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A pilot study on anthropogenic faecal pollution impact in Bahir Dar Gulf of Lake Tana, Northern Ethiopia

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Abstract

The anthropogenic effect on faecal and chemical pollution at Bahir Dar Gulf of Lake Tana, Ethiopia was investigated in the period of October 2006 to February 2007. Faecal and physicochemical pollution levels were significantly increased and clearly discernible in the Bahir Dar Gulf locations as compared to presumptively anthropogenic uninfluenced reference locations near the outlet of the Blue Nile River of Lake Tana. One directly sewage influenced lake site at Bahir Dar Gulf was found to be excessively faecally polluted. The total pooled data set from the study for faecal coliforms, *Escherichia coli* and *Clostridium perfringens* spores ranged from not detectable (n.d.) to log 6.2 CFU, n.d. to log 6.1 CFU and n.d. to log 1.7 CFU per 100 ml, respectively. A high variation was also observable for the physicochemical parameters including the spectral absorption coefficient at 254 nm, ammonia, nitrite, nitrate, total dissolved solids, total suspended solids and pH values. Although the data have to be considered preliminary, it strongly points to the need for systematic water quality monitoring of Lake Tana and its potential impact sources. This is all the more important as the lake is the largest freshwater body in the country serving a multipurpose role and being identified as a growth corridor of the country.

Key words: microbial pollution, water chemistry, tropical surface water quality, anthropogenic influence, faecal indicators.

1. Introduction

Water resources all around the world are under pressure due to human activities that have resulted in pollution of surface waters and increasing eutrophication. The primary influence on ground water quality as well as surface water quality is often caused by anthropogenic influence. Human activities generated inputs of gross amounts of sewage, industrial effluents and numerous other pollutants into water sources often because it is considered expedient and economical to have the unwanted material

carried away ("out of sight") by the flowing water (Wetzel, Likens 1991). Water pollution includes contamination with pathogenic microorganisms, heavy metals, synthetic detergents, oils and various agrochemical inputs.

In a vast majority of developing countries, fast growing populations combined with poor living conditions in rural areas have forced many people to migrate to cities in search for better living conditions (Gelinas *et al.* 1996). The increasing populations have come along with an increasing demand for water and need for proper waste handling, a problem that has been compounded by the fact that these rural-urban immigrants normally settle in shanty areas without any planned infrastructure. Unlike in developed countries, organic pollution in the developing world is often a result of extreme poverty and economic and social underdevelopment. Sanitary conditions and quality of water continue to be a great health risk in the under-developed and developing world. There is still prevalence of water borne diseases, which are almost forgotten in developed countries. Unfortunately, the facilities for disposal of excreta, wastewater, household trash and storm water are rather insufficient. The water distribution network is undeveloped and dilapidated. Domestic sewage is often left untreated and pit latrines or septic tanks are frequently in need of repair and regular emptying. All these conditions have resulted in severe pollution of surface water with materials of faecal origin. A large number of viral, bacterial, protozoan and helminthes-based water borne diseases thus plague these countries. As their population increases, it becomes essential to increase the efforts to control water borne diseases as well (Collazo *et al.* 1987).

Lake Tana's water resources are of crucial importance serving multiple purposes and being the largest fresh water body in Ethiopia. It has also been identified as a growth corridor by the federal government. The lake receives urban surface runoffs, industrial and agricultural waste from the catchment. Proper monitoring of discharges and analysing the effects on Lake Tana's water quality seems to be essential. Unfortunately, not much work has been done on water quality monitoring as far as faecal related microbial and chemical contamination is concerned.

In Ethiopia, some studies have been conducted regarding surface water pollution due to human induced impacts. In South Ethiopia, the physico-chemical characteristics of the rift valley lakes have been studied systematically and in much detail (Kebede *et al*. 1994; Zinabu *et al*. 2002). This is in contrast with the North Ethiopian water bodies where information on physico-chemical and microbial water quality contamination is generally scanty (Talling, Talling 1965; Baxter, Golobitsch 1970; Wood, Talling 1988; Kebede *et al.* 1992; Teshale *et al*. 2001; Yemenu 2005). To our knowledge, the present study is the first attempt to analyse effects of anthropogenic activities on faecal and chemical pollution levels in the Bahir Dar Gulf as compared to presumptively low influenced reference sites of Lake Tana. Although the data set is spatially and temporally limited, the results are considered timely and rather significant calling for further detailed and comprehensive investigations.

2. Materials and methods

2.1. Study area

The study was conducted in the southern part of Lake Tana in the Bahir Dar Gulf area. The Lake Tana region is a region in the northwestern highlands of Ethiopia experiencing changes in the environmental balance forced partly by climate change, but mostly by the persistence of unsustainable production and consumption systems (Teshale *et al.* 2001). Lake Tana, which is also the source of the Blue Nile, is the largest lake (3050 km^2) in Ethiopia, comprising about 50 per cent of the total freshwater resources of Ethiopia. It is a shallow lake with a mean depth of 8 m and maximum depth of 14 m. It is situated at 1800 m above sea level on a basaltic plateau. Seven large, permanent rivers and about 40 small seasonal rivers feed the lake. The lake is characterized as an oligotrophic to mesotrophic with low nutrient concentrations, relatively high silt concentrations with loading rate of 8.96-14.84 million tons of soil per year (Yitaferu 2007; Wondie *et al.* 2007; Teshale *et al*. 2001; Wudneh 1998; Nagelkerke 1997). Its bottom is volcanic basalt mostly covered with little organic matter (Howel, Allan 1994) and the Bahir Dar Gulf and Mehal Zegie area is also covered by plant debris. Lake Tana area has warm temperature climate and mean annual temperature of 13.5-27.7°C, the mean annual rainfall is about 1500 mm, of which 54 percent falls in the months of July and August, when the rainfall can reach 250-300 mm per month. The seasonal rains cause the lake level to fluctuate regularly with an average difference between the minimum, in May-June, and maximum in September-October of about 1.5 m.

Lake Tana and its adjacent wetlands provide directly and indirectly a livelihood for more than 500 000 people (Gordon *et al.* 2007) and about three million people live in the catchment. The population density is high in the areas to the northeast and south of Lake Tana, with the highest in the north and in some parts of Fogera plain to the east (151-200 persons km^{-2}), and about 101-150 persons km^{-2} in the more fertile lowland areas to the east and south west (Teshale *et al.* 2001).