Lake Nakuru

Experience and Lessons Learned Brief

*Eric O. Odada**, Department of Geology, University of Nairobi, Nairobi, Kenya, pass@uonbi.ac.ke
Jackson Raini, World Wildlife Fund for Nature, Nakuru, Kenya
Robert Ndetei, Wetland Programme, Kenya Wildlife Service, Kitengela, Kenya

* Corresponding author

1. Introduction

Lake Nakuru (Figure 1) is one of several shallow, alkaline-saline lakes lying in closed hydrologic basins in the eastern African Rift Valley that stretches from northern Tanzania through Kenya to Ethiopia (Livingstone and Melack 1984). Typical of shallow, saline lakes around the world, climatic variations have caused large changes in its depth and salinity on annual, decadal and longer time scales, with major consequences for the lake's ecology. Daily fluctuations in heating and cooling have resulted in strong cycles of stratification and mixing (Melack and Kilham 1974). High insolation and adequate supply of nutrients usually support abundant phytoplankton (Peters and MacIntyre 1976; Melack et al. 1982; Vareschi 1982). Supersaturation of dissolved oxygen in the upper waters during the day often is observed because of the high rates of photosynthesis (Melack and Kilham 1974; Vareschi 1982).

Alkaline-saline lakes rich in bicarbonate and carbonate (usually called soda lakes), such as Lake Nakuru, are among the world's most productive natural ecosystems (Livingstone and Melack 1984; Melack 1996). A conspicuous feature of these lakes often is the presence of enormous numbers of lesser flamingos (*Phoeniconaias minor*) grazing on thick suspensions of phytoplankton. Low species diversity, but abundant populations of aquatic organisms, make soda lakes especially suitable for the study of trophic dynamics and ecosystem processes (Vareschi and Jacobs 1985).

Biological communities in shallow, tropical saline lakes are susceptible to small variations in water balances and salinities. Paleoecologists have long exploited the salinity-driven shifts in aquatic communities of saline lakes as a means of trying to decipher the climatic history of tropical Africa (Livingstone 2000). In the 1970s, intensive limnological studies of Kenya's soda lakes documented striking changes associated with climatic variations (Melack 1996). During a period of low rainfall and abrupt salinity increase in Lake Elementeita (Kenya, 0°27' S, 36°15' E) and Lake Nakuru (Kenya, 0°22' S, 36°5' E), the phytoplankton abundance decreased, and the zooplankton species composition changed (Melack 1979, 1981, 1988; Vareschi 1982; Vareschi and Vareschi 1984). As species of phytoplankton, such as *Spirulina platensis*, *Arthrospira fusiformis* (Hindak 1985) were replaced by much smaller phytoplankton, the abundance of lesser flamingos also decreased markedly (Vareschi 1978; Tuite 1979). The birds declined at Lake Nakuru, for example, from over one million to a few thousand after the salinity rose about 25% (20 to 25 g/L between September 1973 to March 1974; Vareschi 1982). The phytoplankton abundance also declined, with the species switching to those too small for the flamingoes to filter from the water. Although the sensitivity of these ecosystems to modest changes in salinity has been demonstrated, the underlying mechanisms for the multiple responses could only be surmised (Melack 1988).

The Lake Nakuru catchment basin is a closed drainage system of 1,800 km². The Menengai Crater (8,060-2,040 m asl) lies to the north, Bahati Highlands to the northeast, Mau Escarpment

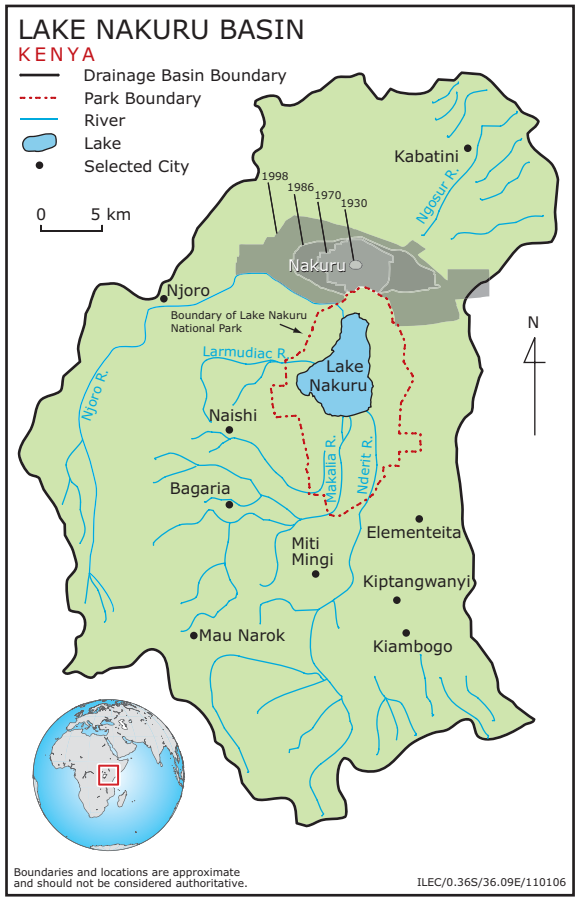

Figure 1. The Lake Nakuru Basin.

(3,000 m asl) to the west, Eburru crater to the south, and gentle grasslands between the Lake Nakuru and Lake Elementeita basins lie to the east. At the sump of this catchment basin is the insulated Lake Nakuru National Park, the buffer zone between human activities and the lake. The geology of Lake Nakuru and its catchment area comprises volcanic rocks (lava flows and pyroclastics) of the Tertiary-Quaternary age, which have been affected by a series of faulting. The soil also is of volcanic origin and, due to its high porosity, permeability and loose structure, is highly susceptible to erosion, land subsidence and fractures during or after heavy rain.

Archaeological evidence suggests that between about 10,000-30,000 years ago, the lakeshore was occupied by a hunter-gatherer people known as "Eburran". Neolithic people subsequently occupied the area, later giving way to the Maasai people, who still occupy some parts of the basin.

The catchment basin has two important biodiversity zones; namely, the forests shrouding the catchment's upper reaches and the Lake Nakuru National Park (LNNP). Interposed between these two zones are areas of human habitation with less biodiversity value, but which are dependent either directly or indirectly on the ecological services provided by the high biodiversity zones. Conversely, the areas of human habitation have direct and indirect impacts on the ecological stability of the biodiversity-rich areas. LNNP offers one of the most exciting concentrations of wildlife in Kenya. The park, occupying an area of 188 km^2, is endowed with diverse habitats, each with its characteristic fauna and flora. Eleven major ecological habitats are represented, ranging from the lake and the mud flats and salt marshes surrounding it, to mosaics of open and wooded grassland, dense forest, bush and cliff habitats.

The park has a very high wildlife concentration, consisting of 70 mammal species, 400 bird species and over 200 plant species. Lake Nakuru, the centerpiece of this wildlife showcase, is internationally renowned for the large concentrations of lesser flamingos that use it for feeding, displaying, and occasionally for breeding. The lake's main primary producer is the cyanobacterium, *Arthrospira fusiformis*, the preferred food of the lesser flamingo. The lake and its littoral area support over 70 species of waterfowl and water-related birds. Each year, the park's resident bird life is enriched by the presence of several species of Palearctic waders that use the lake as a staging ground during their winter migration down the Rift Valley flyway. LNNP is the second most frequently-visited park in the country, earning the Government of Kenya substantial revenue for a relatively low management cost. It is a popular destination for local and international tourists, annually receiving approximately 200,000 visitors and grossing over US$4.5 million from gate collections alone. It is Kenya's first Ramsar site, Africa's first bird sanctuary and a UNESCO-designated World Heritage Site. In addition to generating revenue for the Government, the park also has contributed to the socio-economic development of Nakuru town and its environs through tourism development, hotel accommodation, food, curio sales and other entrepreneurial activities.

2. Background

2.1 Biophysical Features

2.1.1 The Forests of the Catchment Basin

The forested areas of the catchment basin consist of the Eastern Mau, Eburru and Dondori forests (Figure 2). The Eburru forest, composed of indigenous tree species, covers an area of 8,736 ha, while the Dondori forest covers an area of 6,956 ha.

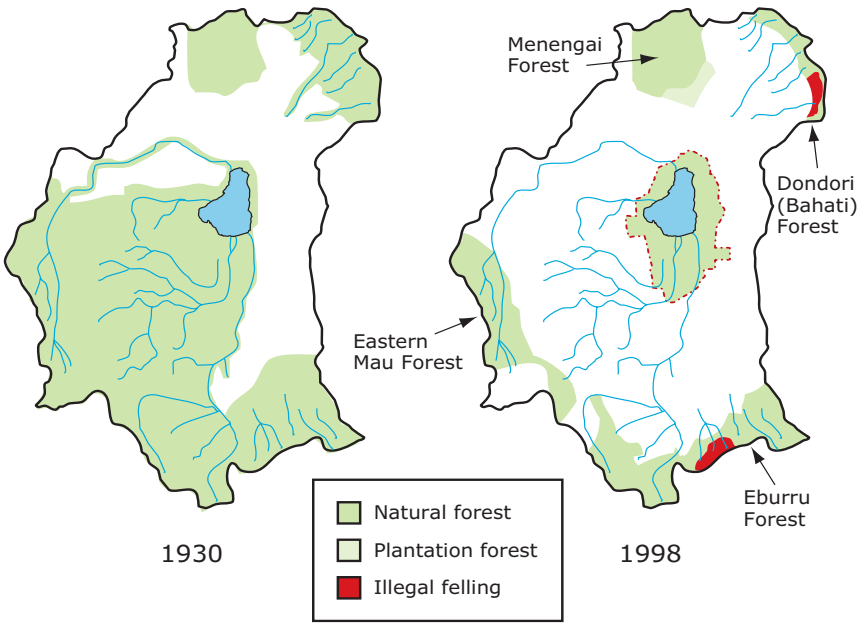

Figure 2. Changes in Forest Cover in Lake Nakuru Basin, 1930-1998.

The Eastern Mau forest forms part of a national watershed (the Mau Complex), being the largest of these forest blocks and covering an area of 65,000 ha. It is mainly composed of plantation and indigenous forests that have been progressively excised over the last 10 years to make way for human settlement. What forest remains now is restricted to the crest of the escarpment, and consists of thickets of bamboo interspersed with stands of *Olea capensis*, *Prunus Africana*, *Albizia gummifera* and *Podocarpus latifolius*.

The Mau forest contains a rich bird fauna, having been accorded Important Birds Area (IBA) status. Forty-nine of Kenya's 67 Afrotropical Highland bird species are known to occur in the Mau Forest Complex, including the grey-throated barbet

(*Gymnobucco bonapartei*), Luhder's bush shrike (*Laniarius leuhderi*), equatorial akalat (*Sheppardia aequatorialis*), red-chested owlet (*Glaucidium tephronotum*), banded prinia (*Prinia bairdii*) and black-faced rufous warbler (*Bathmocercus cerviniventris*). Of these bird species, 11 are listed in the globally-threatened (CITES I and II) category, including the Verreaux eagle (*Aquila verreauxii*), Amani sunbird (*Anthreptes pallidigaster*) and Taita thrush (*Turdus helleri*). Others include regional endemic species, such as Hartlaub's Turacco (*Turaco hartlaubi*), the restricted range Hunter's Cisticola (*Cisticola hunteri*) and Jackson's Francolin (*Francolinus jacksoni*). There is little information available on the fauna of this area.

2.1.2 Hydrology and Water Balance

At 1,759 m asl, Lake Nakuru is one of the highest lakes in the central Kenya dome of the Rift Valley, and its high elevation has hydrological implications on the lake's water balance. Unlike other low-lying Rift Valley lakes that have copious water supply through a series of hot and freshwater springs (e.g., Bogoria, Magadi), there is minimal underground inflow into Lake Nakuru through the axial fault line system. The Baharini Springs, and other springs along the eastern shoreline, are perennial, contributing about 0.6 m^3/s to the lake. The lake's hydrology is dependent on catchment supply through rivers, demanding catchment integrity in order to sustain the lake water level. It has a mean depth of 2.5 m, maximum depth of 4.5 m, and a water volume of about 92 x 10^6 m^3 (long-term mean of 1925-1979, as cited by Vareschi (1982)). The recent (1992-2002) monthly mean lake depth is 1.01 m (range cp: during the 1997/1998 El Niño floods.

Its shallow depth, high evaporation rates and seasonal rivers make the lake a hydrologically-impacted ecosystem, since it does not have any buffering capacity to withstand hydrological impacts driven by catchment processes. Five seasonal rivers (Makalia, Nderit, Naishi, Njoro and Larmudiac), and treated wastewater from Nakuru town, drain into the lake. Some of these rivers (Njoro, Ngosur and Naishi) become influent, disappearing along the fault lines to recharge deep aquifers. There is a clear streamflow response to precipitation in the catchment. The first peak flow occurs in May, a month after peak rainfall, while the second peak flow coincides with that of rain in August. Lake Nakuru is an enclosed lake, with only evaporation accounting for water loss from the lake. The long drought periods of 1993 to mid-1997 have resulted in particularly poor hydrological conditions, as evidenced by the excessive lake level decline (see Figure 3 in section 3.2). As expected, the salinity (as measured through conductivity) is inversely related to lake level/river inflow.

2.1.3 Climate and Rainfall

There is considerable variation in climate within the Lake Nakuru basin depending on altitude and topography. The climate ranges from cold and humid to arid and semi-arid—typical characteristics of the Rift Valley floor. Mean annual rainfall is 750 mm, with peaks in the months of November to December and April to May. It is influenced by the Inter-Tropical Convergence Zone (ITCZ). Mean annual evaporation is 1,800 mm. Isohyetal analyses show a general decrease in rainfall from the crest of the catchment towards Lake Nakuru, which is located in a rain shadow. The rainfall is mainly convective and occurs in the afternoons as heavy storms that may last between 10 minutes to one hour and they are quite erosive, with an energy range among the highest in Kenya. Gully erosion is rampant in northwestern part of the catchment. Areas undergoing serious erosion include newly opened forest zones.

There has been an increase in water abstraction along the upstream parts of the rivers for irrigation, domestic and factory use. There are over 350 registered and unregulated water intakes in the catchment streams. Deforestation, cultivation and urbanization, individually and collectively exert effects that alter the hydrological regime of an area. The destruction of forests poses dire consequences for the biodiversity they support and also has significant and cumulative impacts on the catchment hydrology. Springs that sustained human populations since their arrival in the area over 3 decades ago have dried up. The hydrological impacts are manifested in higher run-off rates; higher and more destructive peak discharges in rivers and other water courses, marked seasonality in stream flow and significant declines in the stable yields of wells and boreholes. As the demand for water grows and abstraction rates increase, the capability of the catchment to harvest and hold rainwater appears to be diminishing.

There are 156 registered boreholes in the catchment and a few unregistered. None of these are metered. The Njoro River watershed has over 41 boreholes in its upper reaches. Nakuru Municipality has over 55 registered boreholes, of these 35 are located in Kabatini aquifer, which recharges the Baharini Springs.

2.2 Political and Socio-Economic Features on Conservation and Development

2.2.1 Land Use and Settlement Patterns

Little is known of the settlement patterns in the lake's catchment basin prior to 1889, although the area has been an important center for human populations for many years, as evidenced by the prehistoric sites located in the vicinity (Horrobin 1971 cited in Mwangi 1994). European travelers visiting the area at the turn of the century provided descriptions of uninhabited landscapes teeming with wildlife (Elliot 1905; Chapman 1908; Percival 1928). Local tales describe occupation of the area by shifting cultivators and pastoral groups, who used the valley floors, grasslands and forest glades for cultivation and wet season grazing practices that continue to this day. Landscape modification during this period led to habitat loss and interference with the migratory routes of endemic wildlife. Together with uncontrolled hunting, this situation precipitated their decimation and dispersal (Kutilek 1974).

At Kenya's independence in 1963, pressure to allocate land to the landless led to a new wave of settlement schemes on the existing large farms, which were sub-divided into

smaller, individually-owned parcels of land. As demand for land increased over the next decade, encroachment into the forest reserves occurred, gradually eroding the thin mantle of protection afforded to the lake by the forests. This settlement was characterized by poor land use planning, with little regard for environmental considerations such as slope and soil characteristics, and leading to degradation of soil conservation structures constructed during the colonial period. The farmers, determined to emulate their more progressive counterparts in other parts of Kenya, invested in hybrid seed, fertilizers and pesticides to boost crop yields. Between 1967 and 1986, more than 400 km^2 of forest and land under natural vegetation in the catchment basin were cleared for settlement. During this same period, the area of the catchment under forest and natural vegetative cover declined from 47 to 26%. Declines also occurred in the land area under large-scale farming and ranching, with small-scale subsistence farming burgeoning from insignificant levels in 1970 to over 35% of the catchment area in 1986. The type of farming practiced by the new settlers depleted the resources available for restoring or improving soil fertility, or curtailing erosion. Land allocation for farming on steep slopes, often exceeding the 55% gradient stipulated by the Agricultural Act, further exacerbated the erosion problem. In combination with other factors, this situation led to a progressive decline in environmental quality and crop yields over the ensuing years.

The aggravating factors include insecure land tenure, inaccessibility of extension services and technological options, low farm prices and disposable income, recurrent droughts, crop pests and, in some cases, wildlife depredation. Large-scale farms (›100 acres), with trained managers and greater access to capital, were able to modernize their operations in the post-independence era, emerging as the most productive farms in the country. However, these gains were achieved and maintained through heavy investments in agricultural machinery and agro-chemicals.

The remaining natural forests in the catchment were gazetted in 1989, and brought under the management of the Forest Department, a time when tree felling in Kenya came under more stringent regulation. In areas bordering the forest, farmers were still able to buy building poles and harvest dead wood from the forests to feed their hearths. In more removed areas, however, where tree planting on farms was equally scarce, fuel wood and building material shortage was beginning to be felt. In the Mwariki settlement on the outskirts of Nakuru, for example, farmers paid more than 30% of their annual income purchasing fuel wood.

In a highly controversial move, the government de-gazetted over 20,000 ha of the Eastern Mau Forest on the western divide of the catchment basin in 1994, a major national watershed, and the source of feeder streams to Lake Nakuru. The decision was ostensibly taken in the interests of "landless" forest dwellers who had been marginalized and excluded from the mainstream of national development since 1946. Other individuals took advantage of this situation to secure parcels of land and, between 1994 to the present, over 30,000 ha of natural and plantation forest are estimated to have been clear felled and the land put under the plough. An influx of estimated 30,000 people migrated into the catchment, drawing attention to the willful blindness of politicians to the environmental consequences of their decisions, and also to the apathetic response of stakeholders, including the resident communities, who stood to lose the most. Despite a belated ban on felling imposed by the government in early 1998, illegal felling continues in the Mau and Dondori forests (Figure 2). However, the December 2002 general elections brought political change in Kenya, which undoubtedly induced institutional changes, and the new regime appears committed to environmental restoration.

2.2.2 Development of Lake Nakuru National Park

The present LNNP resulted from a series of events. In the 1950s, although the lake was one of the best sites for observing flamingos, it also was an ideal site migratory bird sport shooting, raising concern with nature lovers concerned with the fate of the flamingos and who lobbied the Government for protection of the lake. The flamingos were eventually protected under the Royal Game Ordinance 12/51 Section 4, as they faced decimation through commercial exploitation for feathers. In 1952, soda fish (*Sarotherodon alcalicus grahami*) were introduced into the lake from Lake Magadi, diversifying the waterfowl species by attracting fish-eating birds.

Lake Nakuru was declared a conservation area in 1957, and the southern lakeshore was established as a bird sanctuary to protect the lesser flamingos in 1960. The southern two-thirds of the lake was designated a bird sanctuary under the Kenya Royal National Parks in 1961. During 1964-1972, several conservationists (including WWF) undertook to expand the park, when 14,000 to 50,500 acres of land were purchased at a cost of US$500,000. People in many parts of the world, particularly children, raised significant funds in a matter of weeks to help "Save Lake Nakuru".

In 1990 LNNP was designated as a Ramsar site (site No. 476); a Wetland of International Importance, especially as Waterfowl Habitat. Over the years, LNNP has become an island of nature surrounded by a sea of humanity. The potential effects of this insularization are particularly worrying in regard to the sustainable use of the lake.

2.2.3 Development of Nakuru Town

Nakuru was founded in 1904 as a railway outpost, 160 km northwest of Nairobi. It is located along the east-west transport route across the country, linking the Kenyan coast with the Lake Victoria region and neighboring Uganda. It is situated at an altitude of 1859 m as. on a remarkable, overwhelming setting between the Menengai Crater (second largest crater in Africa) and Lake Nakuru, home of the famous flamingos.

Within this region, Nakuru occupies a preeminent position as the administrative capital of the Rift Valley, and as industrial, commercial and service center for the surrounding agricultural

hinterland. It is linked with other towns in the region by a rail and road network. The town is the Headquarters of Nakuru District, and a principal town in the hierarchy, with over 300 trade and service centers in the district.

Nakuru is the fourth largest town in Kenya, supporting a population of 400,000 people. The urban population has been growing at a rate of 10% per annum over the last 3 decades. To accommodate this population growth, the town's boundaries have been progressively extended, presently occupying an area of 290 km^2 (See Figure 1). Land use in Nakuru's developed area is dominated by housing (70% of the area), followed by industry and commerce (18%), and transport (2.5%) (Mbagwa et al. 1998). It also is a major hub for the transportation sector, serving as a transit point for vehicles destined for Uganda, DR Congo, Sudan, Burundi and Rwanda. Once dubbed "the cleanest town in East Africa", Nakuru's standards of urban services and infrastructure have since fallen rapidly, greatly compromising the quality of the living environment.

Because Nakuru is squeezed between the crater to the north and the lake to the south, the urban area develops toward the west, which is geologically unstable, and to the east, an area of rich agricultural value. The conflict between the need for urban expansion and the need to protect the fragile nature results in a complexity posing major challenge for sustainable urban development and lake management.

Like most cities, Nakuru is a large resource consumer and a prodigious waste producer. Although only 19% of the town is covered by sewerage, about 9,000 m^3 of sewage is generated each day. It is being processed in two treatment plants before being discharged into the lake. The town also generates an estimated 240 tons of domestic solid waste per day, with about 60% being moved to approved dumping sites. The remainder accumulates in the environment, being eventually deposited in the lake by stormwater and wind. Pre-treatment of industrial waste is the exception rather than the rule, and stormwater is discharged into the lake without prior treatment.

In terms of lake management concerns, the most significant development in recent years was urban sprawl, with encroachment into farmlands, forest and wildlife habitats at the town's periphery, and the growing waste burden. These developments have adversely affected the water balance and water quality of Lake Nakuru and its feeder streams.

2.2.4 Economic, Social and Health Issues

The major economic sectors in Nakuru are agriculture, commerce, industry, mining, tourism and tertiary services. The main socioeconomic issues include:

- Declining employment trends in the district, against a background of increasing population and labor force;
- Low employment levels and growth in the main complementary towns, compared to population and labor force growth;
- Urban areas in the district are the main employment centers, contributing to more than half of the jobs in the district;
- Excess capacity in resource utilization within the district (tourism, farming, etc.);
- The town contributes significantly to both employment and earnings in the district, enhancing its role as a regional capital;
- Inadequate infrastructure services to meet the densification trends of commercial activities both in the city center and the new areas (packing, service lines, roads, public utilities, etc.);
- Inadequate appropriate space for growth of informal commercial and industrial activities;
- The town's declining industrial base has affected the contradictory policies of the government (high interest rates, poor infrastructure, poor pricing of agricultural produce, etc.) and the liberalization of the economy;
- The town has lost its location advantage, despite its centrality and connectivity to other towns through regional, national and international railway; and,
- Lack of municipal policy on urban economic growth and development, especially industrial and commercial growth (Nakuru Strategic Structure Plan 1999)

Housing is provided by the 3 sectors (government, private, council) in Nakuru, with the private sector being the largest provider. Most structures are unplanned, however, and lack essential amenities (roads, water, sewer, electricity, etc.). Nakuru also faces acute water shortages, with the water demand being 45,000-50,000 m^3/day, resulting in a shortfall of about 1,000 m^3/day. The population increase is putting pressure on the water supply, which partly comes from boreholes, and is likely having repercussions on the underground water supply on which Lake Nakuru partially depends.

The main health providers in Nakuru are government, municipal council, private sector and churches. Like other services, health services are concentrated in high and middle-income areas and the central business district. The low-income areas lack these facilities even though they are where the residents live in unsanitary conditions and with inadequate clean water, leading to health risks. The Poverty Reduction Strategic Paper (PRSP) 2001-2003 indicated that water provision in Kenya is a necessity that has either been done free-of-charge or at a very subsidized level, ensuring that sustaining this policy has been a very illusive goal. In 1999 and 2002, there was a cholera outbreak in some of the Nakuru settlements, resulting from contaminated water, and outbreaks of typhoid and other waterborne diseases are common.

The HIV/AIDS epidemic is the single most important health challenge facing Kenya in its post independence history, causing an estimated 500 deaths each day. Over 2 million people are infected with HIV (about 13% of the adult population; according to the Government), and the Government declared HIV/AIDS a national disaster in

November 1999. Awareness campaigns have resulted in a drop in infection rates by about 3%. The impact of HIV/AIDS is nevertheless being experienced in many spheres, including lake management, because community time, efforts and other resources originally designated for improving livelihoods, and for providing water services and conservation planning, are now spent for HIV/AIDS-related activities. Research in the development of appropriate treatment regimen and vaccines has been encouraged, however, and Voluntary Counseling and Testing (VCTs) is being popularized.

In the rural areas, there is a large disparity between annual farm income among households (minimum US$0; maximum US$4,000), with detrimental impacts on conservation efforts in the basin. A high percentage of households (36%) have no off-farm income, implying a high rate of exploitation and dependence on the basin's natural resources, which could accelerate basin degradation (Aboud et al. 2001).

2.2.5 Financing Lake Management

Although financing management and conservation initiatives in the lake basin can be classified into various categories, the system adopted here is consistent with the land tenure system that can be categorized into Government or public land and private land. Government/public conservation land includes the National Park and the catchment forests, where conservation activities are Government-funded. Other funding mechanisms include bi/multilateral donor support and private donors. The specific area's managing authority is accountable to the Government for any of these funding mechanisms:

- Private land where the Government provides extension conservation activities or goes in partnership with NGO/CBOs, or where donors directly fund communities; and,
- Individual developers and local community finance conservation efforts on their land.

3. Biophysical Environment

3.1 Past and Present Conditions

Although humans have occupied the catchment basin for tens of thousands of years, and established permanent settlements since the turn of the last century, the most dramatic changes (from an environmental and biodiversity standpoint) have occurred over the last 30 years. The Scottish explorer Joseph Thompson journeyed from Naivasha to Lake Nakuru in 1884 and, upon arrival, stood at a high vantage point overlooking the lake, observing the splendor and awesome sight of thousands of lesser flamingos, densely packed along its brilliant white, soda-encrusted shoreline, and creating the unforgettable impression of a surging pink surf. Other outsiders following Thompson, Eliot (1905), Chapman (1908) and Percival (1924, 1928) were to remark that such an impressive assemblage of game could not be seen anywhere else in East Africa.

In 1904, Meinertzhagen reported seeing large herds of Jackson's hartebeest (now extinct) in the area between Nakuru railway station and the lake. (Meinertzhagen 1957 cited in Mwangi 1994). In the 1960's, long after the area's mammalian life was considerably decimated and dispersed, Peter Scott and Roger Tory Peterson still considered Lake Nakuru and its environs to be the "world's greatest ornithological spectacle".

The fate of Lake Nakuru and its environs was to change forever from the beginning of the 20th century, as outsiders flocked in from many areas to hunt, establish farms, build businesses and create modern towns and communication infrastructure. During the past 30 years, the basin was transformed from a sparsely-populated, densely-forested expanse, to a region that is heavily settled, extensively cultivated and rapidly urbanizing. This transformation was accompanied by a precipitous decline in the area's biodiversity. Wildlife also has been obliterated from most parts of the catchment area over the last 3 decades, with the clear felling of vast tracts of natural and plantation forest eliminating wildlife habitat and causing their decimation and dispersal. The only remaining bastions of biodiversity are the forests and the National Park, and even these areas are under threat from conversion to human settlements and the resulting alterations to the catchment's hydrology.

The extent of the Eastern Mau Forest was reduced by 28% between 1967-1989, largely due to excisions human settlements. Further degazettement of about 30,000 hectares of plantation forest followed in 1994, with illegal felling and burning within the gazetted reserve making further inroads into the forest thereafter.

The recent decision by the government to de-gazette a further 35,000 ha of the Eastern Mau Forest will reduce its present area by 50%, resulting in the loss of a large portion of natural forest, the main repository of this ecosystem's biodiversity. A similar situation prevails in Eburru and Dondori forests. A recent survey revealed that large-scale cultivation is occurring within the Eburru forest, and charcoal burning and illegal logging and cultivation is rampant in both Eburru and Dondori forests. Farmers living adjacent to these forests have abandoned exhausted farms to cultivate within the forest.

The Nakuru township was opened to industrialization in the early 1970's, with little thought being given to the impacts of industry on the ecology of the land or the lake, and no conscious effort being made to exclude industries that might present serious environmental problems. A fungicide (copper oxychloride) factory was constructed in the town and operated for a whole year before its impacts on the environment and its potential for polluting the lake were realized. The factory was relocated to another part of the country at a great cost to the government. Further, the town's first solid waste landfill was sited 0.5 km from the northern lake shore, remaining there for several years before the Park was extended to include this area and the landfill was relocated. Leachate from the landfill drained into the lake and the groundwater table during this period, as it does to this day long after being abandoned. Nakuru's first sewage treatment plant began operation in 1953, and began discharging sewage into the lake soon thereafter.

All these changes in the catchment and development in Nakuru have had impacts on the lake.

Recent analysis of river water and lake bottom sediments revealed enrichment with heavy metals and pesticide residues. A pesticide use survey in the basin revealed farmers are still using banned or restricted organochlorine pesticides (e.g., DDT, endosulfan, aldrin, dieldrin). Surveys of benthic macroinvertebrate communities in catchment streams indicate a progressive simplification in community structure from the river headwaters to their discharge points in the lake, being attributed to several factors, including streamflow alterations, alterations to the river bed substrate as a result of siltation, loss of canopy cover, and the toxic effects of pesticide residues and heavy metals. Waterfowl counts carried out at Lake Nakuru show a progressive decline in species diversity and numbers over the last 8 years, attributed to the frequent, protracted dryouts that have occurred in the lake over the last decade. (Further information on toxic and other forms of contamination can be found in WWF-LNCDP (1998)).

In view of these threats to the area's biodiversity, the main challenges confronting lake management including:

- Maintaining the vitality and integrity of the catchment;
- Restoring groundcover in the catchment to the maximum extent under existing land use regimes;
- Restoring the water balance and water quality of the catchment through better land use practices and sustainable water management;
- Entrenching the conservation ethic among catchment residents, and promoting sustained conservation effort by capacity-building and linking conservation with achievement of development aspirations; and,
- Monitoring trends in biodiversity and environmental conservation, in order to evaluate progress and identify new threats.

Major indications of a stressed Lake Nakuru ecosystem date back to 1990, when mass fish deaths were followed by the 1993 flamingo mortalities, and the 1994 lake drying, a likely response to the cumulative effects of disastrous negative impacts on the catchment that translated into lake environmental degradation. Since 1995, the *Arthrospira fusiformis* population in the lake has made only occasional, and very transient, appearances (Figure 3).

Replacing *Arthrospira fusiformis*, the lake's algal composition has been dominated largely by undesirable species of blue-green algae (e.g., *Microcystis sp.*, *Anabaena sp.*). Both species are known to flourish in nutrient-rich waters with high organic content, and both are capable of elaborating potent hepatic and neurotoxins to which birds and fish are susceptible.

Over 20,000 lesser flamingos died at both Lakes Nakuru and Bogoria in 1993. The deaths recurred in 1995 in both lakes, and have since become a regular phenomenon. Affected birds appeared to be in good physical condition, but exhibited a variety of clinical signs, among which neurological signs predominated. Although a comprehensive report has yet to be produced, the data collected thus far provides some information on the present health status of the lesser flamingo population. Liver and kidney lesions were predominant in the sampled birds and, since these organs are associated with the detoxification and elimination of toxic substances, it is tentatively suggested that exposure to toxicants may be occurring or that some disease may be the cause.

Finally, dissolved oxygen levels (Figure 3) vary from supersaturation to near anoxia as a function of stratification and high biological activity of the productive, natural community living in the lake. It is unclear how much more biological oxidation demand is added by the sewage and stormwater inputs.

3.2 Lake and Drainage Basin Resource Conflicts

Issues regarding equitable access to natural resources and sustainable environmental conservation and economic development have arisen in the Lake Nakuru drainage basin. The ever-increasing human population, poor enforcement of environmental regulations, and unsustainable exploitation of natural resources are root causes for human-resource conflict. Denudation and degradation of forestlands, clearing of riverbanks, lack of regulation of the mining industry, poor land use planning and urban development, the prevalence of poverty, and human-wildlife conflicts around LNNP exemplify the conflict between the catchment's natural resources and human population.

The communities in the catchment area are from different ethnic groups, having co-existed peacefully for over 30 years until 1992, when politically-instigated ethnic clashes erupted, resulting in many deaths, property destruction and population displacements. For months following the clashes, farming activities were abandoned and conservation activities came to a halt. The inter-ethnic fighting recurred at the beginning of 1998 with the same disastrous results, with land as the underlying issue of contention.

The human-wildlife conflict between the LNNP administration and its immediate neighbors has continued, with wild animals damaging crops and property in adjacent farms, while the basin inhabitants have continued environmental degradation activities.

The conflict between the need for urban expansion and the need to protect the lake has resulted in a complex situation posing vast challenges to sustainable urban development. The city's fragile ecological setting induces severe constraints and calls for limiting its growth. Conversely, the population growth and economic potential calls for enhanced urban development, and appropriate planning strategies. Thus, the views of all stakeholders in the development process are vital to achieve desirable future outcomes.

4. Management Environment

4.1 Lake Management Programs and Processes

Lake Nakuru is a protected National Park under the Wildlife Act. Although the Kenya Wildlife Service (KWS) is entrusted with managing the lake environment, KWS works in collaboration with other institutions, particularly in addressing threats to the lake originating outside the National Park boundaries.

The target states for healthy ecosystems in the lake catchment include:

- Highly livable cities and rural areas;
- Productive farms and forests; and,

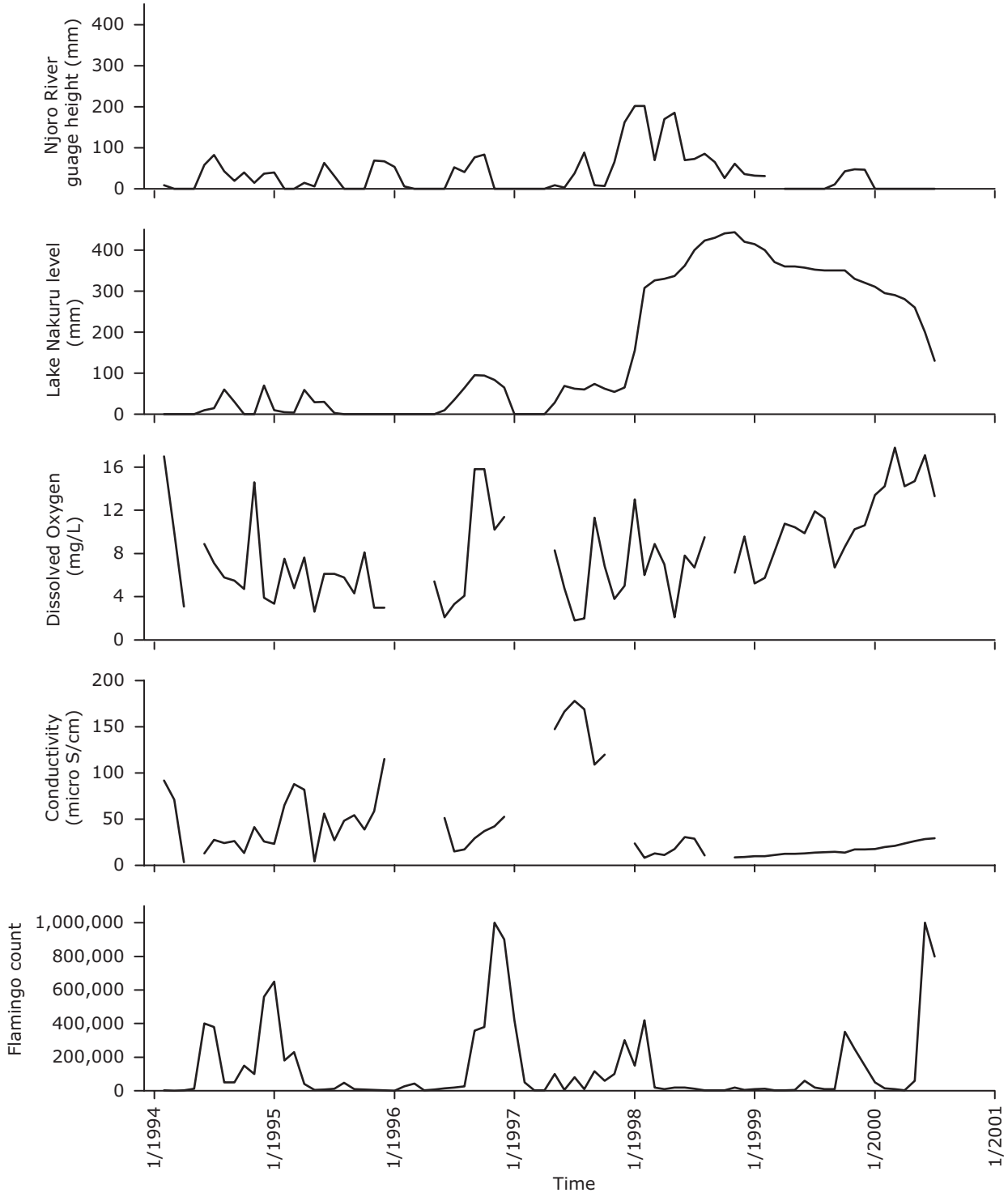

Figure 3. Njoro River Gauge Height, Lake Nakuru Level, Dissolved Oxygen, Conductivity and Lesser Flamingo Population, January 1994-June 2000 (Source: Official Monitoring Data).

- Clean streams, and a lake in which its inherent potential is realized, its capacity for self-repair when perturbed is preserved, and minimal external support for management is needed.

The first major lake management action took place in 1961, when the lake was declared a protected site, with subsequent expansion of a buffer zone. Only the southern two-thirds of the lake and a narrow littoral strip were initially accorded protection. The area under protection was increased to include the entire lake in 1968. In 1974, land was purchased to create a buffer zone around the lake, thereby increasing the park area to its present size of 188 km^2.

In 1970, WWF supported the establishment of the Baharini Wildlife Research Station in LNNP, the aim of the initiative being to generate information that would facilitate the effective management of the lake. Many sentinel ornithological and ecological studies were carried out at Lake Nakuru between 1970-1980.

The Wildlife Clubs of Kenya (WCK) opened its youth hostel in LNNP in 1972, initiating the first wildlife education program in the area. This program, primarily for school children, and other subsequent education and awareness initiatives, increased appreciation of the lake and its attributes, and increased local visitation between 1985-1997 by 70%.

The relocation of a fungicide factory operated in Nakuru was a major contribution to the lake's management. Further, establishment of a Black Rhino (*Dinecous bicopris*) sanctuary, and the subsequent international designation of Lake Nakuru under various conventions, boosted tourism and revenue generation for the lake's conservation.

Lake management programs are based on Government legislation and polices, and also linked to such programs as the National Action Plan on Desertification, Poverty Reduction Strategy Paper and National Biodiversity Action Plan. However, the institutions responsible for lake environment management are not devoid of constraints, some examples being:

- Inadequate resources (e.g., manpower, equipment, funds);
- Inadequate political support and conflict of interest;
- Weak institutional linkages;
- Inadequate capacity; and,
- Poverty prevalence and poor living standards of the local communities.

4.2 Institutions

The main constraints to lake basin management are social, economic and institutional in nature. National lake management systems already exist, and many development partners have demonstrated a willingness to help Kenya address problems of rural poverty through sustainable environmental conservation. All conservation initiatives in the lake basin should have a poverty alleviation component, whose implementation should involve local communities.

Kenya Wildlife Service (KWS). KWS is a government institution mandated to conserve and manage Lake Nakuru under the Wildlife Act, its mission being "on behalf of the Government of Kenya hold in trust for the present and future generations locally, nationally and globally the biological diversity represented by its extraordinary variety of animals, plants and ecosystems ranging from coral reefs to deserts and forests." To this end, KWS, in collaboration with other stakeholders and funding from the Royal Dutch Embassy, developed the Lake Nakuru Ecosystem Integrated Management Plan (LNEIMP) 2002-2012. This ecosystem plan addresses poverty alleviation, and focuses on reducing the challenges and threats facing the lake, and providing an ecosystem-based approach for managing environmental problems and rehabilitation of degraded sites.

Although KWS is actively involved in developing and executing management-orientated research, community and stakeholder mobilization, resource mobilization and administrative issues within the lake environment, it nevertheless has several major constraints in carrying out its mission, including:

- Inadequate resources, funds and equipment;
- Inadequate man power and capacity;
- Political interference;
- Inadequate support from collaborators; and,
- Donor dependency.

Municipal Council of Nakuru (MCN). Under the Local Government Act, MCN is in charge of urban development, setting trade effluent standards. and monitoring. Its major funders for development activities include JICA, World Bank and ADB. MCN has the capacity to collect wastes from established receptacles and make disposal at designated sites. MCN has recently expressed the intention in its strategic plan to privatize waste collection and disposal in some areas of the town, It also has a well-equipped water testing quality laboratory within LNNP, with plans for its joint operation by KWS, MCN and the Water Department.

Localising Agenda 21 in Nakuru. The Municipal Council has adopted Agenda 21, the Programme of Action agreed to by 179 nations at the 1992 Earth Summit (UNCED), reflecting a global consensus towards more integrated policymaking concerning environment and development. Chapter 28 of Agenda 21 calls on local authorities to undertake consultative process with their populations, to achieve a consensus on a "Local Agenda 21" for and with their communities. The Local Agenda 21 framework has been reconfirmed as a valuable approach in the Habitat Agenda to harmonize urban development and the environment, with core funding provided by the Belgian Administration for Development (BADC), and the Post Graduate Center for Human Settlements (PGHS) of the K.U. Leuven being the convener of a consortium of Belgian Universities, municipalities, consultancy firms and NGOs providing support

to Programme activities. Nakuru was the first African City to benefit from the Programme, through which the MCN adopted a resolution to develop a strategic structural plan for Nakuru (NSSP 1999). It was completed in 1999 and describes the existing spatial structure of the town, identifies key planning sectors and offers a vision of the intended spatial structure, including the institutional mechanisms for its implementation.

Production of the NSSP represents an important first step in organizing the town's different needs and requirements into a coherent plan of future development. Partnerships between the MCN and NGOs (e.g., International Council for Local Environmental Initiatives (ICLEI); Intermediate Technology Development Group (ITDG)) have enabled access to clean water and good housing, respectively, by various sections of the local community. However, the constraints to the MCN's efficiency, include:

- Inadequate manpower, capacity and commitment;
- Political influence and interference; and,
- Inadequate resources and equipment.

Ministry of Water Resources Development. This ministry operates within the lake basin under the Water Act, and is responsible for catchment water conservation, water apportionment, pollution control and monitoring, and resource mobilization for water resource development. Constraints to its activities include:

- Inadequate resources and equipment;
- Inadequate manpower, capacity and commitment; and,
- Wide coverage and mandate.

Forest Department. This department operates in the catchment under the Forest Act, being responsible for forest resource development, extension services and resource mobilization. Constraints to its activities include the same as above.

Ministry of Agriculture. This ministry operates in the catchment under the Agriculture Act, providing extension services on sustainable agriculture. Constraints to its activities include the same as above.

Kenya Agricultural Research Institute (KARI). This agricultural-based research institute is responsible for research, capacity building and extension. KARI has been active in reducing agrochemical pollution and siltation, and poverty alleviation, in the catchment.

Provincial Administration. The Provincial Administration is responsible for policy enforcement and creating an enabling environment for sustainable lake environment management. Constraints to its activities include the same as above.

Directorate of Occupational Health and Safety (DOHSS). The DOHSS operates from the Provincial Labor Office, having taken the lead in implementation of Pollution Release and Transfer Registers (PRTR) in Nakuru. The PRTR is a strategy for establishing best estimates of the quantities of pollutants released by local industry into the environment in their liquid and solid waste streams. Highly-experienced personnel also have devoted time and expertise to sensitizing the industrial community to initiate waste reduction programs, and collecting and managing data, with a database containing all the information collected from participating industries being maintained at this office.

National Universities. The mandate of the national universities is to train professionals in various fields, and conduct relevant research work that can lead to the country's development. These institutions have been instrumental in capacity building and applied research, with university staff carrying out specific surveys to identify and provide solutions to environmental problems and sustainable management of natural resources. Information and data collected by these institutions have contributed significantly to developing the integrated management plan for the lake environment, therefore influencing the management regimes of the lake environment. The University of Nairobi, in collaboration with KWS, undertook an elaborate study on invasive plant species in LNNP, and a detailed study that has shed light on the inter-lake movements and management needs of lesser flamingos. Although the public universities have a strong human resource capacity and expertise in various fields relevant to lake management (e.g., research, Participatory Rural Appraisal, ecological monitoring), they lack financial and material resources to enable them to effectively participate in their areas of strength, as well as lacking vehicles and other required equipment. The universities also do not have coordinated networking mechanisms and linkages that would make their research work useful for lake management, and the research in many cases is not management driven. On the other hand, most of the institutions involved in natural resource management also do not make full use of research findings from both local and foreign universities.

Egerton University, in collaboration with KWS, Fisheries Department and Moi University is implementing a component of the LNEIMP on the River Njoro watershed under the Sustainable Watershed Management (SUMAWA) project .

Egerton University. This university, located in the Lake Nakuru catchment basin, is crucial center for information and instruction. Egerton University is less than 25 years old, but has been addressing agricultural biodiversity issues for approximately 30 years while being essentially a training institution for agriculture, forestry and range management students. Since it was upgraded to university status, research in the genetic resources of indigenous crops and conservation of biological resources has expanded considerably. The scope of its training and research activities remains national, however, being less focused on Lake Nakuru's management needs. Nevertheless, the institution actively participated in development of the NSSP, LNEIMP, PRTR and Water Development Plan for Nakuru. Although the university has not officially adopted the Nakuru catchment as a focal

research area, several academicians are conducting research in the catchment basin, thereby being a potential source of advice for lake managers and the government on the basin's development options. Egerton University also has developed a narrative slide package for training farmers on soil and water conservation, carried out a land use and hydrology study of the catchment basin, and an assessment of erosion hazard areas to develop soil conservation management plans. Further, the WWF is carrying out a joint study to establish the cause of flamingo mortalities in Lakes Nakuru and Bogoria in 1993 and 1995.

4.3 Specific Projects

Multi-and bi-lateral donors (Royal Netherlands Government (RNG), UNCHS and BADC, AFD, EU, DANIDA, FINNIDA, DFID, JICA/JBIC, ADB, etc.) and several international non-governmental organizations (e.g., WWF, Earth Watch, World Conservation Union (IUCN)) have supported natural resource management programs in the Lake Nakuru basin. All have different objectives, conservation approaches, and operate under different funding regimes, resulting in a fragmented decision-making structure that disperses environmental management responsibilities among many organizations and agencies. Further, most of the donor-driven projects cease operation upon project completion due to poor coordination, networking and the inability of lead agencies to sustainably implement these lake management programs.

Greater Nakuru Water Supply Project and Nakuru Sewerage Rehabilitation and Expansion Project (GNWSP and NSREP). The GNWSP was signed in 1987, and initiated in 1992 with financial support from Overseas Economic Co-operation Fund (OECF; now the Japan Bank for International Co-operation (JBIC)), and implemented by the Ministry of Water and Natural Resources (MENR). The project was meant to supply water to the towns of Nakuru and Gilgil from the Turasha River near Gilgil and development of a treatment plant with a capacity of 18,000 m^3/day (13,300 m^3 for Nakuru and 4700 m^3 for Gilgil).

On completion of the GNWSP in 1992, the water supply was increased by 13%, with further unexploited potential. Although increased water supply was good news to urban residents, there also was a need to consider the implications of the GNWSP on Lake Nakuru's ecology, and incorporate measures in its design that would mitigate the anticipated adverse impacts, given that the sewage treatment plants were already overloaded and discharging poorly-treated sewage into the lake. The additional water supplies would increase per capita consumption in Nakuru, further aggravating the problem. This situation eventually led to rehabilitation of the Njoro Sewage Treatment Works (NSTW; capacity of 9,600 m^3 /day) and the Town Sewage Treatment Works (TSTW; capacity of 6,600 m^3 / day), part of a JICA loan and grant aid to address the increased wastewater volume associated with the increased water supply. To monitor the plant's effluent quality, a state-of-the-art water quality-testing laboratory was established.

Like many sewage treatment projects in Kenya, the NSREP was patterned on models employed in the developed world, which are not useful in assessing the impacts of shock volumes of stormwater generated during tropical rain storms, which are discharged untreated into the receiving waterbody. The quality of stormwater generated in Kenyan towns, however, is of poorer quality than that generated in developed world towns and cities, primarily because street-cleansing services in Kenyan towns are less efficient and environmental legislation directed to littering and waste disposal less stringently enforced. Thus, it is imperative that Nakuru stormwater be given some form of treatment before being discharged into the lake. Unfortunately, because of lack of technical know-how, low budgetary allocations, frequent equipment failure, poor maintenance of the detention ponds, institutional conflicts, etc, the efficacy of these structures has been steadily declining.

JICA/JBIC Special Assistance for Project Sustainability (SAPS I & II). The GNWSP and NSREP were evaluated jointly by JICA/JBIC in November 2000, confirming that the rehabilitated and expanded STWs contributed to conservation of water quality of Lake Nakuru. The evaluation also identified various environmental concerns, however, including discharges of industrial effluents, solid wastes, contamination from the abandoned dumping site in the park, and agro-chemical pollution from agricultural activities.

The overall goal of SAPS II, therefore, is "Harmonizing Development and Environmental Conservation in the Lake Nakuru Basin through Water Management". However, similar to many plans developed by key stakeholders, the consensus-based lake management and ecosystem-monitoring plan developed under SAPS II still is awaiting implementation. A weak commitment from the Government regarding its obligations (District Environmental Action Plan and the concept of protected areas), lack of capacity, funding, and institutional disputes regarding key project components, put the long-term sustainability of the initiative into question (JBIC 2002a and 2003 b).

WWF Lake Nakuru Conservation and Development Project (LNCDP). Operating under the Non-Governmental Organisations Coordination Act, the WWF Lake Nakuru Conservation and Development Project (LNCDP) was the pioneer Integrated Conservation and Development Project (ICDP) in the Nakuru basin and the second largest African WWF project. It was supported by the EU, ODA (DFID) and WWF International. The 1988-1992 pilot phase identified conservation issues and challenges in the catchment area, and demonstrated that improvements in farming practice could be achieved through education and the provision of material and technical support for conservation actions. The project objectives included (a) a resident population sensitive to local environmental issues, as reflected in their decisions and actions; (b) a population committed to, and benefiting from, integrated and sustainable land use; (c) an institutionalized program for monitoring and evaluating environmental health; and (d) development planning promoting the maintenance of environmental

health. Key project features included its catchment approach to conservation, establishment of strategic partnerships with local communities and organizations, building on existing resources and skills, and demonstrating how conservation can generate economic benefits.

Project achievements include defining the environmental issues in the catchment basin, establishing linkages between land use practices and environmental degradation, and drawing public attention to the threats to Lake Nakuru and the area's natural resources, with school children and urban residents actively involved in environmental awareness campaigns. The wider Kenyan public was informed through 22 newspaper articles in the local press, preaching environmental awareness to all strata of society within the catchment basin. Further, 38 industries in Nakuru committed themselves in 1994 to instituting measures to control wasteful consumption of natural resources and reduce waste emissions to the environment. Finally, the MCN has declared its intention to develop Nakuru town into an "Eco-City" in its 15-year Strategic Structural Plan.

Over 2,000 contact farmers, 41 unemployed youth and 14 chiefs and sub-chiefs have received intensive training in sustainable agriculture and transferred these skills to more than 40,000 other farmers. This voluntary community action laid the foundation for the emergence of village-based extension services, with villagers in 90 villages organizing themselves under the leadership of popularly-elected Village Environment Committees (VECs) who received training in leadership and conservation skills. They also have been engaged in a participatory process to articulate a village-based Natural Resource Management Plan (NRM), currently implemented in 48 villages. Data collected by Village Environment Committees (VECs) indicate that:

- 56% of the farms in the survey area had initiated or completed soil conservation measures;
- 63% of the farms had embarked on integrating trees with crops;
- 66% of the farms with a river frontage had no-cropping buffer strips along their riverbanks;
- 31% of the homesteads had installed energy efficient cooking devices, reducing their fuel wood consumption by 30-50%; and,
- 16% of the farms had constructed small earthen dams to contain water runoff.

Further, residents in 12 residential estates have formed Environmental Health Committees (EHCs) which, with assistance from the MCN conduct public education campaigns, monitor waste disposal practices and organize regular clean-up activities, with KWS, religious and youth groups recently joining in these activities.

Pollution control measures have been initiated by 22 industries in Nakuru with the full backing of the DOHSS, which maintains the relevant database and prepares and submits feedback reports to the participating industries. Eight front-runner industries have assessed their waste practices thus far, identifying priority waste products and developing Waste Reduction Action Plans (WRAPs) for implementation. The remaining 14 industries are at various points along this continuum, with this strategy now being mandatory under the Environmental Coordination and Management Act (EMCA) of 1999.

An environmental monitoring program for Lake Nakuru and its feeder rivers also has been developed, with infrastructure for measuring precipitation and stream flow in the catchment basin being put in place. Community monitors have been trained in monitoring rainfall, riverflow and some aspects of water quality. A 10-year database has been established at the KWS headquarters in Nakuru, including basic water quality parameters, sediment loads, nutrient fluxes, algal succession, benthic macro-invertebrate community structure, and basic hydrological parameters. Environmental contaminant baseline levels have been established and tracked at 5-year intervals, with their portals of entry also being identified.

Further, investigations related to the lesser flamingo deaths in 1993, 1995 and 1997-2000 were conducted, confirming the flamingos were exposed to several environmental toxins of natural and anthropogenic origin. Valuable information on normal health parameters for this species also will aid future diagnosis of death and debility.

Studies were conducted to evaluate the lake's status with regard to organochlorine and heavy metal contamination, as well as a survey to identify benthic macroinvertebrates at established sites along the major rivers, including their potential use as pollution bioindicators in the river water. The first study results confirmed the presence of pesticides and heavy metals and helped identify areas of the catchment in which the chemicals originated. The second survey identified organisms suitable for use as pollution indicators, as well as development of an identification key.

These various achievements represent a start in the long journey towards environmental restoration, sustainable lake management and biodiversity conservation in the catchment basin. Activities initiated by local communities in the urban and rural parts of the catchment are particularly encouraging, and deserving of continued support.

An independent mid-term evaluation in 1997, and an end-of-term evaluation in 2001 identified several features that made the project, "if not unique, then somewhat different from many conservation projects." Not only has it been running for nearly 10 years, but also has had the same Project Coordinator since its commencement in 1988. Although not without its problems, this longevity and continuity are considered important factors in the project's many achievements and overall successful implementation.

Another LNCDP feature is that, although initiated as an NGO project, it has become similar to an official or government project, as evidenced by its substantial budget, number of employees, multiple functions, extensive project area (1,800 km^2), and dependence on the cooperation and participation of government institutions. It obviously differs in its relative freedom from bureaucratic procedures and constraints, informal modus operandi and absence of hierarchy, flexibility of project management, and its adequate, readily-available funds, which gives considerable strength. Further, its project area is on an ecosystem basis; namely, the entire Lake Nakuru water catchment area, rather than the more common administrative basis (e.g., district), facilitating ecological problem identification and project interventions. Further, although increasingly common today, the linking of environmental conservation and development for the resident population promotes a balanced programme of activities (Wass et al. 1998).

The project currently has developed a proposal for supporting community initiatives that have emerged after several years of raising environmental awareness, providing training in conservation skills, testing interventions and demonstrating working models of conservation.

The initiatives proposed by rural communities address water conservation through improvements in soil management, runoff control, water harvesting and riverbank stabilization. The project approach is participatory and flexible, based on the belief that local people must be partners in decision-making, and recognizes there are diverse community interests that must be identified and incorporated into catchment management activities.

Social empowerment is regarded as important as economic benefits and, in fact, real economic empowerment requires social empowerment. The direct involvement of communities in managing their resources also emphasizes the basic principle that people must take responsibility for the resource—and therefore are accountable—before benefits flow.

Other key stakeholders in this process include the Forest Action Network, Friends of Mau Watershed, Forestry Action, and Catholic Diocese. The first two focus particularly on the protection and rehabilitation of gazetted forest, especially in the Mau Escarpment, while the third focuses on protection and rehabilitation of forests in both gazetted and trust land, and the last on promoting sustainable agriculture and supporting self-help groups and water supply.

All these stakeholders conducted and participated in 5 joint planning workshops between 1992-2002 in order to coordinate lake management efforts, achieving the following:

- A shared stakeholder vision of what can be achieved;
- Pooling of available resources to achieve maximum efficiency;
- Equitable sharing of responsibilities among stakeholders, including those not normally involved in environmental conservation; and,
- Enthusiastic participation in conservation efforts by the target community.

Against this background, NGO/CBO strengths include the ability to work at the grassroots level; experience in participatory approaches; and possession of important cultural, indigenous and local knowledge. NGOs and CBOs also generally operate in less-bureaucratic, more-flexible and cost-effective ways, thereby facilitating a faster mobilization of resources. NGO/CBO weaknesses include an often-unarticulated mission, strategic plan and/or clear focus; a discrepancy between ambitions and available resources and skills; and donor dependency. Some organizations also are over-territorial, leading to duplication of efforts and lack of collaboration.

4.4 Reduction of Lake Stresses

Lake Nakuru's location in an enclosed catchment basin subject it to myriad threats that increase stress on it. These stresses, however, have been reduced through various initiatives, including:

- Implementation of the JICA sewage rehabilitation and expansion project in 1996 greatly reduced the pollutant load, thereby contributing significantly to the lake's long-term conservation (Table 1);
- Some industries are deriving benefits from the PRTR (e.g., Spin Knit (K), Ltd., a textile industry for the local and export market, after estimating and valuing the costs of oil discharged from the factory, the management introduced an improvisation cutting its energy costs by 5%, translating into a monthly saving of US$5,000);
- Soil loss from conserved farms has been dramatically curtailed, resulting in stabilizing crop yields and improved soil quality. Planting more than 200,000 trees each year is steadily improving ground cover, and is expected to alleviate the fuel wood crisis and have a positive effect on the catchment's water balance. Failure to document comprehensive baseline data on people's attitudes and the state of the environment prior to the onset of project activities, however, has sometimes made it difficult to demonstrate how the project has led to improvements in the lake's environmental status;

Table 1. Biological Oxygen Demand (BOD; ton/year) of Effluent Entering Lake Nakuru.

Pollution load sources	1995 (before project)	1997 (upon project completion)
Njoro Sewage Works	1,843	53
Town Sewage Works	1121	36
Urban stormwater	161	113

- The LNEIMP has identified critical habitats in the lake basin and prescribed management actions for each zone, including species-critical habitats designated as no-use zones, areas for research, areas for recreation, and specific sites where development can occur; and,
- The government has attempted to harmonize environmental conservation efforts by establishing EMCA as the environment-coordinating institution.

4.5 Traditional and Gender Roles in Basin Resource Management

Most of the residents in the catchment have no long-term knowledge of the local environment, with many hailing from pastoralist backgrounds with no experience in sedentary farming. Some communities still rely on traditional methods of survival, and are generally slow to adopt new practices, even when obviously beneficial. Previously, pastoral ethnic groups that now find themselves on small land parcels that cannot support large livestock herds provide an example, clinging to the idea of keeping larger herds despite the land restrictions and being slow to accept the need to trim herd sizes. The resultant environmental degradation seems to affect women most in the basin, with many spending significant time looking for water, fuel wood and food. In fact, government statistics indicate that women contribute over 70% of farm labor requirements, but they generally do not own the land and cannot decide to carry out certain developments on such land (including activities such as planting tree seedlings, constructing terraces, and replacing slow-growing native cattle with better-breeding and milk producing hybrids), even though the majority of participants in conservation education are women.

Women play important roles in environmental conservation at the farm level, with gender training of lake managers and extension staff being needed to enable them to better understand and address gender realities, and empowering them to address some of the complex gender-related issues via participatory approaches. Although women are an important target group for conservation training, they typically have busy schedules, with many unable to attend sustainable agriculture courses. Thus, special on-site training, conducted at the village level, is needed to meet their needs. The training must be practical, with lessons delivered in the local language.

Such environmental education programs can change attitudes toward resource use, from a purely utilitarian one to one embodying a sense of responsible stewardship, including greater public responsibility toward environmental protection and sustainable development of the areas' natural resources. To this end, gender roles and responsibilities are now being positively accredited to committed and resourceful men and women, with women beginning to acquire leadership positions, as well as an increasing number of female participants in seminars, workshops, park tours and residential training.

4.6 Environmental status

Although basin-wide continuous data and information regarding Lake Nakuru's natural conditions (i.e., topography, geology, meteorology, hydrology, etc.) are available in reports, they are not systematically and comprehensively analyzed to allow the study of relationships among them. Deforestation and human settlements have been the most significant change factors in the watershed's ecological and hydrological balances since the 1970s. Some of the environmental impacts are summarized as follows:

- Alterations in the catchment's hydrological regime, resulting in increased streamflow seasonality, declining water yields from wells and bore holes, and frequent, prolonged dryouts of the lake, as occurred in 1993, 1994, 1995 and 1996;
- Loss of biological diversity and the capacity for disturbance regulation, resulting from catchment basin deforestation;
- Accelerated soil erosion, resulting in loss of farm productivity and income and, in turn, leading to over-exploitation of the natural resource base.
- Water quality deterioration of streams, and exposure of human and livestock populations to pesticide residues and other potentially-dangerous leachates;
- Contamination of the lake with pesticide residues, heavy metals and possibly PCBs, dioxins and furans;
- Contamination of the lake bottom sediments with lead, copper, mercury, zinc, cadmium, chromium, nickel, DDT, dieldrin, and gamma BHC;
- Nutrient enrichment of the lake, resulting in reduced productivity of the lake's natural primary producer (*Arthrospira fusiformis*) and frequent occurrence of toxic blue-green algae (*Microcystis sp*. and *Anabaena sp*.) blooms, leading to desertion of the lake by flagship species such as the lesser flamingo;
- Fish and waterfowl die-offs; and,
- Disappearance of aquatic species, such as the clawless otter (*Aonyx capensis*) last reported in LNNP in the 1970s.

4.7 Enabling Environment

4.7.1. Legislative Framework

Developing environmental conservation strategies and enactment of Environmental Management and Coordination Act (EMCA) provides an enabling environment for the conservation and management of lakes, rivers and wetlands. In Kenya, before enactment of EMCA in 2000, environmental issues were dealt with at sectoral level, with policies and legislation based on institutional mandates and programs, and resulting in 77 conflicting statutes relating to water, lakes, wetlands and environment. In developing the EMCA, all environmental policies were harmonized with environmental management institutionalized under NEMA. Within the framework of Lake Nakuru environment, a District Environment Management Committee (DEMC), the authority responsible

for environmental complaints, was institutionalized, with participation of government institutions, local community, NGOs, CBOs, local authorities, and politicians.

4.7.2 Institutional Roles in Lake Management

Because various institutions have varied roles and responsibilities related to lake environment conservation, there is a need for harmonized institutional collaboration with clearly-defined institutional roles. The various responsible institutions in Lake Nakuru basin management are discussed in Section 4.2.

4.7.3 Formal Plans

The formal plans in the LNCB include:

- Water Master Plan developed by Ministry of Water Resource Development;
- Forest Master Plan developed by Forest Department;
- Nakuru Town Strategic Structure Plan;
- Lake Nakuru Ecosystem Integrated Management Plan;
- Nakuru Action Plan currently under preparation by the various institutions in Nakuru dealing with the environment; and,
- Government Poverty Reduction Strategy Paper.

4.7.4 Government Policy Framework on Environment and Development

A National Policy on Environment and Development was passed by the government as the Environment Management Coordination Act 2000, with the plan's overall goal being to achieve socially-, economically- and environmentally-sustainable national development agendas that ensure a clean environment for all.

4.7.5 Legislative and Administrative Framework

Various legislation and international conventions provide frameworks that guide sustainable management of the lake environment. As an example, the KWS is guided by the Ramsar Convention, World Heritage, CMS, CBD guidelines and Wildlife Conservation and Management Act Cap 376 of 1976 and 1989 Amendment. The Act promotes sustainable development, wise wetland use, and implementation of management plans for biodiversity conservation, wetland conservation and National Parks and National Reserves, and the display of fauna and flora in their natural state for promoting tourism for the benefit of the inhabitants of Kenya. The Director may delegate or assign any of his functions under the Act to any officer in the Forestry or Fisheries Department or any public officer approved by the Minister (honorary warden). Other than the National Parks and Reserves, the Minister may also declare and gazette an area not exceeding 2,600 acres as a local sanctuary where extraordinary measures of protection are taken over species being nurtured for replenishment of stocks. Because the Lake Nakuru ecosystem encompasses the entire Lake Nakuru catchment, the entire catchment integrated Management Plan can also rely on provisions of the Wildlife Act in regard to wildlife conservation and habitat management.

Other government environmental and development policies or legislation relating to managing the Nakuru catchment include EMCA, Water Act, Agriculture Act, Forest Act, Fisheries Act, Land Planning Act, Physical Planning Act, Land Control Act, Local Government Act, Kenya Tourist Development Corporation Act, Tourist Industry Licensing Act, and Registrar of Societies Act.

4.8 Monitoring and Research Capacity

In 1992, the KWS, WWF and the Kenya Wetlands Working Group (KWWG) convened a workshop in Nakuru to review research findings related to the lake and its basin. It also was intended to coordinate research and monitoring efforts in the Nakuru catchment, facilitate information exchange, and focus efforts on the needs of the lake managers, including identifying immediate priorities and long-term requirements for environmental research, monitoring and management of Lake Nakuru. Research institutions at the national level (e.g., Kenya Agricultural Research Institute; Kenya Bureau of Standards) and institutions of higher learning also have adequate laboratory and research capacity.

Nakuru-related research capacity has developed gradually over the years, including the following:

- WWF supported establishment of the Baharini Wildlife Research Station in LNNP in 1970, with the goal of generating information contributing toward effective lake management (subsequently destroyed by bush fire in the Park in the late-1980s);
- JICA installed autographic recorders and new staff gauges on the Makalia and Enderit Rivers in 1992; WWF-LNCDP installed a similar recording station on the Njoro River and Baharini Spring in 1993. Over 12 more stations have been established, with LNCDP maintaining them in collaboration with KWS and MOWD;
- KWS, Kenya Wetlands Working Group (KWWG) and WWF organized a workshop in May 1993 to coordinate research and monitoring efforts in the Nakuru catchment, facilitate information exchange, and focus future research efforts on the National Park's management needs; and,
- KWS organized a stakeholder's workshop in December 1995 to evaluate the application of conservation and biodiversity management research findings, with particular reference to LNNP. Disputes regarding joint ownership by KWS, MOWD and MCN of the Nakuru Water Quality Testing Laboratory constructed by JICA in the same year, however, has led to its under-utilization, as has low budgetary allocations for service and maintenance.

5. Lessons Learned

5.1 Emergence of Political Interests and Commitments

The Government of Kenya has, for decades, pursued conservation-friendly policies aimed at providing favorable conditions and support for local initiatives in natural resource management. Land is a scarce resource in the Nakuru and the Park area, and the latter would have been converted into other uses if not gazetted as a protected area by the government. Conservation of this park in its natural state has facilitated the availability of a beautiful, educational and recreational area right in the middle of Nakuru town. Environmental conservation enjoys political legitimacy, having been incorporated into the educational system. At both individual and institutional levels, however, there remains a glaring gap between acceptance of concepts such as sustainable development, and the task of actually putting the concept into practice.

The need for land in the area and in Kenya as a whole is such that, unless vigilance is maintained by conservationists, pressures to de-gazette some of the park land and protected forests in the Lake Nakuru catchment area for human habitation and use may prevail over conservation concerns. Further, in the Localizing Agenda 21 in Nakuru, the power and revenue of local authorities is often too weak to champion an the process on its own. Rather, the national government also has an important role to play in creating a climate favorable to the Local Agenda 21. Above all, the government could remove all legal and administrative barriers hindering effective implementation of Municipal Local Agenda 21 initiatives, enabling Associations of Local Government Authorities to assume their role.

5.2 Attempts to Establish Sustainable Institutions

5.2.1 Written Agreements are Useful in Guiding Collaboration between Agencies

It is fundamental in any partnership that collaborating organizations have a good understanding of each other (their legal structure, method of operation, expertise, limitations, strengths, weaknesses, etc.). An incomplete or incorrect understanding of the nature of one's collaborating partner can lead to tensions and difficulties in the pursuit of joint activities, causing a failed partnership. Thus, partnerships need to be guided by written agreements, commonly known as Memoranda of Understanding, to regulate relationships between partners on both sides. The LNCDP Project had such a written agreement with KWS. It was very useful overall in minimizing conflicts between the project and KWS staff.

5.2.2 Culture and Gender Roles in Conservation and Development

There is a well-established linkage between the activities of women and environmental degradation, mainly because their livelihoods and responsibilities make them more dependent on natural resources than men. The constraints and pressures they face leave them more vulnerable to lack of water, declining crop yields and shortage of fuel-wood. To this end, women as a group suffer from some of the following:

- Heavy workloads, including farm-work, marketing, household chores and casual labor to meet household consumption needs. Their economic responsibilities also have increased as more men migrate from farms in search of employment;
- Limited access to land and property, thereby making it more difficult to secure loans, and ensuring they have a lower financial status than men;
- Limited access to appropriate services and resources, including health, literacy, training, capital, shelter and food; and,
- Limited access to the technology that could alleviate their tasks as farmers, mothers and community workers; further, women's tasks are arduous and time consuming, with little monetary remuneration.

A major challenge in lake basin management, therefore, is to take the plight of women in account. Experience also indicates that community-training programs yield better results when husbands and wives train together. Although this can represent a problem at institutional training, it can be achieved at field training sessions. Such training also can include gender sensitization, which would help overcome the reluctance of men to allow their wives and daughters to attend training. Further, women are also better at passing on what they have learned to others.

As with men, there are no universal answers in regard to how to best work with women in pursuit of lake management and sustainable development. Rather, there are differences in their positions and the conditions that they face and in the opportunities open to them. The following provide some guidance in some general ways that can help this situation:

- Conduct a community-based needs assessment, seeking women's knowledge, experiences and skills in natural resource management, allowing them to prioritize these needs;
- Project activities should recognize the different interests and responsibilities in different lake management activities by gender, age class and status of different members of the rural households;
- Make a conscious poverty focus by linking poverty and gender priorities, including ensuring that the management activities do favor wealthy and progressive women at the expense of others; recognizing the need to eliminate the disadvantages of, and prejudices against, the poorer and powerless households; and seeking to provide equal opportunities and access to resources and benefits to all; and,
- Adopt an inclusive approach that works for the involvement of women, men, and children in households and communities, rather than provoking confrontations between them.

5.2.3 *NGOs and CBOs Roles as Conservation Catalysts*

NGO and CBO projects will be more effective and sustainable in the long term if they play facilitating, rather than implementing, roles. Projects should facilitate the operations of key existing stakeholders, rather than implementing activities and, in the process, establishing temporary parallel structures to already-existing ones. Experience indicates that NGOs and CBOs have great potential to act as catalysts to, and motivators of, government institutions/organizations, and local NGOS and CBOS by providing information/data, capacity building, financial resources, applying gentle pressure and initiating convincing activities. The Local Agenda 21 project, for example, acted as a catalyst to leverage additional funding (e.g., from international organizations, bilateral development aid agencies, national ministries, international and local NGOs, CBOs and municipalities from developed countries). However, this leveraging of resources to implement action plans is only possible by virtue of a catalytic multiplier effect of the core funding, enabling local teams to formulate well-prepared action plans.

Further, while ICDPs have proven effective in delivery, it is vital to re-evaluate some of the underlying assumptions. ICDP projects, for example, should only support livelihood initiatives that are feasible, that contribute to and result from natural resource conservation, and that are made sustainable over the long term by the beneficiaries themselves.

However, a single ICDP approach has several limitations, including a limited coverage scope that can miss important habitats, an uncoordinated approach to conserving species and their habitats, and limited impacts on national policies (especially for migratory species). While Lake Nakuru and Bogoria are the most important feeding sites for flamingos, for example, they breed in Lake Natron, which is seriously threatened and not protected by a major conservation project. Thus, the conservation and management work in Lakes Bogoria and Nakuru will not ensure sustainable conservation of flamingos and other migratory species.

5.2.4 *Making Maximum Use of Lake Conservation Networks*

Institutions have differing abilities to manage lake environments in regard to facilities, expertise and funding levels. Modern technologies (e.g., Internet access) have contributed significantly in providing new ideas on lake environment management efforts without necessarily requiring that managers physically visit the sites. Such possibilities did not exist in the past and, as a result, different projects have remained rather isolated from each other.

5.3 Financing Mechanism and Subsidies for Lake Management

The Government of Kenya has funded Lake Nakuru basin environmental conservation activities through various departments and institutions, consistent with the budgetary allocations. Each institution and department document the various activities they have implemented, as required by the Government, with the main constraint to this format of programs and activity implementation being poor coordination and evaluation.

Subsidy provisions to the local community include:

- Community access to the park at subsidized rates that include provision of transport and gate entrance concessions;
- Support to community natural resource and environmental conservation initiatives;
- Community capacity building through training and extension;
- Support to community development projects and programs (water supply, health provision, agricultural development, etc.); and,
- Development of projects assisting villagers to prioritize problems, identify solutions and prepare viable proposals fitting project mandate; the design of projects and responsibility for implementation will continue to rest in the villages, thereby shifting the emphasis from the Project telling communities what to do, to the communities making considered choices regarding what needs to be done.

The Government of Kenya retrenched its agricultural extension personnel, following introduction of World Bank-sponsored retrenchment policies. Thus, the partnerships with some of the most affected institutions (e.g., MOA; MENR) have been considerably weakened in the field, since the government extension staff were an integral part of conservation efforts. Further, the danger of relying on multiple agencies to carry out conservation in an uncoordinated, piece-meal fashion is obvious. Thus, a coordinating body to orchestrate participation of all stakeholders in ensuring environmental health for the benefit of all is needed, as well as ensuring long-term funding is available to support lake basin management initiatives. With available funds, it also is desirable that a Village Environmental Fund be established to which villages could make requests for assistance, with decisions on what to do lying within the villages and their environmental committees.

5.4 Legislative Frameworks and Policies for Lake Management

Although effective legislation and by-laws already exist, they generally are poorly enforced, resulting in a high frequency of illegal environmental activities (e.g., uncontrolled sand harvesting and quarrying along river channels; illegal diversion and damming of streams and rivers; dumping industrial wastes in unapproved areas; cultivation along river bank buffers; illegal conversion of public utility land for private use). The situation is further aggravated by lack of harmonized legislation and community involvement in policy enforcement. The government's policy implementation efforts are increasingly undermined by structural adjustment programs, diminishing aid, and worsening trade terms, highlighting

the need to evolve a new conservation and development paradigm emphasizing the subsistence values of protected areas and natural resources. Enacting EMCA 2000, however, transferred environmental legislation enforcement to the local community by establishing various environment management committees and public complain committees, geared toward law enforcement.

5.5 Influence of Politics on Resource Management

Local parliamentary and civic general elections are held every 5 years. Political change undoubtedly induces some delays in implementing certain activities, particularly regarding institutional changes and government resources. The political factor is an integral part of formulating and implementing projects, both at national and local levels. This factor can be handled constructively by familiarizing newly-elected politicians to environmental legislation, ongoing conservation initiatives, and long-term vision and actions already achieved, while also providing the opportunity to consider the priorities of the new leadership. Since the local community elects these politicians, community involvement and commitment to environmental conservation can positively influence resource management.

5.6 Stakeholder Participation

5.6.1 Partnerships in General

The following lessons were learned in regard to partnerships in general:

- Although partnerships can be highly beneficial, they also must clearly be more than just another name for donor relationship;
- Partnerships are particularly valuable when dealing with complex interdisciplinary, crosscutting issues, such as the tasks required under the CBD, ICDPs, etc. The development of the Nakuru Strategic Structure Plan and the Nakuru Integrated Management Plan, for example, required considerable coordination to keep time, quality and resources on schedule, and further build synergies on the need to conserve;
- Partnerships are not ends in themselves, but rather must be clearly directed toward achievement of a common purpose which each organization could not do on its own, and where each provides added value to the other;
- Partnerships are a tool that should always be considered in implementing any project, in order to increase the effectiveness and efficiency of the activity;
- Practically none of the partners are sufficiently empowered to carry out the work, and although some momentum has been built at the grassroots level, community organization and creation of awareness has not yet reached a sufficiently critical mass to become self-sustaining;
- Partnerships build consensus on sustainable lake environment conservation initiatives; and,
- Partners should be treated equally, involved in decision making, and informed/sensitized on issues relating to legislation and management decisions.

5.6.2 Community Mobilization Effectiveness

Community response to mobilization is influenced by tradition, ethnic backgrounds, attitudes and perceptions. While some communities quickly develop and implement ideas, others are slow to respond. The biggest hindrance is the fact that many communities cannot immediately identify the potential benefits to them of particular activities. Thus, projects should undertake a process of re-ordering the sequence of activities to be introduced to communities, starting with the quickly-maturing ones, and followed by those that take longer periods for results to be observed.

Communities can more readily adopt conservation messages and activities using this approach, with quickly-adopted activities being those affecting their livelihoods (e.g., energy-saving cookers whose wood saving results are immediate; planting quickly-growing trees, in contrast to those taking several years to mature; the promotion of vegetable growing through "double-digging," an intensive cultivation method that significantly raises crop yields).

5.6.3 Working with Loosely-Organized Community Groups as Opposed to Formally-Organized Ones

Most conservation activities such as training, school education conservation activities and tree planting are done in groups. Thus, it is easier to reach large numbers of people through community group, in contrast to targeting individuals separately. Formally-organized community groups tend to become more cohesive and generate a wider diversity of their own ideas, as well as becoming more quickly self-driven for independent action and, therefore, more sustainable.

5.6.4 Quick Results versus Long-term Benefits

Donor-driven projects are under pressure by both donors and partners to show results. Whereas it has been easy to quantify certain results (number of trees planted; meters of terraces constructed; number of people trained, etc.), it is not always easy to demonstrate the impacts of many other activities (e.g., education; training). In fact, community mobilization and education is a long-term, people-intensive process, and all stakeholders, including donors, must have patience and not necessarily expect quick results. In implementing Local Agenda 21, for example, it was realized that, although external initiatives can be catalytic in putting Local Agenda 21 processes in place, patience was needed to see the results materialize. Thus, considerable time flexibility is required to allow local actors to fully support politically- or socially-sensitive action plan components.

5.6.5 Capacities to Carry Out Social Analysis and Being Prepared to Manage Effects of Social Conflicts

Progress in lake environment management is clearly best seen where peace prevails. The overall effect of the instability in the Lake Nakuru basin, for example, was a virtual cessation

of conservation activities in some cases, undermining work done over the years. Many farmers have abandoned their farms in fear, with the conservation structures created through their hard work being destroyed. Extension staff from different ethnic communities also often face distrustful communities, making their operation in the area more difficult and hazardous.

The economic position of people in the affected areas suffered major setbacks due to the loss of livestock and crops. Many families were strained by food shortages and high reconstruction costs. Those living in Nakuru peri-urban areas were forced to move and establish homes in the town, where the cost of living is prohibitive. Further, home-based income-generating activities, such as communal and individual tree nurseries, disintegrated, resulting in the loss of thousands of tree seedlings. Of the 30 community rainfall stations established in 1994, 15 stopped operating and 9 gauges were completely destroyed. Although most have been replaced, huge gaps in the records remain, posing difficulties in analyzing the data.

5.6.6 Replicability of Experiences

The Rift Valley saline lakes are ecologically linked and flamingos use all the saline lakes in the Valley. Many of the lessons learned at Lake Nakuru can be replicated in the other Rift Valley saline lakes. Although the results of piecemeal work at single sites have less impact on regional policy formulation, the collective results of such work stand a better chance of achieving positive regional and global effects on policies and joint actions. Further, trends in the conservation development circles are being more directed toward "the big picture", which might make fundraising easier. Strategies for achieving this transformation could include the following:

- Gathering lessons from Lake Nakuru;
- Creating a small steering committee to spearhead the future direction;
- Recruiting a small core secretariat to implement ideas generated by the steering committee;
- Securing donor support for the organizational design work;
- Securing commitment and collaboration of the region's governments; and,
- Making plans for, and implementing a phase out of, some project activities.

5.7 Linkages with Other National and Regional Efforts

Basic concepts of governmental policy on the environmental management of Lake Nakuru is evident from the fact that Lake Nakuru has been designated a Ramsar site, a National Park, and a World Heritage site. In addition, MENR has considered the possibility of gazetting the Lake Nakuru basin as a special conservation area (SCA), because of its environmental significance. The policy direction of environmental management is to reduce threats facing the lake and the park. The natural resource base and the environment will improve as a result of commitment to national and regional efforts, and involvement of all stakeholders. Given the transboundary nature of the Rift Valley saline lakes that are habitat to the flamingos and other migratory bird species, it is essential that all countries with saline flamingo lakes become members of the African-Eurasian Waterbird Agreement (AEWA) and other relevant international and regional conventions. The following plans also should be considered where they pertain to flamingo lakes:

- Ethiopia accedes to becoming a Ramsar signatory;
- Trade in flamingos in Tanzania is governed by the known population numbers across the flamingo home range;
- The economic value of flamingos in relation to tourism and trade in all countries is determined;
- Enable communities to maximize benefits from key flamingo lakes via responsible community management;
- Facilitate formation of wildlife protocols between countries where needed;
- Develop and integrate water resource and wetland policies; and,
- Any major development in flamingo lakes be assessed through proper environmental impact assessments (EIA).

5.8 Integration of Relevant Plans and Programs in Lake Nakuru Basin

Apparent contradictions between sectoral development plans exist in national development plans, thereby confusing field practitioners. Kenya's current 5-year development plan, for example, emphasizes development of the industrial sector and modernization of the agricultural sector through intensification of land use. The same plan reiterates the government's commitment to environmental conservation. However, new clear-cut policy guidelines have been formulated to harmonize the industrial, agricultural and environmental development policies, which should be harmonized at the planning stage. Further, although many environmental management plans and programs of government institutions or NGOs and church organizations have been developed in the basin, many have not been implemented because of a failure to secure funding, or have simply been suspended. The few completed programs have been traditionally supported by multi-and bi-lateral donors, such as the Royal Netherlands Government (RNG), UNCHS and BADC, AFD, EU, DANIDA, FINNIDA, DFID, JICA/JBIC, etc. These situations result in a fragmented decision-making structure that disperses environmental management responsibilities among many organizations and agencies. Thus, integration of relevant plans and programs into an umbrella whole basin master plan in the Lake Nakuru basin is essential. There also is a need to harmonize the relationship between the MCN and all stakeholders (KWS, private sector, NGOs, CBOs, District Development and Planning Liaison, etc.) to ensure more efficient utilization of available scarce resources and effective participation.

5.9 Incorporation of Scientific Information and Research

Although expensive, applied science in the form of research and monitoring is fundamental for managing lakes. Several scientific studies in Lake Nakuru, for example, provided information for better understanding ecosystem functions and guiding appropriate actions (e.g., relocating the dumping site and fungicide factory). When data interpretation is done poorly, however, considerable resources can be wasted before the real issues are identified. Involving various disciplines in investigating ecosystem issues provides in-depth and better understanding of ecosystem issues. Scientific information was instrumental in formulation of the Lake Nakuru Ecosystem Integrated Management Plan, for example, proposing appropriate actions to be taken for sustainable lake environment management. The main gaps have been identified as (a) lack of information dissemination to managers on research findings; (b) inconclusive research findings; and (c) lack of collaboration between researchers and research projects. Other gaps include lack of a central research database, inadequate research facilities, need for simplified research indicators, and the need to translate research findings into simplified language that lake managers and resource users can understand.

In conclusion, the concept of sustainable development in a lake basin such as Lake Nakuru must be perused in principle and in practice and must be applied equally in politics, as well as in farming for many more years, or at least until the idea becomes accepted and integrated in our collective thinking and wisdom. Experience is that sustainable development requires more than just an attitude, a commitment or a set of new skills. It also requires the right environment in which to take root and fulfill its promise and vision. Modifications in political, economic, social and cultural practices will need to be effected to ensure such an environment exists. All these changes call for concerted efforts over many years, across many disciplines and at many levels of governance. In the light of this reality, the recommendation that a permanent Lake Nakuru Catchment Management Center be established appears both attractive and realistic.

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