.

5.3 Diversification of Income

Income diversification offers more alternatives for meeting livelihood needs. It reduces over-dependence on one resource, which often can lead to environmental degradation. For example, the Pokots and the Ilchamus are mainly pastoralists and keep large herds of cattle which do not match the carrying capacity of the grazing land. This causes problems of overgrazing, with increased soil erosion and the siltation of rivers and lakes. In addition to land degradation, their animals die during drought periods, thereby reducing their livestock products. Other income-generating activities (e.g., bee keeping, micro-enterprises) are necessary because they reduce pressure on land and minimize risks.

5.4 Biodiversity—A Source of Income and Food

From the perspective of the local people, biodiversity in arid and semi-arid areas involves a pastoral risk management strategy. From their perspective, biodiversity is a source of food and income. During severe droughts, pastoralists hunt wildlife to supplement their protein supplies. Similarly, they burn acacia and other trees to produce charcoal for sale to compensate for livestock losses. Biodiversity conservation is acceptable to the local people if it can generate socio-economic benefits higher than the subsistence utilization, a mentality caused by a lack of awareness. It is worth noting that improved rangeland can attract more biodiversity with more gains. For example, four animal species have returned to a piece of land rehabilitated for a period of 12 months. Similarly, birds have built nests on trees in demonstration plots set up by a local NGO, whereas there are no nests on trees in nearby degraded areas. Thus, it is important to have sufficient information on biodiversity in the lake basin, including the social dimension of its conservation.

5.5 Conservation to Focus on the Means of Achieving the End Result

Conservation projects should focus not only on producing physical end products, like the total area and species conserved, but also on the means of achieving the end result. This is critical especially when multiple stakeholders are involved. The LBCB Project applied the participatory approach and formation of partnerships among key stakeholders to create synergy and increased sense of ownership, as a means of enhancing the conservation of natural resources in the Lake Baringo drainage basin. While it is prudent to take an integrated approach involving various development partners and stakeholders, it also is important to critically examine some of the underlying assumptions. Most development agencies share the same vision of livelihood improvement, but have their own preconceived ideas about community approach and implementation strategy. They also operate on different budgets and time scales. If the operations of these partners are not regulated and harmonized, it can create confusion for the local communities, and scrambling for recognition at the expense of conservation. The UNEP/GEF Project played a pivotal role in the synchronization of activities among the stakeholders through a participatory approach.

5.6 Awareness Creation, Capacity Building and Sustainable Resource Use

Creation of awareness and education of the stakeholders on various management scenarios are the major aspects of building capacity for implementing and addressing the principles of sustainable lake management. The local communities who are the direct beneficiaries, and who exploit the resources to meet their livelihood demands, should be made aware of the risks involved in such exploitation. In the majority of cases, they only consider the short-term benefits, at the expense of the long-term ones. In addition to the excessive exploitation of fish, the forest reserves also have been exploited not only in the hillslopes of the Lake Baringo drainage basin, but in all forest areas of Kenya. The forest area of Kenya is currently less than 2%, much less than the 9% forest coverage characterizing Africa and 20% of the

world. The Government of Kenya targets a coverage of 10%. As the Government plans to achieve this goal, education of the masses, to live in harmony with the natural resources, is essential.

5.7 Inclusion of the Entire Drainage Basin in the Lake Management Plan

The management of the lake should not concentrate only on the water body itself, but should also extend to the whole basin that drains into the lake. In most cases, the administrative boundaries do not coincide with river basin boundaries, as is the case for the Lake Baringo drainage basin, which is located in four districts of Baringo, Koibatek, Nakuru and Laikipia. However, the LBCB Project was designed only for the Baringo District. This made the involvement of the other districts in resource management efforts difficult, even though activities in parts of these latter districts in the catchment directly affected the management of the lake. Thus, management programs should be designed to include the entire drainage basin.

5.8 Financial Investment in Lake Basin Projects

Financial constraints made the UNEP/GEF funded LBCB Project focus mainly on the Baringo District. The project was a medium-sized project (MSP), for which the upper funding limit at the time was US$750,000. One lesson learned in this effort is that financial investments larger than that available through the MSPs are needed for formulating effective integrated lake basin management programs, and that time frames longer than three years, the average duration of an MSP, are needed to bring about changes in management of an entire lake drainage basin.

5.9 Water Conservation for Domestic and Livestock Use

Alternative water resources, such as rainwater harvesting through roof catchment, should be explored to supplement river water for domestic use. This will reduce water abstractions through damming, thereby also allowing more water to flow downstream and into the lake. This should be practiced not only in the semi-arid downstream area, but also in the humid upstream area as well. This is because the people located upstream use more water, while those located downstream, as well as the lake, are most affected by water shortages. Thus, the upstream population should rely more on rainwater for domestic use, so that most of the river water can flow downstream and into the lake.

5.10 Documentation and Extension

The information and data gained from lake management programs and experiences can be disseminated to national and local governments, lake management practitioners, non-governmental organizations and other stakeholders through reports, seminars, workshops and the Internet. All should be available in libraries as well, where they can be easily accessed. Field days through PRA also are an avenue for disseminating the information, particularly to the local communities.

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