Effect of Solid Waste Disposal on Chemical Quality of Groundwater in Ife North Local Government Area, Osun State, Nigeria: A GIS-Based Assessment

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Abstract

Indiscriminate waste disposal is a major environmental challenge in developing countries, especially as the wastes often end up downstream. The present study investigated the vulnerability of selected groundwater sources in semi-rural communities in Ife North Local Government Area of Osun State, Nigeria, to contamination by adjacent waste dumpsites. The specific objective was to assess the chemical quality of the groundwater in the area. Data used were results of the laboratory investigation of selected water samples from sampled groundwater sources and information about the uses of the groundwater by the residents. The parameters pH, conductivity, and TDS were assessed in situ and chemical parameters such as Lead, Iron, Copper and Sulphate were assessed in the laboratory. Results showed that the groundwater sources close to the dumpsites were more contaminated than the sources farther from the dumpsites. At distances less than 50m to the dumpsites, the concentration of the chemical metals did not meet the WHO standard, however, it decreased with distance from the dumpsite. For instance, although sulphate concentration was below the recommended maximum, sulphate concentration decreased with distance from the dumpsite. The study concluded that groundwater sources around dumpsites were contaminated and unfit for potable use in the area.

Keywords: Solid waste, ground water, dumpsite, chemical, assessment, Nigeria.

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Introduction

Water is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself. It is vital for reducing the global burden of disease and improving the health, welfare and productivity of populations. It is central to the production and preservation of a host of benefits and services for people. Water is also at the heart of adaptation to climate change, serving as the crucial link between the climate system, human society and the environment (UN, Water). Water plays a vital role as an environmental factor to all forms of life, and in the socio-economic development of human populations. About 70% of the earth is filled with water, making water a fundamental asset for the world economy (John, 2012; Water Science for Maryland, Delaware, 2017). We depend on water not only for life itself, but indeed for our economic wellbeing as well. Water plays a role in the creation of everything we produce. There are no substitutes to water, and though it is renewable, there is only a finite amount of it (Cosgrove & Loucks, 2015). Groundwater is used domestically, agriculturally and industrially. It is distinguished from other water bodies due to two main reasons: It has slow movement within rocks which makes it to be very susceptible to pollution. Also, the chemical properties of the groundwater are dependent on the physio-chemical composition of the rock containing the groundwater (Water Science for Maryland, Delaware, 2017). Wastes are materials humans consider no longer useful and these are generated at different levels during the extraction of raw materials, the processing of raw materials into intermediate or final products and the consumption of final products and other human activities. When waste is not well disposed, it has an adverse effect on the soil of the area where it is dumped. It also has an adverse effect on the surrounding underground water of the area. Wastes contaminate water at varying degrees and some wastes are more hazardous than others.

There are different ways of managing the waste, which are generated by humans. These are broadly classified into traditional and emerging methods (Ofoezie and Bulu, 2015). The traditional methods are open burning, composting, landfill and incineration. Open burning which is burning of the generated waste in open space has been adopted in different countries over time. This method is practiced because it is the cheapest and fastest method of taking care of waste. This method is still mostly practised by low level countries and most developing countries of the world (Alexander, 2017). The emerging methods, which have taken over the previous ways of managing waste include waste reduction, waste recycling and waste treatment. These types of managing waste believes that all wastes are not useless and can still be reused for another function if it is processed again (Ofoezie and Bulu, 2015).

When waste is not well managed and disposed properly, it poses health related problems for the residents of the area. It has been shown that poor waste disposal has effects on the environment and on groundwater causing different health hazards, for example, the Gazipur municipal dumping site, Delhi, was found prone to the groundwater contamination through leaching action (Ratna et al., 2021; Kumari et al., 2019; Nitin & Choudhary, 2013). Waste management has been a problem in Nigeria. This problem has manifested in form of piles of disposed heaps of uncovered waste and illegal dumpsites on major roads and at street corners. Open dumps are the major causes of environmental degradation and public health concerns in many developing countries including Nigeria (Imam et al., 2008, Ferronato & Torretta, 2019). These waste dumps may contain a mixture of general waste and toxic, infectious or radioactive wastes and are susceptible to burning and exposure to scavengers. Waste management has been a major problem in Nigeria and the Osun state is no exceprtion. Solid waste, if not well managed, constitutes wellbeing perils, causes hostile scent, and contaminates the underground water sources when rain falls (Singh et al., 2022;

Nwosu and Pepple, 2016; Aboyeji and Eigbokhan, 2016). This research examined solid waste dumped around well points in the study area using geospatial techniques and laboratory analysis. This is because the waste management system in the study area has not been effective enough and there has been growing environmental problems due to the increasing population, the increasing number of small scale industries in the area and some other factors which cause the waste disposed in the study area to increase. Wastes are seen dumped along the roads and in the bushes, also on rivers and drainage areas. The indiscriminate dumping of refuses along roads and drainages is likely to affect water quality which in turn affects the health of the people living in the area. In this regard, this study evaluated the effect of waste disposal on the chemical quality of groundwater with a view to ascertaining the fitness of such water for households'use in Ife North Local Government Area of Osun State. The specific objective was to examine the quality of groundwater in the area. The null hypothesis tested was that waste dumpsites near groundwater sources do not have effect on the groundwater quality of Ife North Local Government Area of Osun State.

Study area

Ife North is a Local Government Area (LGA) in Osun State, in the south western part of Nigeria. Its headquarters is in Ipetumodu, a town to the north of the area. The LGA is in the outskirts of the town of Ile-Ife and the major language spoken is Yoruba. Ife North lies between latitudes $7^{\circ}28'$N and $7^{\circ}31'$N and longitudes $4^{\circ}27'$E and $4^{\circ}28'$E (Figure 1). The Local Government Area has a total land area of 889 km^2. It lies at the intersection of roads from Ibadan to Ife and from Ife Central to Ede. It comprises of Ipetumodu (the local government headquarters), Edunabon, Moro, Yakoyo, Asipa, Akinlalu and Isope (which had fused with Ipetumodu). According to the 2006 National Census, Ife North Local Government Area has a total population of 153,274.

Ife North Local Government is the home of the Centre for Distance Learning of the Obafemi Awolowo University. It also contains two tertiary institutions and a secondary school. The major economic activities in the area are farming and the public sector which are basically government owned secondary schools (Jeje, 2014). Ife North has an undulating topography which is characterized by ridges, regolith covered hills and a few rock outcrops. It is also underlain by a basement complex of Nigeria rocks composed mostly of granitic rocks and metamorphic rocks (Jeje, 2014).

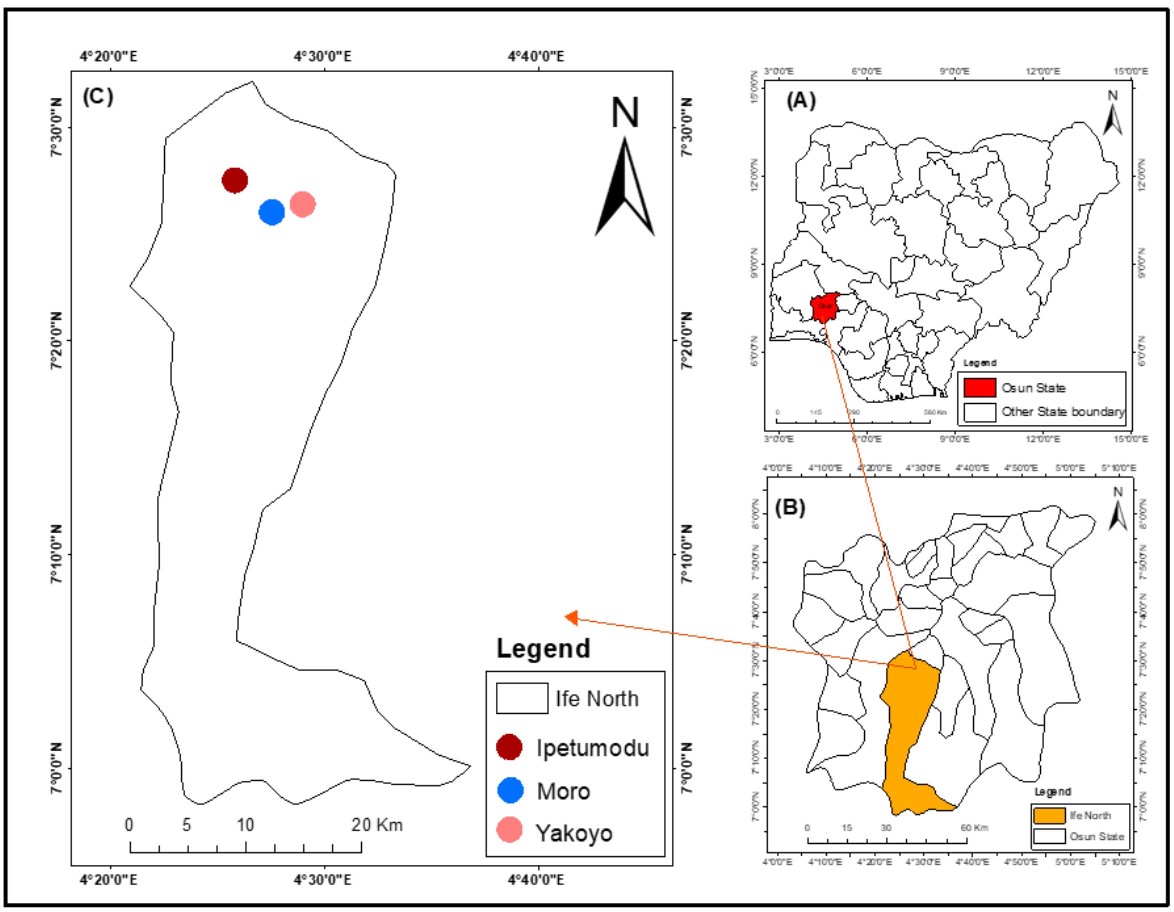

Figure 1: Map of the Study Area

Materials and Methods

Population, sampling and data collection

The target population were the residents of the local government area. The data used for this research were primary and secondary data. Three towns (Ipetumodu, Moro and Yakoyo) were sampled purposively being the populous communities in the Local Government Area. Information was gathered on the groundwater points closest to the waste collection points through field observation. Water samples were collected with sterilized 250 ml bottles from the groundwater points close to the waste dumpsites; they were numbered from 1 to 9 against their locations and taken to the Centre for Research and Development Laboratory, Obafemi Awolowo University Ile-Ife to assess the chemical quality of the groundwater. The samples taken from each community of the three communities were taken far from each other (Figure 2) and at three locations; between 15 and 45 metres, between 50 and 100 metres, and above 100metres because distance to the dumpsite and concentration of heavy metals were being examined. Coordinates (x, y) of the locations from which water samples were obtained were taken with a global positioning system (GPS) at ± 3m accuracy and in UTM zone 31N, the zone of the study area. The secondary data was a base map of the area from ArcGIS 10 online where the roads were digitized to get the road network of the area.

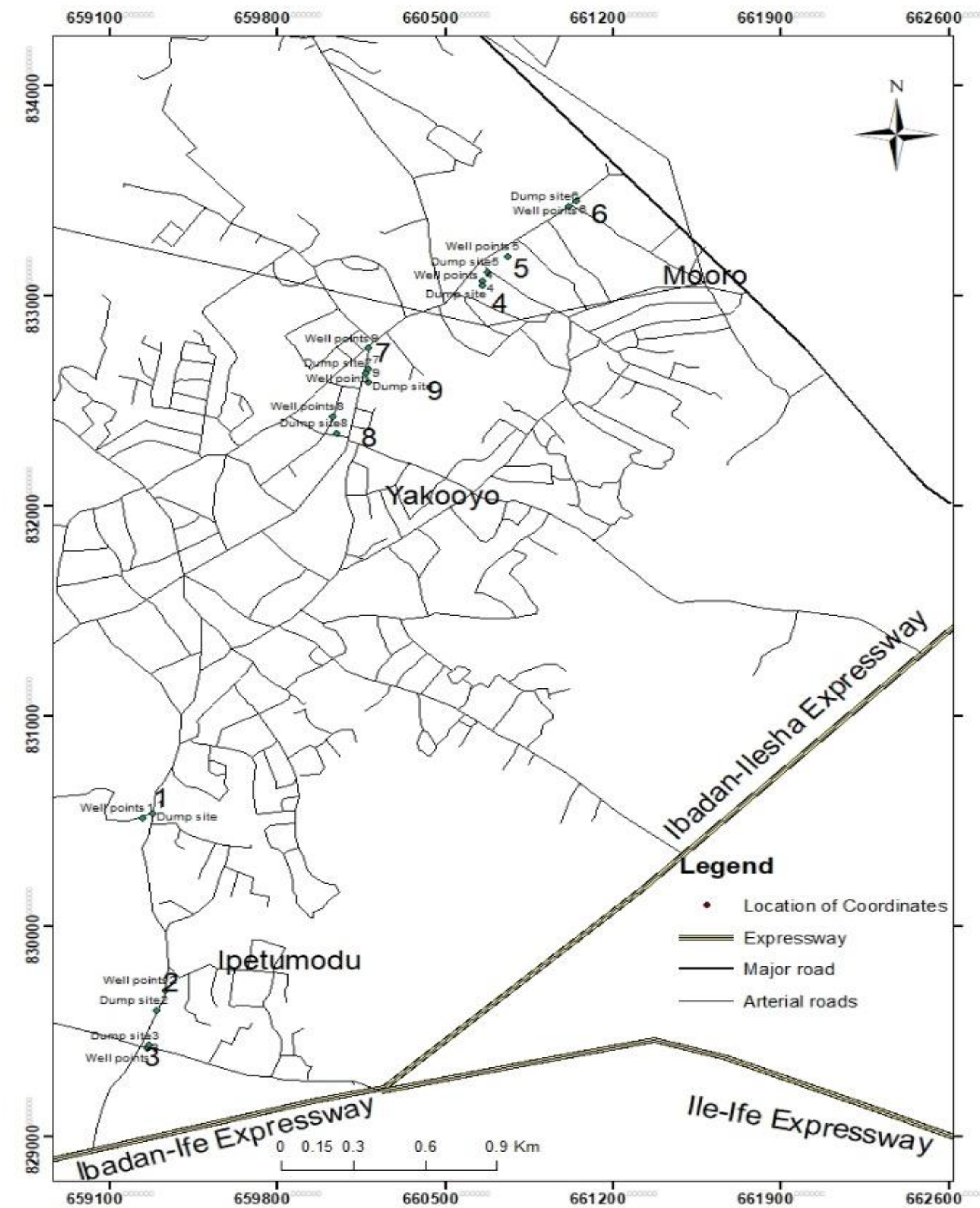

Figure 2: Map showing the location of the sampled points (1-9)

Analysis of water samples

Water samples were taken to the laboratory to determine the concentrations of selected heavy metals (lead (Pb), copper (Cu), iron (Fe)) and anions (sulphate (SO_4^{2-})) that are associated with leachates from dumpsites and are known to have severe health implication when consumed in contaminated water (Aboyeji and Eigbokhan, 2016; Brian, 2014), they are inorganic compounds that can pollute groundwater. The concentrations of Pb, Cu and Fe were determined using Atomic Absorption Spectrophotometer at their respective wavelengths whereas sulphate was determined using spectrophotometric methods as described in APHA [1998]. Prior to laboratory analysis, pH, conductivity and total dissolved solids (TDS) of the water samples were obtained *in situ* using pen-type pH/conductivity and TDS meters. To ensure quality control, the water samples were analysed within seven hours that they were taken into the laboratory, and the instruments were properly calibrated following standard laboratory protocols.

The groundwater sources were considered based on their distance to the dumpsites. The chemical variables used for testing the quality of the groundwater sources used were Lead, Iron, Copper and Sulphate.

Data Analysis

In order to check for the quality of the water, water samples were taken from groundwater points in three communities with three different divisions from the groundwater points and the dumpsites namely between 15 - 45 metres, between 50 - 100 metres and above 100 metres. Furthermore, descriptive statistics and inferential statistics with the use of the Statistical Package for Social Sciences (SPSS) were employed in displaying the results. ArcGIS, a geospatial software, was used to assess the location and proximity of the sampling points to the dumpsites to determine any effect from the dumpsites at 25 m radius. To examine the hypothesis that dumpsites near groundwater sources do not have effect on the groundwater quality of Ife North local government area of Osun State, regression analysis was carried out.

The regression is:

$$Y = a + bx + c \qquad \text{Eqn. 1}$$

Where Y = Distance,
x = chemical variables (Iron, Lead, Copper and Sulphate)
b = Standardized Coefficients (Beta)
c = standard error of the estimate

Results and discussion

Characteristics of selected dumpsites

In Moro, the wastes generated were majorly household wastes consisting in food remnants, paper waste, and plastic bottles which are mostly generated by the presence of the students from the Centre for Distance Learning and at other areas. In Ipetumodu, waste is generated from the residential areas, small scale industrial establishments such as filling stations, block making industries and retail outlets (e.g cement mini-depot). Wastes generated from this area include plastic kegs, leakage from fuel tanks and cement dust due to damaged goods. Most of the wastes generated here are toxic, for instance, leakage from fuel tanks can seep into water bodies and fuel tanks in the community. The type of wastes generated in Akinlalu and Edunabon are mostly household wastes and agricultural wastes because of the presence of residential community-towns, and also because the residents are mostly farmers. In Yakoyo, Isope and Asipa, the wastes generated are mostly household wastes.

Most households in Moro, Yakoyo, Isope, Akinlalu, Edunabon, Asipa and some parts of Ipetumodu dispose the waste generated at the back of the house collectively with the waste burned at the point of collection. The residue are left at the burning site. Our field observation showed that most of the wastes which are collected and burned are burned near the groundwater sources (Figure 3). At some locations in Ipetumodu, the wastes are collected in drums by the waste collectors to be disposed in a refuse dump. The households who use the waste collectors pay some amount of money to the waste collecting agencies to collect waste on their behalf.

(a). Yakoyo in Ife North LGA

Figure 3: A typical vunerable groundwater source in the study area

Uses of the groundwater in the study area

At the study area, it was observed that the main sources of water are the groundwater sources, therefore, the groundwater sources are used for domestic activities like cooking, bathing, washing, etc. Also, due to the presence of some small scale industries in the area, water is used for some other processes by block making industries.

Quality of selected groundwater

Measurement of pH relates to the acidity or alkalinity of the water. Acidic water can lead to corrosion of metal pipes. Meanwhile, alkaline water shows disinfection in water. Figure 4 shows the pH reading at different sampling points. The readings were 6.6 at sampling point 1, 6.6 at sampling point 2, 6.7 at sampling point 3, 6.65 at sampling point 4, 6.5 at sampling point 5, 6.8 at sampling point 6, 6.5 at sampling point 7, 6.8 at sampling point 8 and 6.9 at sampling point 9. The WHO standard for suitable drinking water quality is between the values of 6.5 and 8.5. With this result, therefore, all the sampling points fall within the WHO standard for pH reading for potable water.

Figure 5 shows the conductivity reading at different sampling points. Conductivity measures at different points were 550 µS/cm at sampling point 1, 500 µS/cm at sampling point 2, 250 µS/cm at sampling point 3, 400 µS/cm at sampling point 4, 445 µS/cm at sampling point 5, 390 µS/cm at sampling point 6, 322 µS/cm at sampling point 7, 442 µS/cm at sampling point 8 and 450 µS/cm at sampling point 9. The WHO standard for suitable drinking water quality is ≤ 1000µ. However, these results indicate that all the sampling points fall within the WHO standard for conductivity of potable water.

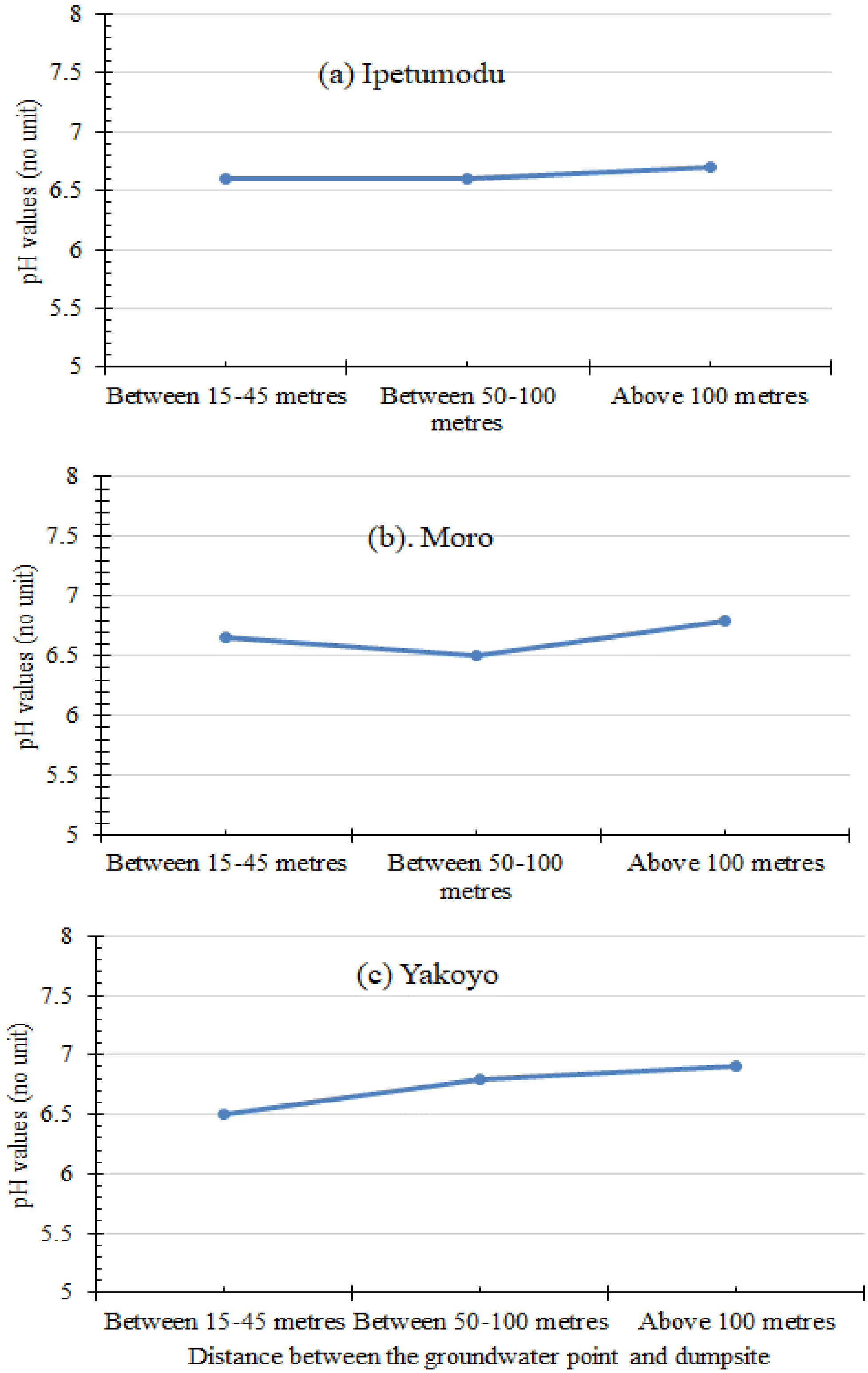

Figure 4: pH at Different distances in (a) Ipetu (b) Moro and (c) Yakoyo

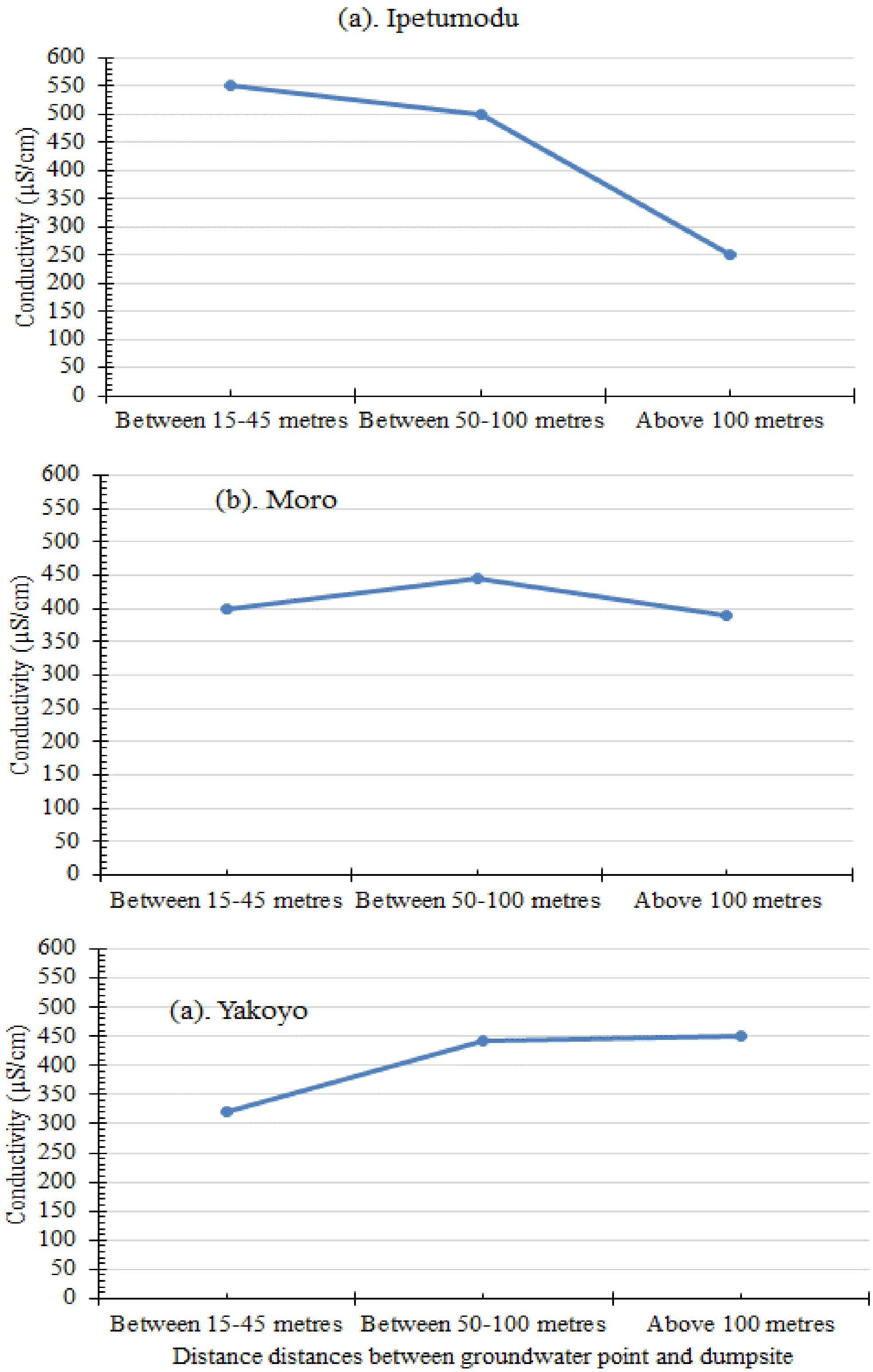

Figure 5 Conductivity at Different distances in (a) Ipetu (b) Moro and (c) Yakoyo

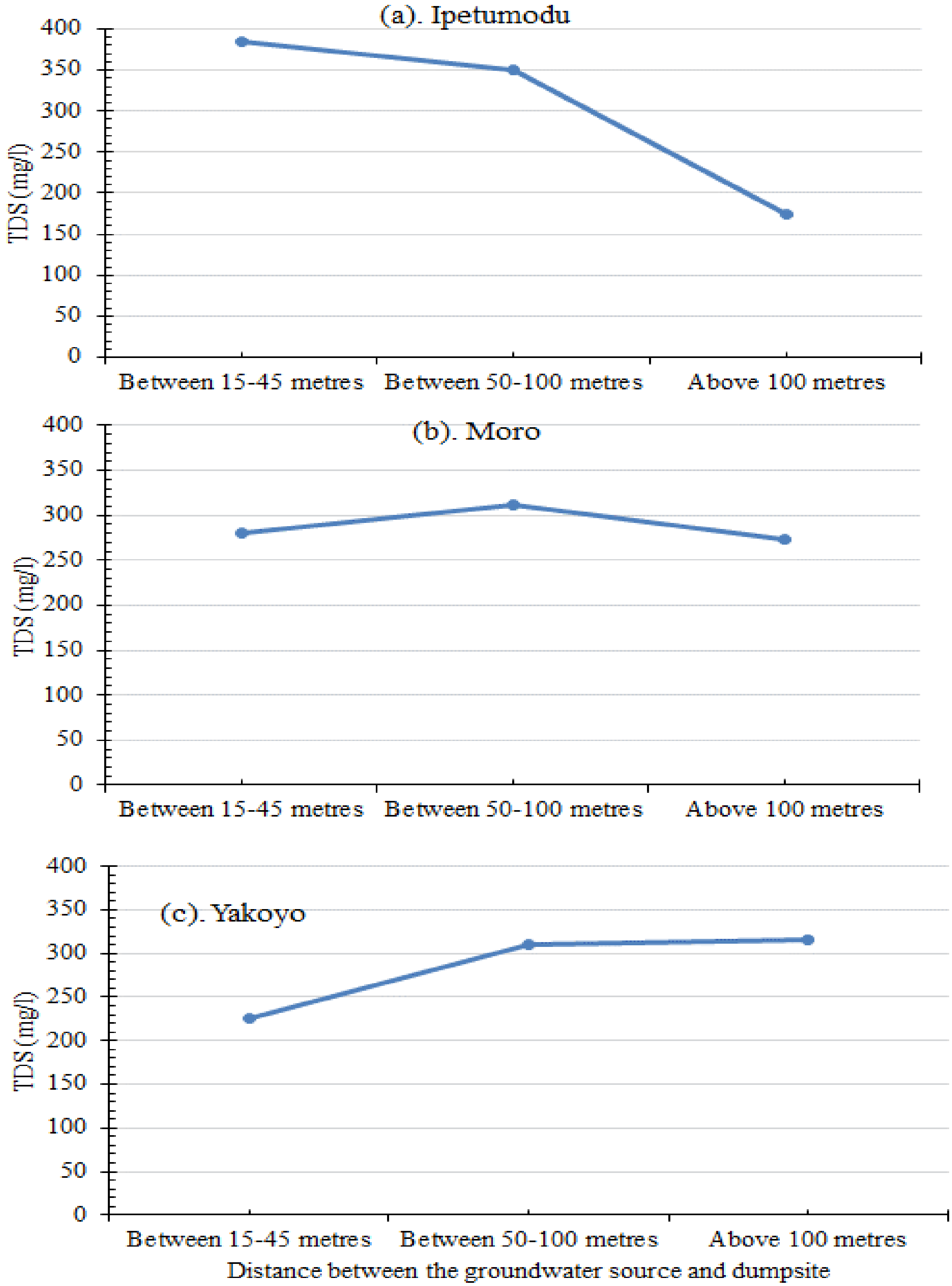

Figure 6: TDS at Different distances in (a) Ipetu (b) Moro and (c) Yakoyo

Total Dissolved Solids (TDS) are the inorganic matters and small amounts of organic matter, which are present as solution in water. Figure 6 shows the TDS readings at different sampling points. The readings were 385 mg/L at sampling point 1, 350 mg/L at sampling point 2, 175 mg/L at sampling point 3, 280 mg/L at sampling point 4, 311.5 mg/L at sampling point 5, 273 mg/L at sampling point 6, 225.4 mg/L at sampling point 7, 309.4 mg/L at sampling point 8 and 315 mg/L at sampling point 9. The WHO standard for potable water TDS is $\leq 300 \geq 600$. This indicates that all the sampling points fall within the WHO standard for TDS reading potable water.

Lead (Pb)

The concentration of Lead at different sampling points and distances were 0.012ppm at sampling point 1, 0.009 ppm at sampling point 2, 0.015ppm at sampling point 3, 0.018ppm at sampling point 4, 0.011ppm at sampling point 5, 0.007ppm at sampling point 6, 0.015ppm at sampling point 7, 0.008ppm at sampling point 8 and 0.006ppm at sampling point 9 as shown in figure 7. The WHO standard for suitable drinking water quality for Lead is a maximum of 0.01ppm. These results indicate that not all sampling points had suitable Lead concentration in drinking water. Sampling points 1-3 were in Ipetumodu, points 4-6 in Moro and 7-9 in Yakoyo. The concentration of Lead decreased with distance from the dumpsite except in Ipetumodu, which suggests that there are other factors contributing to Lead concentration in the area.

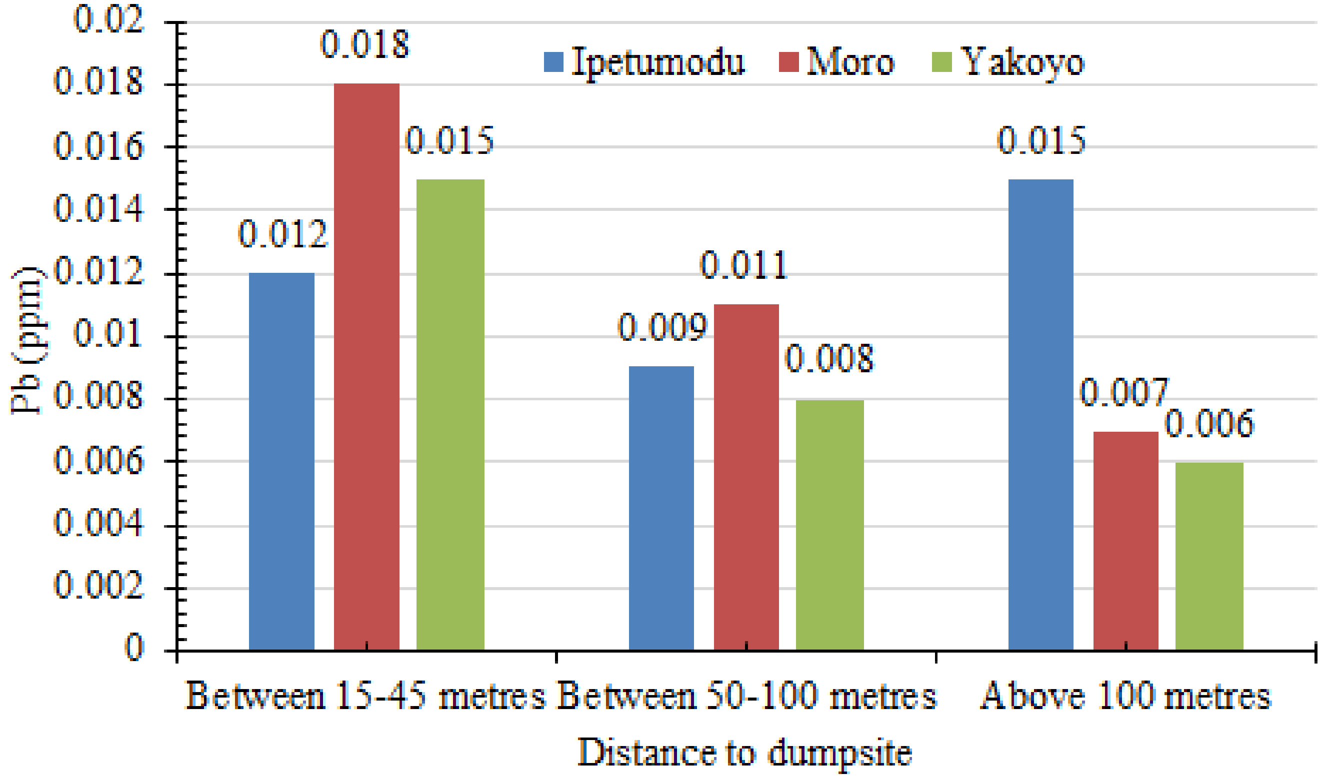

Figure 7: Concentration of Lead at different distances in the different towns

Copper

The Copper readings at different sampling points are 0.0094ppm at sampling point 1, 0.072ppm at sampling point 2, 0.066ppm at sampling point 3, 0.082ppm at sampling point 4, 0.070ppm at sampling point 5, 0.070ppm at sampling point 6, 0.085ppm at sampling point 7, 0.055ppm at sampling point 8 and 0.080ppm at sampling point 9 as shown in figure 8. Sampling points 1-3 are in Ipetu, points 4-6 in Moro and 7-9 in Yakoyo. The WHO standard for suitable drinking water quality for Copper is maximum of 2.0 ppm. With this result, it is suggestive that the sampled points have suitable Copper concentration in drinking water.

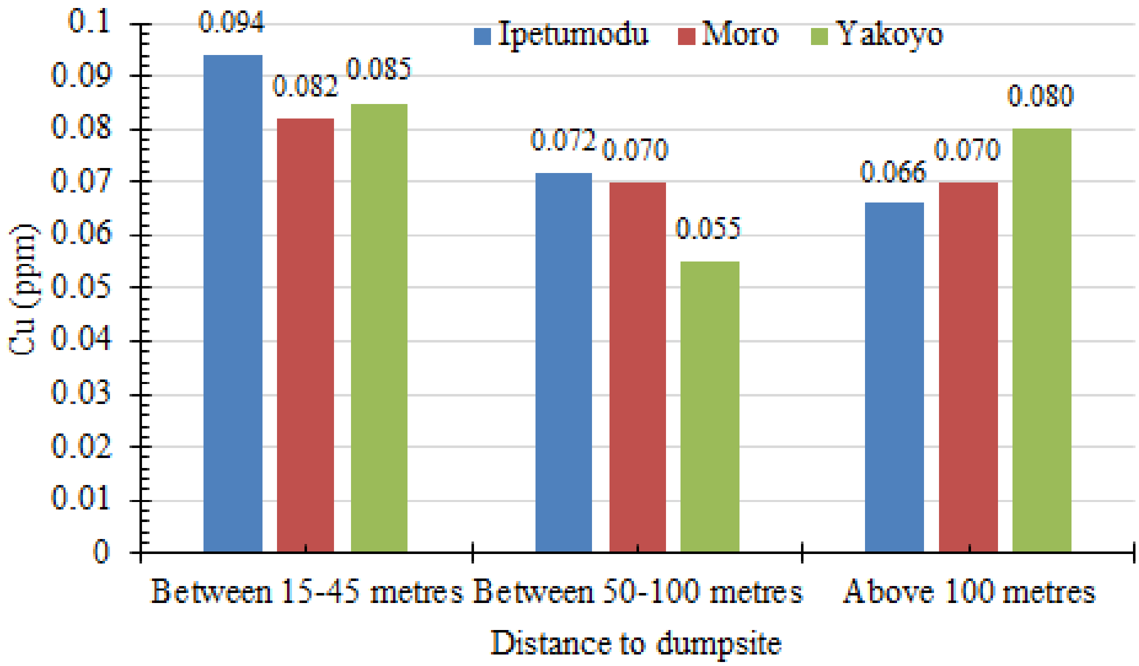

Figure 8: Concentration of Copper in groundwater at different distances from the dumpsites

Iron

The Iron readings at different sampling points are 0.108ppm at sampling point 1, 0.119ppm at sampling point 2, 0.087ppm at sampling point 3, 0.088ppm at sampling point 4, 0.093ppm at sampling point 5, 0.095ppm at sampling point 6, 0.110ppm at sampling point 7, 0.101ppm at sampling point 8 and 0.085ppm at sampling point 9 as shown in figure 9. The WHO standard for suitable drinking water quality for Iron concentration is maximum of 0.300 ppm. With these results, the sampling points are suitable for Iron concentration in drinking water.

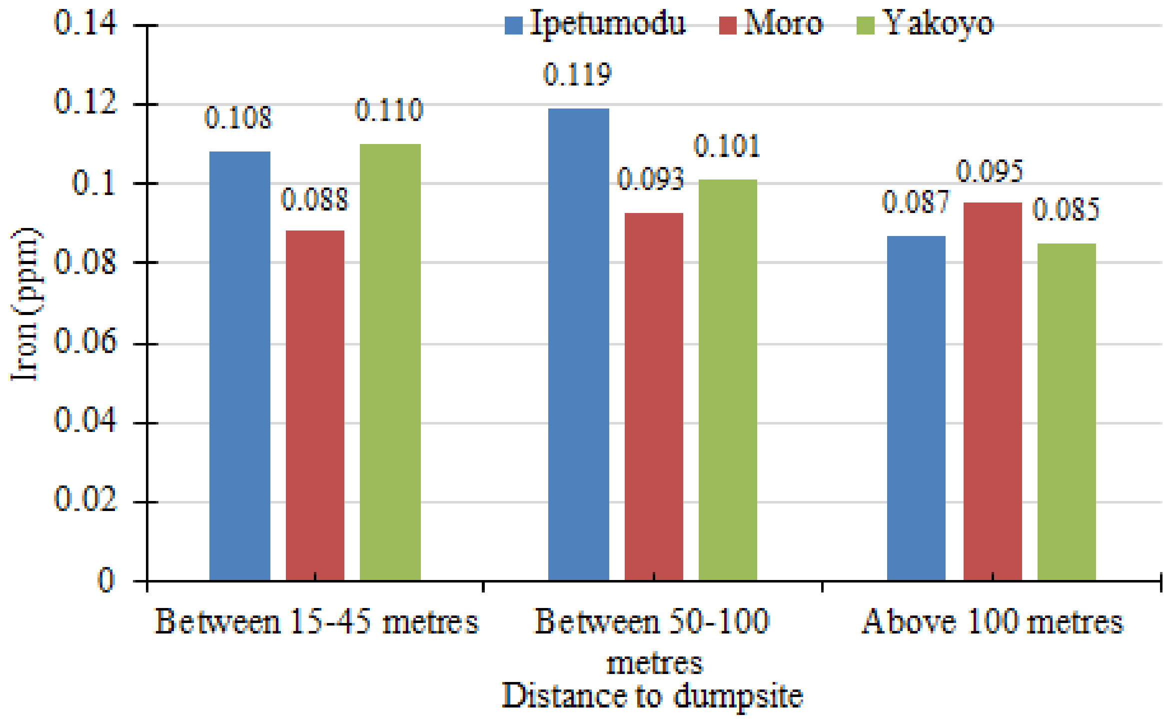

Figure 9: Amount of Iron concentration at different distances from the dumpsite

Sulphate

The Sulphate readings at different sampling points are 331.71ppm at sampling point 1, 321.34ppm at sampling point 2, 272.25ppm at sampling point 3, 396.41ppm at sampling point 4, 311.55ppm at sampling point 5, 274.45ppm at sampling point 6, 398.75ppm at sampling point 7, 299.67ppm at sampling point 8 and 278.74ppm at sampling point 9 as shown in figure 10. Sampling points 1-3 are in Ipetumodu, points 4-6 in Moro and 7-9 in Yakoyo. The WHO standard for suitable drinking water quality for Sulphate is maximum 400 ppm. These results indicate that the sampled points have suitable Sulphate concentration in drinking water, and thus, the community in general. Though Sulphate concentration is below the recommended maximum, Sulphate concentartion however, decreased with distance from the dumpsite alluding to the fact that dumpsites have great effects on sulphate concentration.

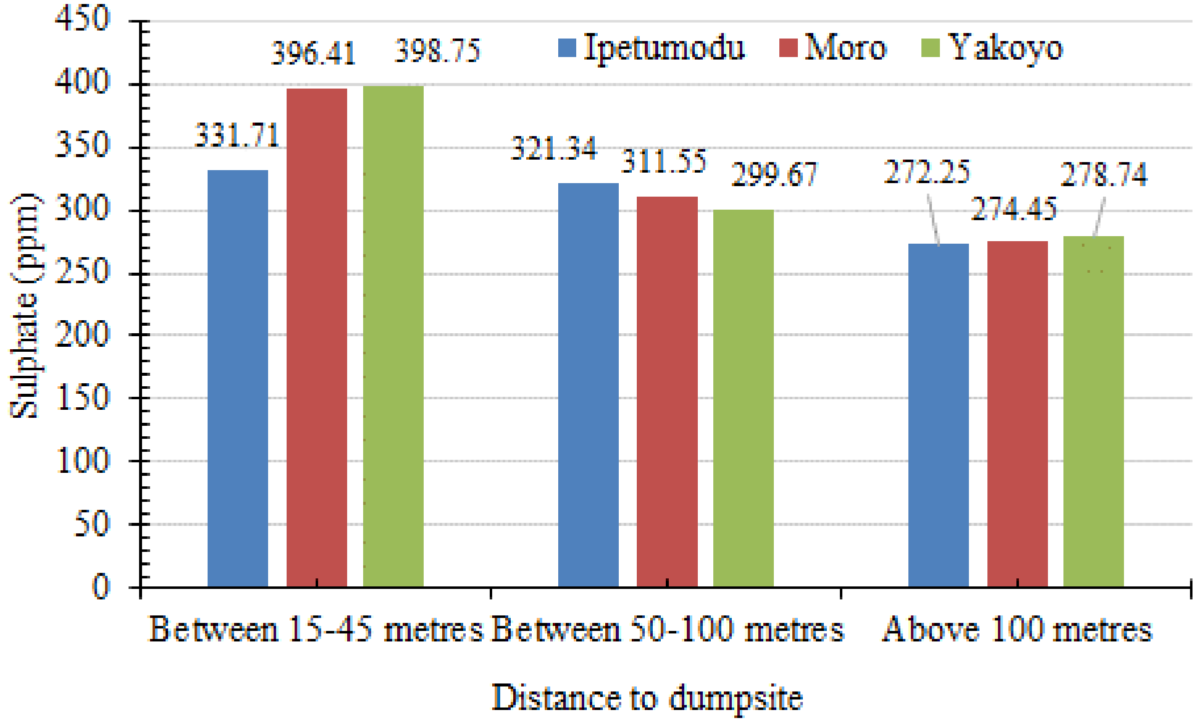

Figure 10: Sulphate concentration in the groundwater at different distances

Comparison of Heavy Metals at each distance with WHO Standard

Heavy metals tend to accumulate in human organs and nervous system and interfere with their normal functions (Rahmanian *et al*., 2015). The concentration of heavy metals for each water sample parameter as compared with the WHO standard for water quality is as shown in Table 1. For Lead, the maximum concentration that a portable water should have is 0.01ppm. At locations between 15 - 45 metres, at sampling point 1, sampling point 4 and sampling point 7. These concentrations are above the standard and they do not meet the WHO water quality standard for Lead. At distances between 50 and 100 metres, at sampling point 2, sampling point 5 and sampling point 8. At this distance, it is only at sampling point 2 (0.011 ppm) that the concentration does not meet with the WHO standard for Lead concentration. At distances greater than 100 metres, the concentrations at sampling point 3, at sampling point 6 and at sampling point 9. At these distances, it is only at sampling point 3 (0.015 ppm) that the concentration is greater than the set standard for Lead concentration in water by the WHO. It, therefore, means that the water is not fit for use. Young children, infants, and fetuses are particularly vulnerable to Lead because the physical and behavioural effects of Lead occur at lower exposure levels in children (Wani, *et al.*, 2015).

For Copper, the WHO standard for maximum concentration potable water should have is 2.0 ppm. At locations between 15 – 45 metres, the concentrations are 0.094ppm at sampling point 1, 0.082ppm at sampling point 4 and 0.085ppm at sampling point 7. These concentrations meet up with the set standard for Copper water quality. At distances between 50-100 metres, the concentrations are 0.072ppm at sampling point 2, 0.070ppm at sampling point 5 and 0.055ppm at sampling point 8. These values meet up with the standard set for Copper water quality by the WHO. At locations which have the distance greater than 100 metres, the concentrations are 0.066ppm at sampling point 3, 0.070ppm at sampling point 6 and 0.080ppm at sampling point 9. These values meet up with the standard set for Copper water quality by the WHO. When Copper exceeds the normal standard, its consumption can cause nausea, vomiting, diarrhoea, gastric (stomach) complaints and headaches. Long term exposure over many months and years can cause liver damage and death (www.lenntech.com).

For Iron, the maximum concentration that water should have is 0.300 ppm. At distances between 15 – 45 metres, the concentrations were 0.108ppm at sampling point 1, 0.088ppm at sampling point 4 and 0.110ppm at sampling point 7. These concentration are not more than the set standard for water quality and this indicates that the water meets the standard for concentration of Iron in water. At distances between 50-100 metres, the concentrations are 0.119ppm at sampling point 2, 0.093ppm at sampling point 5 and 0.101ppm at sampling point 8, the concentrations of Iron in the water are not more than the standard set for maximum water quality therefore, this indicates that the water meets the standard for Iron water quality by the WHO. For distances greater than 100 metres, the concentrations are 0.087ppm at sampling point 3, 0.095ppm at sampling point 6 and 0.085ppm at sampling point 9, the concentrations of Iron in the water are not more than the standard set for maximum water quality therefore and this indicates that the water meets the standard for Iron concentration in water quality as defined by the WHO. Water with high concentration of Iron has a metallic taste to it, which makes it very unpleasant to drink. When it is used for cooking, it darkens what it is used for and can cause vomitting (Gupta and Gupta, 2020).

For Sulphate, the maximum concentration water should have is 400 ppm; the Sulphate concentrations for distances between 15-45 metres are 331.71ppm at sampling point 1, 396.41ppm at sampling point 4 and 398.75ppm at sampling point 7, these parameters meet up with the standard for sulphate water quality, for distances between 50-100 metres, 321.34ppm at sampling point 2, 311.55ppm at sampling point 5 and 299.67ppm at sampling point 8, these concentrations meet up with the standard for water quality for sulphate. This result is similar to observations of Oladimeji et al. (2009). For distances that are above 100 meters, the concentrations are 272.25ppm at sampling point 3, 274.45ppm at sampling point 6 and 278.74ppm at sampling point 9, these concentrations meet up with the standard for water quality for sulphate. When Sulphate is high in water, it may have a laxative effect that can lead to dehydration and its of special concern for infants (Water Research Center, *undated*).

Table 1: The comparison between WHO standard [2009] and the concentration of the metals at different locations.

Metals	WHO Standard (ppm)	Locations	Between 15-45 metres (ppm)	Between 50-100 metres (ppm)	Above 100 metres (ppm)
Lead (Pb)	0.0100	Ipetumodu	0.012	0.009	0.015
		Moro	0.018	0.011	0.007
		Yakoyo	0.015	0.008	0.006
Copper (Cu)	2.000	Ipetumodu	0.094	0.072	0.066
		Moro	0.082	0.070	0.070
		Yakoyo	0.085	0.055	0.080
Iron (Fe)	0.300	Ipetumodu	0.108	0.119	0.087
		Moro	0.088	0.093	0.095
		Yakoyo	0.110	0.101	0.085
Sulphate (SO_4)	400.00	Ipetumodu	331.71	321.34	272.25
		Moro	396.41	311.55	274.45
		Yakoyo	398.75	299.67	278.74

Relationship between Location of Groundwater sources and the Dumpsites

The samples collected are representative of each community. The samples were spread across each community with the samples taken far from each other (see Figure 2). The samples were collected in different distances to check the effects of wastes at different distances. ArcGIS 10 was used to digitize the road map of the area from a basemap of the area. The dumpsites and wellpoints were added as files. Proximity analysis using buffering was thereafter carried out at different distances between the well points and dumpsites.

The buffering of the groundwater points in Moro (Figure 11) at 25 metres area of influence shows that at well point 4, there is a dumpsite that falls within 25 metres from the well point, therefore, there will be influence of the dumpsite on the well point, at well point 5, there is no dumpsite that falls within 25 metres from the well point, therefore there will not be much influence on the well point. At well point 6, there is no dumpsite that falls within 50 metres from the well point, therefore, there will not be much influence of the dumpsite on the well point.

The buffering of the groundwater points in Ipetumodu (Figure 12) at 25 metres area of influence shows that at well point 1, there is a dumpsite that falls within 25 metres from the well point, therefore, there will be influence of the dumpsite on the well point, at well point 2, there is a dumpsite that falls within 25 metres from the well point, therefore, there will be influence on the well point. At well point 3, there is no dumpsite that falls within 25 metres from the well point, therefore, there will not be much influence of the dumpsite on the well point.

The buffering of the groundwater points in Yakoyo (Figure 13) at 25 metres area of influence shows that at well point 7, there is a dumpsite that falls within 25 metres from the well point, therefore, there will be influence of the dumpsite on the well point, at well point 8, there is no dumpsite that falls within 25 metres from the well point, therefore, there will be lesser influence on the well point. At well point 9, the dumpsite is the not close to the well point at 25 metres from the well point, therefore, there will not be much influence of the dumpsite on the well point.

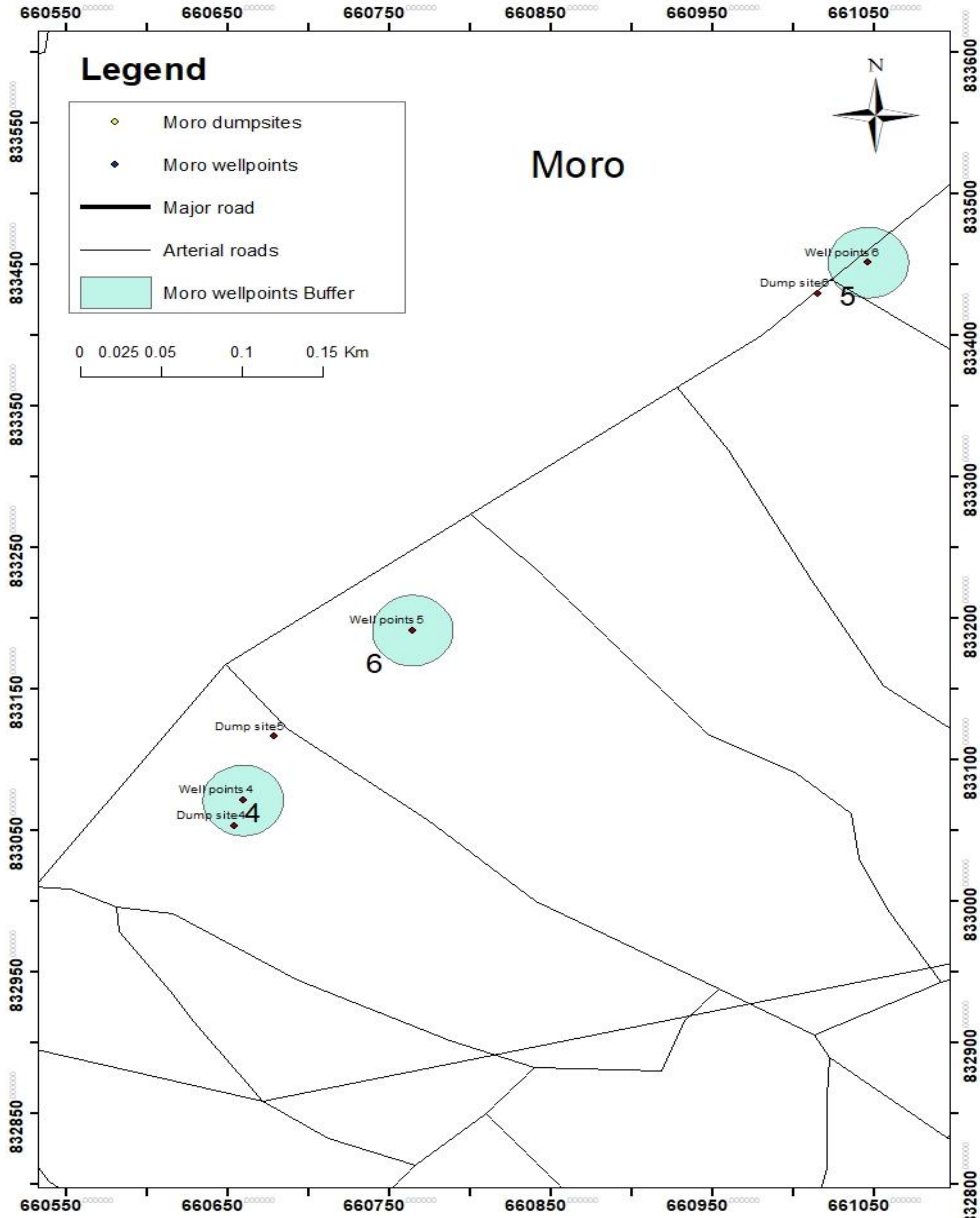

Figure 11: The buffering of the wellpoints in Moro at 25 metres distance

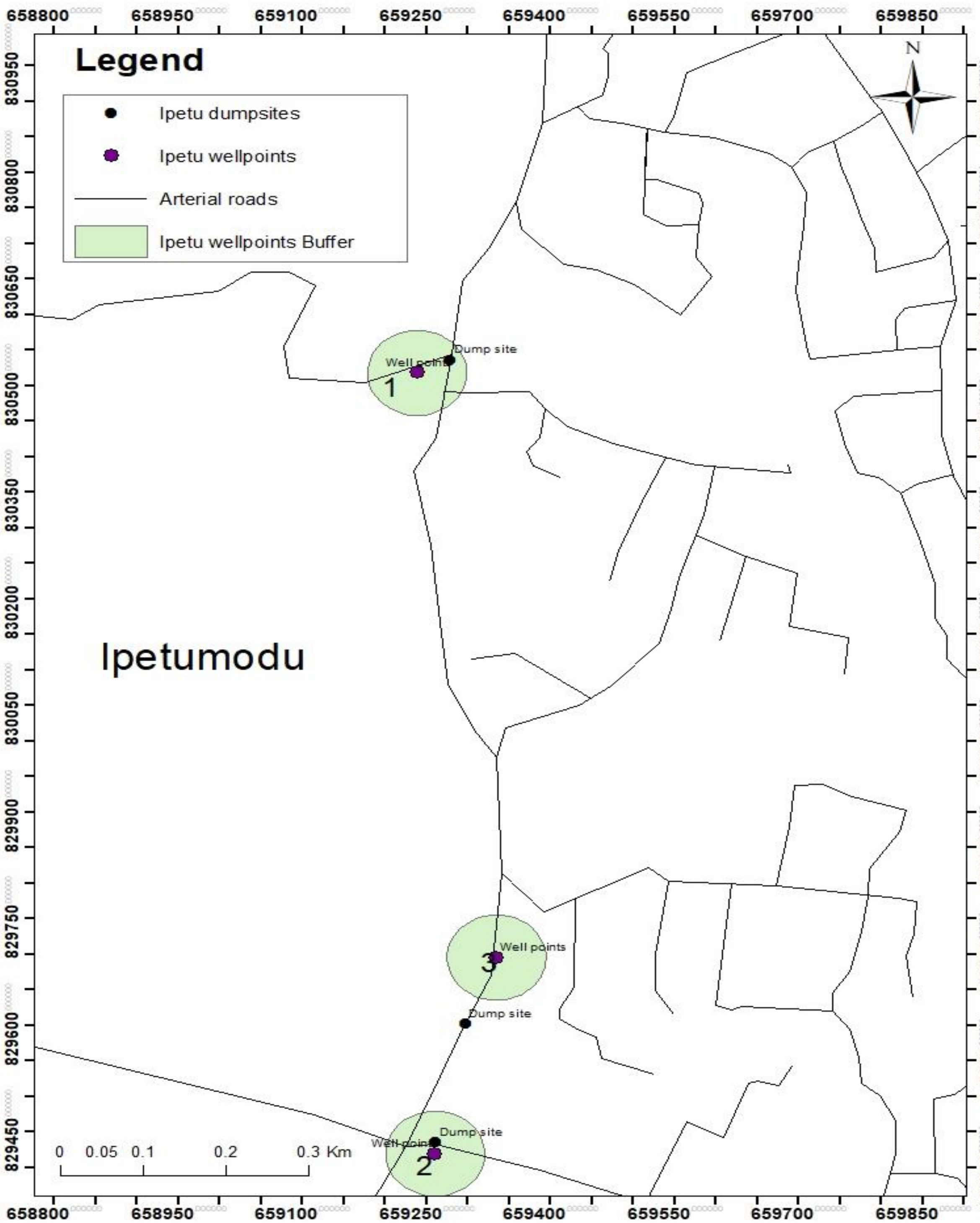

Figure 12: The buffering of the wellpoints in Ipetumodu at 25 metres distance

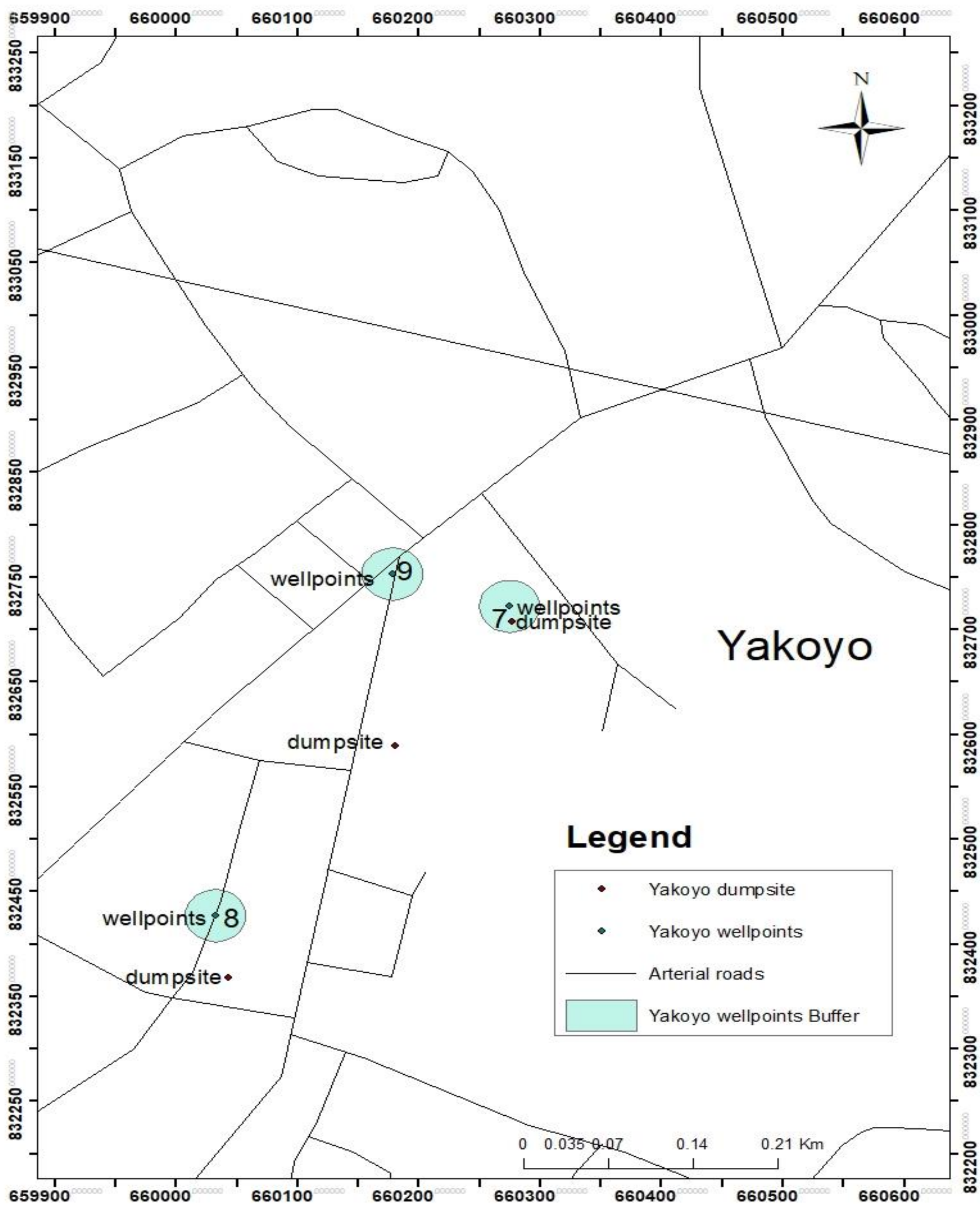

Figure 13: The buffering of the wellpoints in Yakoyo at 25 metres distance

Changes in concentrations of selected variables away from dumpsites

The results of the regression analyses as stated in equation 1 are shown in Table 2.

Table 2: Change in concentration of selected chemical variables away from dumpsite

Variable	Trend (a + bx + c)	R^2
Iron	298.81-0.54x +46.48	0.29
Copper	191.741- 0.375x + 51.47	0.14
Lead	$160.151 - 0.664x + 41.28$	0.44
Sulphate	$342.097 - 0.805x + 32.76$	0.65

Results of the analysis of variations/change in the concentrations of selected variables as one moves away from the targetted source of pollutants (dumpsites) indicated that the ions (Fe, Cu, Pb and SO_4^{2-}) reduced at different rates. The coefficient of determination (R^2) suggests that the rate of decrease in SO_4^{2-} and Pb were much better explained by distance (R^2 = 0.65 and 0.44. respectively) than by either Fe or Cu. The results suggest possible diffuse sources of Fe, Cu and Pb in the area, and this implies that the heavy metals in the groundwater need further investigation to identify the other sources.

In general, this study rejects the null hypothesis that dumpsites near groundwater sources do not have effect on the groundwater quality of Ife north local government area of Osun State and accept the alternative hypothesis that dumpsites near groundwater sources have effect on the groundwater quality of Ife north local government area of Osun State.

Conclusion

Wastes are known to be harmful to human health. This study has examined the waste dumpsites close to groundwater sources and their effects on the chemical quality of water from the groundwater sources. The results of the chemical parameters checked showed that their concentration decreased with distance from the dumpsite. Although the closeness of dumpsites to groundwater sources has an adverse influence on the groundwater sources, waste dumpsites are not the only variable that can affect the quality of groundwater. There are other variables which could contaminate and reduce the quality of the water.

This research also looked into the types of waste generated in Ife north local government area of Osun State and discovered that the wastes are mostly household wastes and wastes from farmlands. Waste disposal methods in different places affect the quality of the surrounding water in those places and if the waste generated is not properly treated, the waste will cause nuisance to the dwellers of the area. This research recommends that the waste dumpsites close to the wells should be moved away from the wells in order to protect the quality of water sources and the health of residents in the area. Also, the residents of the area should be sensitized about the benefits of using a collective waste dumping system where all the wastes are treated in a place far away from the groundwater sources for drinking.

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