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Inner Murchison Bay - water quality trends

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Inner Murchison Bay – water quality trends

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LAKE VICTORIA, THE second largest freshwater lake in the world, is situated in East Africa, bordered by the countries of Kenya, Uganda and Tanzania. A large number of people in these countries depend on the lake as a source of drinking water. In Uganda, National Water and Sewerage Corporation (NWSC) has four raw water intakes on the lake for the urban centres of Kampala, Jinja, and Entebbe. Two of these intakes (Gaba 1 & Gaba 11 for Kampala) are in the Inner Murchison Bay (IMB). Using water quality data (mean monthly values) for the period 1994 – 1998 this study attempted to establish the trends of water quality in the IMB. Core parameters of colour (apparent), electrical conductivity (E.C), turbidity and faecal coliform content were considered.

Since NWSC draws raw water from the lake for treatment, water quality data for treated water for the same period were considered with a view to establishing whether change in quality of raw water would affect the resulting quality of treated water. The findings were used to demonstrate the ability of the current water treatment process to produce water of acceptable drinking water standards.

Methodology

A literature review of the global state of freshwater sources was carried out with a view of establishing pollution problems facing surface water sources world-wide, and the steps taken to contain them. Studies carried out on Lake Victoria in particular were reviewed. This was followed by an analysis of water quality data obtained from NWSC laboratory for both raw and treated water from Lake Victoria for the period 1994-1998. The data included water sampled at Gaba 1, Gaba 11, Jinja, and Entebbe. The aim of the analysis was to establish whether there were any recognisable and significant trends for the core parameters of electrical conductivity, colour, turbidity and faecal coliform count.

The period chosen for study was considered best because of the rapid economic development experienced in Uganda since the early 1990's. The above parameters were chosen because these are suitable indicators of water quality change in surface water and also as they were being determined at the water works on a daily basis. EC was determined using a DREL/5 spectrophotometer, colour using a comparator and turbidity using a turbidometer. The faecal and total coliforms were determined using membrane filtration. All the methods are described in Standard Methods (APHA, 1992). Mean monthly values for all the parameters were used for analysis of results.

Global problems facing surface water sources

Over the past decades, increased anthropogenic activity in water catchments has adversely affected the natural quality of surface water sources. While it was assumed that nothing could go wrong with the vast water bodies, it has come to be realised that, even though water is capable of self-purification, the rate at which this happens depends on several other factors. Vast water bodies were believed to be capable of taking in all sorts of waste, but some of these waters have been polluted to such an extent that aquatic life is endangered (Meybeck et al, 1989). Discharge of domestic and industrial waste has resulted in contamination by toxic substances, rendering the water unfit for human consumption if not treated.

Drinking water quality

In many low income communities in developing countries, large sections of the population depend on raw/untreated water for drinking from lakes, rivers and swamps for drinking. As a result, quality criteria for raw water should be set, albeit, at realistic levels. While developed countries in Europe and United States have raw water guidelines, the same cannot be said about developing countries (Helmer and Hespanhol, 1997).

Sources of water pollution

Many sources of water pollution are a result of human activities. Such sources include domestic sewage, industrial effluent, agriculture, navigation, urban run-off and solid waste disposal. The nature of pollutants from the above mentioned sources include but are not limited to bacteria, nutrients, heavy metals, pesticides, herbicides, industrial organic chemicals, suspended solids, oils and grease (Chapman, 1997).

Water pollution control

All the nations of the world acknowledge the danger posed by human activities to the environment in general and to water sources in particular, and as a result, many countries have formulated policies and legislation to control pollution. Without urgent and properly directed action, developing countries face increasing problems of disease and environmental degradation as a result of contamination of water sources. At the Earth Summit in Rio de Janeiro in 1992, world leaders acknowledged the importance of protecting freshwater sources. Chapter 18 of Agenda 21

lays down key principles and recommendations for sound water resources management to ensure protection of the quality and supply of freshwater resources (Helmer and Hespahol, 1997).

In many countries, pollution control is effected using legislation. However, experience of the developed countries has shown that this approach has not been easy to implement and that any success was slow and evolved over decades. Two approaches are employed in legislation. One is Environmental Quality Objectives (EQO), which is receiving-water oriented, while the other is Uniform Emission Standards (UES), which attempts to limit all polluting discharges uniformly with no regard to dilutions. In some countries, both approaches are employed (Ellis, 1989). Success in enforcing environmental protection regulations has however been different from country to country.

Issues on lake Victoria

Despite the fact that Lake Victoria is the second largest freshwater lake in the world only a limited number of studies have been carried out on its water quality. However, pollution problems facing the lake are not peculiar, and appear to be similar to those of other lakes the world over. Boardering three countries makes the management of the lake more complicated as this makes it a regional responsibility. A breakdown of the lake surface area, shoreline and basin per country is as follows according to WulfKlohn and Mihailo (1998):

Kenya	4,113 km ² (6%) lake surface and 550 km of shoreline
Tanzania	33,756 km ² (49%) lake surface, and 1150 km shoreline
Uganda	31,001 km ² (45%) lake surface and 3450 km shoreline

Sources of pollution into lake Victoria

Literature review showed that sources of pollution of L. Victoria are similar to those of other surface water bodies. Other sources of pollution into the lake are:

- Domestic waste and human excreta
- Urban run-off
- Industrial waste
- Solid waste disposal sites
- Pesticides and herbicides from farming communities within the catchment

In addition to those mentioned above, there is a peculiar problem of a threat from toxic chemicals used by fishermen.

Data analysis and findings

Data analysed showed that there was a significant increase in colour (apparent) of raw water for the period under consideration (Fig.1 below). There was an indication that colour of treated water increased with increase of colour of

raw water (Fig. 11 below). Water treatment has apparently become more complicated due to the presence of organic matter as result of eutrophication. Presence of blue-green algae has been identified, and this could be the cause of high colour in both raw and treated water (Kanyesigye, 2001).

Nutrient load

The water quality of L. Victoria has declined as a result of increased inflow of nutrients. Considering that fertiliser usage in the catchment is low, most of the nutrients are from human and animal waste and from soil particles washed off land by soil erosion from burning wood-fuels (TED Studies, 1999). According to a recent study (Chege, 1995) results showed that on a daily basis Tanzania is responsible for 2 million litres of untreated sewage and industrial waste flow into the lake.

On the Uganda side of the lake, 80% of the nutrients originate from the Nakivubo catchment into the IMB, and this is from non-industrial sources (COWI, 1998). From Kampala alone, the total load was estimated to be 168 kg/day, and only 85% of this was from Bugolobi Sewage Treatment Works. From other rural urban centres within the catchment, with an estimated population of 139,997, the estimated load was 1287 kg/day Total Nitrogen, and 233 kg/day Total Phosphate (IMWM, 1999).

Treatability of the water

Presence of phosphorous and nitrogen compounds in the lake has stimulated increased algae growth noted to be five times since 1960s (TED Studies, 1999). There has been a noticeable increase in coagulant chemical used at the clarification stage as a result (NWSC WQ Database). Furthermore, if the clarification stage is bypassed during treatment, algae cause filters blockage. This in turn leads to a need for more frequent backwashing of the filters. It should be noted that since values obtained on a daily basis were not used for analysis but monthly means instead it was not possible to subject the available data to detailed statistical analysis.

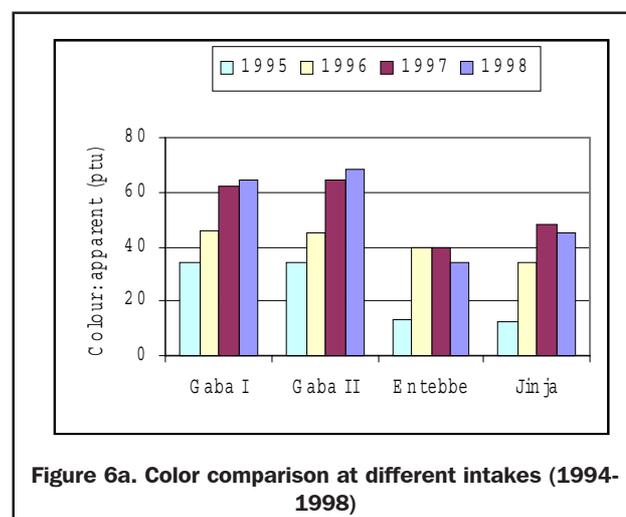


Figure 6a. Color comparison at different intakes (1994-1998)

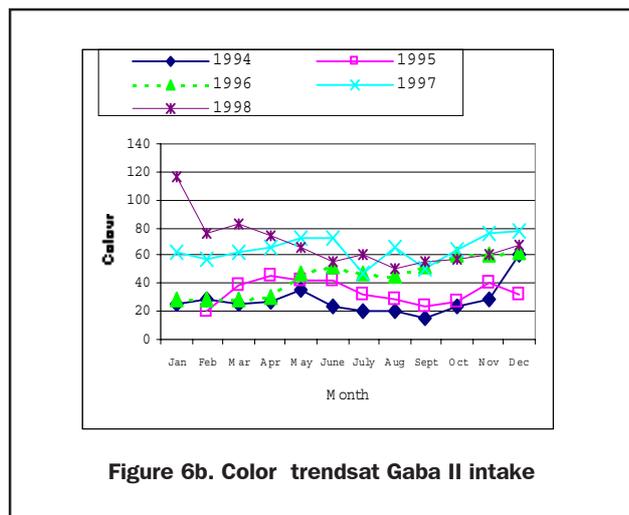


Figure 6b. Color trends at Gaba II intake

Bacteriological quality of the water was found to be acceptable based on faecal coliform counts. However this may change with the recent opening of the Nakivubo Channel, which drains directly into IMB and carries with it run-off and wastewater especially from slum areas with limited sanitation facilities. So far NWSC does not test for chlorine resistant pathogens and so there is no record on their presence and/or quantities in the water.

Conclusions from the study

IMB -Lake Victoria water quality

- There was considerable increase in the colour of raw water (two to three times) from the IMB for the period under consideration.
- Increase in colour was not due to metallic ions such as iron and manganese
- Colour may be due to organic matter from decaying vegetation and/or industrial waste
- Bacteriological quality at the level of £ 100 FC/100ml was acceptable for a surface water source. This is based on faecal coliform content only

National water and sewerage corporation water treatment plants

- There are process limitations at Gaba 1 and Gaba11 WTPs once the colour of raw water exceeds 50PtCo.units.
- The indication that low raw water colour did not necessarily result in low final water colour may be an indication of either operations inefficiency, or presence of substances the process is not capable of removing.

Recommendations

- Further research to establish cause of colour in the water

- Include other more chlorine resistant organisms (F.Streptocci) in routine quality monitoring process.
- Carry out unit by unit process of the treatment to ascertain all units are efficient
- Move away from the critical control point principle to a multiple barrier approach during quality monitoring and management

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