Tracing the Possible Root Causes for Fleeing Flamingos in Kenya's Lake Nakuru National Park

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Abstract

A Fishbone diagram was used to identify possible root causes for the diminishing number of flamingos in Kenya's Lake Nakuru by analyzing twelve authenticated articles published in 2007. Human activities at the lake's catchment area particularly deforestation was found to be the major cause for the flamingo situation in the lake. Wanton destruction of vegetation at the Mau Forest Complex has caused rivers to dry up, therefore reducing the inflow of water into the lake. Due to negligible monetary benefits from tourism trickling down to host communities in Kenya, the poor population in Nakuru's upstream strives to make ends meet through agriculture and exploitation of forest products, unaware of the detrimental impacts of their actions on the flamingos downstream that attracts over 200,000 tourists annually. This necessitates adoption of an integrated, sustainable development approach in planning and management of the resources.

Keywords: Lake Nakuru; Tourism; Fleeing Flamingos; Sustainable development; Deforestation; Climate change; Pollution

Introduction

Tourism is the fastest growing global industry, and has become a major source of employment supporting 74 million and approximately 215 million direct and indirect jobs, respectively (UNWTO, 2006). Thus, the tourism industry has not only been hailed as an imperative engine for economic growth, but a fundamental vehicle for development (Skinner and Cliftons, 2006). Confronted with serious problems of underdevelopment and poor economic performance, African countries are increasingly turning to tourism as an appropriate tool for socio-economic development and poverty reduction (Akama and Kieti, 2006).

Since her independence in 1963, Kenya has been pursuing various tourism policies whose common objective has been to increase gross earnings by the industry. Largely, the government is achieving this objective judging from the substantial increases in receipts over the last five years. For instance, earnings from the industry have increased to $803 million in 2006 compared to $506 million in 2004 (UNWTO, 2006).

In spite of the growth and increased revenue, the success is negated by massive leakages of tourist receipts. Very little monetary benefits accruing from tourism trickle down to the host community, and has not helped in eradication of poverty particularly at the coast (Akama and Kieti, 2006) and notably Maasai land, that both account for 64% of all tourists to Kenya (GOK, 2004; Kiprutto, 2007).

The industry is also confronted by environmental problems, emanating from tourism as well as other development activities. Self destructive tendencies follows haphazard mushrooming of tourism and hospitality facilities in fragile coastal and marine ecosystem in Kenyan coast that has caused accelerated and severe problems of tourism resource degradation, and reduction of the quality of the tourism product (Scheyvens, 2002). In addition, tourist congestion along the coastal beaches and other destinations such as Masai Mara during the peak season has resulted in environmental pollution that can be dangerous to the very resources. This scenario can be exemplified to a farmer who prefers to harvest a coconut by cutting down the coconut tree, and denying it another chance to bear more fruits in the next season.

Environmental problems not attributed to tourism industry such as pollution from industries also threaten tourism in Kenya. As the country attempts to move away from poor economic performance towards prosperity, both anticipated and unanticipated detrimental effects of pollutants from industries and agricultural activities affect some tourism resources. The health of Lake Nakuru in Kenya, which is world famous as the feeding ground of thousands, and sometimes millions of Lesser Flamingos *(Phoeniconaias minor)*, is experiencing harmful effects of the ongoing deforestation at the Mau forest, industrial and agricultural development activities in the surrounding area.

Lake Nakuru is a shallow alkaline lake in Kenya's Rift Valley province. Its maximum area is 45 Km^2. The flamingos, together with hippos, reedbuck, black rhino, giraffe, lion, leopard, bushbuck and 400 species of birds resulted in creation of Lake Nakuru National Park in 1961 with a size of 164 km^2. Tourism has therefore emerged as an important economic activity in a predominantly agricultural area. A total of 200,000 tourists visit the park every year (GOK, 2004), and this has made tourism an important source of employment to some residents.

Lately, however, the flamingos have been dying at the lake while several others have migrated to other lakes. This undoubtedly threatens tourism in Nakuru area. The specific causes of the migration and deaths are still unclear, but it is suspected that human activities at the surroundings of Lake Nakuru are the major cause. The study therefore focuses on the impacts of the general development around Nakuru on the environment and consequently on the resources upon which the tourism industry depends on. The aim of the study is to establish the possible root causes of the flamingo situation in Lake Nakuru.

Review of related literature

Although lakes are the world's most popular tourism attractions, increased pressure from tourism and recreation, impact of climate change, environmental change and increased competition for land and water has made sustainable development of lake tourism problematic (Hall and Harkonen, 2006). Plenty of literature on environmental problems, their causes and impacts on various activities exist. Studies including Evans (1982); Chukwuma (1996); Mbaria and Mureithi (2003) focused on causes of environmental change. GTZ and ESD (2007) gives an account of the effects of climate change on the environment while UNEP (1997), UNWTO (2004), Becken and Hay (2007) and Amelung (2007) focuses on its implications for tourism.

Forests have undergone massive destruction at local, regional and global scales, yet they provide a wide range of benefits to both mountains and downstream populations, notably the protection of watershed, as centres of biodiversity and supports important resources for tourism and recreation among other benefits (Price, 2003). The main causes of forest destruction in Kenya are clearance for agriculture; intensive logging for vineer, sawnwood and chip wood; exploitation for charcoal and fuelwood; shifting cultivation on too short a cycle; urban and industrial expansion; overgrazing and gathering of fodder for domestic animals; forest fires; and the effects of war (Evans, 1982; Mbaria and Mureithi, 2003). This has condensed the forest cover in Kenya and helped destroy important catchment areas. For instance, in the past 100 years, Lake Nakuru's 1,800 sq. km. catchment basin has been transformed from a sparsely settled and heavily forested area teaming with wildlife to one that is heavily settled, extensively cultivated, and urbanized (Thampy, 2002), and has greatly affected the lake's ecosystem. Chukwuma (1996) indicates that growing population is resulting in over-cultivation and deforestation which tend to result in erosion and desertification and a derelict environment.

Deforestation decreases natural seepage into underground aquifers, leading to accelerated surface runoff and resultant soil erosion, which leads to siltation in water bodies that alters the volume of the water. Burton (1997) attributed the critically low level of Lake Chapala in Mexico to cumulative impacts of upstream activities including excessive drawing of water from Lerma River for domestic and irrigation purposes, and destruction of forests that have caused runoffs, erosion and ultimate siltation. Runoffs also help transport pollutants to a river, swamp, lake and other water bodies. Non point source pollution in Lake Victoria that include agricultural runoff and sediments loading aggravated by deforestation and overgrazing provide rich nutrients for the colonizing water hyacinth threatening fishing, travel and tourism activities in the lake (ATA, 2007).

Water pollution results mainly from agriculture, industrial wastes containing trace metals and polychlorobiphenyls (PCBs) which concentrate at the lower levels of rivers and lakes, mining wastes that concentrate trace metals which lead into streams in proximity to derelict mines, atmospheric deposition of fly ash from incinerators, sprayed pesticides, emissions of sulphur and nitrogen oxide from industries and vehicles generating acidity in fresh water, as well as urban runoff which encompasses trace metals and inordinate toxic and innate substance that is obviously detrimental to life (Chukwuma, 1996). Consequently, a variety of biodiversity including the core tourism resources are lost, which affects tourism business.

Studies on the once fresh water inland lake in California, Salton Sea that formed in 1905 has become 25% saltier than the Pacific Ocean due to pollution, and has caused massive deaths of fish and birds, therefore hurting activities of birders and sports fishermen (Riedel, *et al*., 2002). The 1999/2000 study on pollution status in Lake Nakuru (Marusa and Wangila, 2003) found that heavy metals were almost uniformly distributed within the lake as pesticide residues were found predominantly in its northern and southern river inlets. Thampy (2002) asserts that the most pressing problems confronting Lake Nakuru are threats to its water balance and water quality arising from human activity in its catchment basin. On the other hand, Codd (2003) and Ndetei and Muhandiki (2005) appear to absolve heavy metals from flamingo deaths and attribute the situation to the toxin-producing

cyanobacteria that usually dominate with declining water volume. Deaths are therefore associated with receding water levels.

Climate change and global warming has been found to change the environment. Climate change may result either from natural factors such as changes in the sun's intensity or slow changes in the Earth's solar orbit, or from human activities that change the composition of the atmosphere like the burning of fossil fuels, and the land surface such as deforestation and urbanization (GTZ and ESD, 2007). Drought and other extreme climatic events such as cyclones and hurricanes and flooding are common impacts of climate change. Drought can have serious consequences on resources upon which tourism are depended on. UNEP (1997) reported that during the 1992 drought, Victoria Falls lost some of its attractiveness because of much reduced water discharge over the falls. In addition, decreased rainfall resulted in reduction of the spray that maintains the rainforest that is part of Victoria Falls aura resulting in the death of flora around the falls. On the other hand, flooding can damage the tourism infrastructure and pose a great risk for the safety of both tourists and host communities. Such climate-related hazards can greatly suffer from secondary effects such as economic impacts at local business, or negative image in the media (UNWTO, 2004).

Climate change can also alter the natural environment that represents both a key attraction and basic resources for tourism (Becken and Hay, 2007). They include coastal erosion, damage to coral reefs and other sensitive and biodiversity-rich ecosystems. Fiji tourism faces major issues resulting from climate change such as shoreline and beach erosions, temporarily reduced water availability, interrupted supply chain, coral bleaching, and physical damage to property (UNWTO, 2004). Climate variability and changing weather patterns can also affect the planning of tourism programs and daily operations, while changing weather patterns at tourist destinations and tourism generating countries can largely affect tourist's comfort, decisions for trips and the ultimate flow of tourists. Low arrivals in Spain, Italy and other destinations that currently attract the traditional 'sun and sand' tourist segment is expected as the current 'summer peak' season gradually becomes *too-hot-for-comfort* (Amelung, 2007).

It is apparent from the literature review that human activities continue to disturb the natural environment and resulting in climate change or causing pollution. Of particular concern to the present study is the quality and dropping of water volume at downstream rivers and lakes that affects the living organisms inhabiting them. Consequently, activities at the water bodies including tourism are waning. This study aims at identifying possible root causes of flamingo departure and deaths in Lake Nakuru. Thus, this paper contributes towards understanding the flamingo problem by developing a cause-effect model that integrates human activities and climate change as the possible causes of the problem under study.

Methods

Secondary data from KWS et.al., (2004) and World Lakes Database (www.ilec.or.jp/database/afr/afr-07) provided information of past activities both in Lake Nakuru and at the catchment area. These activities, which occurred between 1960 and 1986 were summarized in a table form. To reveal the current situation, many reports relating directly or indirectly to the flamingo situation in Lake Nakuru were extracted from Internet articles. However, twelve reports were used for the study after they were found to be authentic. The current reports and news used in this study expressed concerns about the migration and fateful deaths of flamingos, causes and their implications for tourism in Nakuru, and were all published in 2007. Hing and Dimmock (1997) used this method when they reviewed published articles to identify tourist markets, tourist flows, tourism development, sustainable tourism development and social, economic and cultural impacts of tourism from 1989 to 1996.

The possible causes of migrations and deaths of flamingos from the current reports were summarized in a tabular form. Problem analysis was performed using a fishbone chart approach to identify all the possible underlying causes. Invented by Kaoru Ishikawa in 1943, fishbone diagram, also known as cause and effect diagram assist in categorizing the many potential causes in a problem in an orderly way and identifying root causes. It provides a comprehensive view of all the causes of a particular outcome. Spacecraft engineers have been using these diagrams for many years to diagnose mechanical problems and troubleshoot a satellite link (Skjei, 2005). Other methods of problem analysis such as conceptual plan and five 'why' method (5-why) were inappropriate. Conceptual plan approach is not systematic, and would be too complex and chaotic while the 5-why method of cause identification tends to move to one direction. However, fishbone diagrams permits a rigorous analysis that overlooks no possible problem source. This method attempts to highlight all the possible root causes identified from these reports, and aided in the development of a framework that provides the basis for future detailed investigations and experiments.

Results and Discussions

Twelve current articles on the problem of diminishing number and deaths of flamingos in Lake Nakuru (Table 1) were primarily processed by summarizing and tabulating them. Subsequently, the causes cited in each article were identified and listed. Similar causes were later grouped together to produce a shorter list representing all the causes in a sensible manner. The causes of fleeing flamingos were identified as diminishing water volume; diminishing flamingo food; rising toxic levels; ecosystem imbalance; industrial and sewage discharge to lake; clearing forests; agricultural chemicals; tourists activities; climate change; siltation; evaporation; rising temperatures; over logging; rivers and streams drying up, and introduction of tilapia into the lake.

From the list of possible causes, problem analysis was performed using a fishbone diagram (Figure 1) to aid in categorizing the many potential causes of the problem of diminishing number of flamingos in an orderly way, and try to identify the root causes.

Diminishing water volume

The lake has lost half of its water in the last two decades (KWS, *et al*, 2004). This is a precarious sign as the lake has completely dried up before in 1955. The possible causes for water volume are drying up streams that feed the lake, siltation and rising temperatures. Reduction in the water flowing in the three major tributaries: Njoro, Makalia and Nderit imply that Lake Nakuru cannot be replenished adequately. These rivers were permanent in 1982, but have now become sporadic and heavily laden with silt during rainy seasons (KWS, *et al*. 2004). Siltation and rivers drying up are caused by over logging and clearing of forests for agriculture and settlement. Indeed, the rapid population growth in the basin estimated at 1.5 people (Raini, 2009) has exerted pressure on the surrounding vegetation. Eastern Mau forest which is a major national watershed, and the source of the feeder streams to Lake Nakuru has lost over 46% of its vegetation and plantations to settlement since 1994 when it was degazetted (Table 2).

Kenya is a poor nation whose majority of the population entangled in a vicious circle live below the poverty line. Overpopulation, poverty, ignorance and greed have resulted in excessive exploitation of forests. Overpopulation and poverty are inseparable in developing nations, and demonstrates how the vicious circle has ensnared the poverty-stricken. The poor households in Kenya tend to have more children than the well up families. Therefore, the poor households cannot afford to educate their children who cannot get employment and therefore end up as poor as their parents.

Chukwuma (1996) indicates that no consensus exists among the various groups concerning the appropriate approach to population problem, but outlines the three broad-based approaches: population rate, development and resource approaches. Population rate approach uses various parameters such as birth rate, which influence population growth for the projection of future trends. Lowering the birth rate by family planning using contraceptives is the basis of this approach. On the other hand, development approach asserts that development *per se* slows population growth by offering women of child bearing age alternatives for social wellbeing, satisfaction and security. Resource approach contends that a population is not overpopulated if it can be sustained without depletion of the resource-base and without environmental degradation. Kenya adopted population rate approach in the 1980s before abandoning it. The introduction of compulsory free primary education in 2003, free secondary education in 2008 and the enactment of the legislation protecting the girl child in 2007 supports the development approach and could be the solution to Kenya's population problem in the long run.

Serious disparities between the rich and the poor also exist in Kenya. It is common to find one individual owning thousands of acres of land almost the size of a district 'temporarily' inhabited by thousands of landless citizens referred to as squatters. No wonder when the government degazetted as a forest reserve part of the Eastern Mau forest to settle the Ogiek community, landless citizens from other parts of Kenya, with some assistance of corrupt government officials, took advantage and invaded the forest in great numbers. The Ogiek is a small indigenous forest dwelling tribe dependent for its existence and welfare on forests, but with little interest in commercial forestry and minimal contact with the commercial society (Mbaria and Mureithi, 2003). To date, over 30,000 people from elsewhere have encroached into the Eastern Mau forest cutting down 46% of its vegetation to pave way for agriculture. Aggressive timber merchants who found an opportunity to enrich themselves also emerged from among the new residents. Tree felling went on uncontrollably until the government outlawed it in 1998. Moreover, after the ban, illegal logging for commercial purposes goes on. Over reliance of traditional biomass by the rising population at the catchment areas has also accelerated deforestation.

Although Kenya has policies that protect forests from wanton destruction, there are some shortcomings. First, the administrative capacity and implementation is weak. This is a characteristic of developing nations with extensive contradictory regulations, which overwhelm the enforcement capabilities of governments and their

agencies, and the resultant effect is skeptical perceptions of laws and the environmental commitments of governments as well as emergent corruption (Chukwuma, 1996). For instance, the Nakuru County Council and Nakuru Municipal Council give licenses to timber merchants operating timber yards and stores at various trading centers within their jurisdiction. This has created the impression that timber ceases to be illegal the moment they are on display at the yard regardless of the source. Apparently, disconnect between the state and the local governments in formulating and subsequently implementing policies is real.

Secondly, the forest legislation does not involve the local community in the management of the forests. For instance, apart from an offer under Section 12 to reward informers, the Forest Act does not define the role of the public in forestry development in terms of other incentives, and criminalizes removal of all including the minor forest products by the local community. All decisions concerning forest management are also made by the government. The minister is vested with exclusive powers including declaring that a forest area shall cease to be a forest area and may, under certain conditions, authorize any person to, on his behalf, issue licences for all or any of the purposes referred to in sub-section 1 of section 8 of the Forest Act (GOK, Forest Act).

While the poor population that has settled in Mau forest are not ignorant of the benefits indigenous vegetation has for them, they cannot comprehend how its conservation relates to tourism in Nakuru, the reason being that tourism does not benefit them. Although tourism is Kenya's fastest growing economic sector and second largest foreign exchange earner after tea, it has generally failed to cause positive socioeconomic change of the locals who continue to languish in poverty (Akama and Kieti, 2006). Nevertheless, there exist isolated cases of mild gains by locals. Zeppel (2006) explains how few communities in Uganda and Kenya have benefited from conservation. The Maasai in Kenya gain wildlife-related income from tourism lease fees, bed night levies, entry fees, employment as service staff and guides, handicraft sales and other activities. On the other hand, community campsites at Bwindi and Mgahinga parks in Uganda provide local benefits from mountain gorilla tourism. Revenue sharing by park agencies with local communities and income from wildlife-based ecotourism on group land was spent on schools, health clinics and water. Therefore there is need for formulation of a working tourism policy that would increase the local participation in tourism development and one that supports employment opportunities for locals in order to improve their economic welfare.

Rising toxic levels and diminishing Flamingo food in Lake Nakuru

The study identified industrial discharge, tourism activities, agricultural chemicals and sewage discharge as possible sources of contamination of Lake Nakuru (Figure 1). This is in agreement with previous findings by Marusa and Wangila (2003) and Ndetei and Muhandiki (2005) that linked the presence of high toxic wastes particularly from the town's two sewage plants and local factories to the massive deaths of flamingos. Ndetei and Muhandiki (2005) noted that the lesser flamingos that died at the sewage treatment ponds in Nakuru in late 1996 exhibited the same symptoms as those that died at the lake. They also indicate that there has been a general increase in the level of heavy metals and agrochemicals from farms in the lake over time.

Apart from producing acute and chronic toxicities in birds, presence of pollutants in the lake has resulted in an imbalance in the ecosystem that has caused a food shortage for the flamingos. Therefore, the study attributed the declining level of algae in the lake to water pollution. The diminishing flamingo food could also be the result of the 1959 and 1982 introduction of tilapia *(Tilapia grahami)* (Table 2) that led to competition for the planktonic blue-green alga, (*Spirulina platensis*) fed on by the flamingos. This could be a possible cause for migration of flamingos to other lakes including Lake Simbi Nyaima in Western Kenya.

Climate change

Rising temperatures are being felt globally, and is responsible for increasing the evaporation rate at the lake. Rising atmospheric temperatures (global warming) is the result of climate change caused by concentration of Green House Gases (Figure 2). GHGs are brought about by deforestation, burning of fossil fuel and pollution. The impacts of climate change in Nakuru are obvious. The environs of the lake now receives less rains, experience erratic rainfall patterns, intense and frequent drought and floods.

Like many other developing nations, Kenya is not a major emitter of the GHGs. However, Kenya has destroyed most of the forests. With just 1.7% remaining forest cover, man made CO_2 is not effectively 'sank' from the atmosphere (GTZ and ESD, 2007). Ongoing deforestation at the catchment of Nakuru also causes a release of carbon to the atmosphere through decay of trees, exposed soil and burning of charcoal, consequently increasing the concentration of GHGs, which in turn bring about rising temperatures. Accordingly, the high temperature results in higher evaporation rate and altering of the water temperatures that could destroy or introduce some

organisms in the lake, which could cause some imbalance in the ecosystem. Like coral bleaching in Fiji caused by climate change (UNWTO, 2004), diminishing algae in Lake Nakuru could actually be the negative effects of climate change. Therefore, the diminishing flamingo food in Lake Nakuru would eventually make the destination less attractive to tourists as the flamingos could continue fleeing. Consequently, fewer tourists would visit the park, leading to significant decline in revenues and loss of employment opportunities by the host community who depend on tourism for their livelihoods.

Conclusion and areas of further research

This study traced the possible root causes for migration and deaths of flamingos at Kenya's Lake Nakuru by analysing twelve internet articles published in 2007 using a fishbone diagram. Human activities at the catchment area that have come along with wanton destruction of vegetation by people who have been encroaching into the Mau forest complex since 1994 have reduced the inflow of water into the lake. Forty six percent of the Mau vegetation has been lost to destructive timber merchants engaged in illegal logging, new farmers clearing the forest for agriculture and the rising population who rely on traditional biomass as a source of energy. The effect of deforestation is soil erosion that has resulted in siltation at the lake, which in turn has reduced its water volume. Receding water levels at the lake give rise to the toxin-producing cyanobacteria that causes flamingo deaths (Ndeti and Muhandiki, 2005).

It is therefore necessary that the government reviews the laws meant to protect forests, and come up with implementable policies. Formulation of such policies should bring in the views all stakeholders including the local governments, local community and the business community. Such participative approach facilitates inclusion of diverse interests in the policy-making.

Although the Government has considered forceful eviction, the ultimate solution to the lake's problem is adoption of integrated catchment approach (Ndetei and Muhandiki, 2005) that would involve the people at the catchment in planning and management of Lake Nakuru resources. The community has the potential to help maintain the balance between tourism activity, social and environmental concerns, and therefore provide fundamental framework within which sustainable tourism development can be delivered (Robson & Robson, 1996). Indeed, the Government could adopt the Gandhian principles of headwater management (Jansky *et al*., 2005) which advocates for 'uplift of all'. Projects under this principle aim at aiding local communities to build self-sustaining local systems for the management of their own livelihoods and environment including the services their lands provide to outside communities. This might help eliminate perception among communities residing at the catchment area that exploitation of tourism resources downstream only benefits outsiders.

Tourism in Nakuru partly depends on the existence of the lake and the 'grazing' flamingos. The cause-effect model for the diminishing number of flamingo in Lake Nakuru (Figure 2) supplies a working framework for future studies employing experimental designs to establish the true causes of flamingo deaths. It is also paramount to carry out further research on the impacts of deforestation and climate change on the lake's ecosystem. This way, tourism planners and other stakeholders in the area would make informed decisions concerning development and conservation of Lake Nakuru.

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Table 1: Articles on diminishing number and deaths of flamingos

Source	Article title
Voice of America (VOA), January.2007 -	Kenya experiencing the effects of deforestation
http://iampatsy.blogspot.com Feb.2007 -	Unhappy about the Oregonian article - Death of flamingos in Kenya
www.gobalooningkenya.com Ballooning Kenya, March.07 -	Flamingo situation
www.greendiary.com Green Diary, April.2007 - Kenyans replant a whole forest to cajole the majestic Flamingos back	
Business Daily, May.2007 -	Nakuru flamingos return to uncertain future
http://en.wikipedia.org Wikipedia, June.2007 -	Greater & Lesser Flamingos flock to Lake
http://en.wikipedia.org Wikipedia, Aug.2007 -	Number of Flamingos has been decreasing
Environmental News Network (ENN): August.2007 - Flamingo deaths in Lake Nakuru	
Business Daily, November.2007 -	Shrinking Lake Nakuru
http://blog.midwestlakes.org - Great lakes shrinkage theory - Flamingos have reduced from 1m 5 years ago to 30,000,	
http://origin.foxnews.com FoxNews.com, Nov. 2007 - Flamingos vanishing from shrinking Kenyan Lake	
www.physorg.com Nov.2007 - Lesser flamingos find refuge at Kenyan Lake Oloidien that recently turned saline	

Table 2: Events and Human activities around Nakuru 1955-2004

Lake Nakuru	**Past activities:** *1955* – Lake dried up completely *1959 & 1982* – Tilapia (Sarotherodon alcalicum grahami) introduced to lake. *1974* – Planktonic productivity and flamingo population decreases abruptly
Forest/catchment	**Past activities:** *1994* – 20,000ha of 65,000ha Eastern Mau de-gazetted to settle the Ogiek, a native community living in the forest. *1994-1998* – Over 30,000 non Ogiek people migrated to Mau to settle. *1994-2004* – Estimated 30,000ha (46%) of the Mau cleared.
Nakuru District	**Population:** *1960s* - 50,000 *1990s* - 1,000,000
Nakuru Town	**Population:** *1969* = 47,151 *1979*=- 92,851 *1989*=- 163,982 *1999*=- 239,000

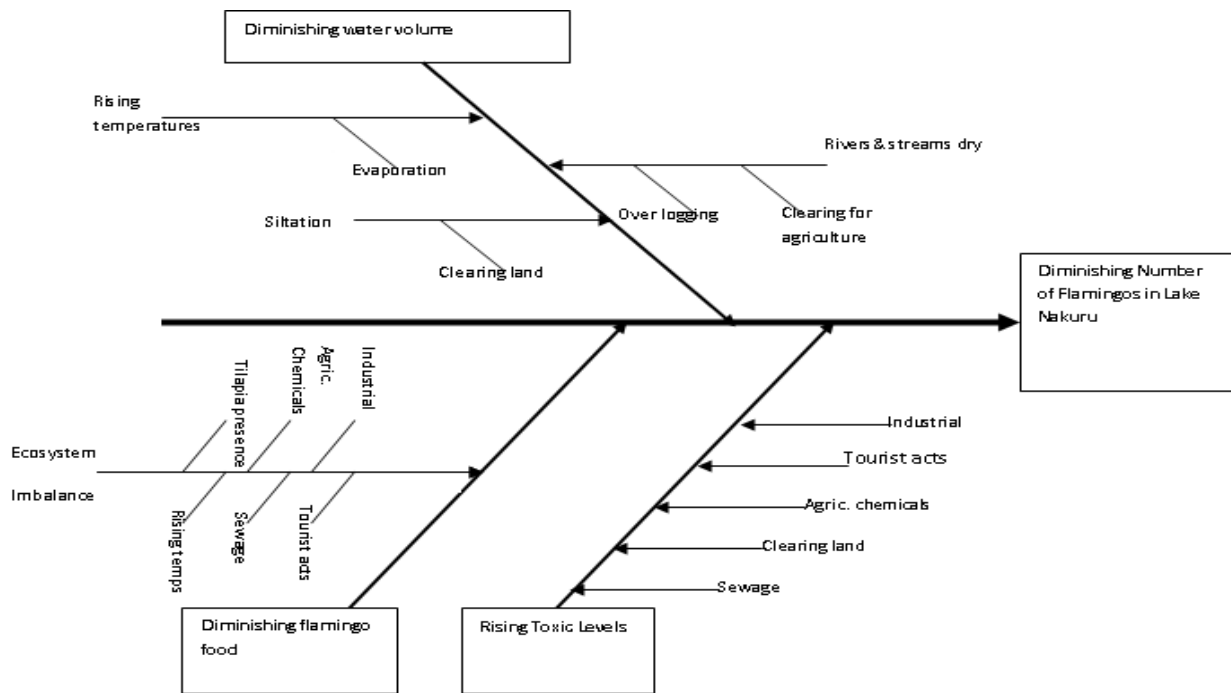*Source:* KWS *et al.* (2004) and World Lakes Database (www.ilec.or.jp/database/afr/afr-07)

Figure 1: Cause-Effect for diminishing number of flamingos in Lake Nakuru
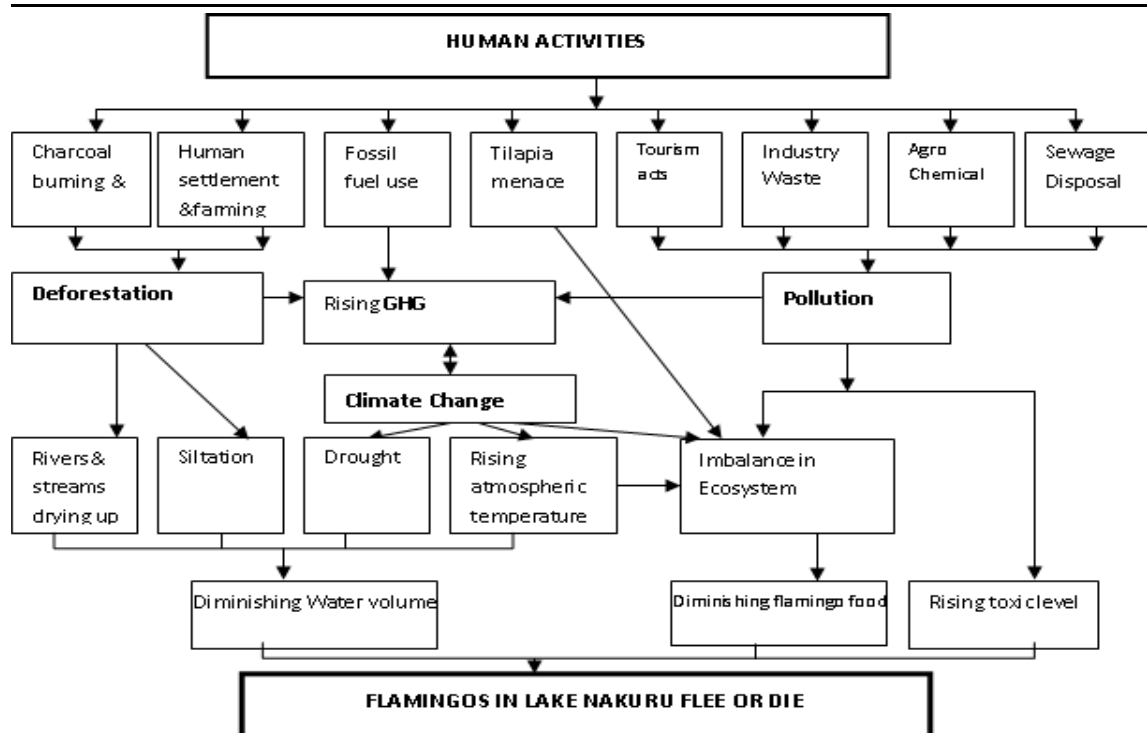
Figure 2: Flamingo death and disappearance causal model

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