A STUDY OF THE HYDROGEOLOGY, SOLID WASTE DISPOSAL
AND RIVER WATER POLLUTION IN THE NAIROBI AREA

by

MOSES N. MASIBO

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Department of Geology
UNIVERSITY OF NAIROBI

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DECLARATION

I Moses Nabiswa Masibo, hereby declare that this is my own work and has not been presented for a degree in any other University.

All sources of information have been specifically acknowledged by means of references.

Moses Nabiswa Masibo

This thesis has been submitted for examination with my approval as a University Supervisor.

Dr. S.J. Gaciri
This study evaluates the hydrogeology of the Nairobi area and attempts to explain the causes of river water pollution in relation to waste disposal. It covers an area of about three hundred and twenty square kilometres between latitudes 1° 12.6’S and 1° 19.2’S and longitudes 36° 45’ E and 36° 58’E, and includes Nairobi City, the capital of Kenya.

From a maximum altitude of about 1800 m in the western part of the area the land drops to about 1500 m in the east, the slope corresponding to the lava flows which are of intermediate composition and grade from phonolites and trachytes to tuffs and pyroclastics.

The area receives an annual rainfall of 843 mm with a temperature of 20° C and is drained by a number of streams which flow eastwards, mainly the Nairobi, the Ngong, the Mathare and the Ruiru, the latter three becoming tributaries of the larger Nairobi further downstream in the northeast.

The Athi Lake Beds which occur at a depth of about 87 m in the central region constitute the major aquifer in the area. Other sources of water but of less significance are the weathered zones which represent old land surfaces and the superficial deposits at the top of the geologic sequence. The drainage system in the area has attained a fairly equilibrium stage as is apparent from stream network analysis. The Nairobi river generally had the highest mean discharge values (0.204 - 2.03 m³/sec) while the Ruiru had the lowest (0.087 - 0.444
The City area generates various solid, liquid and gaseous wastes from its commercial, industrial and domestic sectors. The City Commission which manages the area operates a fleet of waste collection trucks which ferry these wastes from residential areas, institutions and factories to the solid waste disposal site at Dandora in the northeast which is an abandoned quarry in the phenolites close to the Nairobi river. These trucks are not enough and the wastes are often left to pile up for long periods in places where they are a nuisance to residents particularly in the low income areas. The Dandora quarry has the water-bearing Athi Lake Beds at its bottom and therefore it is not suitable to dump wastes in it since it will result in groundwater pollution.

A reconnaissance survey revealed that the Nairobi River was very polluted as it flowed close to the city and also through the residential areas in the northeast where it received a sewage effluent at Kariobangi. The Ngong River received a number of effluents as it flowed through the Industrial area. The Mathare River was also adversely polluted as it flowed through the Mathare, Huruma and Kariobangi slum areas and the Ruiruaka which receives the Kenya Breweries factory effluent at Ruaraka strongly smelled of alcohol for a distance of over 2 km downstream at Kassarani.

Riverwater analysis showed positive correlation between the major cations of Ca\(^{2+}\), Mg\(^{2+}\), Fe\(^{2+}\), Na\(^{+}\), K\(^{+}\), and Si\(^{4+}\).
The occurrence of fairly high values of these cations in the upper reaches of the rivers where natural conditions were prevalent suggested a geological origin for them. There was also a notable correlation between the heavy metal ions of Cd$^{2+}$, Pb$^{2+}$ and Cr$^{3+}$ and the occurrence of high values of these at the Industrial area suggested Industrial pollution as their main source.

The occurrence of high values of electrical conductivity and total Dissolved Solids (TDS) in polluted areas qualifies these parameters as good indicators of river-water pollution in the area.

Na$^+$ was the most predominant cation followed by K$^+$, Ca$^{2+}$ and Si$^{4+}$ respectively. The Ngong River had the highest total cations concentration and the RuiRuaka had the least.

The fact that the Ngong river which is quite polluted loses some of its water to the water-bearing Athi Lake Beds in the northeast poses a danger of groundwater pollution.

Water seepages from the waste disposal site at Dandora into the Nairobi river may further pollute its water.

However, a general downstream decrease in the concentrations of the cations as well as in the electrical conductivity, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) values was evident away from the city area. This phenomenon was due to the self purification of the streams.