Dynamics of Sewage Spillage and Storm Water Pollution on Lake Victoria Basin- A Case Study of Kisumu Municipality

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Abstract

Lake Victoria and its basin offer the riparian communities a wide range of vital environmental and social-economic services such as fisheries, transport, tourism, wetlands and water for domestic and industrial use. However, over the past 30 years these services have deteriorated as, the lake and water resources in the basin have experienced intense pressure from various sources among them sewage spillage and storm water pollution. This has been due to the rapid urbanization within the Lake Victoria basin, especially the growth of urban centers along the shores of the Lake.

Inadequate attention is paid to sewage spillage and storm water pollution within urban centers in the Lake Victoria basin, yet these immensely contribute to the contamination of the lakes ecosystem and slow sustainable development of the region.

Kisumu municipality is a major urban center in the Lake Victoria basin and faces challenges of sewage and storm water pollution. Short water supply and poor sanitation framework have overburdened the municipal creating a situation where semi-treated or untreated sewage is in some areas discharge directly into water courses, especially in areas surrounding informal settlement. The municipals sewage system was designed to serve about 17% of the current population and is thus overwhelmed. This results in sewage and storm water runoff ending up being channelled into the various rivers and streams that flow into Lake Victoria. Over 80% of Kisumu residents are not served by the sewerage system and rely on pit latrines with a small portion using septic tanks. When full sludges from these septic tanks and pit latrines are usually disposed of at the municipals overstretched and malfunctioning sewage treatment plant ending up into rivers, ground water and the lake either semi or untreated.

Many residents in the municipality depend on underground well water for their domestic use. These wells are poorly constructed and protected and are thus susceptible to contamination by storm water. In the rainy season, storm water causes floods and flushes the faecal matter from latrines. This faecal matter is deposited into the open wells and contaminating the water. In the last few years there has been an explosion of waterborne diseases in the municipality which has partly being attributed to well water contamination.

Keywords: sewage, storm-water, urban, water

I. Introduction

Lake Victoria is the second largest freshwater Lake in the world after Lake Superior in the United States of America. The lake is shared by three countries, Kenya, Uganda and Tanzania and covers a surface area of about 68,800 km^2. The catchment of the lake covers an area of about 185,00km^2 and traverses five countries - Tanzania, Uganda, Kenya, Rwanda and Burundi. The Lake Victoria region has one of the highest population growth rates in the world. The Lake is a very important reservoir of fresh water in the region and supports about 35 million people who depend on water and natural resources for their livelihood.

As early as the 13th and 14th century Lake Victoria was well surrounded by organised and settled communities which had and still enjoy interactions. The coming of the European settlers in the 18th century and Asians who were brought by colonialists to build the Kenya-Uganda Railway, further enhanced the trade interactions between the communities. The earlier barter trade system within the communities became prominent as canoes and dhows transported goods. Market centers developed and later small towns were established around the lake ports. This was the origin of the municipalities and cities that are now well established. These major towns include Kampala, Entebe and Jinja in Uganda; Kisumu and Homabay in Kenya; Mwanza, Musoma and Bukoba in Tanzania. The populations of these towns range from 0.2 to 2 million. A study conducted by Lake Victoria Environment Management Project (LVEMP) indicates that there are 87 large towns in Lake Victoria basin

with the respective numbers in Kenya, Tanzania and Uganda being 51, 30 and 6. Urbanization in the Lake Victoria basin has led to proliferation of informal 'squatter' settlement in major towns. Such informal settlements lack proper waste disposal sanitary facilities. The fraction of households with sewer in these towns is less than 30%. Existing sewage treatment facilities in all major towns have generally poor coverage and are in very deplorable shape. Raw sewage is discharged into small rivers and streams or directly into Lake Victoria, contributing significantly to water pollution.

Kisumu is the third largest city in Kenya and the principal city of Western Kenya with a population of over 700,000 people. It is the second most important city after Kampala in Uganda in the greater Lake Victoria basin. Kisumu is among the fastest growing cities in the Lake basin with an annual growth rate estimated at 2.8% and densities of 828 persons per km^2. This brings the associated complexes in urban planning that have resulted in the rapid expansion of informal settlements and mounting pressure on the inadequate waste management system.

The current water supply and sewage system commands 40% and 10% coverage respectively. Sewage is by far the most expensive sanitation technology and its costs continue to rise. According to World Health Organisation, more than 90% of sewage developing countries is discharged without treatment. In Kisumu the sewage treatment system has been ineffective and in some instances it has not worked for several months implying that raw sewage is released into rivers ending into Lake Victoria and underground water. Furthermore, the sewage network is old and was meant to serve a small population, but with the rapid population growth the system is serving a population 5 times more than is was planned for. This leads to frequent bursting of sewerage systems and spilling of its contents that ends up polluting water resources with the basin. Kisumu is situated in the mainland surrounded by and highlands undertaking large scale cultivation of sugar, and tea. Rain water from the highlands results in flooding within Kisumu municipality and the water is channelled into storm sewers which eventually discharge into Lake Victoria. With the expansion of Kisumu municipality as an urban center various constructions have taken place increasing the impervious surface such as parking lots, roads, buildings and compacted soil that does not allow rain to infiltrate into the ground thereby generating more runoff .This additional runoff erodes water courses (streams and rivers) causing floods as the storm water collection systems are overwhelmed by the additional flow. Moreover, these systems are clogged with solid and liquid waste that dissolve in the storm water or are carried as suspended matter into rivers and eventually Lake Victoria.

II. Kisumu sewerage pollution and storm runoff

The pollution load to Lake Victoria due to urban waste water and runoff is high. A study by LVEMP indicated that that the pollution load into Lake Victoria from the urban areas was 6,955t-BOD/y, 3028t-Total -N/y and 2,686t-Total P/y. These figures represent the pollution load from the urban areas close to the lake shore without consideration of the pollution load originally from towns located far away from the lake shore and which drain into Lake Victoria via streams and rivers. This implies that the cumulative pollution load is much higher.

Tab 1: Nutrient pollution load on Lake Victoria

Source	BOD (tons/year)	Total Nitrogen (tons/year)	Total phosphorus (tons/year)
Catchment	0	49,510	5,690
Atmosphere	0	102,150	24,400
Industrial	5,610	410	340
Municipal	17,940	3,510	1,620
TOTAL	23,550	155,580	32,050

Kisumu storm water challenges are closely linked to the to the city topography. The city is curved into a trough with the walls of Nandi escarpments to the East dropping into the Kano flood plains and gently flowing to Dunga wetlands at the shore of Lake Victoria. In addition, the destruction of vegetative cover has resulted in the increase in surface runoff in the town. The current storm water infrastructure is inadequate covering less than 20% of the municipality and is blocked with solid waste and soil rendering them ineffective.

Effluents from some 100,000 people connected to the sewers are emptied untreated into the lake at the shallow Winam Bay. This is as a result of the dilapidated and faulty sewerage treatment facility. Moreover, loads of nutrients from pit latrines and leaking sewers find their way into the lake though untreated storm water.

III. Impact of sewerage pollution and storm runoff

Sewage spillage is a point source of pollution while storm runoff is a non point source as its source is difficult to identify. Kisumu like many other urban

centers within Lake Victoria basin faces a myriad of health problems. Some of these health situations are directly contributed by sewage spills that pollute water sources such as rivers, lake water and ground water which are the main sources of water for many residents in Kisumu. In a participatory study carried out by OSIENALA in two contrasting peri-urban neighborhoods of Kisumu (Migosi and Manyatta). Manyatta is a mixed slum dwelling about 4km to the south of north-east from the Town centre. It is a relatively old estate dating back to colonial times. Migosi on the other hand is relatively affluent, middle class neighbourhood covering 0.875 Square km. It is approximately 4.5 Km in the north of north east from the town centre. Manyatta and Migosi are in close proximity, separated by a main road, Kisumu-Kibos road. Most households have pit latrines within their residential plots. Many latrines are situated close to wells and/or reach into the groundwater. Because the population density is high, and because many people use pit latrines, groundwater pollution is high as was evidenced by high faecal coliform counts in some wells.

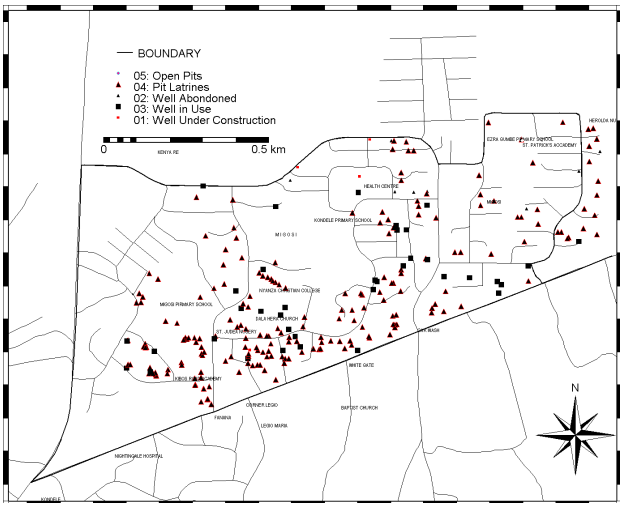
Tab.2 Feacal Coliform Count in Migosi and Manyatta

Fc/100ml Dispersion	**Manyatta No**	**Frequency (%)**	**Migosi No**	**Frequency (%)**
< 1	32	53.33%	22	53.33%
1-100	9	15.00%	-	-
-100	12	20.00%	4	10.00%
-1000	6	10.00%	8	20.00%
-5000	1	1.66%	4	10.00%
-10,000	0	-	2	6.25%
TOTAL	60	100%	40	100%

Combined with the fact that burst sewers are leaking for months on end it is inevitable that groundwater also become grossly polluted. Residents have had no choice but to accept such conditions while the Municipal Council of Kisumu sources for funds to ensure adequate provision of water to its residents.

Raw sewage contains biological agents such as bacteria, viruses, fungi and parasites that cause serious illness and even death. In recent years new strains of waterborne illness that were not common have been on the rise such as leptospirosis and hepatitis A. There has also been an increase in waterborne diseases such as diarrhoea, stomach cramps and cholera due to increase in *giardia* and *cryptosporidium* parasites and *gram-negative* bacteria commonly found in sewage.

Map 1: Wells and pit latrines distribution in Migosi, Kisumu

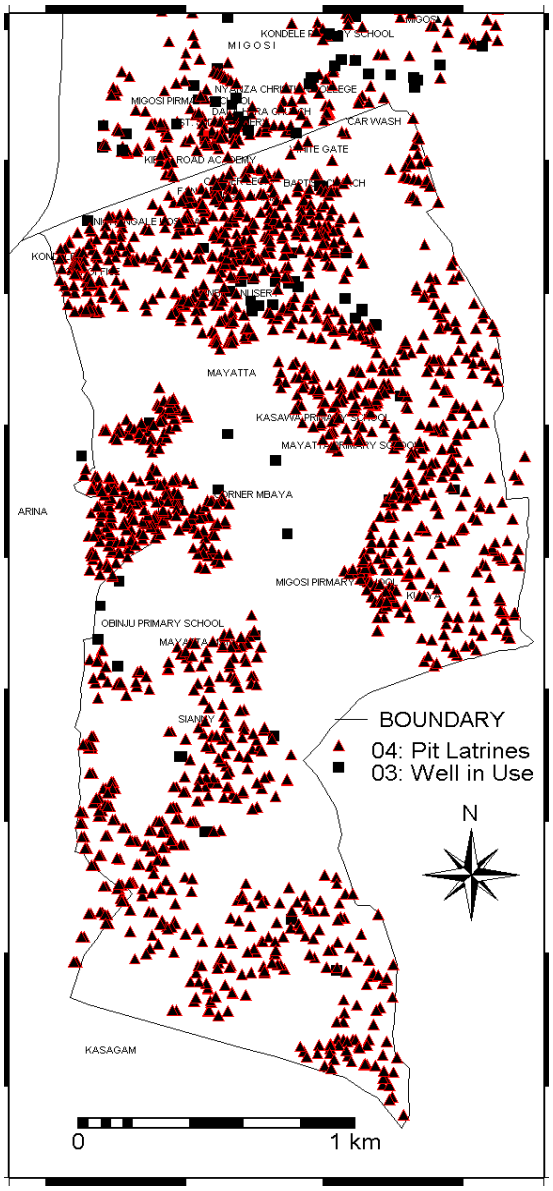


Sewage spills into the lake causes increased nutrients. This has resulted in rapid eutrophication of Lake Victoria over the later part of the 20th century. Euthropication forms ambient conditions in the lake that favour dominance of nitrogen fixing cyanabacteria and the spread of aquatic weeds such as water hyacinth (*Eichornia Crassipes*). Water hyacinth infestation has chocked water ways and landings thereby hindering commercial transportation, especially movement by small boats which are the main means of transportation. Reduced accessibility to harbours has occasioned unprecedented delays in commercial water borne transport for people and goods resulting in losses for fishermen especially when their catches rot due to delays. The water hyacinth has also blocked water access since tradition collection areas and water dumping equipment are chocked with the weed. In addition, the water hyacinth mats provide a suitable environment for prolification of *biomphalaria* snail, which hosts *Schistosomiasis* (bilharzia) and breeding sites for mosquitoes which transmit malaria.

Storm runoff has increased algal bloom with intense blooms occurring during the rainy season. As the growing population in the peri urban areas of Kisumu Municipality strive for self sufficiency in food crops and increased yields from cash crops there is amplified use of pesticides and fertilizers. These agro-chemicals are rich in nutrients and when they are washed off by surface runoff to the lakes and rivers they propagate eutrophication that results in algal blooms. These are dense growths of algae forming scum over the water surface. The major algae blooming zone on the Kenyan side of the lake is in the Nyanza Gulf that encompasses

Kisumu municipality and is mainly dominated by the blue and green algae. The algae bloom deoxygenates the water with oxygen concentration in water depths greater than 25 meters falling below 3.0m/g, the lowest level for most fish species in the lake resulting in absence of fish in these habitants. Furthermore, the water is not suitable for domestic and recreational purposes. Some algae blooms are known to produce toxins that are harmful to human, aquatic life and other wildlife. The algae bloom also clog filters in water treatment facilities thereby reducing their lifespan and therefore resulting in increased treatment costs due to cost incurred in eradicating the algae and frequent replacement of machine parts.

Map.2 Well and pit latrines distribution in Manyatta, Kisumu



Storm runoff sweeps other wastes into water resources thereby compounding the water pollution problem in the lake basin. Many of Kisumu municipality residents use latrines which often are shallow and overflowing. The runoff takes with it sewage from these latrines and deposits it in the rivers, lake and ground water through shallow wells. This is of paramount concern as over 75% of the residents in Kisumu use ground water as the main source of drinking water and for other households needs. In addition, solid waste disposal in the municipality is a challenge and this waste ends up in the common storm water drains or streams and eventually ends up in the lake polluting the water.

IX. Way forward

Kisumu municipality needs to develop integrated waste management system. Sewage and storm water pollution challenges are integrated with other waste management and development challenges such as solid waste disposal, poverty and sanitation practices. The municipality should have a compressive and sustainable solid waste collection and disposal framework that should encompass citizen awareness, sensitization and participation. This will ensure that solid waste is collected, sorted and disposed off without ending up in water bodies.

Sewage systems are costly and to ensure its success adequate resources are required which the Municipal Council of Kisumu does not have. Thus, other sustainable sanitation alternatives based on equity, prevention and sustainability need to be adopted such as use of urine-diverting (ecosan) toilets. Ecosan systems prevent ground water contamination, have no problem of sewage overflow and are easily adoptable at the household level with minimum construction and maintenance cost. The system ensures equity in distribution of water prevents harm to human health and achieves zero pollution discharge.

Long term storm water management need to be adopted such as Integrated Water Management (IWM) of storm water. IWM has the potential to solve issue affecting the health of water ways, improve runoff quality and reduce the risk and impact of flooding and delivery additional water resource to agreement portable supply. IWM offers several techniques including storm water harvest (to reduce the amount of water that can cause flooding), infiltration (to restore the natural recharge or ground water), biofiltration (to store and treat runoff and release at a controlled rate to reduce impact on streams and wetlands). IWM solutions include use of retention ponds, use of underground storage tanks, storm water treatment system, biofilters etc

The municipality needs to develop and enforce policies and legislation to deal with sewage system management and storm water management. Though Kisumu municipality, like many other urban centres within the lake basin have environmental and waste management policies, these policies do not comprehensively address sewerage and storm water issues. These need to be clearly articulated in the municipal by laws and enforced accordingly.

V. Conclusion

Storm water and sewage spillage can no longer be viewed as pollution sources with lesser impact as compared to agricultural, mining and industrial pollution sources. Concrete strategies need to be formulated that will holistically address sewage and storm water challenges especially in urban centers in developing nations as they lack adequate financial technical and managerial resources to successfully protect lake land water resources

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