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WATER AND SANITATION FOR ALL: PARTNERSHIPS AND INNOVATIONS

Integrated water quality management in Harare

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THE MASS FISH death witnessed in April 1996 on Lake Chivero is a graphic representation of the consequences of poisoning Harare's water supply. The ensuing ban on the use of the Lake meted out considerable social and economic hardship to local communities involved in the Lake's recreational and fishing industries. Other ongoing, effects of pollution of Lake Chivero include water treatment difficulties, water hyacinth infestations and the clogging of downstream commercial farming irrigation pipes. Lake Manyame, just downstream of Lake Chivero and also a supply of drinking water, is in a situation to receive polluted waters from overspill by Lake Chivero. It is only a matter of time before these pollutants breach the front-line of Harare's water treatment works and bring health, environmental, social and economic impacts of a grander scale to the citizens of Harare (Bailey et al, 1996).

Mass fish deaths occurred previously in the lake in 1970 and 1991. The periodic mass fish deaths observed have mostly been green-headed bream Oreochromis macrochir. Several causes have been suggested for the mass death observed, all are likely and all find their roots in the pollution of Lake Chivero and are compounded by the physical dynamics of the lake. These causes are: anoxia, ammonia poisoning, heavy metal poisoning and a cocktail of acid gas emissions from the bottom waters of the lake.

At present, approximately 1.5 million people, 13 per cent of the population of Zimbabwe, live within the catchment area of lake Chivero and this figure is projected to rise to over 2 million people, or 14.6 per cent of the national population, by the turn of the century. By 2010 the population of the catchment is estimated to be 3.8 million people which will be 17.3 per cent of the total population. The Upper Manyame River Basin (UMRB) with a drainage area of about 3900 km2, extending upstream from Manyame Dam is where the Harare City and its satellite towns, Chitungwiza, Norton and Ruwa exist and also the sources of raw water. The present annual daily average water consumption is approximately 350 Ml/day.

Quantity of pollution loads increase year after year at more higher rate than expansion of treatment facilities required and type of pollution loads become more diversified due to variety of industrial development. This scenario can only lead to an ever increasing rate of accumulation of pollutants in Harare's main water supply. Thus it is the most important issue to formulate and implement a comprehensive water pollution control plan urgently.

The plan should aim at revealing the sources, types and quantities of pollutant loads generated in the UMRB and to be discharged into the existing reservoirs and other important water source works and formulating the adequate plant to control such pollutant loads for conservation and preservation of the water resources. A framework for addressing the information needs of catchment water quality management should be developed, backed by appropriate research, i.e. it should entail the following: situation analysis (screening or scoping), planning (evaluation and prioritisation), assessment (knowledge base, water quality data, modelling) and implementation (selection, operation and auditing).

History and the state of the lake

- **1952:** Lake Chivero was created by the impoundment of the Manyame River at Hunyani Poort to supply the city of Harare with water. Located at Hunyani Poort is Harare's water treatment works, Morton Jaffray.
- **1960:** During winter the first indication of the eutrophic state of the lake was the appearance of a major blue-green algal bloom.

- **1964:** The algal bloom was a permanent feature resulting in serious difficulties in water purification. It was also the probable cause of gastro-enteritis in children in Harare (Zilberg, 1966).
- **1968:** Very significant decline in lake level had major ecological effects, particularly on the water chemistry and benthic fauna of the lake.
- **1970:** There was a massive fish kill on the Lake. By 1971 the lake was described as hypertrophic, with massive algal and macrophytic infestations (in particular water hyacinth) and extensive de-oxygenation particularly at times of overturn (Thorntom and Nduku, 1982). In 1970 in response to the state of the lake, the Harare City Council started a major programme of using treated sewage effluent to irrigate pasture. During the late 1970's the lake returned to a mesotrophic condition and the use of sewage irrigation appeared successful.
- **1972:** Water hyacinth virtually eradicated from the lake surface through chemical control.
- **1973:** New intake tower and tunnel, located 200m offshore was commissioned, the first tower being badly affected by algal blooms.
- **1977:** Nearly 100 per cent of municipal wastewater effluent had been diverted and treated to tertiary standards
- **1982-1984:** A gradual rise in nutrient status was noted. During the 1982-1984 droughts massive outbreaks of water hyacinth occurred. This pattern of massive infestations by water hyacinth continued from the mid 1980's to the present.
- **1987-1996:** Lake Chivero spilled only once in 1990. From 1990 until 1996 Lake Chivero failed to spill.
- **1991:** There was fish death.
- **1996:** Biggest fish death witnessed on Lake Chivero.

Phosphorous (P) and nitrogen (N) are the most important limiting nutrients on productivity in Zimbabwean impoundments such as Lake Chivero (Thornton and Nduku, 1982). Results of water sampling in the Lake (1993 to 1995) clearly show that phosphate and nitrate levels have risen exponentially (average values of 7mg/l for P and 10 mg/l for N). Levels of nitrate and phosphate have risen far beyond those levels recorded in the lake in the early 1970's when it was described a hypertrophic (nitrate approximately 0.45 mg/l, phosphorous approximately 0.2mg/l; (Thornton and Nduku, 1982).

Monitoring the levels of heavy metals in the waters and the fish of Lake Chivero (Zaranyika et al, 1993) demonstrates that Copper, Cadmium, Lead and Nickel are in dangerously high concentrations. depending on which standard one adopts. Lead and cadmium have no benefit to the human diet and are toxic to human and animal life. Heavy metals were present in low concentrations in 1974 (Greichus et al., 1978).

Major pollution sources

Discharge from sewage works

Sewage works are the main and most easily identifiable source of pollution. All domestic and industrial waste water in Harare goes in to the sewerage system and all waters in the sewerage system are treated. In Chitungwiza the system is theoretically the same. In the 1980's and 1990's rapid expansion of Harare's population and industry concurrent with poor planning with regard to waste water treatment lead to treatment plants being overloaded. In 1993 Harare City Council commenced long-needed improvement works which are due to be completed in 1998

Chitungwiza is a post Independence urban development, and has rapidly expanded. Development here has clearly outstripped urban infrastructure. Its sewerage system is insufficient to deal with the capacity of sewage flowing through it, with the result that raw sewage overflows on to streets, and hence eventually ends up in the rivers untreated as surface runoff. The reason for Chitungwiza's tardy action is chronic underfunding.

In Zimbabwe indirect reuse of wastewater to augment potable water supplies is encouraged through a Ministerial policy in view of the impending water stress situations in this semi-arid country. Even before the advent of planned water reuse, Harare's citizens had for many years drunk their "own bath water". However reduced water flows in feeding rivers during droughts result in effluent flows increasing with respect to natural flows. This means that the water on reaching the lake has a higher concentration of effluent. If the lake, due to the drought, does not spill then it acts as a 100 per cent sink of all the effluent flowing in to it.

Illegal discharges in to rivers and sewers by industry

Both small and large industries are supposed to abide by the sewer use ordinances administered by the Harare City Council. Many industries do not have effluent pretreatment facilities so they let obnoxious waste to enter the sewer system, or even worse into the storm water drainage system. Thus it is relatively easy for industries to make illegal discharges of waste water. The machinations of the legal process means that an industry that is caught polluting can expect to wait up to five years to go to court and then to be fined a paltry Z$ 1000 (US$100) some industries make that amount of money in a matter of minutes. This is an incentive to pollute.

Storm water drainage

Storm water drainage in the catchment flows straight in to the rivers without any form of treatment. Increased urbanisation, with resultant building and pavement, leads to increased surface runoff which is channelled in to the storm water drainage system. As the drains feed directly in to the rivers there is no opportunity for

environmental assimilation. Therefore a multitude of other materials which form an important source of non-point pollution. A study in the 1970's, on storm water drainage in the catchment showed a clear relationship of increased nutrient loading with urbanisation (Thorntom and Nduku, 1982). From their estimations they found that"... diffuse source storm water runoff can potentially supply sufficient nutrients to lakes such as Lake Chivero to maintain a eutrophic state.." The same researchers found that lead in storm-water run-off was associated with areas of vehicular traffic and areas of light industry.

Commercial farming

Commercial farming is also a source of pollution from runoff containing nutrients and various noxious substances from the use of fertiliser, herbicides and pesticides. As yet, no research has been presented to this investigation concerning the magnitude of this source to nutrient loading in the catchment. A study in to pesticide residues in Lake Chivero (Mhlanga and Madziva, 1990) found traces of BHC's, aldrin, dieldrin, DDE, DDD, and DDT were detected in water, soil, fish and sediment samples.

Legislative and institutional framework

In Zimbabwe, no one agency has sole responsibility for water pollution control. Authority is divided among several ministries, such as Lands and Water Resources, Local Government, Rural and Urban Development, Environment and Tourism, and Health and Child Welfare and others. At the national level, there are four major government agencies which are directly involved in the water pollution control and two particularly concerning with its planning and financial management aspects (JICA, 1996).

Harare City council is the main on the ground manager of the water resource. It is responsible for monitoring water quality in areas under its jurisdiction. Chitungwiza undertakes the same function as Harare City Council. It does not have its own trade waste inspectors and has to rely on occasional visits by Harare City council trade waste inspectors. The Water pollution Control Unit's (WPCU) role under the newly formed Ministry of Land and Water Resources. (This ministry administrates the Water Act), is to monitor the quality of the water resource and also to police both government and non-government over violations of water quality.

The primary focus of the Water Act is that of development and utilisation of water resources. It has a short-term basis on use here and now. For this very reason it does not reflect provisions for environmental concerns, like water pollution. Legislation is reactive to a criminal offence, such as water pollution, rather than preventative. The prosecution route is very circuitous and slow. At times it is slowed down by the Attorney General.

The Ministry of Environment and Tourism should be pivotal in the legislative management of the environment. However with regard to water quality it has vague and trifling powers under the Natural Resources Act and Parks and Wildlife Act. Zimbabwe's environmental legislation is contained in over 18 different statutes and administered by at least 8 different Ministries.

".....Sound resource and environmental management in Zimbabwe has been hampered by resource management laws that have been evolved over the years in an ad-hoc manner and are now fragmented, uncoordinated, overlapping, expensive to administer and essentially ineffective because they rely on a criminal law approach which addresses matters after their occurrence" (Henley, 1990).

A "laissez-faire" attitude, which is the result of fragmented legislation and uncoordinated sectorial approach prevails. This situation leads to confusion and so nobody takes responsibility

Conclusions and recommendations

The present mechanisms in place to manage the quality of Harare's water are not working as well as they should. This situation is a result of poor urban planning; ineffective legislation compounding lax policing of water pollution; and a lack of incentive for private and public bodies to minimise their contribution to water pollution. Harare and Chitungwiza are rapidly expanding and therefore their demands for wholesome water are increasing. This means that the recycled component of raw water is rising.

The "polluter pays principle" is at the centre of most pollution prevention programmes in the Western World, and polluters pay large sums of money no matter how large or small their operation is. Making a few examples of companies here in Zimbabwe might be enough to scare them into cleaning up their permanently, or at least until a reminder is needed. Community-based programmes which ensure that people keep an eye on one another would probably work better than the "polluter pays principle" which tends to focus more on industries who are not the only polluters.

This paper recommends that an Integrated Catchment Management Plan for the UMRB drawn up and implemented as a matter of urgency. In order to produce an ICMP for the UMRB it is necessary to:

Implement a systematic survey of water, sediments and groundwater of Lake Chivero and Lake Manyame and their catchment to determine the precise nature of the dynamics of the pollution, and to determine the magnitude of the sources of pollution; reassessment of water quality management philosophies i.e. prevention and minimisation and development of Receiving Water Quality Objectives (RWQO) in the UMRB to compliment the Uniform Effluent Standard (UES) approach which forms the basis of the present pollution control activities in Zimbabwe. One of the major drawbacks of the latter is that it ignores the impacts of effluent discharges on water quality in receiving waters and also

that it provides no framework for control of non-point sources and multiple point sources of a particular pollutant and consequently cannot guarantee that quality objectives in receiving waters will continue to be met.

Research the technical and other management practises and infrastructures required to address water quality issues;

Review and amend the legislation to meet the needs of effective water resource management.

Generally, resource constraints are due to the limited capacity (system constraints) of the authorities to generate tax revenue, insufficient tax collection efforts, and failure to recover costs of services. The whole water pollution control sector needs to be reviewed. The pollution control programmes have tended to be rigidly sectorial but there is a need for a more intersectoral and participatory approach so as to archive co-ordination.

"Water pollution control itself is an integral part of water resource development, and water pollution is nothing more nor less than mismanagement of the water resources".

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