Concentrations of Hydrocarbons and Heavy Metals in Groundwater from Andoni Local Government Area of Rivers State Nigeria

Ideriah T.J.K.[1], Abam T. K. S.[2], Uzamaden, G. I.[2], and Okafor, C[3]

[1]Institute of Pollution Studies, Rivers State University, Port Harcourt.

[2]Institute of Geosciences and Environmental Management, Rivers State University, Port Harcourt.

[3]Chemistry Department, Rivers State University, Port Harcourt.

DOI: https://doi.org/10.51584/IJRIAS.2024.907011

Received: 30 June 2024; Revised: 08 July 2024; Accepted: 12 July 2024; Published: 30 July 2024

ABSTRACT

The concentrations of Polycyclic Aromatic Hydrocarbons (PAHs), Total Hydrocarbons contents (THCs) and heavy metals in groundwater from parts of Andoni Local Government Area in Rivers State were determined using Gas Chromatography-Mass Spectroscopy for PAHs, Spectrophotometer for THC and Atomic Absorption Spectrophotometer for heavy metals. The results showed maximum mean levels of Polycyclic Aromatic Hydrocarbons (0.642 ppm) and Total Hydrocarbons content (3.23±4.24 ppm), Manganese (0.705±0.125), Iron (0.217±0.300), Lead (0.355±0.488), Chromium (0.096±0.132) and Nickel (0.151±0.149) mg/L. The Polycyclic Aromatic Hydrocarbon levels were above permissible limits and the Total Hydrocarbons content levels were above acceptable limits in some stations. Lead and nickel levels were above standard limits in some stations. The high levels of lead and nickel portend toxic and carcinogenic risks in some stations, especially to the environment and children in the study areas. The results showed that Groundwater in the study area is poor for drinking purposes in some areas and can pose health hazards in the area if consumed without proper treatment. Thus, adequate treatment of the groundwater in the affected areas is recommended.

Keywords: Polycyclic Aromatic Hydrocarbons, Heavy Metals, Groundwater, Quality Index, Andoni

INTRODUCTION

Water is an essential natural resource for sustaining life and environment but over the last few decades is deteriorating due to its over exploitation. Water quality is essential parameter to be studied when the overall focus is sustainable development keeping mankind at focal point (Saxena and Saxena, 2015). Groundwater is the major source of drinking water in rural as well as in urban areas and over 94% of the drinking water demand is met by groundwater (Saxena and Saxena, 2013). The quality of water is described by its physical, chemical and microbial characteristics. Venkateswaran *et al,* (2020) remarked that the quality of water is identified as the normal, physical and compound condition of water, as well as any adjustment that may have been initiated by anthropogenic action. The ground water quality is the consequence of every one of those procedures and responses that follow up on water from the minute it is first gathered until time it is stored in a well, which is regularly controlled by different physiochemical attributes (Arumugam et.al.2009).

Groundwater is the largest and most important water resource in Africa (Mac Donald *et al* 2012). Groundwater has long been considered as one of the purest forms of water available in nature and for semi-

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

rural people (Tyagi *et al,* 2002). It is often more reliable, in closer proximity to users, less vulnerable to pollution, and more resilient to climate variability than surface water (Mac Donald *et al* 2011; Lapworth *et al* 2013). Access to safe and reliable water is critical for improving health and livelihoods for low-income communities in Africa and elsewhere globally (Hunter *et al,* 2010). Groundwater is a valuable resource often used for industry, commerce, agriculture and most importantly for drinking (Akinbile, 2012). Often, the raw water used for domestic purposes is vulnerable to contamination due to the human influence resulting in pollution. Groundwater pollution is mainly due to the process of industrialization and urbanization that has progressively developed over time without any regard for environmental consequences (Longe and Balogun, 2010). Fawell, (2007) stated that disposal or illegal disposal of waste solvent in pits has also been identified as a significant cause of groundwater pollution.

In recent times, the impact of leachate on groundwater and other water resources has attracted a lot of attention because of its overwhelming environmental significance. Laechate migration from wastes sites or landfills and the release of pollutants from sediments (under certain conditions) pose a high risk to the groundwater resources if not adequately managed (Ikem *et al,* 2002). Wastes placed in landfills are subject to either groundwater overflow or infiltration from precipitation and as water percolates through the waste, it picks up a variety of inorganic and organic compounds, flowing out of the wastes to accumulate at the bottom of the landfill. Municipal landfill leachate are highly concentrated complex effluents which contain dissolved organic matters; inorganic compounds such as ammonium, calcium, magnesium, sodium, potassium, iron, sulphates, chlorides and heavy metals such as lead, zinc, nickel; and xenobiotic organic substances (Lee and Jones-Lee, 1993; Christensen *et al,* 2001).

Akinbile (2012) observed, toxic chemicals that have high concentrations of nitrate and phosphate derived from the waste in the soil can filter through the dump and contaminate both the ground and surface water. Nwankwoala *et al,* (2020) also noted that oil spills are common environmental issues prevalent in the Niger Delta region. This oil spills on the environment eventually lead to soil and groundwater contamination. Municipal solid waste leachate contains variety of chemicals like detergents inorganic chemicals and complex organic chemicals and metals (Cocchi and Scagliarini, 2005). These components are themselves very much toxic for the environment, and additionally uncontrolled microbial action may result in release of more toxic elements which were present in a free or reactive form in the waste (Fatta and Loizidou, 1999). Ogbuagu *et al,* (2011) examined the presence and concentration of six polynuclear aromatic hydrocarbons (PAHs) in groundwater sources of impacted by effluent discharges from the nearby Port Harcourt Refinery company effluent discharges to contaminate the groundwater.

Most rural settlements in Nigeria and Rivers State in particular, depend on improvised water sources like hand-dug wells, mono-pumps, and boreholes not usually treated for their water needs, where there are no nearby streams. Owing to the non-availability of government provided pipe-borne water, it has become imperative to ascertain the quality of water consumed by the inhabitants in rural areas. This research work is one of those avenue and is of immense importance particularly to the people of Andoni local government area of Rivers State in that it will help ascertain the water quality parameters of the groundwater used by the people and expose how environmental activities in the region interfere with the concentration of contaminants of the hydrological resource.

Most efforts in research and control programmes to assess the pollution loading into the environment have been made in most urban areas of Nigeria and Rivers State in particular, but only insignificant or negligible efforts have been taken in rural communication such as the study area of this research. Most rural communities in Nigeria are of little education, as Andoni local dwellers are not in exemption, it is believed that the knowledge from this research will help in enlightening rural dwellers the quality of water they consume, and how their activities affect their health through this water.

This study aims to determine the levels of Polycyclic Aromatic Hydrocarbons, Total Hydrocarbon

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

Compounds and Heavy metals in the groundwater from the study area. It will also estimate the health risks associated with the heavy metal levels in the groundwater.

MATERIALS AND METHODS

The Study Area

Water samples were collected from the groundwater (boreholes and wells) in plastic containers. Sample containers were rinsed with samples before proper sampling was done. All samples collected were well labelled with date and time. The samples were then transported to the laboratory for preservation, preparation and analysis.

The Andoni Local Government Area has an Area of 279km^2 and a density of 1097km^2. The population projection for 2006 was 311,506 by the National Population Commission of Nigeria (NPC, 2006). Nwankwoala and Walter (2012) averred that most Niger Delta region are of a Benin formation and therefore are highly permeable, prolific, productive and the most extensively tapped aquifers. The hand-dug wells in the study areas were dugged into it.

The LGA lies between the co-ordinates 4 32’ 57” N and 7 26’ 47” E (Fig. 1). Andoni is divided into Districts namely, Ngo, Unyeada, Asarama, Ataba, Isiokwun, Agwut-Obolo and Okwanija. These districts consist of communities mostly surrounded by rivers and swamps. Samples were randomly collected from two communities in each District depending on the type of groundwater available for the inhabitants.

The main source of drinking water to the study area is hand-dug wells. These wells are recharged through direct precipitation where the annual Rain-fall is a high as 2000 to 2400mm. However, during dry season, they are refilled through water infiltration on the highly permeable sand of the Benin formation although not at a higher level as observed in the rainy season.

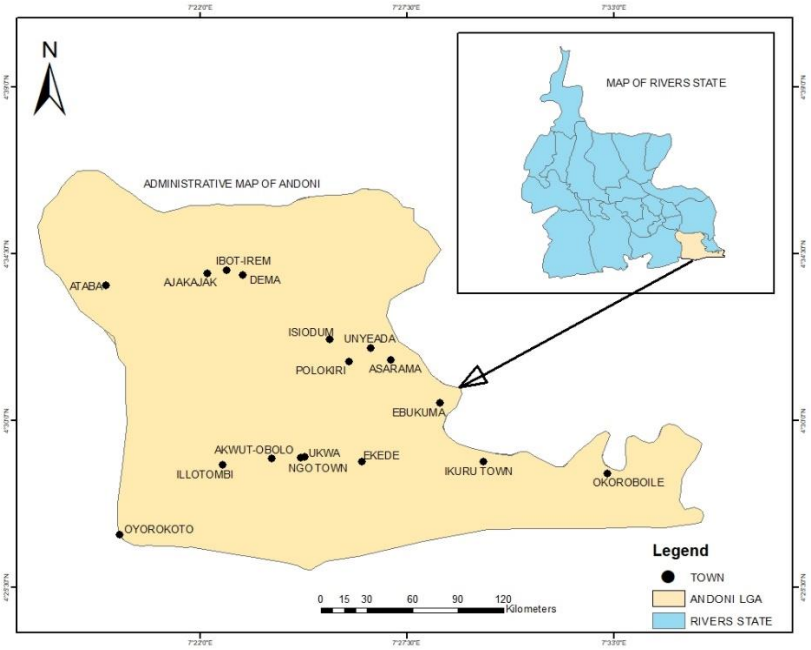

Fig. 1: Map of the Study Area showing sampling locations

Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Water

The respective samples were raised into micro vials (100 microlitres) and preserved in the refrigerator until

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

they were injected into the Gas Chromatography – Mass Spectrometer (GC-MS) instrument. The PAHs extracts were analyzed by using a 3800 Varian Gas Chromatography Coupled to a Varian Saturn 2200 Mass Spectrometer, equipped with a 30m x 0.25 mm i.d (inner diameter) WCOTCP-Sil 8 CB column. The GC – MS was operated under the following conditions: the initial column temperature was 70 °C. After an initial holding time of 1 min, the temperature was programmed to rise to 300 °C at a rate of 10 °C /min for 30mins.

The injector and detector temperatures were 25 °C and 300 °C respectively. Helium was used as the carrier gas at a flow rate of 2 ml/min. The method was according to the established procedure by the EPA method 8270D. PAHs concentrations were identified based on their retention time and confirmed by comparing their mass spectra with the reference standard.

Extraction and Determination of THC

Total hydrocarbons were analyzed using a method adopted from Howard *et al* (2009). Groundwater samples were extracted according to standard methods. The filtration method was used to transfer the extracts into 50 ml flasks and then topped up to the 50 ml mark with the extraction solvent, toluene. Triple extractions were performed on all the samples. The concentrations of total hydrocarbon content in Groundwater samples were determined using spectrophotometer at a wavelength of 420 nm. The concentrations of the hydrocarbon content were obtained from a standardized calibration curve initially prepared and the values compared with those obtained from blank solutions using the same measurement procedures.

Determination of Heavy Metals

Sample was analyzed using Atomic Absorption Spectrophotometer (AAS). To determine the concentrations of heavy metals, the sample was aspirated into a flame where it became atomized. A beam of light was directed through the flame into a monochromator and later into a detector that measured the intensity of the light energy absorbed. The quantity of light produced by a specific lamp, absorbed in the flame is directly proportional to the concentration of the element in the sample.

Calculation:

$$\text{Conc.(ppm)} = \frac{\text{Sample absorbance}}{\text{Standard absorbance}} \text{ x conc. of std. x dilution factor}$$

RESULTS

Heavy Metal Analysis

The heavy metal properties of the groundwater samples are shown in Table 4.1 and Figs. 4.2 – 4.6.

Mean chromium levels fell between 0.003±0.000 and 0.096±0.132 mg/L; Mean nickel levels fell between 0.001±0.000 and 0.151±0.149 mg/L; Mean iron levels fell between 0.005±0.000 and 0.217±0.300 mg/L; Mean lead levels fell between 0.010±0.000 and 0.355±0.488 mg/L; while mean manganese levels fell between 0.046±0.021 and 0.705±0.125 mg/L.

Table 4.1. Concentrations of Heavy Metal in Groundwater from the study Area

Samples	**Mn**	**Fe**	**Pb**	**Cr**	**Ni**	**Mn**	**Fe**	**Pb**	**Cr**	**Ni**
	mg/l	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**
	SET 1					**SET 2**				
Oyorokotor W 1	0.376	0.005	0.455	0.003	0.256	0.041	0.005	0.010	0.003	0.045

Illotombi W 1	0.155	0.005	0.577	0.025	0.001	0.063	0.005	0.010	0.003	0.001
Agwut-Obolo	0.793	0.005	0.700	0.003	0.084	0.616	0.005	0.010	0.057	0.001
Ukwa Well	0.183	0.144	0.010	0.003	0.001	0.062	0.005	0.010	0.003	0.001
Ngo Well	0.363	0.240	0.644	0.003	0.238	0.043	0.005	0.010	0.003	0.001
Ekede Well	0.408	0.378	0.318	0.003	0.144	0.194	0.005	0.010	0.003	0.001
Ikuru BH	0.274	0.005	0.083	0.003	0.188	0.116	0.005	0.010	0.003	0.001
Ebukuma	0.229	0.042	0.192	0.003	0.054	0.040	0.005	0.010	0.003	0.001
Asarama BH	0.379	0.429	0.010	0.003	0.007	0.079	0.005	0.010	0.003	0.001
Unyeada Well	0.178	0.019	0.010	0.189	0.001	0.099	0.005	0.010	0.003	0.001
Polokiri Well	0.025	0.005	0.286	0.003	0.021	0.105	0.005	0.010	0.003	0.001
Isiodum Well	0.061	0.005	0.010	0.029	0.001	0.031	0.005	0.010	0.003	0.001
Ataba Well	0.089	0.005	0.579	0.003	0.001	0.038	0.005	0.010	0.003	0.001
Ajakaja Wel	0.121	0.143	0.039	0.003	0.001	0.043	0.005	0.010	0.003	0.001
Ibot-Irem Well	0.139	0.202	0.010	0.003	0.001	0.057	0.005	0.010	0.003	0.001
Dema Well	0.129	0.416	0.010	0.003	0.001	0.059	0.005	0.010	0.003	0.001

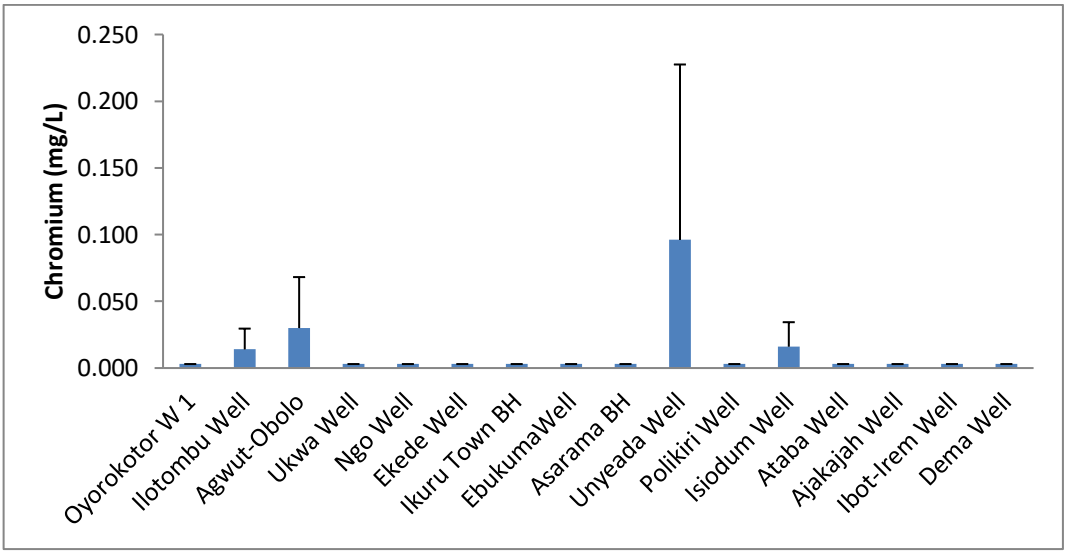

Fig. 4.2: Mean Chromium Levels

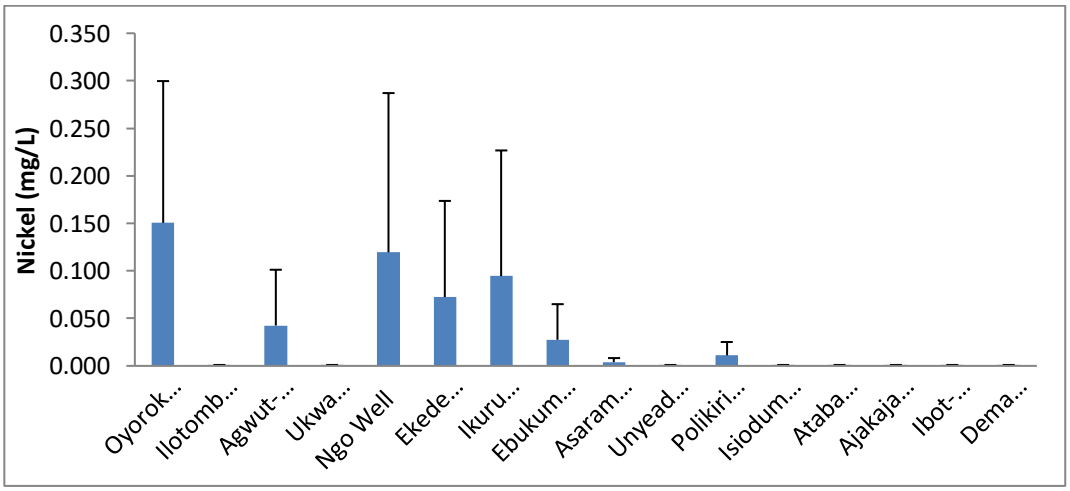

Fig. 4.3: Mean Nickel Levels

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

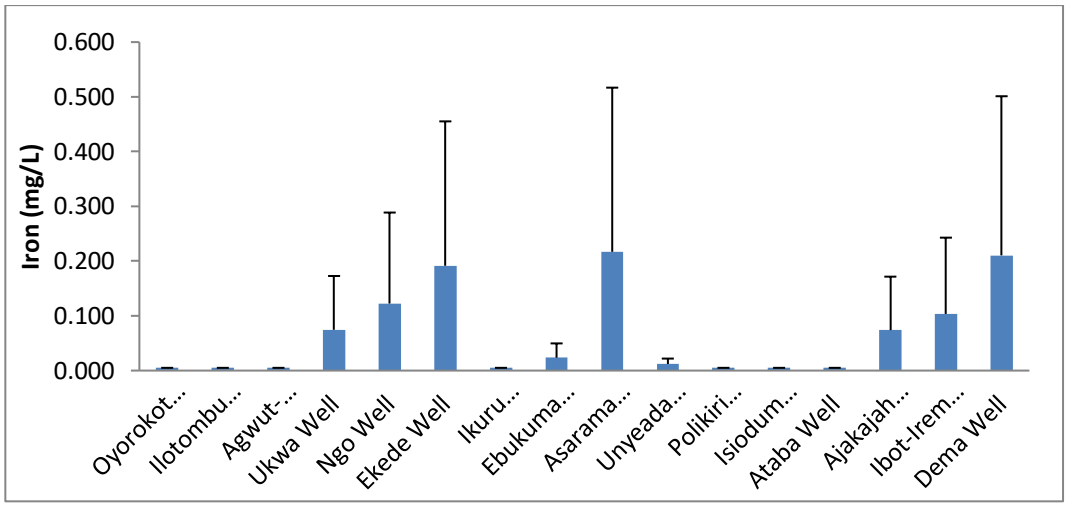

Fig. 4.4: Mean Iron Levels

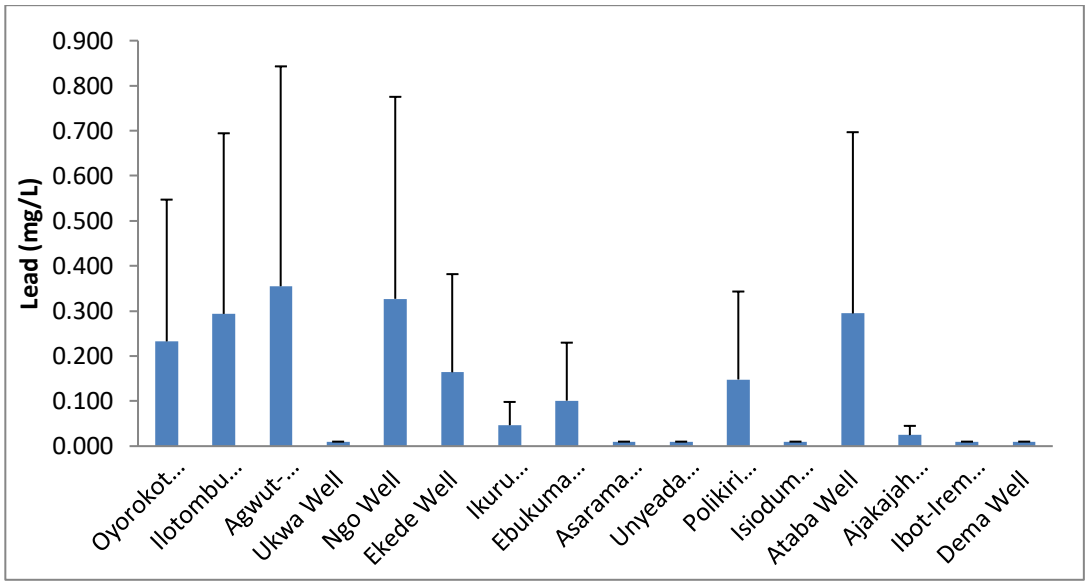

Fig. 4.5: Mean Lead Levels

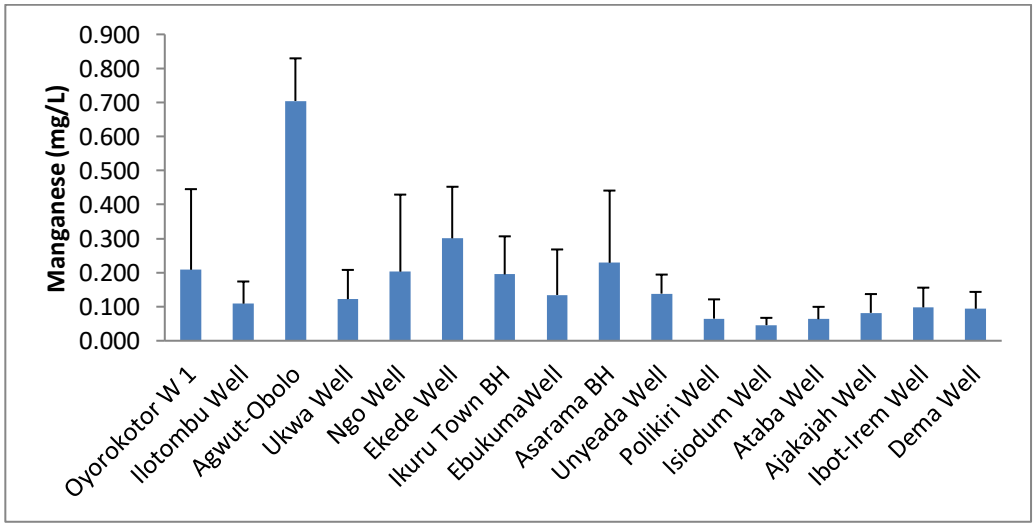

Fig. 4.6: Mean Manganese Levels

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

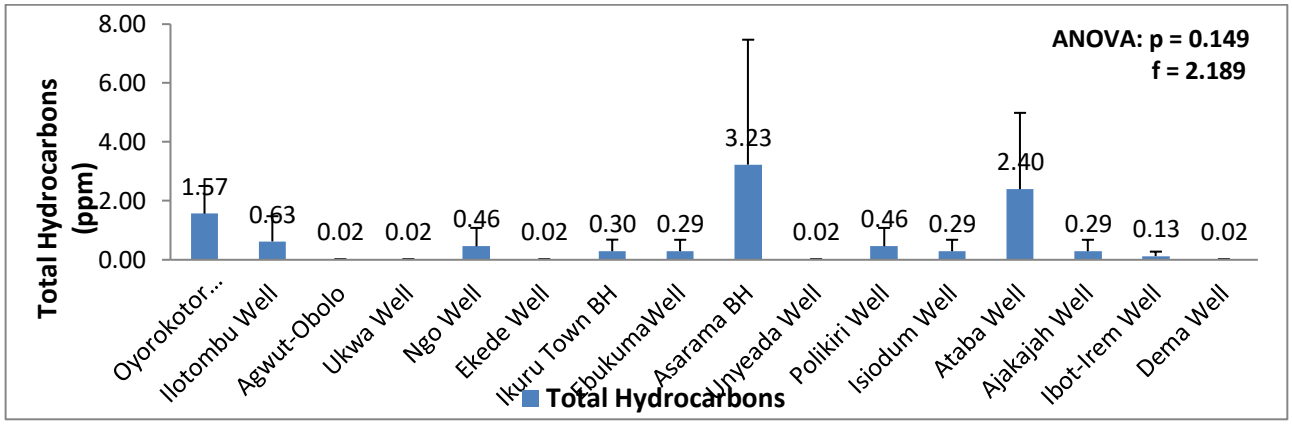

Fig. 4.7: Mean Total Hydrocarbon Levels

Polycyclic Aromatic Hydrocarbon (PAHs)

Results of the PAH analysis of the groundwater samples is shown in Table 4.2. The levels of the various PAH within detection limit are as follows;

Naphthalene levels ranged between 0.000 – 0.103 ppm; Acenaphthene levels ranged between 0.000 – 0.118 ppm; Acenaphthylene levels ranged between 0.000 – 0.028 ppm; Fluorene levels ranged between 0.000 – 0.028 ppm; Phenanthrene levels ranged between 0.000 – 0.016 ppm; Anthracene levels fell between 0.000 – 0.027 ppm; Fluoranthene levels fell between 0.000 – 0.023 ppm; Pyrene levels fell between 0.000 – 0.225 ppm; Benz(a)anthracene levels fell between 0.000 – 0.029 ppm; Chrysene levels fell between 0.000 – 0.097 ppm; Benzo(b)fluoranthene levels fell between 0.000 – 0.080 ppm; Benzo(k)fluoranthene levels fell between 0.000 – 0.016 ppm; Benzo(a)pyrene levels fell between 0.000 – 0.025 ppm; Indeno(1,2,3-c,d))pyrene levels fell between 0.000 – 0.087 ppm; Dibenz(a,h)anthracene levels fell between 0.000 – 0.034 ppm while Benzo{g,h,i)perylene levels fell between 0.000 – 0.014 ppm. Total PAH levels ranged between 0.01 and 0.648 ppm across all sampling stations.

Table 4.2: Levels of Polycyclic Aromatic Hydrocarbon

PAH COMPONENT (ppm)	Oyorokotor W 1	Illotombu W 1	Agwut-Obolo	Ukwa Well	Ngo Well	Ekede Well	Ikuru BH	Ebukuma	Asarama BH	Unyeada Well	Polokiri Well	Isiodum Well	Ataba Well	Ajakaja Well	Ibot-Irem Well	Dema Well	USEPA (2007) LIMIT
Napthalene	0.000	0.070	0.000	0.000	0.063	0.000	0.000	0.000	0.000	0.108	0.000	0.000	0.000	0.000	0.000	0.000	-
Acenapthene	0.118	0.103	0.000	0.004	0.092	0.006	0.018	0.103	0.024	0.007	0.000	0.003	0.000	0.000	0.000	0.000	**0.002**
Acenaphthylene	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.028	0.000	0.000	0.000	0.000	0.000	0.000	**0.002**
Fluorene	0.007	0.028	0.000	0.000	0.025	0.000	0.013	0.028	0.025	0.014	0.000	0.000	0.000	0.000	0.000	0.000	**0.1**
Phenanthrene	0.006	0.006	0.000	0.000	0.006	0.010	0.009	0.006	0.016	0.004	0.000	0.000	0.000	0.000	0.000	0.000	**0.1**
Anthracene	0.014	0.000	0.003	0.000	0.000	0.004	0.000	0.000	0.000	0.027	0.000	0.000	0.001	0.000	0.003	0.000	**0.005**
Fluoranthene	0.023	0.010	0.000	0.000	0.009	0.015	0.002	0.007	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.005**
Pyrene	0.225	0.000	0.000	0.000	0.000	0.000	0.021	0.030	0.140	0.016	0.000	0.000	0.000	0.000	0.000	0.000	**0.005**
Benz(a)anthracene	0.006	0.000	0.000	0.002	0.000	0.029	0.007	0.003	0.006	0.004	0.093	0.000	0.000	0.003	0.000	0.002	**0.0002**
Chrysene	0.097	0.000	0.000	0.000	0.000	0.012	0.008	0.016	0.000	0.049	0.000	0.000	0.000	0.000	0.000	0.000	**0.005**
Benzo(b)fluoranthene	0.080	0.003	0.000	0.000	0.003	0.003	0.045	0.006	0.000	0.015	0.014	0.000	0.000	0.000	0.000	0.000	**0.0002**
Benzo(k)fluoranthene	0.014	0.016	0.000	0.000	0.015	0.000	0.015	0.012	0.012	0.012	0.008	0.000	0.000	0.000	0.000	0.000	**0.0002**
Benzo(a)pyrene	0.021	0.006	0.003	0.000	0.005	0.000	0.000	0.025	0.000	0.004	0.009	0.000	0.000	0.001	0.000	0.000	**0.0002**
Indeno(1,2,3-c,d) pyrene	0.000	0.012	0.000	0.000	0.011	0.003	0.000	0.000	0.000	0.080	0.087	0.000	0.000	0.000	0.000	0.000	**0.0002**
Dibenz(a,h)anthracene	0.023	0.025	0.000	0.000	0.023	0.000	0.004	0.023	0.000	0.022	0.034	0.000	0.000	0.000	0.000	0.000	**0.0002**

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

Benzo{g,h,i)perylene	0.012	0.006	0.000	0.000	0.005	0.000	0.000	0.006	0.013	0.007	0.014	0.000	0.000	0.000	0.000	0.000	**0.0002**
Total PAHs	0.648	0.285	0.006	0.006	0.257	0.082	0.142	0.265	0.263	0.397	0.259	0.003	0.001	0.004	0.003	0.002	

DISCUSSION

Polycyclic Aromatic Hydrocarbons

Acenapthene levels were above the USEPA (2007) permissible limit of 0.002 ppm in Oyorokotor W 1, Illotombu W 1, Ukwa Well, Ngo Well, Ekede Well, Ikuru BH, Ebukuma, Asarama BH, Unyeada Well and Isiodum Well. Polokiri Well station recorded level below the permissible limit while levels were undetected in other stations. Acenaphthylene levels were above the USEPA (2007) permissible limit of 0.002 ppm in Unyeada Well; other stations recorded acenaphthylene levels below the permissible limit. Fluorene and Phenanthrene levels were below the USEPA (2007) permissible limit of 0.01 ppm across all stations. Anthracene levels were above the USEPA (2007) permissible limit of 0.005 ppm in Oyorokotor W 1 and Unyeada Well stations. Fluoranthene levels were above the USEPA (2007) permissible limit of 0.005 ppm in Oyorokotor W 1, Illotombu W1, Ngo Well, Ekede Well, Ebukuma and Asarama BH stations. Pyrene levels were above the USEPA (2007) permissible limit of 0.005 ppm in Oyorokotor W 1, Ikuru BH, Ebukuma, Asarama BH and Unyeada Well stations. Benz(a)anthracene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Oyorokotor W 1, Ukwa Well, Ekede Well, Ikuru BH, Ebukuma, Asarama BH, Unyeada Well, Polikiri Well, Ajakajah Well and Dema well. Chrycene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Oyorokotor W 1, Ekede Well, Ikuru BH, Ebukuma and Unyeada Well stations. Benzo(b)fluoranthene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Oyorokotor W 1, Illotombu W 1, Ngo Well, Ekede Well, Ikuru BH, Ebukuma, Unyeada Well and Polikiri Well stations. Benzo(k)fluoranthene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Oyorokotor W1, Illotombu W1, Ngo Well, , Ikuru BH, Asarama BH, Unyeada Well and Polikiri Well stations. Benzo(a)pyrene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Oyorokotor W1, Agwut-Obolo, Ngo Well, , Ekede Well, Polikiri Well and Ajakajah BH stations. Indeno(1,2,3-c,d) pyrene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Illotombu W1, Ngo Well, , Ekede Well and Polikiri Well stations. Dibenz(a,h)anthracene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Oyorokotor W1, Ngo Well, , Ikuru BH, Ebukuma, Unyeada Well and Polikiri Well stations. Benzo{g,h,i)perylene levels were significantly above the USEPA (2007) permissible limit of 0.0002 ppm in Illotombu W1, Ngo Well, Ebukuma, Ajakajah Well, Unyeada Well and Polikiri Well stations. The total PAH levels in all groundwater samples exceed the limit of 5.0×10^{-4} ppm as recommended by WHO (2007), and this poses serious environmental concerns as the consumers of the water from the sample area are liable to health risks due to bioaccumulation of these PAH compounds. The health effects of PAH compounds are not stereotyped; individual PAH compounds have different health effects (Rengarajan *et al.*, 2015). Many PAH compounds have mutagenic, carcinogenic, teratogenic, and immunotoxic effect on humans (Bolden *et al*., 2017). Some chronic health effects of these PAH compounds include eye cataracts, kidney and liver damages, breathing problems, decreased immune function, lung malfunctions, and asthma-like symptoms (Abdel-Shafy and Mansour, 2016). Naphthalene, if ingested or inhaled in high concentrations, can cause the breakdown of red blood cells (Rengarajan *et al*., 2015).

Total Hydrocarbon Content

The mean Total Hydrocarbon (THC) levels were below the recommended Department of Petroleum Resources limit intervention value of 600 µg/L (0.6 ppm) for groundwater (DPR, 2002); except for stations Oyorokoto W1, Asarama BH and Ataba Well, which had levels above the recommended limit. Some THC compounds are carcinogenic to humans (ATSDR, 1995).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

Heavy Metals

The permissible limit for chromium in drinking water is 0.05 mg/L as set by NSDWQ (2015) and WHO (1996). Only Unyeada Well 2 had groundwater with mean chromium levels of above the acceptable limit. A study by Tukura *et al* (2014) recorded high Chromium concentrations in 52 borehole water sources from twelve local governments in Nasarawa State and attributed it to surface contamination originating from anthropogenic and geological sources. Excess chromium ions in water may have an erythropoietin impact, such as an expanded event of goiter among people and animals (Oyeku and Eludoyin, 2010).

The NSDWQ (2015) set limit for nickel in drinking water is 0.02 mg/L. Oyorokotor W1 (0.151 mg/L), Agwut-Obolo (0.043 mg/L), Ngo Well (0.120 mg/L), Ekede Well (0.073 mg/L), Ikuru Town BH (0.095 mg/L) and Ebukama Well (0.028 mg/L) all had mean nickel levels above the acceptable limit. Victor and Fortune (2020) reported high nickel levels in a study carried out at Rumuola. Nickel may be present in groundwater as a consequence of dissolution from nickel ore-bearing rocks, influenced by high acidity (low pH) of the water (WHO, 2005).

The permissible limit for iron in drinking water is 0.30 mg/L as set by NSDWQ (2015) and USEPA (2004). All stations recorded mean iron levels below the permissible limit. Uzoije *et al* (2014), in a similar study at Buguma, reported higher iron levels in most of the sample areas in the range of 1.07 – 4.64 mg/L. Ugbaja and Otokunefor (2015) reported iron concentration levels below the permissible limits in Aluu, Rumuosi and Rumuekini Communities in Obio-Akpor. Biologically iron is the most important nutrient for most living creatures as it is the cofactor for many vital proteins and enzymes (Jaishankar *et al*, 2014). Water containing an excessive concentration of iron has been reported to constitute a human health hazard leading to hemochromatosis, whose signs include fatigue and eventually, heart disease, liver complications, and diabetes (Nwachukwu *et al*, 2014). Children are highly susceptible to iron toxicity as they are exposed to a maximum of iron containing products (Albretsen, 2006).

The NSDWQ (2015) and WHO (1996) set limit for lead in drinking water is 0.02 mg/L. Oyorokotor W1 (0.233 mg/L), Ilotombu Well (0.294 mg/L), Agwut-Obolo (0.355 mg/L), Ngo Well (0.327 mg/L), Ekede Well (0.164 mg/L), Ikuru Town BH (0.047 mg/L), Polikiri Well (0.148 mg/L), Ataba Well (0.295 mg/L) and Ajakajah Well (0.025 mg/L) all had mean nickel levels above the acceptable limit. Other stations recorded higher mean lead levels below the permissible limit. Lead causes damages to the nervous connection most especially in young children and also cause blood and brain disorder (Elinge *et al*., 2011). Lead in drinking water could have significant medical effects on renal functions (Alasia *et al*., 2009). Other symptoms of acute lead poisoning are headache, irritability, and abdominal pain (Jarup, 2003).

The permissible limit for manganese in drinking water is 0.2 mg/L as set by NSDWQ (2015) respectively. All stations had mean manganese levels below the set limits except those at Agwut-Obolo (0.705 mg/L) and Ekede Well (o.301) stations. Uzoije *et al* (2014), in a similar study at Buguma, reported similar manganese levels in most of the sample areas in the range of 0.001 – 0.12 mg/L, with only two sample stations having high levels of 0.079 and 0.12 mg/L. Studies have linked excessive manganese to the human kidney, liver, and pancreas diseases and also causes of neurological disorders (Longe and Balogun, 2010).

In general, the level of the pollutants observed in this study are attributed to fishing and artisanal crude oil activities, as well as ground water flow from the surrounding River.

CONCLUSION

Results from the assessment of groundwater from the study area found levels of total hydrocarbons content (THC) to be above permissible limits in some stations. Some stations recorded high levels of lead and

nickel, above permissible limits. The Polycyclic Aromatic Hydrocarbon levels were above permissible limits. The study recommends that groundwater in the study area should be properly treated before consumption to avoid health risks that could result from its prolonged use. Also there is need for regular monitoring of the groundwater and public enlightenment of the inhabitants on the status of their drinking water source.

REFERENCES

1. Abdel-Shafy, H. I., and Mansour, M. S. (2016). A review on polycyclic aromatic hydrocarbons: source, environmental impact, effect on human health and remediation. *Egyptian Journal of Petrochemicals* 25: 107–123.
2. Akinbile, C. O. (2012). Environmental Impact of Landfill on Groundwater Quality and Agricultural Soils in Nigeria. *Soil & Water Resources, 7(1): 18—266.*
3. Alasia, D., Wokoma, F., and Iyagba, A. (2009). Abstracts from the world congress of nephrology, Milan, Italy. *NDT Plus, (2),* 1733.
4. Albretsen, J. (2006). The toxicity of iron, an essential element. *Veterinary Medicine,* 82–90.
5. ATSDR (Agency for Toxic Substances and Disease Registry). (1999b). *Toxicological Profile for Lead.* US Department of Health and Human Services, Public Health Service.
6. Arumugam, K., Elangovan, K. (2009). Hydrochemical Characteristic and groundwater quality in Tirupur region, Coimbatore district, Tamil Nadu, India. *Environ. Geol*. 58, 1509-1520.
7. Bolden, A. L., Rochester, J. R., Schultz, K., and Kwiatkowski, C. F. (2017). Polycyclic aromatic hydrocarbons and female reproductive health: a scoping review. *Reproductive Toxicology* 73: 61–74.
8. Christensen T.H.; Kjeldsen, P.; Bjerg, P.L.; Jensen, D.L.; Christensen, J.B. and Baun, A. (2001). Biogeochemistry of landfill leachate plumes. *Applied Geochemistry, 16: 659–718.*
9. Cocchi, D. and Scagliarini, M. (2005). Modelling the Effect of Salinity on the Multivariate Distribution of Water Quality Index. *Journal of Mathematics and Statistics, 1(4): 268—272.*
10. DPR (Department of Petroleum Resources) (2002). *Environmental Guidelines and Standards for the Petroleum Industries in Nigeria (EGASPIN*). https://www.iea.org/policies/8676-environmental-guidelines-and-standards-for-the-petroleum-industry-in-nigeria-egaspin
11. Elinge, C. M., Itodo, A. U., Peni, I. J., Birnin-Yauri, U. A. and Mbongo, A. N. (2011). Assessment of heavy metals concentrations in borehole waters in Aliero Community of Kebbi State. *Advances in Applied Science Research,* 2, 279-282.
12. Fatta, D.A. and Loizidou, M. (1999). A study on the Landfill Leachate and its Impact on the Groundwater Quality of the Greater Area. *Environmental Geochemistry and Health, 21(2): 175—190.*
13. Fawell, J. (2007). Chemical contaminants of concern for drinking water. In: Lozan, J. L., H. Grassl, P. Hypfrer, L. Menzel and C. D. Sehonwiese. Global change: Enough water for all? *Wissenschaf, Cliché Auswertungen, Hamburg*. 122 – 125.
14. Guidelines for Canadian drinking water quality. (1992). Department of National Health and Welfare. [Supporting documentation].
15. Howard G, Calow R, MacDonald A, Bartram J (2009). Climate change and water and sanitation: likely impacts and emerging trends for action. *Annu Rev Environ Res.* 41:253–76
16. Hunter, P.R.; MacDonald, A.M. and Carter, R.C. (2010). Water Supply and Health. *PLoS Medical, 7(11).*
17. Ikem, A.; Osibanjo, O.; Sridhar, M.K.C. and Sobande, A. (2002). Evaluation of Groundwater Quality Characteristics Near Two Waste Sites in Ibadan and Lagos, Nigeria. *Water, Air and Soil Pollution, 140 (1-4): 307–333.*
18. Jaishankar, M., Mathew, B.B., Shah, M.S., Gowda, K.R.S. (2014). Biosorption of Few Heavy Metal Ions using Agricultural Wastes. *Journal of Environment Pollution and Human Health.* 2 (1): 1-6.
19. Jarup, L. (2003). Hazards of heavy metal contamination. *British Medical Bulletin*, 68, 167-182.
20. Lapworth D.J.; MacDonald, A.M.; Tijani, M.N.; Darling, W.G.; Gooddy, D.C.; Bonsor, H.C and Araguás-Araguás, L.J. (2013). Residence Times of Shallow Groundwater in West Africa:

Implications for Hydrogeology and Resilience to Future Changes in Climate. *Hydrogeology Journal, 21(3): 673–686.*

21. Lee G.F. and Jones-Lee, A. (1993). Groundwater Quality Protection: A Suggested Approach for Water Utilities. *Report to the CA/NV AWWA Section Source Water Quality Committee, Aug, 8.*
22. Longe, E. O. and Balogun, M. R. (2010). Groundwater quality assessment near a municipal landfill, Lagos, Nigeria. *Research Journal of Applied Science, Engineering and Technology, 2*(1), 39-44.
23. MacDonald A. M., Bonsor, H. C., O'Dochartaigh, B. E. O. and Taylor, R. G. (2012). Quantitative Maps of Groundwater Resources in Africa. *Environmental Resource Letter, 7.*
24. MacDonald, A. M., Bonsor, H. C., Calow, R. C., Taylor, R. G., Lapworth, D. J., Maurice, L., Tucker, J. O. and Dochartaigh, B. E. (2011). Groundwater Resilience to Climate Change in Africa. *British Geological Survey Open Report, OR/11/031, BGS, Keyworth, UK.*
25. NSDWQ (Nigerian Standard for Drinking Water Quality) (2015). Nigerian Industrial Standard, ICS.
26. Nwachukwu, R., Vitus, A., Janefrances, N. (2014). Health Risk Assessment in Relation to Heavy Metals in Water Sources in Rural Regions of South East, Nigeria. *Int. J. Phys. Sci*. 9 (6) 109 -116.
27. Nwankwoala, H. O. and Walter, I. O. (2012). Assessment of Groundwater Quality in Shallow Coastal Aquifers of Okrika Island, Eastern Niger Delta, Nigeria. *Ife Journal of Science 14, 2, 297 – 304.*
28. Nwankwoala, H. O., Nwowo, K. N. & Udom, G. J. (2020). Assessment of heavy metal status of groundwater in parts of Aba, southeastern Nigeria. *International Journal*, 4(11), *27-36*.
29. Ogbuagu, D H., Okoli, C.G., Gilbert, C.L., and Madu, S. (2017). Determination of the contamination of groundwater sources in Okrika main land with Polynuclear Aromatic Hydrocarbons (PAHs). British Journal of Environmental of Climate Change 1(3): 90-102 Sciencedomain international.www.sciencemain.org.
30. Oyeku, O. T. & Eludoyin, A. O. (2010). Heavy metal contamination of groundwater resources in a Nigerian urban settlement. *African Journal of Environmental Science and Technology, 4(4), 201-214.*
31. Rengarajan T., Rajendran P., Nandakumar N., Lokeshkumar B., Rajendran P., Nishigaki I. (2015). Exposure to polycyclic aromatic hydrocarbons with special focus on cancer. *Asian Pac. J. Trop. Biomed.* 5 182–189.
32. Saxena, U. and Saxena, S. (2013). Statistical Assessment of Groundwater Quality using Physico-chemical parameters in Bassi Tehsil of Jaipur District, Rajasthan, India. *Global Journal of Science Frontier Research, 13(3): 23—31.*
33. Tukura, M. I., Ayinya, G., Ibrahim, I. G. and Onche, E. U. (2014). Assessment of heavy metals in ground water from Nasarawa State, Middle Belt, Nigeria. *American Chemical Science rnal*, 4, 798-812.
34. Tyagi, P.D., Buddhi, R., Chaudhary, K. C. and Sawhney, R. L. (2002). Degradation of groundwater quality in industrial area in India, *Ind. J. Environment. Protect*, 20, 174–181.
35. Ugbaja, V. C. and Otokunefor, T. V. (2015). Bacteriological and physicochemical analysis of groundwater in selected communities in Obio-Akpor, Rivers State, Nigeria. *British Microbiology Research Journal, 7*(5), 235-242.
36. US EPA Risk Assessment Guidance for Superfund (RAGS) (2004). Human Health Evaluation Manual Vol. 1, [Internet]. Washington, D.C.: United States Environmental Protection Agency, Part E: Supplemental Guidance for Dermal Risk Assessment. Available from: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e.
37. USEPA (Environmental Protection Agency) (2007) The National Water Quality Inventory: Report to Congress for the 2002 Reporting Cycle—A Profile. United States Environmental Protection Agency. Washington DC, October. Fact Sheet No. EPA 841-F-07-003.
38. Uzoije, A. P., Onunkwo-A. A., Uche, C. C. and Ashiegbu, D. (2014). Evaluation of groundwater quality of coastal aquifer systems in Buguma City, Rivers State south-southern Nigerian.*Civil and Environmental Research, 6*(7), 31-38.
39. Victor, E. A. and Fortune, A. A. (2020). Geostatiscal modelling of groundwater quality at Rumuola Community, Port Harcourt, Nigeria. *Asian Journal of Environment and Ecology, 12*(1), 37-47.
40. Venkateswaran, S., Vijay Prabhu, M., Mohammed Rafi, M., Vallel, L.K. (2020). Assessment of

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

Groundwater Quality for Irrigational use in Cumbum Valley, Madurai District, Tamil Nadu, India. *Nat. Environ. Pollut. Technol.* 10, 207-212.

41. WHO (World Health Organization) (2005). Guidelines for Drinking-water Quality, World Health Organization, Geneva.
42. WHO (World Health Organization) (WHO) (1996). Guidelines for Drinking-Water Quality – Second Edition – 2 – Health Criteria and Other Supporting Information. WHO, Geneva, Switzerland.