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Pollution Special Study (PSS)

Overall findings of study

by
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Pollution Control and Other Measures to Protect Biodiversity in Lake Tanganyika (RAF/92/G32)
Lutte contre la pollution et autres mesures visant à protéger la biodiversité du Lac Tanganyika (RAF/92/G32)

Le Projet sur la diversité biologique du lac Tanganyika a été formulé pour aider les quatre Etats riverains (Burundi, Congo, Tanzanie et Zambie) à élaborer un système efficace et durable pour gérer et conserver la diversité biologique du lac Tanganyika dans un avenir prévisible. Il est financé par le GEF (Fonds pour l'environnement mondial) par le biais du Programme des Nations Unies pour le développement .	The Lake Tanganyika Biodiversity Project has been formulated to help the four riparian states (Burundi, Congo, Tanzania and Zambia) produce an effective and sustainable system for managing and conserving the biodiversity of Lake Tanganyika into the foreseeable future. It is funded by the Global Environmental Facility through the United Nations Development Programme.

Burundi: Institut National pour Environnement et Conservation de la Nature
D R Congo: Ministrie Environnement et Conservation de la Nature
Tanzania: Vice President's Office, Division of Environment
Zambia: Environmental Council of Zambia

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1. Introduction

Lake Tanganyika, situated in the western arm of the African Rift, is about 650 km in length and with an average width of about 50 km. It contains 17% of the world's freshwater and hosts about 2000 species, half of them endemic to the Tanganyika Basin.

Though about 10 million people reside in the catchment, little work has been done to date in examining the pollution problem in Lake Tanganyika. This is perhaps because industries are few and concentrated in only five locations around the lake. Nonetheless, people inhabit most of the lake's shoreline and their activities, domestic and industrial, have begun to affect the water quality in some areas.

The Tanganyika catchment contains a range of human establishments, from villages to towns to capital cities and these host a variety of industries and activities including: farming with fertilisers and pesticides, ports and harbours with international shipping routes, paint, sugar, soap, battery, textile, beverage brewing, and pharmaceutical factories, petroleum products depots, power generating stations, commercial fishing industries, and slaughterhouses. This document reviews our understanding, to date, of the risk that such pollution-generating activities pose to the lake's biodiversity.

For our purposes, pollution is defined as: **the anthropogenically accelerated inputs of: nutrients (especially phosphorus and nitrogen), some organic compounds (e.g. sewage and effluent from palm oil or sugarcane plantations), and inorganic compounds (e.g. pesticides, heavy metals, oil residues etc.) into the lake**. LTBP carried out water quality studies and an industrial pollution inventory to address the impact of pollution on the lake's biodiversity.

2. Water Quality Studies

National teams in Burundi, Tanzania and Zambia[1] collected more than eighteen consecutive months of water quality data in each country, including approximately 5,800 determinations spread across the following categories: carbonate alkalinity, bi-carbonate alkalinity, suspended solids, phosphate-phosphorus, total phosphorus, silica, chlorophyll *a*, dissolved oxygen, pH, ammonium-nitrogen, nitrate-nitrogen, nitrite-nitrogen, sulphate, electrical conductivity, water clarity, temperature and phytoplankton diversity. Sampling sites encompassed a range of human impacts, from nearly pristine control sites within national parks, open water control sites and a variety of near-shore sampling sites near ports, markets, towns and villages, municipal water supply intakes, and industries. In addition, the Burundian sampling protocol included: rivers which passed through urban areas and their points of entry into the lake.

[1] Owing to regional insecurities, the LTBP-sponsered rehabilitation of the Centre de Rechereche en Hydrobiologie in Uvira, DR Congo was suspended on several occasions. These delays meant that there was not a functional chemistry laboratory in Uvira until September 1999 –a couple of months before the close of PSS fieldwork. Unfortunately, renewed regional insecurities precluded a visit by international PSS consultants to oversee the calibration of laboratory equipment and launching of a water-quality monitoring programme.

The determinands varied among stations, full statistics will be available in the PSS Summary Technical report. In Burundi the nitrogen parameters were on average 0.5-1.0 mg/l, this is ten times greater than levels recorded in the other countries. Phosphorus parameters, however, were more equitably distributed, with averages of <1 µg/l in Burundi, 5 µg/l in Tanzania and 8 µg/l in Zambia.

Phytoplankton data show that species associated with eutrophic waters are abundant in Bujumbura Bay, common in Kigoma Bay and rarer in Mpulungu Bay compared to the abundance of these species in open waters or in waters adjacent to protected catchments.

All data considered suggest that Lake Tanganyika currently falls into the 'oligotrophic' category of Wetzel's classification of lake productivity levels (Wetzel,1983). While not 'ultra-oligotrophic' which typically describes pristine systems, oligotrophic lakes are nonetheless considered to be healthy and not of great concern with respect to water quality as a function of nutrient enrichment.

However, Dr. F. Chale's work in Kigoma Bay, Tanzania shows some cause for local concern. Kigoma Bay is about 4 km long, 3 km wide, 25 m deep and is surrounded by Kigoma Town (population 135,000) which draws its domestic water supply from the Bay. In water quality comparisons between Kigoma Bay and offshore waters, Kigoma Bay waters were found to be significantly higher in nutrients and 2.23 times less transparent than offshore waters (N: 56 µg/l *vs* 34 µg/l; P: 12.55 µg/l *vs* 6.47 µg/l). A similar trend was found in comparisons with unimpacted near-shore areas, suggesting that nutrient input into the bay from external sources is considerable. These values are elevated enough to render Kigoma Bay 'meso-eutrophic' on Wetzel's classification of lake productivity levels. Kigoma lacks a waste water treatment facility. Many households have built toilets with pipes leading to the town's storm water drains. These drains thus act as conveyers for domestic effluents to enter the bay which may be responsible for the high N and P concentrations and enrichment in plant nutrients.

3. Industrial Pollution Inventory

In February 2000, PSS members from Burundi, DR Congo, Tanzania, and Zambia participated in a workshop to plan a survey of industrial pollution in their countries. PSS team members designed a detailed questionnaire covering the nature and quantities of chemical products, and energy used in various industries with detailed descriptions of solid and liquid waste treatment measures. These data are currently being entered into a regional Microsoft Access Database which links to the project GIS.

Industries are found only in the largest towns and cities along the lakeshore. Consequently the PSS survey was executed such places, including: Bujumbura, Burundi; Uvira, DR Congo; Kigoma, Tanzania; and Mpulungu, Zambia. Unfortunately security restrictions prevented visits to Kalemie, DR Congo or the palm-oil processing installations in Rumonge, Burundi. Each national team has submitted a report on their findings, summarised below:

3.1 Burundi

Bujumbura: population 400,000-600,000. Industries include: the Port, brewery, textile (two companies), battery, paint (three companies), soap (two companies), cottonseed oil and pharmaceutical factories, slaughterhouse, dairy processing, and petrol depots among others.

- The brewery (2,100 cubic meters per day) and the textile (2,350 cubic meters per day) factories discharge significant quantities of wastewater. Other industries discharge considerably less (totalling 5,000+ cubic meter per day all together). However, wastewater from industries in Bujumbura can contain notably: acetylene, ammonium sulphate, blood and offal, calcium hydrochloride, cadmium, calcium hydroxide, chrome, chromium hydroxide, cobalt, copper, detergent, disinfectants, hydrocarbons, iron sulphate, lead, mercury, nitric acid, sodium carbonate, sodium hydroxide, sulphuric acid, and zinc of varying concentrations and quantities. Industrial wastewater enters the lake directly or by transiting several m to km via an influent river. Construction of a water treatment plant designed to treat 38% of Bujumbura's wastewater was nearly finished five years ago but completion is awaiting financing of finishing works.

- Domestic wastewater from Bujumbura is also discharged into the lake directly or via influent rivers.

3.2 DR Congo

Uvira: population 300,000. Industries include: the Port, petroleum products depot, cotton processing plant, sugar processing plant with inquiries into the general hospital and agricultural practices.

- Uvira Port is the transit point for some 13,000 tons of cargo annually. The port has no infrastructure for disposing of liquid or solid wastes and petrol products can be seen on the lake's surface.

- Industrial and domestic waste water was highlighted as a concern. The petrol depot discharges wastewater directly into the lake (1,000 cubic meters/year) and the sugar processing plant puts out 7.5 thousand tons/year of waste water containing some chemical products into the Rusizi, and ultimately the lake. Also, Uvira has no sewage system and no water treatment plant.

3.3 Tanzania

Kigoma: population 135,000. Industries include: TANESCO power plant, the Port (TRC port operations, AMI cargo) with additional inquiries into the Urban Water Supply Authority and the Town Council Health Officer.

- TANESCO is hard-pressed to fulfil its mandate of supplying 11.5 million kWh electricity to its 4000 clients, and has had to 'cut-corners' in production. Their environmentally-

unfriendly habits have been documented in detail in the IWACO report but include discharging unknown quantities of untreated water and inadvertently discharging on average, tens of litres of waste fuels into the lake each day.

- Kigoma Port is the transit point for some 138,000 tonnes of cargo annually. Processes are in place for disposing of liquid and solid wastes and these are deemed to be effective.

- Water extraction and disposal were of some concern. The water intake for Kigoma (carrying 5.3 million cubic meters annually) is located meters from sites where TANESCO oil waste products and raw sewage from the police and prison quarters are entering the lake. Kigoma lacks a water treatment plant.

3.4 Zambia

Mpulungu: population 71,000. Industries include: the Port, 8 industrial fishing companies.

- Mpulungu Port is an international transit point for passengers and cargo. Cargo includes petroleum products, food stuffs, chemicals and construction materials. While the harbour authority tries to ensure safe passage of goods, accidents or leaks sometimes occur and the harbour has no mechanisms for dealing with clean-up.

- The eight industrial fishing companies extract water from the lake to cool the compressors of the blast freezers. Nothing is added to the water, it merely circulates through the compressors with a 2 degree temperature increase and then it returns to the lake. No significant solid wastes are generated in this process.

- Mpulungu lacks a water treatment plant. During the rainy season especially, raw sewage enters the lake.

4. Heavy Metals

Recent studies (Benemariya *et al*., 1991; Sindayigaya *et al*., 1994) and work done in this project (Chale, unpublished data) examined concentrations of cadmium, copper, iron, lead, manganese, and zinc metals in molluscs and economically important fish from Burundian and Tanzanian waters. Heavy metals were found in these organisms, however, all data fall within the acceptable ranges of the World Health Organisation (WHO) standards for metals in foods.

5. Pesticides

Deelstra *et al*. (1976) and work done in this project (Chale, unpublished data) surveyed the level of pesticides in economically important fish from Burundian and Tanzanian waters, respectively. While the studies are not directly comparable in terms of temporal and spatial sampling, it is interesting to note that Burundian samples (collected from Bujumbura Bay and up to 20 km south in 1976) showed DDT and DDE (the breakdown product of DDT)

concentrations one to two orders of magnitude greater than the Tanzanian samples (collected from ten sites approximately even-spaced along the length of the coast). While these results indicate that pesticides are entering the lake and the food chain, the levels (in Burundi in 1976) are considered low and comparable or lower than ranges from Lake Victoria and other African lakes and rivers. According to WHO and other standards, these levels do not pose a health risk.

6. Discussion

Our data and the existing literature on pollution in Lake Tanganyika show that overall, the lake is currently relatively unaffected by pollution. The waters are generally oligotrophic and though we do not have quantitative field data on industrial pollutants, the industrial pollution inventory, water quality analyses and phytoplankton studies offer little indication that pollution is significantly altering the lake's water quality or food web as of yet. This is good news because maintaining healthy ecosystems is much easier than repairing damaged systems.

However, our data do show that human activities are beginning to alter the quality of littoral habitats. Kigoma Bay is on a eutrophying trajectory. Furthermore, the variety of industrial contaminants being emitted into the lake especially in Bujumbura Bay is cause for concern. Finally, nowhere are domestic and industrial wastes treated before they return to the lake.

Given that no industrial or domestic wastewaters are treated and a range of worrying chemicals are being emitted into the lake, how can Lake Tanganyika still be considered healthy? It is a big lake and outside of Burundi, riparian communities are relatively small. With relatively low levels of pollutants entering the lake, they are rapidly diluted. However, current growth rates suggest that the population around the lake will double every 25-30 years. Industries will undoubtedly continue to grow around the lake as well. As population pressure and industries grow, maintaining a healthy, pollution-free status will require some active changes.

While the current levels of pollution give us reason to be optimistic, how vulnerable is Lake Tanganyika to pollution? The hundreds of rivers entering the lake, including the Rusizi and the Malagarasi, drain 250,000 square kilometres hosting about 10 million people. A single river, the Lukuga, exits the lake. Tanganyika has an average residence time of 440 years and a flushing time of 7000 years. Thus pollutants that enter the lake will stay there for a long time. Unlike Lake Victoria which has a residence time of 5 years, severe pollution in Lake Tanganyika would not be ameliorated within a few years or even within a few generations.

Assuming that pollution increases with increasing population growth, what is at stake if no changes in behaviour are put into place? The great majority of species in Lake Tanganyika reside in the littoral zone of the lake, that is from 0 to 40 m depth. They are extremely vulnerable to pollution because it is this zone that is most effected by human activities, notably industrial and domestic run-off. Moreover, tens of millions of people depend on Lake Tanganyika as a source of freshwater for drinking and washing and a supplier of fish which forms the principle source of protein in the local diet. In addition, more than one

million fishermen and tens of thousands fish processers and sellers depend on the health and well-being of the fish stocks for their livelihoods. Fish from Lake Tanganyika is marketed as far as a thousand kilometres away from the lake in Dar es Salaam, the Copper Belt and Lubumbashi. Minimising pollution in Lake Tanganyika benefits biodiversity and moreover safeguards human diets and livelihoods.

7. Key Recommendations

- Establishing Environmental Impact Assessment (EIA) capabilities in the Francophone countries and reinforcing them in the anglophone countries especially with respect to industrial practices near the lake, is a priority.

- Monitoring of water quality on a long-term basis will be a key to maintaining a healthy lake ecosystem.

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