ASSESSMENT OF GROUNDWATER QUALITY IN THE VICINITY OF ISALE OSUN SOLID WASTE DUMPSITE IN OSOGBO, OSUN STATE. NIGERIA.

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A THESIS SUBMITTED TO THE INSTITUTE OF ECOLOGY AND ENVIRONMENTAL STUDIESOBAFEMI AWOLOWO UNIVERSITY, ILE-IFE,NIGERIAIN PARTIAL FULFILMENT OF THE REQUIREMENTS FORTHEAWARD OF MASTER OF SCIENCE (M.Sc.) DEGREE IN ENVIRONMENTAL CONTROL AND MANAGEMENT,OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA.

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DEDICATION

This work is dedicated to my beloved parents, with all my love.

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LIST OF ABBREVIATIONS USED

A.P.H.A	American Public Health Association
AAS	Atomic Absorption Spectrophotometer
ANOVA	Analysis of Variance
CA	Cluster Analysis
DO	Dissolved Oxygen
e.g.	*exempli gratia* (for example, for instance)
EC	Electrical Conductivity
EDTA	Ethylenediaminetetraacetic Acid
EPA	Environmental Protection Agency
et al.	*et alli* (and others)
etc	*et cetera* (and the rest, and all others)
FES	Flame Emission Spectrophotometer
GDWQ	Guidelines for Drinking Water Quality
GPS	Global Positioning System
kg	Kilogram
Km	Kilometer
meq/L	Milliequivalents per Litre
mg	Miligram
mg/L	Milligrams per Litre
NA	Not detected
NS	Not Stated

NTU	Nephleometric Turbidity Unit
op. cit.	*opuscitatum* (in the work cited)
PAST	Paleontological Statistics
PCA	Principal Component Analysis
pH	Hydrogen ion (potential of hydrogen)
Pt-Co	Platinum Cobalt unit
QA/QC	Quality Assurance / Quality Control
R	Correlation coefficient
S.A.R	Sodium Adsorption Ratio
S.E.M	Standard error of the mean
SSA	Sub-Saharan Africa
SWD	Solid Waste Disposal
SWM	Solid Waste Management
TDS	Total Dissolved Solids
TDS	Total Dissolved Solids
TH	Total Hardness
UN	United Nations
UNICEF	United Nations Children‟s Fund
USA	United States of America
WHO	World Health Organisation
WWAP	World Water Assessment Programme
µS/cm	Microsiemens per Centimetre

ABSTRACT

This study determined the composition of solid wastes and the physico-chemical quality of groundwaterwithin the vicinity of the Isale Osun solid waste dumpsite. This was with a view to assessing the impact of dumped solid wastes on the groundwater quality of the study area.

An area of 1 m^2 portion was randomly selected on the dumpsite for three trials. Solid wastes on each of the selected portion were collected, sorted, weighed and classified according to their constituents. Groundwater samples (24) were also collected from six hand-dug wells at varying distance (161 m, 164 m, 206 m, 215 m, 249 m and 362 m) away from the perimeter of the dumpsiteover the two seasons of annual cycle (dry and rainy seasons)from September 2013 to May 2014. The water samples were analysed for their physico-chemical parameters such as: pH, electrolytic conductivity, apparent colour, turbidity, dissolved oxygen (DO), biological oxygen demand (BOD_5), total suspended solids (TSS), total dissolved solids (TDS). The other parameters determined were: alkalinity, acidity and major ions (Cl^-, HCO_3^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^+, K^+), nutrient compounds (NO_3^-, PO_4^{3-}) and some heavy metals (Cu, Pb, Cr, Fe, Mn, Cd, Zn). All determinations were carried out using standard instrumental methods involving the use of pH/conductivity meter, flame analyser, colorimeter and spectrophotometer while the main non-instrumental method adopted was volumetric/titrimetric analysis with adequate quality assurance and quality control measures. The data obtained were analysed using the descriptive statistics (mean, range and percentage), ANOVA, regression and correlation analysis, cluster analysis and principal component analysis (PCA).

The results showed that theoverall average waste compositions at the dumpsite comprised:food/wood (43.48%), textile (11.02%), papers (8.56%), plastic (4.19%), glass

(2.94%), metals (0.64%) while the unclassified component was 11.75%. The physico-chemical parameters such as: pH, conductivity, TDS, acidity, alkalinity, total hardness, HCO_3^-, PO_4^{3-}, Cl^-, Mg^{2+}, Ca^{2+}, K^+, Na^+, Zn, Mn, Fe, Cr, Pb, Cu and Cd were significantly ($p < 0.05$) higher in the water samples collected closer to the dumpsite than those collected further away. However, some of the parameters, notably alkalinity (135.75 mg/L), SO_4^{2-} (35.88 mg/L), NO_3^- (1.22 mg/L), HCO_3^- (162.87 mg/L), Ca^{2+} (66.77 mg/L), Mg^{2+} (25.21 mg/L), Na^+(18.75 mg/L), were significantly ($p < 0.05$) higher in the dry than the rainy seasons. Most of the physico-chemical parameters were within the maximum permissible levels recommended by WHO except turbidity (0.37 – 75.50 NTU), TSS (8.0 – 329 mg/L) and acidity (51.45 mg/L). Amongst the heavy metals tested for, only Cd (0.007 mg/L) exceeded the WHO acceptable limit in all the water samples collected during the entire study period.

This study revealed that the high concentrations of some of the physico-chemical parameters of groundwater in the study area could be associated to the occurrence of the Isale-Osun dumpsite. The degree of groundwater pollution tended to decrease with distance away from the dumping site.

CHAPTER ONE

INTRODUCTION

1.1 Background to Study

Water is an indispensable resource for life;it is essential for livelihood as well as for the socio-economic development of human communities. The availability of water is important, but more important is the quality of the available water. However, the acceptable quality of water is dependent largely on the intended water usage. Adequate provision of safe drinking water remains a major challenge to many people worldwide, especially those living in under-developed regions of the world. In spite of the efforts made at various levels around the globe, there are about 800 million people living without access to adequate and improved water supplies, most of which live in the rural and peri-urban settlements of under-developed and developing countries. The situation is at its worst in Sub-Saharan Africa (SSA) where only around 16% of the population has access to safe and adequate water supply through improved piped systems (WHO/UNICEF, 2012).

In Africa, including Nigeria, a majority of the population without access to safe and adequate water supply consequently rely on self-supply options, such as; hand-dug wells, ponds, dug-outs, riverbed waterholes, streams, springs and rainwater sources for drinking and other domestic uses. Untreated groundwater represents about 75% of total water supply in Nigeria's urban Kano (Ince *et al.*, 2010). Moreover, in some urban areas with very limited surface water availability, such as Harare in Zimbabwe, groundwater sources are the single most important option, representing almost 100% of their water supply (King, 2003).

According to Bartram and Balance (1996) groundwater is held in the pore space of sediments such as sands or gravels or in the fissures of fractured rock such as crystalline rock and limestone. The body of rock or sediments containing the water is termed an aquifer and the upper water level in the saturated body is termed the water table. Groundwater is the largest available source of fresh water as one third of global fresh water is found underground (Learner, 2012). In line with the hydrological cycle, ground water is naturally recharged from surface water and atmospheric precipitations via percolation down into subsurface aquifers, also it plays a significant role in maintaining the surface water systems through flows into lakes and base flow into rivers; thereby, supporting the inflow needs of the surface water.

The deterioration of groundwater quality results from wide-ranging human activities on land, such as industrialization, urbanization, agriculture and waste disposals, which are associated largely with urban settlements (Wakawa *et al*., 2008).

It is important to note that, once groundwater becomes contaminated, full restoration of its quality is very difficult and even impossible in some cases. Therefore, it is imperative that groundwater resources be protected adequately from the increasing threat of contamination, if they are to remain as important and dependable sources of water supply. Hence in this research, emphasis is placed on the quality of groundwater within the vicinity of solid waste dumpsite. The problems associated with solid waste and its management has been the focus of considerable environmental attention during the last quarter of the twentieth century as communities the world over have begun to recognize the hazards that its management entails. Most of the dumpsites which are found too close to residential buildings in Osun State were unauthorized by the Local Health Authorities. Again some of these dumpsites were located along the river

courses and on undeveloped plots of lands similar to the situation in the study area of Isale Osun, Osogbo.

1.2 Statement of Research Problem

Open solid waste dumps are well known to release large amounts of hazardous and deleterious leachates into the groundwater, surface water and soil. Groundwater is the major source of potable water supply in most parts of Osun State including Osogbo, the statecapital. There is therefore the need to assess the impact of Isale Osun waste dumpsite on groundwater in its neighbourhood, hence this study.

1.3 Justification for the Study

In any society, population increase brings about an increase in waste generation. However, lack of organized waste collection system may lead to indiscriminate waste disposal whereby wastes are dumped close to residential buildings where they are unauthorized by the Local Health Authorities. Again some of these dumpsites are most times located along the river courses and on undeveloped plots of lands and such is the case of the Isale Osun dumpsite in Osogbo, Osun State. Rapid urbanization, particularly in low-income developing countries has left little space for disposal of the increasing amounts of waste material being generated in urban settings (Sangodoyin, 1993).

The Isale Osun dumpsite is unauthorized by the government and therefore lacks any form of management technology, maintenance or enforced prohibition. The effect of the dumpsite is more pronounced due to the fact that it is sited within the residential area. At the dumpsite, precipitation that infiltrates the waste materials mixes with the organic, inorganic and moisture contents of the waste to leach toxic compounds. It is generally believed that the leachate thus

formed contains dissolved organic and inorganic solutes, which potentially percolate through the soil to alter the physico-chemical characteristics of the groundwater aquifer. Leachate is highly mineralized water containing constituents such as sodium chloride, nitrate, trace metals, and a variety of organic compounds. Rapid percolation of leachates is most likely to occur in humid climates like Osogbo, where rainfall exceeds the absorption capacity of the disposal area. It is, therefore, a cause for concern because there is significant reliance on groundwater sources by the majority of urban and suburban populations of the whole country. So, the lack of proper monitoring and evaluation of groundwater quality in the whole country imply greater risk to public health and environmental quality.This research seeks to investigate the effect of Isale Osun dumpsite on the groundwater quality within the vicinity of the dumpsite.