

THE NIGERIAN GEOGRAPHICAL JOURNAL

New Series Volume 8 No. 1 (2012)



**PUBLISHED BY THE ASSOCIATION OF NIGERIAN GEOGRAPHERS
FORMERLY NIGERIAN GEOGRAPHICAL ASSOCIATION FOUNDED IN 1957**

THE NIGERIAN GEOGRAPHICAL JOURNAL

Edited by
Professor Sani A. Mashi

New Series
Volume 8 No. 1 (2012)

Published by:
The Association of Nigerian Geographers,
National Headquarters, Abuja, Nigeria
www.ang.org.ng

PRINTED BY
SHUKRAH PRINTERS LTD, AH 6 GAMAGIRA ROAD,
S/GARI T/WADA KADUNA TEL: 08036986610

TABLE OF CONTENT

Volume 8 (1)

Title	Author	page
Developing an Integrated and Intermodal Transportation System for Nigeria	P.C. Onokala	01 - 31
Household Solid Waste Management in Addis Ababa: Implications for Nigeria's Urbanization	D.S.A Alaci, H.Y Tifwa and S.N. Jiya	32 - 46
Effects of Urban Land Use on Some Groundwater Quality Parameters in Ilorin Metropolis, Nigeria	T.M. Agaja and L.T Ajibade	47 - 59
Local People's Perception and Awareness of Open Space Benin City, Edo State, Nigeria	F. N. Ogeath and P.A.O Odjugo	60 - 79
Temporal Variation in the Levels of Concentration of Metal Contaminants in River Kubanni Zaria, Nigeria	A.W. Butu, E.O. Igusi & A.A. Bichi	80 - 93
Geographic Analysis of Wetland Area in Ile-Ife, Nigeria: Imperative for sustainable Urbanization	S.A. Adewumi and F. Ujoh	94 - 108
Analysis of Extreme Rainfall Events and Risk of Drought and flood occurrences in Nigeria	A.T. Umar	109 - 120
Quality of Water Supply from Hand -Dug Wells in Warri -Effurun Metropolis, Delta State, Nigeria	O.Ohwo	121 - 134
An Assessment of effects of Automobile Emitted Carbo Dioxide on Urban Surface Air Temperature in Anyigba, Nigeria	S.D Musa, O.O. Ifatimehin and S.T. Tijjani	135 - 147
Growth and Yield Response of Okra (<i>Abelmoschus esculentus</i>) to Microclimatic Modifications in Benin City, Nigeria	G.O. Atedhor and P.A.O Odjugo	148 -161
Operational Methods of Transportation Used for the Movement of Agricultural Products in Zaria, Kaduna State, Nigeria	J. Salas, H. Bamaiyi, A. Michael and I.I Okino	162 - 171

EFFECTS OF URBAN LAND USE ON SOME GROUNDWATER QUALITY PARAMETERS IN ILORIN METROPOLIS, NIGERIA

T.M. Agaja* and L.T. Ajibade

Department of Geography and Environmental Management, University of Ilorin, Ilorin, Nigeria.

*Correspondence (:specialgel@yahoo.com', +234-8055916475)

ABSTRACT

This study examined the effect of urban land use on groundwater chemistry in Ilorin metropolis with particular reference to industrial, agricultural, abattoir, waste dumpsite, cemetery and institutional land use. Due to the existing land use, Purposive sampling technique was adopted to sample groundwater from 36 points in 6 different land uses in the study area. The samples were analysed for nitrate, pH, total hardness, coli form count, phosphate, sodium, potassium, calcium and magnesium. Both descriptive (bar graph) and inferential (new duncan multiple range test) statistical method was employed to determine the variation in concentration of groundwater parameters between the land use. The study revealed that there is a significant relationship between urban land uses and all the groundwater parameters considered. The study recommends that relevant agencies should make continuous effort to educate the populace on the impact of indiscriminate waste disposal on groundwater quality within the study area.

Keywords: Groundwater, Quality, Urban land use, Pollution, Management,

INTRODUCTION

Groundwater is an important resource because of its potential for abstraction and beneficial use as well as for its interaction with the wider environment. In addition to groundwater abstractions for public supply, groundwater is relied upon for domestic water supplies from

springs, wells or boreholes (Eisen and Anderson, 1979).

In recent years, increased emphasis has been placed on urban hydrology. However, most of the efforts have been directed towards quantifying the effects of urbanization on surface- water systems while relatively little attention has relatively been given

to identifying the impacts on groundwater quality (Eisen and Anderson, 1979).

Most groundwater contaminants are closely linked to urban land use practices: excessive pesticide and fertilizer use; leaking underground storage tanks; malfunctioning private septic systems; and spills or leachate from industrial sites, uncapped wells and road salts.

Groundwater pollution occurs when waste products or other substances change the chemical or biological characteristics of the water and degrade water quality so that animals, plants or human uses of the water are affected. Pollutants include plant nutrients, bacteria, viruses, pesticides, herbicides, hydrocarbons (including petrol and oil), heavy metals and other toxic chemicals. (Water and Rivers Facts Sheet, 1998)

Groundwater pollution is much more difficult to abate than surface water pollution because ground water can move great distances through unseen aquifers and due to its slow dynamics, once polluted, any remedial action would take years and this is usually very expensive.

Sulphate, nitrate, phosphate, chloride, sodium and calcium ions are frequent contaminants. Toxic

metals, pesticides and industrial chemical are also hazardous (Strahler and Strahler, 1997). Non-porous aquifers such as clays partially purify water of bacteria by simple infiltration (adsorption and absorption), dilution and in some cases, chemical reaction and biological activity. However, in some cases, the pollutants merely transform to soil contaminants. Groundwater that moves through cracks and caverns is not altered and can be transported as easily as surface water (Sangodoyin and Agbawehe, 1992).

Groundwater is an important source of clean drinking water in many areas, but sustainable management has not yet been established for many of these resources. The capacity for land to retain water is shrinking all over the world. Water is discharged at an ever-increasing rate as forests are felled and the land is drained and built up. Changes are still being made to land use with little or no heed to the longer-term consequences and the impacts on downstream areas (Strahler and Strahler, 1997).

A relatively simple way to study the effects of land use on groundwater quality according to Eckhardt (1995) is to compare the predominant land uses within a given area with the

concentrations of selected contaminants in water drawn from shallow aquifers within that area.

Analysis of the relationship between land use and the magnitude of contamination in a specific area primarily is based on the following two assumptions. First, it is assumed that contaminated groundwater at a well originated as uncontaminated recharge (precipitation) that passed through a contaminated area before reaching the well. Land use and land cover largely determine the type and amount of contaminants entering streams, lakes, and underground pathways, including aquifers.

Some contaminants occur and move naturally whereas others are produced by human activities, and their movement often is accelerated as a result of rainfall that accentuates runoff and infiltration (Eckhardt, 1995). Second, it is assumed that the contaminants detected in groundwater were present within the well's contributing area and were transported by groundwater flow to the well.

The source(s) of contaminants within a contributing area, such as buried septic systems and leaking underground fuel tanks, can be difficult to identify and locate. In

many instances, these sources can be inferred from the type and intensity of land use within the contributing area. Factors that can affect the movement of contaminants from source areas to wells are the chemical nature of the contaminant, physical properties of the soil and aquifer material, amount and timing of recharge, and direction and velocity of groundwater movement. (Eckhardt, 1995).

Several studies have been conducted on the relationship between land uses and groundwater quality (Asimi, 1998; Benka- Coker, et. al; 1999, Faye et. al; 2008, Victoria S.Benson et.al; 2006, Kresse et. al; 2012). However, there is inadequate information of the nature of such relationships for Ilorin area of Nigeria.

This study was hence initiated to evaluate the effect of urban land uses on groundwater chemistry in Ilorin metropolis by identifying different urban land use activities, determining variations in the concentration of groundwater parameters from one land use type to the other and examining the effects of different urban land uses on groundwater chemistry within the Ilorin metropolis.

STUDY AREA

The study area is Ilorin, the capital of Kwara State, Nigeria. It is located on the intersections of latitude $8^{\circ}24'N$ and $8^{\circ}36'N$ and longitude $4^{\circ}10'E$ and $4^{\circ}36'E$ and lies in the plane of South Western part of Nigeria (Oyegun, 1983) in the traditional zone between the forest and savanna regions of Nigeria.

The city has an area of 100km^2 while its population as at 2006 census was 781,934 (FRN Official Gazette, 2009).

The area experiences two alternating climatic conditions, with mean annual rainfall of about 1,318mm which spreads from April to November. The dry season, characterized by hot temperature, extends from November to March, while the wet season, characterized by high humidity, extends from April through November.

Extremely high temperature is experienced between February and April, which usually exceeds 30°C .

The area also experiences harmattan during the months of December to January. The temperature is uniformly high throughout the year with a mean annual temperature of 26.8°C , but open air insolation can

be very uncomfortable during the dry season.

The geology of the area consists mainly of crystalline rocks of the Precambrian age. The rock types include granite and biotite, gneiss, schist and quartzite and also the undifferentiated types. These rocks are heavily faulted and weakened. They form low inselbergs and in many places have been greatly weathered *in-situ*; hence, there are several pockets of weathered sand and sandy clay for instance within the Asa basin (Oyegun, 1983).

There are several land use types in Ilorin including commercial, industrial residential, agricultural, institutional, recreational, cemetery, etc. The most dominant is the commercial land use with several markets such as Oja Oba, Ipata, Baboko, Gegele, Ago etc.

Apart from the traffic and the influx of population experienced in these markets, the area is also noted for generation of wastes. Such wastes include remnant of foods, decays from abattoirs, debris of animal, plants, and other decomposed items that could have great effect on groundwater through percolation and rain wash or erosion.

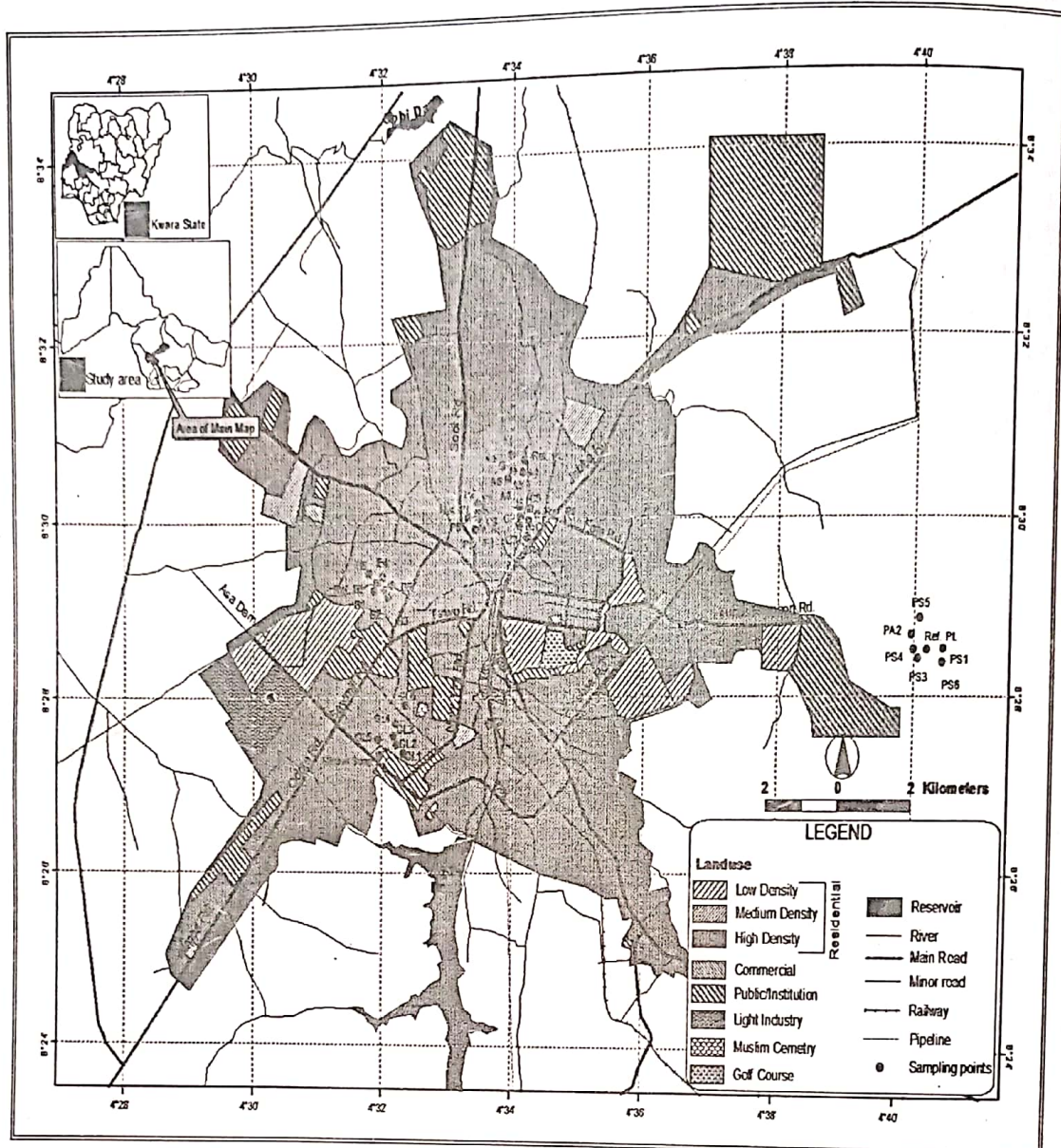


Figure 1: Ilorin Land Use Map Showing Pollution Sources and Sampling Points
(Source: Jimoh, 2000)

METHODOLOGY

The study employed a purposive sampling technique to determine the pollution sources (reference points) across Ilorin metropolis and

this was selected due to the concentration of land use activities (Figure 1).

Of the six land uses selected (industrial, agricultural, abattoir,

waste dumpsite, cemetery and institutional land use), water samples were collected from six wells within an areal extent of 5km² in each of the six selected land uses making a total of 36 water samples. These were put in 1 litre plastic containers and taken to the Biochemistry Laboratory, University of Ilorin for analysis which helped in the determining variations in the concentration of groundwater parameters from one land use type to the other.

Descriptive and inferential statistics were used in this study to analyze the data collected. Whereas means and bar graphs were used to summarize the data. New Duncan Multiple Range Test was used to determine if there is a significant relationship between types of urban land use and groundwater parameters.

RESULTS AND DISCUSSION

Total hardness has the highest concentration in groundwater from the industrial land use with a mean value of above 700mg/l while the cemetery land use displays the lowest concentration of total hardness with a mean value of 100mg/l. This suggests that the major source of total hardness is

because of the effluent or wastewater from the industries in the area.

Next to it in concentration is phosphate with a mean of 250mg/l in agricultural, waste dumpsite and cemetery land use while calcium, magnesium and pH have the lowest means in all the land uses (Figure 2).

Following Priyardarshi (2003), the observations may have been as a result of the level of infiltration of polluted waters, hydraulic conductivity, saturated thickness and the depth of groundwater. The pattern exhibited by the water compounds varies from one land use to the other as shown in Tables 2. The New Duncan Multiple Range test showed the sites with different mean contaminants.

Site 2 (industrial land use) appears to have the highest Total hardness of 738.52 followed by sites 1 (institutional) and 3 (cemetery) with a mean Total hardness of 441.66 and 354.50 respectively. Site 5 (abattoir) is the least contaminated site with a Total hardness of 89.55. This suggests that the major source of total hardness in the groundwater is the effluent or wastewater from the industries in the area.

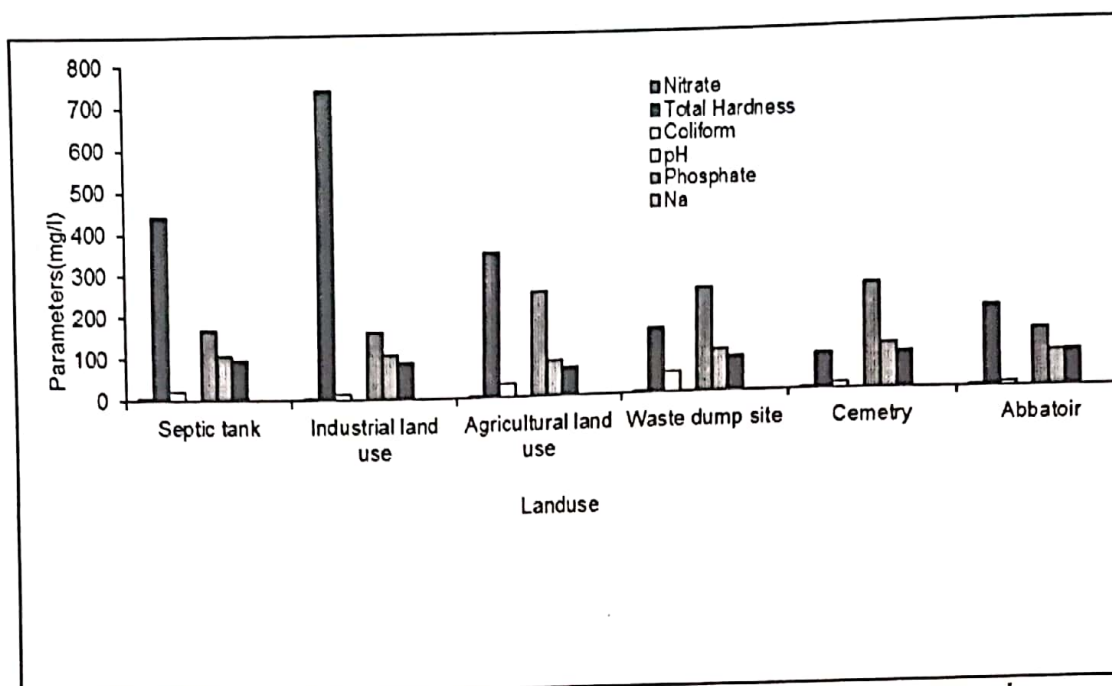


Figure 2: Mean Values of the Various Groundwater Quality Parameters under Different Land use Types in Ilorin, Nigeria

There are no major health implications of hard water; infact the National Research Council Report of the USA (2008) submits that hard drinking water generally contributes a small amount towards total calcium and magnesium of human dietary needs.

They ascertain that in some instances, where dissolved calcium and magnesium are very high, water could be a major contributor of calcium and magnesium to the diet.

The highest mean value of pH can be found in site 3(cemetery) with 7.2467 followed by site 4 (agricultural) with 7.0567. Sites 1,2

and 5 (institutional, industrial and abattoir) with mean values of 6.7683, 6.9433 and 6.9367 fall within the same level of significance while the least contaminated site is site 6 (waste dumpsite) with mean values of 6.52. The value of pH in the sample can be attributed according to American Well Owner Report (2006), to the composition of the rock and sediments that surround the travel pathway of recharge water infiltrating to the groundwater, dumping of chemicals into the water by individuals, industries and communities as well as the amount of acid precipitation that falls in the water shed.

Agricultural land use (site 4) appears to have the highest mean value of coliform count with 49.000, followed by cemetery land use (site 3) with 33.667. Institutional, industrial, abattoir and waste dumpsite (site 1, 2, 5 and 6) fall within the same range of 21.667, 13.667, 14.167 and 12.000 respectively.

Coli form as a groundwater parameter has a great impact on both living and non living things on the earth surface.

The American Well Owners Report (2006) asserts that water contaminated with sewage or similar wastes tests positive for coli form bacteria which causes in infectious diseases, such as typhoid, fever, cholera, hepatitis, dysentery, diarrhea, giardiasis, and hemolytic uremic syndrome.

Sodium	1(Institutional)	110.330c
	2(Industrial)	108.500b
	3(Cemetery)	87.000a
	4(Agricultural)	104.670b
	5(Abattoir)	115.000c
	6(Waste dumpsite)	90.833a
Potassium	1(Institutional)	99.000b
	2(Industrial)	91.333b
	3(Cemetery)	68.167a
	4(Agricultural)	88.500b
	5(Abattoir)	92.833b
	6(Waste dumpsite)	92.167b
Calcium	1(Institutional)	3.088a
	2(Industrial)	3.122a
	3(Cemetery)	3.073a
	4(Agricultural)	3.728c
	5(Abattoir)	3.052a
	6(Waste dumpsite)	3.472b
Magnesium	1(Institutional)	3.207a
	2(Industrial)	3.403a
	3(Cemetery)	3.425a
	4(Agricultural)	4.895c
	5(Abattoir)	3.230a
	6(Waste dumpsite)	3.955b
Nitrate	1(Institutional)	0.7a
	2(Industrial)	4.99c
	3(Cemetery)	0.4a
	4(Agricultural)	0.6a
	5(Abattoir)	0.9a
	6(Waste dumpsite)	2.3b

Note: Means with the same alphabet are not significantly different from each other.

Table 2: New Duncan Multiple Range Test for Biochemical Groundwater Parameters

Parameter	Location	Response
Coliform	1(Institutional)	21.667a
	2(Industrial)	13.667a
	3(Cemetery)	33.667b
	4(Agricultural)	49.000c
	5(Abattoir)	14.167a
	6(Waste dumpsite)	12.000a
Phosphate	1(Institutional)	172.115a
	2(Industrial)	166.232a
	3(Cemetery)	259.240b
	4(Agricultural)	258.465b
	5(Abattoir)	266.715b
	6(Waste dumpsite)	146.067a

Table 2: New Duncan Multiple Range Test
for Physical Groundwater Parameters

Parameter	Location	Response
Total Hardness	1(Institutional)	441.66c
	2(Industrial)	738.52d
	3(Cemetery)	354.50c
	4(Agricultural)	160.25b
	5(Abattoir)	89.55a
	6(Waste dumpsite)	206.58b
pH	1(Institutional)	6.7683b
	2(Industrial)	6.9433b
	3(Cemetery)	7.2467d
	4(Agricultural)	7.0567c
	5(Abattoir)	6.9367b
	6(Waste dumpsite)	6.52a

Note: Means with the same alphabet are not significantly different from each other.

Cemetery, agricultural and abattoir (sites 3,4 and5) have the highest mean values of phosphate with 259.240, 258.465 and 266.715 while the remaining three sites (institutional, industrial and waste dumpsite) fall within the same range of low values of 172.115,166,232 and 146.067 respectively.

According to Zhu et. al:(2008), phosphate is a dietary requirement, with recommended intake of 800mg/day and is a major component of fertilizer for better food productions.

Sites 1 and 5 (institutional and abattoir) have the highest mean values of sodium with 110.330 and 115.000 while sites 2 and 4

(industrial and agricultural) follow with values of 108.500 and 104.670. The values, 87.000 and 90.833 being the least values can be found in sites 3 and 6 (cemetery and waste dumpsite) respectively. Potassium present a unique pattern where all values of the sites (99.000, 91.333, 88.500, 92.833 and 92.167) significantly fall within the same range except site 3(cemetery) with 68.167.

According to Hem (1986), the presence of potassium in drinking water will help to preserve osmotic pressure in human bodies and also perform vital functions such as its role in nerve stimulus, muscle contractions, blood pressure regulation and protein dissolution, preventing cardiovascular disease.

For Calcium , agricultural land use (site 4) has the highest mean value of 3.728 followed by waste dumpsite (site 6) with 3.472 while institutional, industrial, cemetery and abattoir land use (sites 1,2,3 and 5) have the lowest value of 3.088,3.122,3.073 and 3.052 respectively.

According to Hem (1986), calcium constitute a part of dietary mineral for human which is responsible for membrane function, nerve stimulant transmission, muscle

contraction, protein constructs and DNA replication.

Magnesium also has a pattern similar to calcium with site 4 having the highest value of 4.895, followed by site 6 with 3.955 while sites, 2, 3 and 5 have the lowest values of 3.207, 3.403, 3.425 and 3.203. Industrial land use (site 2) has the highest mean value of 4.99 in nitrate. This is followed by waste dumpsite (site 6) with 2.3. Institutional, cemetery, agricultural and abattoir land use (sites 1, 3, 4 & 5) have the lowest mean values of 0.7, 0.4, 0.6, & 0.9 respectively.

According to Sangodoyin and Agbawehe (1992), McElwee and Cao (2000), Forman et al (1985); there are factors that affect the concentration of groundwater parameters such as the level of infiltration of polluted waters, hydraulic conductivity, saturated thickness, nature of land use, and source of pollution, porosity and permeability, the depth of groundwater and population pressure bringing about the contamination of groundwater in the study area.

CONCLUSION

The results obtained in this study shows that there is a significant

relationship between land use type and concentration of groundwater parameters in the study area, with the parameters varying significantly among the different land uses in the study area.

In order to improve the health care system of Ilorin and improve the socio-economic well-being of the populace, there is a need to embark on environmental impact and suitability assessments of an area before wells and boreholes are constructed. This is because pollutant parameters such as sodium chloride, coliform and potassium could result into various health problems if absorbed excessively and absorbed when it contains undissolved metal ions such as zinc, mercury, silver etc. Such health problem could include cancer, hypertension, high blood pressure, stomach upset. (Sangodoyin 1993: Ifabiyi 2003).

To this extent therefore, there is a need for integration of groundwater utilization into land use planning which will improve groundwater management for sustainable development (Foster et al:2006). This is important especially because of the significant effect of land uses on the quality of groundwater most especially during the recharge capacity which is majorly as a result of urbanization.

Similarly, rationalization of water use especially in the industrial sector through waste water reuse and recycling is a promising option for the protection and preservation of groundwater in the area. Waste water treatment fee could be imposed and with the amount determined based on the amount of water consumed as well as the volume of waste discharged into the water. This will help minimize the discharge of untreated waste water and solid wastes which will eventually pollute the groundwater.

REFERENCES

- American Well Owner Report (2006). Home Septic System Part II-The Absorption Field, A Quarterly Publication of the American Groundwater Trust. Issue 2006, No 3.
<http://www.agwt.org/sites/default/files/2006-3%20TAWO.pdf>
- Asimi, M.A. (1998). Effect of Liquid Waste on Surface and Underground Water in Ipata and Baboko Slaughtering Slabs. *Unpublished B.Sc Dissertation*. Department of Agricultural Engineering, University of Ilorin, Nigeria.
- Ayoade, J.O. and Oyebande, B.L. (1978). Water Resources. In: *A Geography of Nigerian Development*, (ed. by J.S.Oguntoyinbo, M.O Filani & O.O.Areola) pp.40-56. Heinemann, London.
- Benka-Coker, M.O. and Bafor, B.E. (1999). Waste Management and Water Pollution. In: J.A. Pickford (ed.). *Proceedings of the 25th WEDC Conference*, pp. 12-16, Addis Ababa, Ethiopia, Loughborough University, United Kingdom.
- Eisen, C.E and Anderson.M.P.(1979). Effect of Urbanization on Groundwater Quality-A Case Study. *Groundwater*, 17(5),456-462
- Eckhardt, D. A. and P. E. Stackelberg (1995). Relation of Ground-Water Quality to Land Use on Long Island, New York. *Ground Water*, 33(6):1019- 1033.
- Faye C.S., Sow N.R., Dieng N.M, Kaba M., Diouf O.C., Bocoum .O. and Faye (2008) Impact of Land Use on Groundwater Quality in the Thiaroye Unsewered Suburb (Dakar Senegal): Remote Sensing and GIS Approach, International Symposium " Coupling Sustainable and Groundwater Protection" Geology Department University Cheikh Anta Diop Dakar.
- Federal Republic of Nigeria (2009). Legal Notice on Publication of 2006 Census Final Results. *Official Gazette*, Federal Government of Nigeria.
- Forman, D., Al-Dabbagh, S. and Doll, R. (1985). Nitrates, Nitrites and Gastric Cancer in Great Britain, *Nature*, 313,620-625.
- Foster.S.,Gardunol.H.,Tuinhof.A, & Marcella Nanni.K.K (2006). *Sustainable Groundwater Management Concepts and Tools*.

- World Bank Publication,
Washington D.C USA.
- Hem, J. D. (1986). Study and Interpretation of the Chemical Characteristics of Natural Water. *Geological Survey Supply Paper* 1473.
- Ifabiyi, I.P. (2003). Chemical Characteristics of Shallow Wells in Ibadan North East L.G.A Oyo State, *Ilorin Journal of Business and Social Science*, Faculty of Business and Social Science, University of Ilorin Publishers, Ilorin, pp.118-126.
- Jimoh, H.I. (2000). Effects of River Erosion on Houses: A Case Study of Asa River Catchment in Ilorin Kwara State, Nigeria. *Ilorin Journal Business and Social Science*, 7(1):17-23.
- Kresse, T.M, Warner, N.R, Hays, P.D., Down, A., Vengosh, A., and Jackson, R.B. (2012). Shallow Groundwater Quality and Geochemistry in the Fayetteville Shale Gas-Production Area, North-Central Arkansas, 2011: U.S. Geological Survey Scientific Investigations Report 2012-5273, 31 p.
- McElwee, C.D. and Cao, H. (2000). Groundwater Availability and Accessibility, *Provinces Kansas Water Plan Fund*, Available Online at: <http://www.lentech.com/groundwater/pollution-sources.htm#ixz zo q4zuxDNp>.
- National Research Council Report on Urban Storm Water (2008), www.epa.gov/npdes/stormwater
- Oyegun, R. (1983), *Water Resources in Kwara State Nigeria*. Matanmi and Sons Printing and Publishers, Ilorin.
- Priyadarshi, N. (2003). The Effect of Urbanization on Groundwater in Ranchi City, India. <http://science.jrank.org/pages/47438/contaminant-transport.Html#ixzzohm1y10Ad>.
- Sangodoyin, A.Y. and Agbawhe, O.M. (1992). Environmental Study on Surface and Groundwater Pollutants from Abattoir Effluents, *Bioresource Technology*, 41:193-200, Elsevier Science Publishers Limited, England.
- Sangodoyin, A.Y. (1993). Consideration on Contamination of Groundwater by Waste Disposal Systems in Nigeria. *Environmental Technology*, Vol.14, No.10, pp.957-264.
- Strahler, A. and Strahler, A. (1997). *Physical Geography: Science and System of the Human Environment*, Second Edition, Wiley Publishers, USA.
- Strahler, A. and Strahler, A. (2002). *Physical Geography: Science and System of the Human Environment*, Fifth Edition, Wiley Publishers, USA.
- Victoria S. Benson, Joh A. Vanleeuwen, Javier Sanchez, Ian R. Dohoo and George H. Somer (2006). Spatial Analysis of Land Use Impact on Groundwater Nitrate Concentration. *Journal of Environmental Quality* 35:421-432. USA.
- Water and Rivers Commission (1998). *Western Australia's Groundwater Resources*, Water Facts Sheet 10, <http://www.wrc.wa.gov>

Zhu W, Graney J. and Salvage K
(2008) Land-use Impact on
Water Pollutant Elevated
Pollutant Input and Reduced
Pollutant Retention. *Journal
of Contemporary Water*

Research and Education Issues
139. Universities Council on
Water Resource pg 15 -21.