

(RESEARCH ARTICLE)



Environmental compliance and influence of fuel dispensing infrastructure on groundwater quality in urban and peri-urban environment

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Abstract

The study assessed the level of compliance to Environmental Impact Assessment, Conformity to 15m sitting distance to dispensing outfit, and Proximity to Public facilities. Also, the effect of these dispensing outfit on groundwater quality of hand-dug wells at close proximities to petrol filling stations in Ado-Ekiti metropolis of Ekiti-State were equally considered. The result revealed that only 12% out of the Seventy-two (72) filling stations examined complied with the guideline while 88% fall out of compliance. Two water samples each were collected from Five (5) different stations along the major roads within the study area. The physicochemical and heavy metal parameters of the water samples were analyzed in the study area. The sample were collected from five selected functioning petrol stations above 25 years of establishment in the metropolis with hand-dug wells within and around its premises. Samples were analyzed for physicochemical and heavy metal parameters such as Temperature, Turbidity, Total Hardness, Total Suspended Solid, Conductivity, Chloride, Manganese, Chromium, Iron and Zinc. Results were compared with the World Health Organization Standard for Drinking Water Quality which showed abnormality in concentration of some parameters such as Turbidity, Chloride, Chromium and Manganese. The results from physicochemical and heavy metal water samples revealed that activities at the petrol filling stations, coupled with non-compliance in some areas within the area may have contributed to the contamination of the groundwater which is an indication of unchecked and uncontrolled activities of filling stations. These may pose significant health risks to both consumers and the environment at large in the vicinity.

Keywords: Petrol Stations; Non-compliance; Hand-dug well; Physicochemical; Water Quality; Degradation

1. Introduction

Access to safe and portable water is a crucial challenge in most of the rapidly urbanizing regions of developing countries and communities like Ado-Ekiti. In many urban and Peri-urban areas, groundwater serves as the primary supply as a result of inadequate piped water infrastructure. Contamination of Groundwater mainly occurs from filling station through leakages from underground storage tanks, pipelines, and pump dispensing facilities. Problems emanated overtime from corrosion, poor infiltration, or poor maintenance which usually resulted in the release of petroleum hydrocarbons into the subsurface environment. According to Ulakpa, *et al*, (2022) most of the Petrol Filling Stations were sited too close to residential areas and road, violating safety criteria, potentially increasing exposure risk to pollutants. Emphasis was laid on poor compliance with environmental siting norms, risks to human health and environment. These contaminants penetrate the soil and infiltrates downward to groundwater aquifer, especially where water table is high or soil is permeable. Filling stations (petrol stations) are facilities used for the storage and dispensing of petroleum products such as petrol, diesel, and lubricating oils, while they play an essential role in transportation and economic activities, therefore, poorly designed, sited, or managed filling stations can significantly contribute to environmental hazards. The work of Bello & Anobeme, (2015) on the effects of oil spillage on the properties of soil and environment around the marketing outlets of some petroleum marketing companies in Calabar, Cross River State,

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showed that oil spill has negative effects on the chemical and biological properties of soils and the crops or vegetation in the surrounding.

When petroleum compounds enter the groundwater, they worsen water quality, making it unsafe for domestic use and drinking. Long term exposure to contaminated groundwater can lead to serious health risks, involving carcinogenic and neurological effects. Gbadebo, *et al*, (2024), Assessed Potential Health Impact of Volatile Organic Compound of Underground water samples around a fuel stations in Oshogbo, Osun-State, Nigeria and detected multiple volatile organic compounds near ground water close to the filling stations. Water quality, encompasses the physiochemical and biological characteristics of naturally occurring water for its designated uses, can be altered by both natural processes and anthropogenic activities, thereby posing potential health risk to consumers. The need for good environmental performance has always been a requirement, but in consideration of high risk and dangers which is associated with petroleum product as a highly inflammable product, its exploration, transportation, offloading, storing and sale points and facilities should not be taken for granted. Numerous cases of fire outbreaks are recorded in recent years, according to WHO (2004) report, more than 2.3 million lives and properties worth more than 4.5 billion are lost to fire outbreaks associated to petroleum product mishandling.

Recent studies have shown that proximity to filling stations associated with concentration of total petroleum hydrocarbons (TPH) as contributed to some of the challenges associated with water quality in our societies. According to UNESCO 2007 & Odukoya, 2015, Over 80% of diseases and deaths in low – middle income countries are attributed to bad/low water quality. Pollutants enter water bodies due to accidental spills of chemicals, indiscriminate waste disposal (liquid and solid), Excessive application of pesticides, wrong fertilizers application, runoff from agricultural land, waste ponds, septic tanks, intrusion of salt water, underground leakages of storage tanks, pipeline vandalization. The study carried out in Maiduguri and Jere, Borno State, on the workers in the filling stations and the residents residing close to the vicinity of the filling stations in Nigeria, revealed that in one time or the other people suffers health challenge due working in the filling stations and living close to petroleum filling station vicinity. (Mshelia, *et al*, 2015). However, Arokoyu *et al* & Odipe *et al* reported a geometric increase in the construction of filling stations in Nigeria at erratic and clustered patterns at close proximities to residential areas nationwide. Njoku & Alagbe (2015) also highlighted some of the illegal location of Petrol filling stations in Oyo State using GIS to assess suitability of petrol filling stations revealed low level of compliance. The rapid increase in petrol station has not been properly checked and this has greatly resulted into many environmental issues and health problems due to soil and groundwater pollution by leaking underground tanks from filling stations globally. Akinyosoye & Balogun, (2023), identified petroleum hydrocarbons from leaking underground storage tanks and operational spills as significant sources of groundwater contaminations. Badu, (2015), Olukoya *et al*, (2016), & Rao *et al*, (2017), highlighted threat to drinking water and environment due to petroleum hydrocarbon leakages as a result of poorly sited of stations and violation of environmental standards. Therefore, unchecked, non-compliance and adherence with construction of petrol stations pose a great risk to human health and the environment where they are sited. Odipe, *et al*, (2020) also evaluate physicochemical and heavy metal parameters in well near filling stations in Ilorin metropolis and concluded that groundwater contamination posed health risks.

Ado, is the most populous settlement in Ekiti-State with high concentration of transportation system been the state capital. The inconsistency of poor power supply from the National grid have led to significant demand for petroleum products in the vicinity. The increased population and transportation activity result in greater fuel consumptions, therefore, put pressure on local supply networks and also, the reliance on backup generators due to epileptic power supply exacerbates the demand for petroleum, imparting air quality and potentially leading to pollution. These factors highlight the need for better urban and energy management in the region.

2. Materials and Method

2.1. Study Area

Ado-Ekiti metropolis is located between latitude 7° 37' 15.999"N and longitude 5° 13' 17.0004" E, UTM Easting 745,075.60 UTM Northing 843,041.77. It shares common boundaries with Akure North Local Government, Ado, the capital of Ekiti State is in Southwest region of Nigeria, was declared a state on the 1st of October 1996 alongside five other states in the country. As one of the newest states of the federation, it was carved out of the territory of old Ondo State, and covers the former 12 local government areas that made up the Ekiti Zone of old Ondo State. On creation, it had 16 Local Government Areas (LGAs), having had an additional four carved out of the old ones. It was part of the Ondo Province in Western Region of Nigeria.

The State is located within an upland region that rises over 250 meters above sea level. It is underlain predominantly by metamorphic rock characterized by a generally an undulating terrain. The landscape is made of ancient plains

interrupted by step-sided outcrops, that occur either as isolated formations or in groups and ridges. The State is made of tropical climate with two major seasons comprising wet season (April–October) and the dry season (November–March). Figure 1a and figure 1b shows the map of Ekiti –State showing the location of Ado-Ekiti. and typical layout of a filling stations in Nigeria.

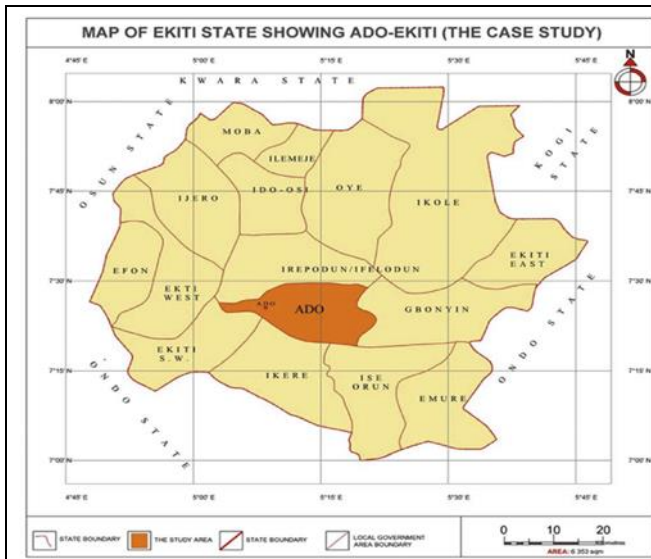


Figure 1a Ekiti-state Map showing Ado- Ekiti



Figure 1b Layout of a Typical filling station

2.2. Reconnaissance Survey

A reconnaissance survey was carried out on the selected filling stations in the study area. The DPR (zonal office Ado) provided the list of all licensed filling stations in Ado metropolis and this enabled the determination of the sampling techniques and in designing research instrument. The fillings stations were visited so as to ascertain they have not been decommissioned. Information on the laws and regulation relating to operation of filling stations in Nigeria and Ado were obtained from National Environmental Standard and Regulation Enforcement Agency (NESREA), National Oil Section and Regulation Agency (NOSDRA), Federal Fire Service (FFS). The level of compliance to EIA (Environmental Impact Assessment) on close proximities to residential building and the frequency of petrol station in Ado Ekiti metropolis were also determined. There exist more than ninety-four (94) filling stations at the time of study. Seventy-two of the filling stations were located along the five (5) major roads in the area. According to the physical planning Standards set by DPR (2007) and guide line procedures for approvals of construction and operation of a petrol filling station retail outlet, the distance from the road to filling station pump should not be less than 15meter. Since filling station were represented as point facilities and road as line feature, a 15-meter buffer zone was established along the road. The physicochemical along heavy metal parameters of the water samples were analyzed in the study area. Water samples were collected from five selected functioning petrol stations above 25 years of establishment in the metropolis from hand-dug wells within and around its premises,

Table 1 Sampling Sites and their Designated Code

Site Code	Location Point	Zone
Point A	Ejigbo	Ilawe, road
Point B	Ejigbo	Fed, poly road
Point C	Ejigbo	Ikere, road
Point D	Ejigbo	Fajuyi, Iyin road
Point E	Ejigbo	Fajuyi, Adebayo road

2.3. Water Sample Collection

Water Samples were collected from Ten (10) hand dug wells within and around the premises of five (5) filling stations that were functioning while Grab/spot sampling method was adopted. 100ml sample bottles were used for the collection of water samples, which were labelled at the point of collection and transported to the laboratory for immediate analysis. Parameters such as, Colour, Odour, Temperature, Turbidity, Total Dissolved Solid, Chloride, Total hardness, pH, Conductivity Iron, Zinc, Chromium, Manganese. Heavy metals were measured using the atomic absorption spectrophotometer. (AAS). The method of Association of Official Analytical Chemist (AOAC,2005) was used for mineral analysis. The quality of groundwater was later compared with the World Health Organization drinking water quality standards (WHO, 2011).

3. Results and Discussions

The study shows the frequency of petrol station in Ado Ekiti metropolis, analysis of the differences in the level of compliance, conformities to location guidelines alongside with the hazards associated with their operation. The physicochemical characteristics of surrounding well water were analyzed alongside with the heavy metals concentration.

3.1. Conformity of Petrol Station at 15meter Siting Distance

The study revealed that only 11% of the 72 filling stations were in compliance with the 15meter siting distance to nozzle in Ado Ekiti metropolis. This was also revealed in the work of Ulakpa., *et al*, (2022). The values are shown in Table 2 represented on a chart in Figure 2.

Table 2 Petrol station at 15meter siting distance to nozzle in Ado Ekiti metropolis

S/NO	Road	Types of road	No of Station	15m from road
1	1 (Ilawe)	Major	13	3
2	1 (Ikere)	Major	18	2
3	1 (Poly)	Major	13	1
4	1(Adebayo)	Major	16	2
5	1 (Iyin)	Major	12	0
Total	5	5	72	8

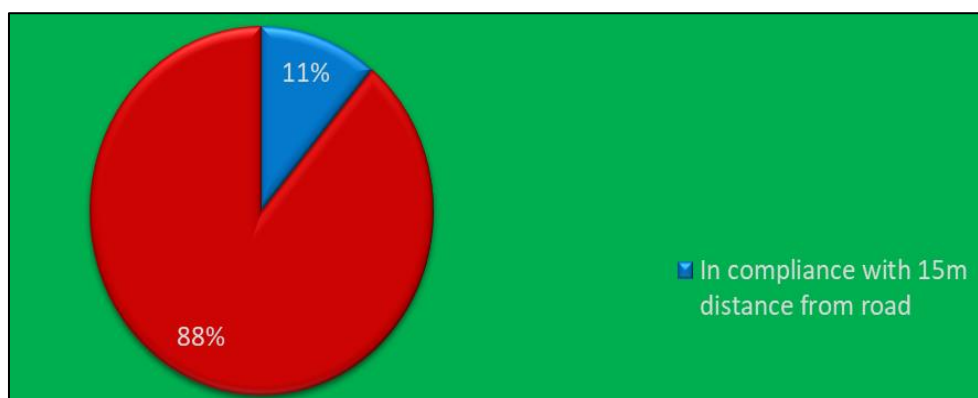


Figure 2 Chart of Petrol station at 15meter siting distance to nozzle in Ado- Ekiti metropolis

3.2. Level of Compliance to Location Guidelines

Distances between stations in the area were determined by the use of GPS. The findings indicated that the maximum distance observed between petrol filling stations was approximately 1,220 meters. The results further revealed that more than half of the filling stations were located less than 400meters from the nearest filling station, however, only

8.74% of the stations failed to adhere to the minimum required separation distance of 400meters from one another. (with no road separation).

Table 3 Conformities to Location Guidelines

S/NO	Road	Types of road	No of Station	400m to another	Non-function
1	A (Ilawe)	Major	13	4	4
2	B (Ikere)	Major	18	2	5
3	C (poly)	Major	13	2	3
4	D (Adebayo)	Major	16	4	2
5	E (Iyin)	Major	12	0	3
	Total 5	5	72	12	17

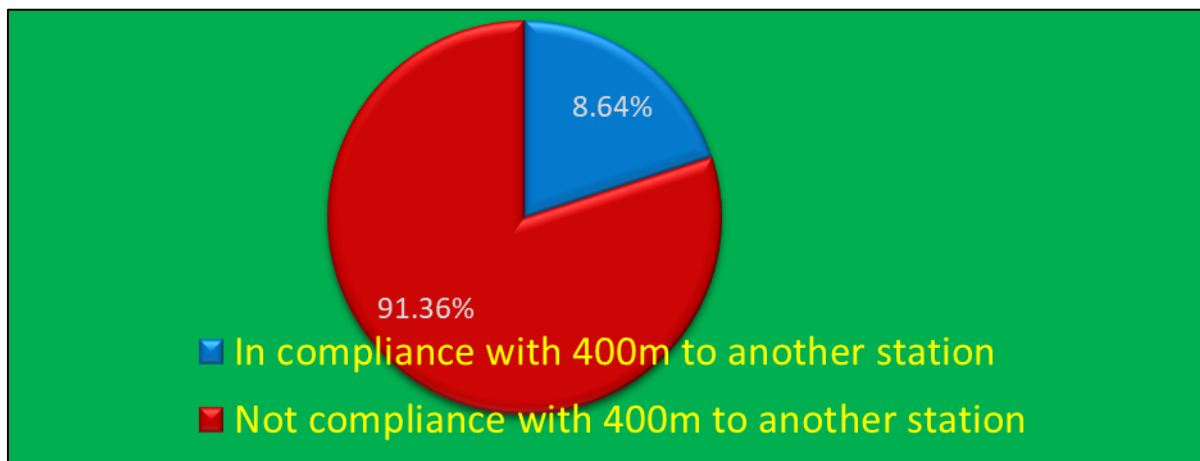


Figure 3 Chart showing Conformity to Location Guidelines

3.3. Level of Compliance to Public Facilities

According to the criteria set by the DPR (2007) petrol filling stations are not allowed to operate adjacent to public facilities such as hospitals etc. In case they are to operate, the minimum distance of 100meter has to be set back. The findings revealed that majority of the stations complied with the approved standard. Table 4 and Figure 4 Shows that only few of the station (5.04%) could not meet the criteria.

Table 4 Level of compliance to hazards (Distance to Public Facilities)

S/NO	Road	Types of road	No of Station	100m from Public Facilities
1	A (Ilawe)	Major	13	3
2	B (Ikere)	Major	18	2
3	C (Poly)	Major	13	0
4	D(Adebayo)	Major	16	2
5	E (Iyin)	Major	12	0
Total	5	5	72	7

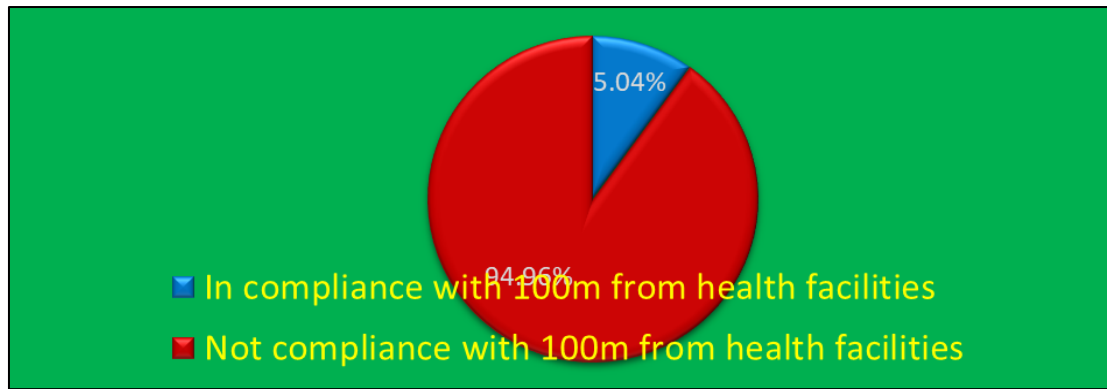


Figure 4 Chart Showing level of compliance to hazards

3.4. Physicochemical Parameters of Water Samples

Table 5 shows the profiles of the physicochemical parameters of water samples at each station while comparison with international drinking water standard were made. Parameters were represented in the Tables and charts with significant values showing possible anomaly from the country’s standards for drinking water respectively.

3.4.1. (A). Analysis of Physicochemical Characteristics of Water Sample

Temperature (°C): The Temperature of the water samples in the five zones were recorded with an average temperature of 20.1 for all the zones. The values were ambient according to WHO standard. Table 5 and Figure 5 shows the values obtained from each of the samples taken at each location across the study area.

Table 5 Temperature of the Water samples from the five Locations

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zone A	27	25.5	26.6	27.1	26	24.1	26.1	26.3	27.5	27
Zone B	25.5	26.9	26.9	25	24.9	25.6	26.4	25.8	25.4	25.5
Zone C	26.8	27	25.4	25.3	28.3	25.8	26.2	24.5	27	26.8
Zone D	27.4	27.5	25.4	25.3	28.3	25.8	26.2	24.5	27	27.4
Zone E	28.4	27.5	26.8	28.4	27.6	25	28	25.3	25.3	28.4
WHO	Ambient									

Note: *r = right side *L = Left side.

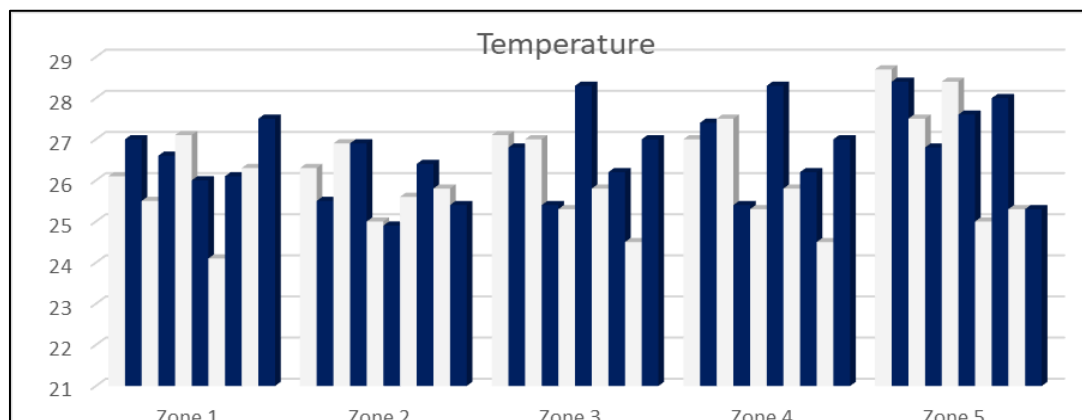


Figure 5 Graph of Temperature for the five zones

Turbidity (NTU): Turbidity can be measured by its effect on the scattering light, which is termed as nephelometry. DR900 were used for sample with moderate turbidity and nephemeter for sample with low turbidity. Higher the intensity of scattered lights the higher the turbidity. The turbidity of the water samples showed that only 46% of the water sample is within the recommended value of 5 NTU stated by WHO while 54% are not within the required standard as shown in Table 6 and Figure 6 respectively. Turbidity means high TSS and this can be seen in the values of TSS in Table 8.

Table 6 Result of Turbidity of the water samples for the five zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zone A	13	6	5	10	37	5	6	13	3	10
Zone B	2	2	1.87	1.86	1.91	2	2	1.91	1.91	2.04
Zone C	24	34	17	11	39	32	22	16	11	19
Zone D	14	12	5	0	0	0	20	9	32	13
Zone E	0	0	7	4	11	12	10	3	2	0
WHO	5									

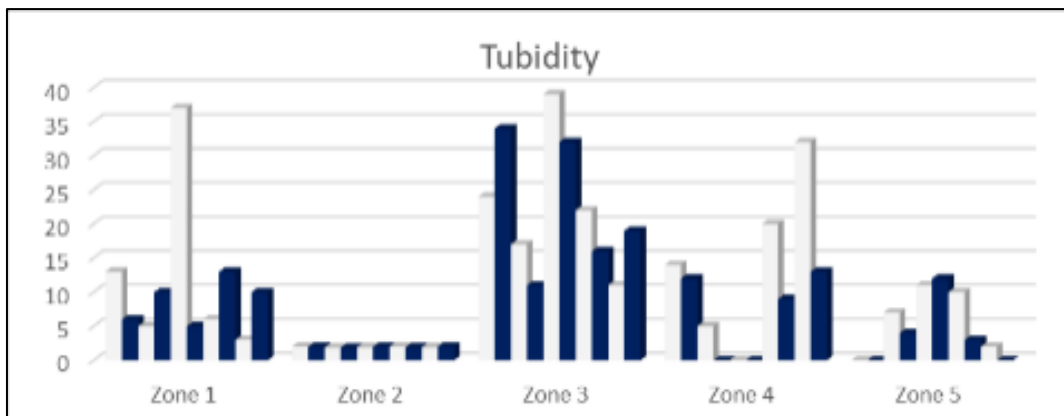


Figure 6 Chart showing Turbidity of the water samples

Total Hardness: The Total Hardness values of all the samples in Table 7 represented in Figure 6 were within the recommended WHO standard limit of 150mg/l.

Table 7 Total Hardness of the water samples for the five zones

Zone	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zone A	39.4	36.1	35.7	39.4	34.1	34.4	35.6	37.5	37.5	37.5
Zone B	39.4	27.4	39.1	37.4	35.6	39.4	39.1	39.6	38.7	34.1
Zone C	39.4	37.5	37.5	37.5	37.5	37.4	38.1	38.7	38.7	38.7
Zone D	39.4	36.1	34.0	34.6	35.7	39.4	27.6	34.4	34.1	35.6
Zone E	39.4	39.4	27.4	39.1	39.1	39.6	37.4	35.6	35.6	34.1
WHO	150									

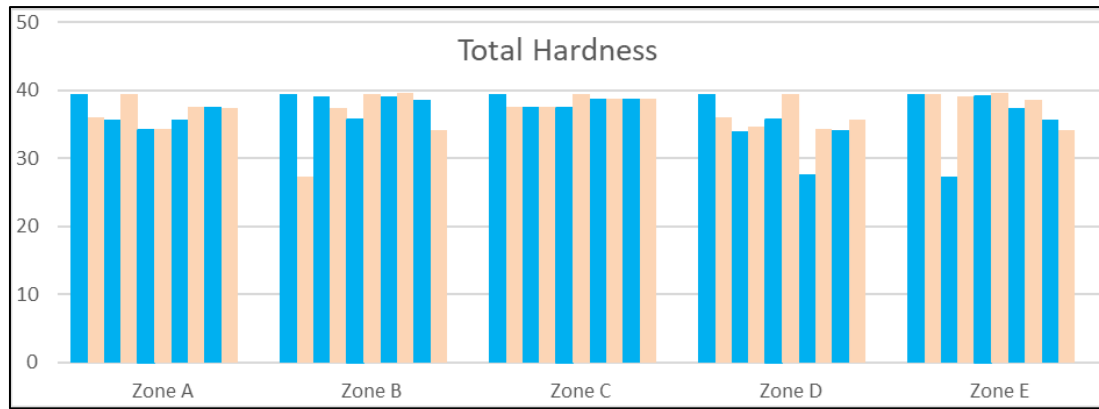


Figure 7 Graph on Total Hardness of water samples for the five zones

Total Suspended Solid: WHO does not specify a health based guide line value for Total Suspended Solids in drinking water, however TSS level less than 5mg/l are recommended. The Total Suspended Solid of most water samples analyzed for the five zones are higher than 5mg/l. The values of water samples ranged between 3 and 60mg/l as shown in Table 8 and Figure 8.

Table 8 Total Suspended Solid for the five Zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zones A	15	19	30	30	23	33	52	14	13	9
Zones B	11	11	8	5	21	19	13	12	10	15
Zones C	5	3	60	17	19	5	27	17	9	9
Zones D	22	4	4	3	40	43	5	3	3	4
Zones E	53	30	45	35	50	35	57	40	23	10
WHO	5									

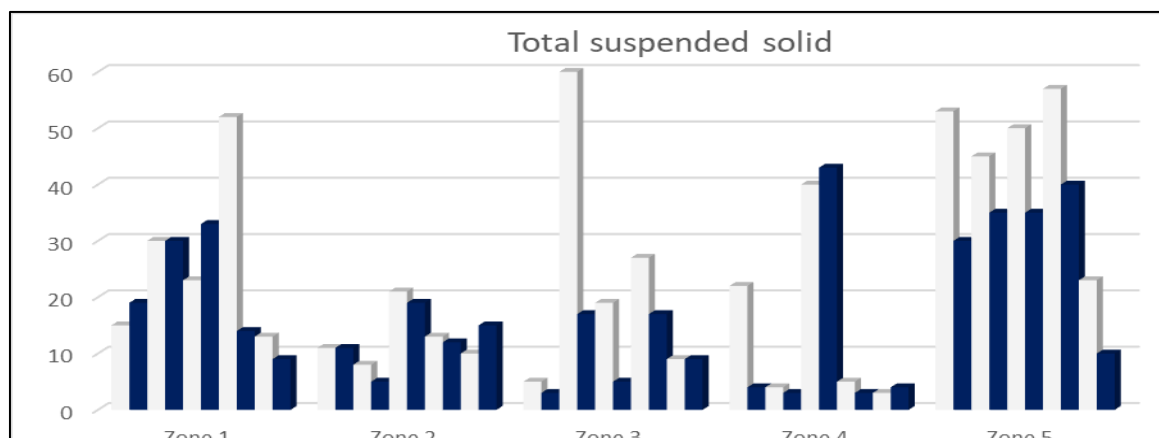


Figure 8 Chart of TDS for the five Zones

Conductivity: Conductivity is measured in uS/cm across all samples and ranged from 6 and 110uS/cm where most of the samples have low conductivity. This could be attributed to high resistivity property of hydrocarbons. All the water samples are within the recommended value as shown in Table 9 and Figure 9 respectively.

Table 9 Conductivity of the water samples for the five zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zones A	45	54	59	60	20	23	48	57	116	105
Zones B	47	94	18	21	35	28	15	21	26	19
Zones C	19	25	29	15	6	18	8	32	36	11
Zones D	18	17	29	58	31	26	32	39	44	35
Zones E	20	18	30	25	20	23	34	64	68	87
WHO	1000									

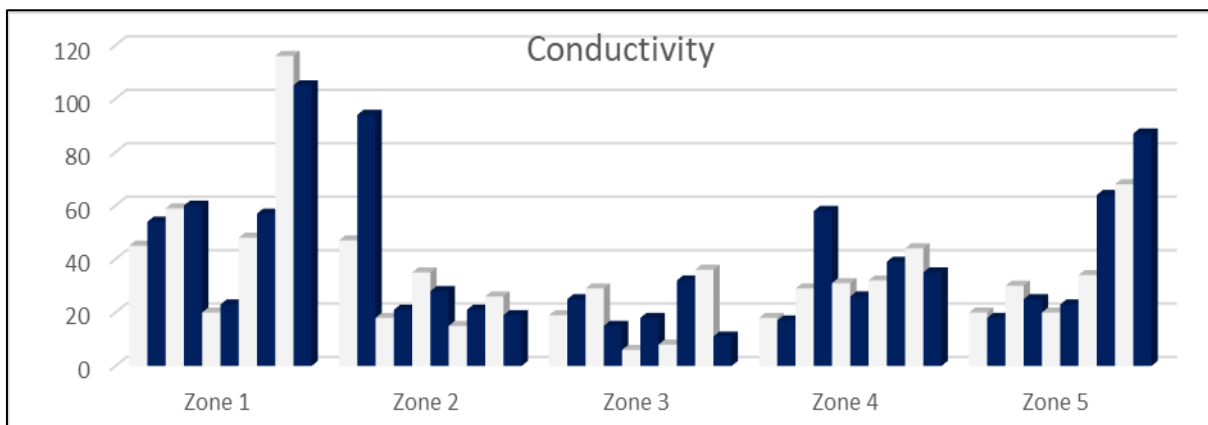


Figure 9 Chart showing conductivity of water samples for the five zones

Chloride: Table 10 showed that only 24% of the water samples are within the recommended Standard of 250mg/l which is an indication of petroleum related contaminations due to close proximity of the filling stations. The effects of this is bad taste, corrosion and reduction of water quality. Akinyosoye, O., & Balogun, B.O. (2023), identified petroleum hydrocarbons from leaking underground storage tanks and operational spills as significant sources of groundwater contaminations.

Table 10 Chloride of the water samples for the five zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zones A	896	1447	1102	1516	1034	1102	827	965	1171	1171
Zones B	116	110	146	183	329	110	146	342	123	173
Zones C	116	109	146	183	329	109	143	128	156	149
Zones D	136	36	129	128	144	157	157	143	143	143
Zones E	135	171	143	136	206	157	143	128	156	149
WHO	250									

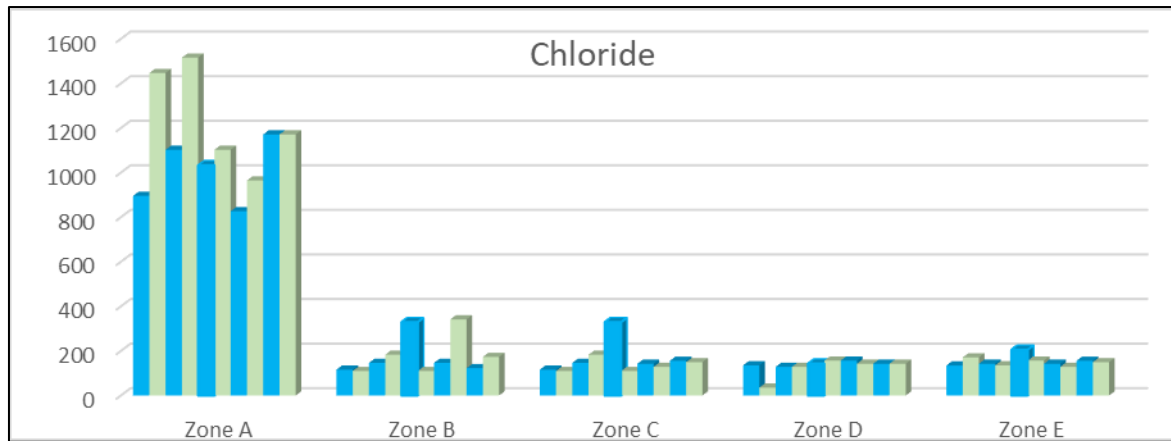


Figure 10 Chart of chloride values for the five zones

3.4.2. Analysis of Heavy Metal Parameters in the Five Zones

Manganese: The values of manganese from Table 11 represented on the chart ranged between 0.1 to 5.6mg/l which shows that most of the values were above the permissible limit of W.H.O (0.3 - 0.5mg/l) for drinking water. Odipe, et al., (2020), also evaluate physicochemical and heavy metal parameters in well near filling stations in Ilorin metropolis and Concluded that groundwater contamination posed health risks.

Table 11 Manganese values of the water samples for the five zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zones A	2.2	0.1	1.4	5.6	0.3	1.7	0.3	0.7	0.3	0.4
Zones B	0.5	0.3	0.2	1.2	1.9	0.5	0.9	1.7	2.2	3.2
Zones C	1.2	0.6	0.4	1.2	0.4	0.8	1.4	2.2	0.8	2.1
Zones D	2.2	1.6	1.2	0.2	3.2	2.2	0.3	0.9	1.3	0.9
Zones E	0.7	0.2	1.9	0.9	0.2	1.3	1.4	0.3	0.5	0.3
WHO	0.5									

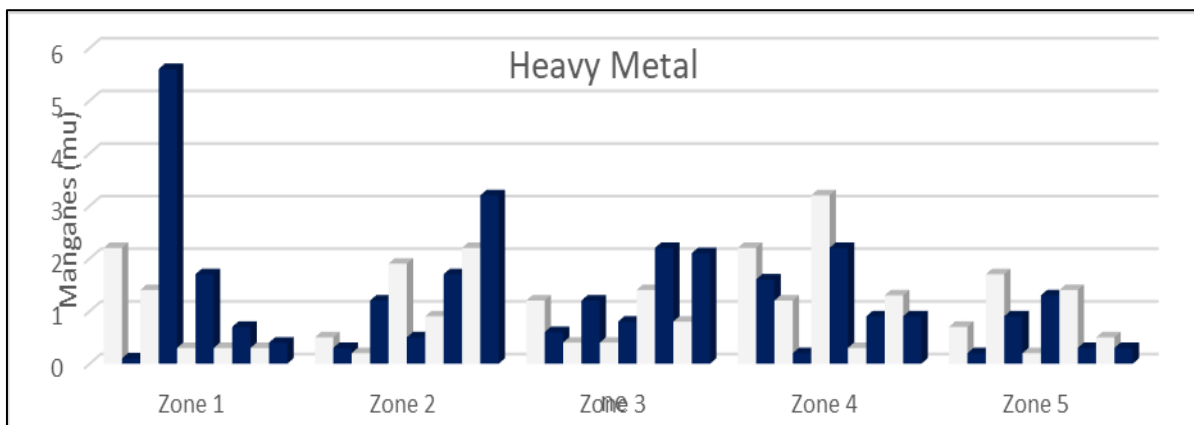


Figure 11 Chart of manganese showing water samples for the five zones

Chromium: The Result of water samples in Table 12 and the chart in Figure 12, showed that 70% of the water samples are within the W.H.O standard of 0.01-1.4mg/l for drinking water in all zones with 4% higher than the limit while presence of Chromium was not detected in 26% of water samples. This was in line with work of Odipe et al., (2020) and Adedeji et al., (2024).

Table 12 Chromium values of the water samples for the five zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zones A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zones B	0.2	0.04	0.02	0.10	0.04	0.00	0.01	0.01	0.03	0.02
Zones C	1.2	0.6	0.4	1.2	0.4	0.8	1.4	2.2	0.8	2.1
Zones D	0.01	0.01	0.02	0.10	0.04	0.02	0.01	0.01	0.03	0.02
Zones E	0.01	0.00	0.09	0.04	0.002	0.009	0.002	0.001	0.00	0.005
WHO	1.4									

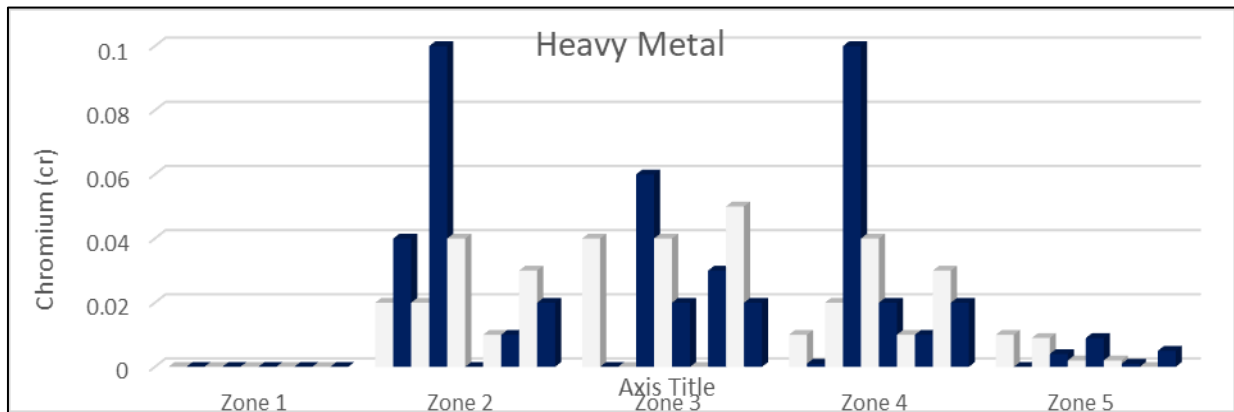


Figure 12 Graph of Chromium (Cr) for the five zone

Iron (Fe): Iron content of the water sample from Table 13 and the chart in Figure 13, showed that 88% of the water samples are within the permissible limit of 0.3mg/l, while Iron were undetected in 6% of the water samples.

Table 13 Result of Iron (Fe) in the five zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zones A	0.09	0.11	0.05	0.09	0.2	0.31	0.21	0.08	0.04	0.21
Zones B	0.06	0.03	0.05	0.22	0.04	ND	0.04	0.03	0.02	0.02
Zones C	0.04	0.05	0.145	0.1	0.01	0.01	0.03	0.04	0.01	0.02
Zones D	0.06	0.03	ND	0.22	0.04	0.08	0.04	0.03	0.02	ND
Zones E	0.34	0.11	0.05	0.09	0.2	0.31	0.21	0.08	0.76	0.21
WHO	0.30									

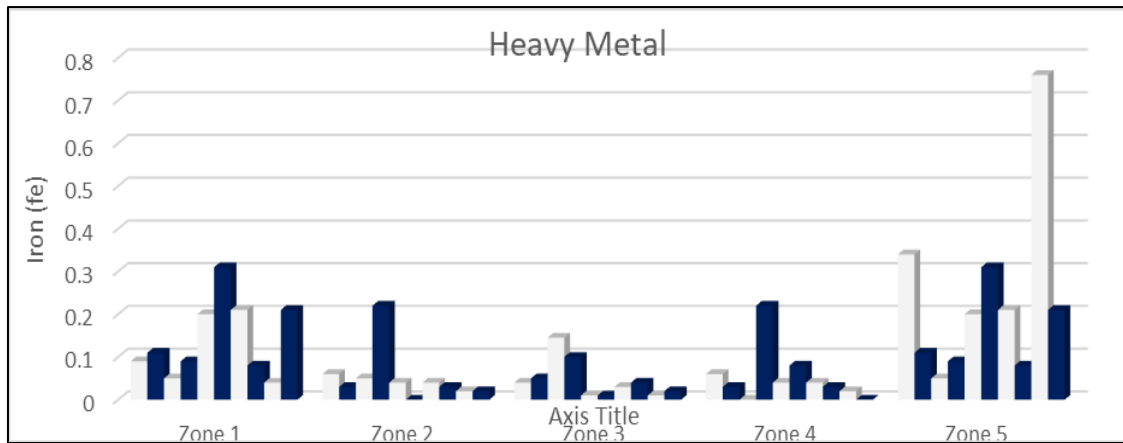


Figure 13 Graph of Iron (Fe) for the five zones

Zinc: 88% of the values of zinc from the Table 14 were within the standard limit of 3.0mg/l for drinking water while Zinc were undetected in 12% of the water samples. The water samples ranged between 0.00 and 0.009mg/l.

Table 14 Result of Zinc for the water samples in the five zones

Zones	Point A(r)	Point A(l)	Point B(r)	Point B(l)	Point C(r)	Point C(l)	Point D(r)	Point D(l)	Point E(r)	Point E(l)
Zone A	0.03	0.07	0.21	0.00	0.01	0.03	0.02	0.01	0.03	0.04
Zone B	0.09	0.05	0.06	0.08	0.07	0.00	0.02	0.04	0.03	0.04
Zone C	0.06	0.04	0.56	0.07	0.07	0.08	0.02	0.05	0.01	0.07
Zone D	0.09	0.05	0.00	0.08	0.07	0.04	0.02	0.04	0.03	0.04
Zone E	0.00	9.01	0.56	0.00	0.01	0.04	0.01	0.03	0.00	0.01
WHO	3.00									

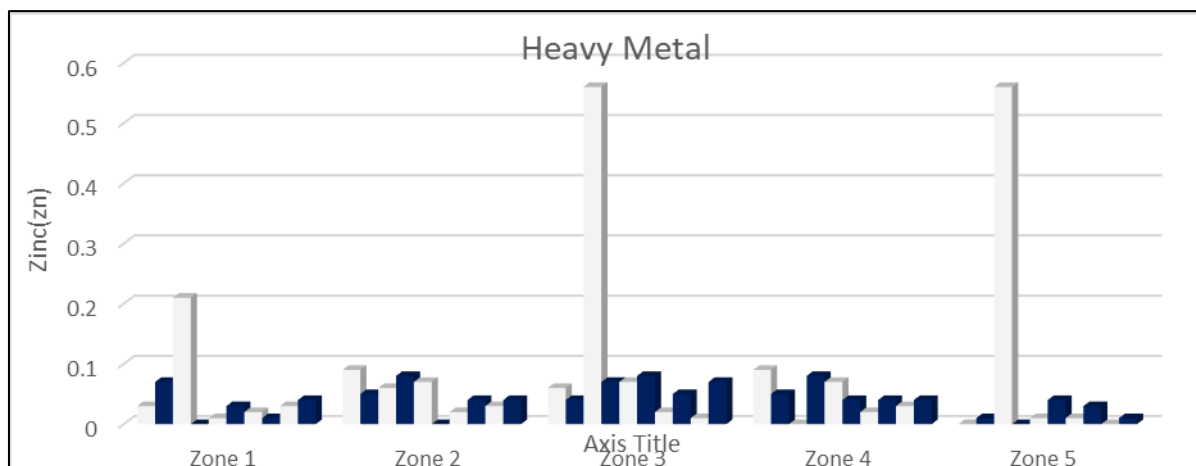


Figure 14 Graph on Zinc at five zones

4. Conclusion

The findings show that majority of the filling stations does not complied with the 15m sitting distance to the Nozzle. Out of the 72 Stations examined only 11% complied with the sitting distance.

The findings of the ground water samples analyzed within the filling stations revealed high varying levels of contaminations in Turbidity, Chloride, Chromium and Manganese suggesting potential groundwater contamination

from underground storage tanks. This is an indication of unchecked and ongoing use of the water source, coupled with the uncontrolled activities of filling stations, poses significant health risks to both consumers and the environment at large.

The heavy metals present in the water samples at high concentrations are primarily toxic elements that pose significant health challenges, even at low levels of exposure.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that, there are no conflicts of interest regarding the publication of this paper. The research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

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