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Organic and Heavy Metal Assessment of Groundwater Sources Around Nigeria National Petroleum Cooperation Oil Depot Aba, South-Eastern Nigeria

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Abstract
Organic and heavy metal assessment of groundwater sources around Nigeria National Petroleum Cooperation (NNPC) oil depot Aba, South-Eastern Nigeria has been done to assess the concentration and spatial distribution of pollutants in the available water sources, since groundwater is the principal source of drinking water in the study area. Fifty eight (58) water samples were collected within the study area, and were subjected to chemical analyses. The result of the analyses revealed that Arsenic conc. (mg/l) ranged between 0-1.35, Copper concentration (mg/l) ranged between 0 - 0.95. Iron concentration (mg/l) ranged between 0-0.09, Mercury concentration (mg/l) ranged between 0-0.014 while Lead concentration (mg/l) ranged between 0-0.4, Benzene concentration (mg/l) ranged between 0-0.5 Ethlybenzene concentration (mg/l) ranged between 0-1.3, Toluene concentration (mg/l) ranged between 0-0.66, Xylene concentration (mg/l) ranged between 0-0.32. This study therefore, recommends among others that Since the study indicated that the sources of organic and inorganic pollutants were not restricted to NNPC depot alone, routine monitoring of abandoned underground petroleum tanks, and other petroleum related anthropogenic activities in the area is strongly advocated.
Keywords: BTEX, Heavy Metal, NNPC Oil depot, Aba, Groundwater

1. INTRODUCTION

Groundwater is one of earth's most vital renewable and widely distributed resources, as well as an important source of water supply throughout the world. According to Sodde and Barrocu, (2005) groundwater accounts for about 98% of the world's fresh water and it is fairly well distributed throughout the world. About two billion people (approximately one- third of the world's population) depend on groundwater supplies, withdrawing about 20% of global water (600 – 700km^3) annually, much of which is from shallow aquifers (Foster *et al.,* 2005).

Mitra and Roy (2011) noted that pollution of groundwater by heavy metals (including; zinc, copper, chromium, nickel, cadmium, lead and mercury) could come from several sources, such as industrial discharges from chemical and metallurgic factories, or leakage from landfills. They stressed that groundwater pollution can result in poor drinking water quality, loss of water supply, high clean-up costs, high costs for alternative water supplies, and/or potential health problems (Akakuru et al., 2015). A wide variety of materials have been identified as pollutants in groundwater, these include synthetic organic chemicals, hydrocarbons, inorganic cations, inorganic anions, and radionuclides (Fetter, 2005).

Crude oil, when refined, contains a wide range of components such as hydrocarbons, heavy metals, dye additives, antioxidants, and corrosion inhibitors (Akporido, 2008). The refined products show higher toxicity compared to crude oil since metal speciation is altered and new metals added to the matrix during the refining processes (Uzoekwe and Oghosanine, 2011). Oil spillage constitutes an important source of pollution in oil producing areas of the world, especially in developing countries like Nigeria. An oil spill involves the release of a liquid petroleum hydrocarbon into the environment due to human activities.

The Nigeria National Petroleum Cooperation (NNPC) depot that supplies refined petroleum products to consumers in Abia State and other South-eastern States of Nigeria is located at Umuakpara in Osisioma Ngwa Local Government Area of Abia State. The presence of the depot in this area is a potential threat to the environment (including soil and groundwater sources). These threats come from leakages and spills associated with loading and offloading of petroleum products in these depots as well as washing of oil storage tanks has adversely impact the environment (Ogoko, 2014).

1.1 Location of the Study Area

The study area comprises parts of Osisioma Ngwa, Isiala Ngwa, Obio Ngwa, Aba North, Omumma LGAs (all in Abia State), Etche LGA (in Rivers State) and Ngor Okpala LGA (in Imo State). It lies between latitudes 5^{o}07^1 to 5^{o}15^{1}N, and longitudes 7^{o}14^1 to 7^{o}22^{1}E (Fig 1). It is densely populated, with an average population density of 3500 inhabitants per square kilometre (Adindu *et al.,* 2012). The people are predominately traders.

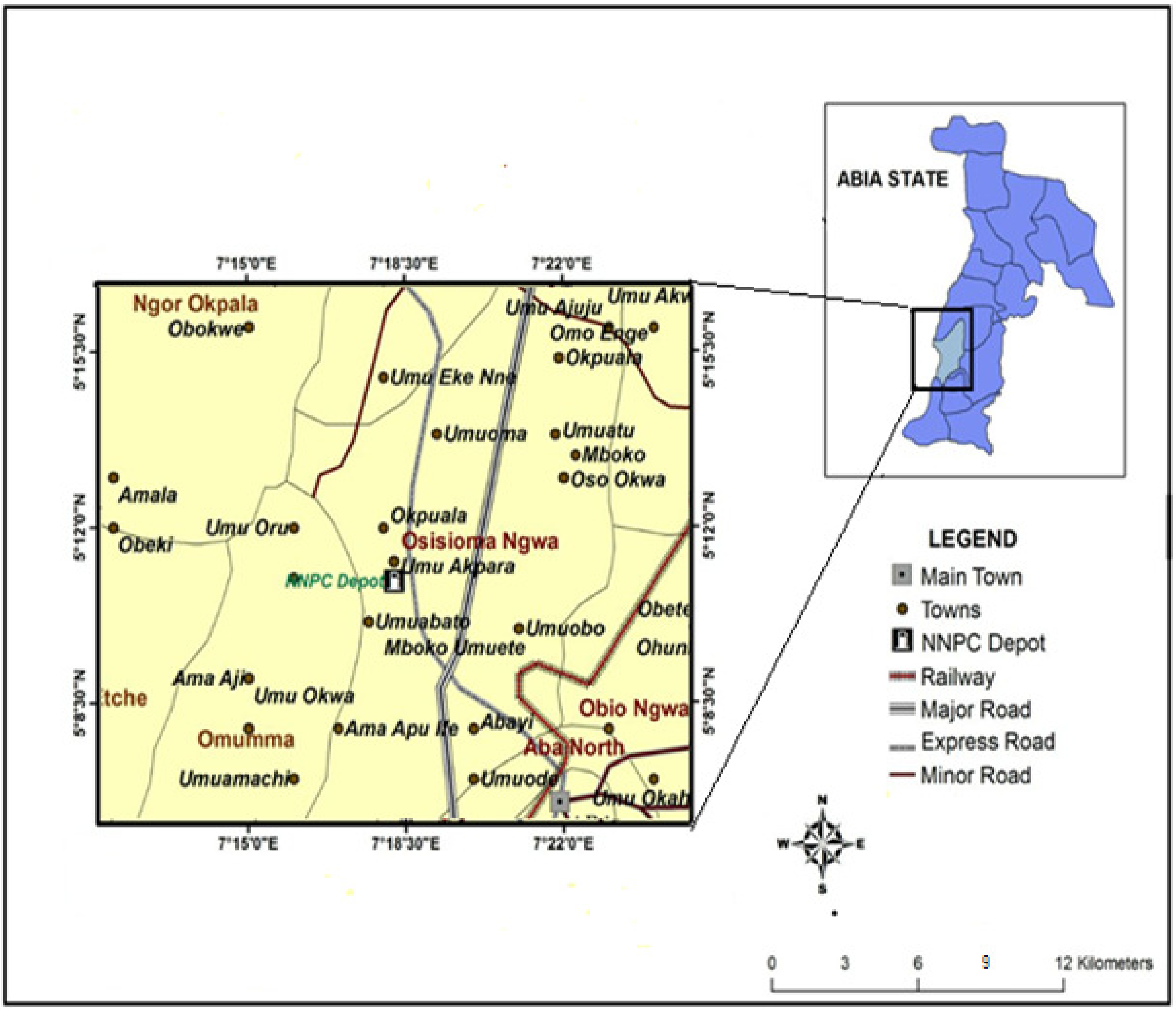

Fig 1: Location map of the study area

2.0 Methodology

Water sample collections were done in line with the guidelines of American Public Health Association (1995). To reduce the risk of sample contamination, all water samples were collected in fresh sample containers (polyethylene plastic cans), which were acid – washed to reduce the effect of interferences between containers and sample. This was done by washing each container with a detergent and rinsing with tap water; re-rinsing with 1:1 nitric acid solution; rinsing with deionized water and air-dried. Before collection, each container was rinsed with the sample to be collected. Samples were labelled and transported to the laboratory in ice-pack cooler kit, samples collected were analyzed within 24 hours of collection. Fifty eight (58) groundwater samples within the study area were collected. Water samples collected were subjected to chemical and Gas Chromatography (GC) analyses. Heavy metals analysed included: Arsenic, Copper, Iron, Mercury, and Lead. Organic pollutants analysed were: Benzene, Ethylbenzene, Toluene and Xylene (BTEX).

3.0 Results and Discussions

3.1 Arsenic concentration

Arsenic concentration (mg/l) ranges between 0-1.35 in the study area. Arsenic has not been demonstrated to be essential in humans. The acute toxicity of arsenic compounds in humans is predominantly a function of their rate of removal from the body. The presence of Arsenic concentration in the study are could be attributed to spillage from the petroleum product due to intense activities that takes place within the vicinity of the petroleum depot. Cheng (2016) observed that Arsenic has not been demonstrated to be essential in humans; the acute toxicity of Arsenic compounds in humans is predominantly a function of their rate of removal from the body. Fig. 2 shows the spatial distribution of Arsenic in the study area.

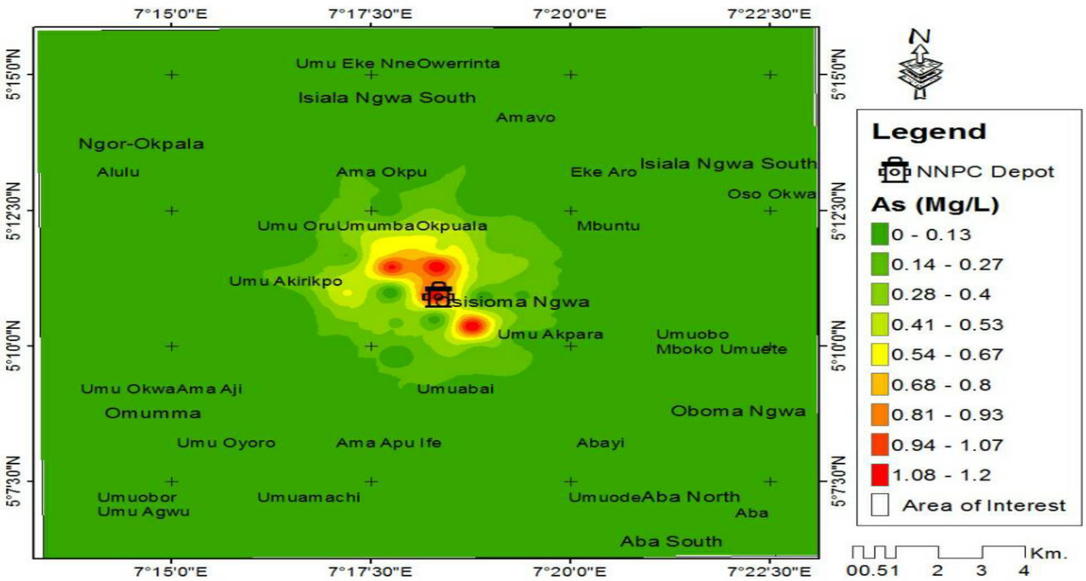

Fig. 2: Spatial distribution of Arsenic in the study area

3.2 Copper concentration

Copper concentration (mg/l) ranges between 0 - 0. 95 in the study area. The presence of Cu in most of the samples in the study area could be as a result of various anthropogenic activities domiciled in the area, as these have constituted serious water quality problems which have resulted to environmental and health challenges in their host communities. Copper is both an essential nutrient and a drinking-water contaminant. It is used to make pipes, valves, and fittings and is present in alloys and coatings (Mitra and Roy, 2011).). Fig. 3 shows the spatial distribution of Copper in the study area.

Fig. 3: Spatial distribution of Copper in the study area

3.3 Mercury concentration

Mercury concentration (mg/l) ranges between 0-0.014 in the study area, The concentration values of Hg observed in most of the samples in the study area could be attributed to spillage from the petroleum product, due to intense activities that take place within the vicinity of the petroleum depot. These anthropogenic activities domiciled in the area have constituted serious water quality problems which have resulted to environmental and health challenges to the groundwater users. The toxic effects of inorganic mercury compounds are seen mainly in the kidney in both humans and laboratory animals following short-term and long-term exposure. In humans, acute oral poisoning results primarily in haemorrhagic gastritis and colitis; the ultimate damage is to the kidney

(Ogoko, 2014). Fig. 4 shows the spatial distribution of Mercury in the study area.

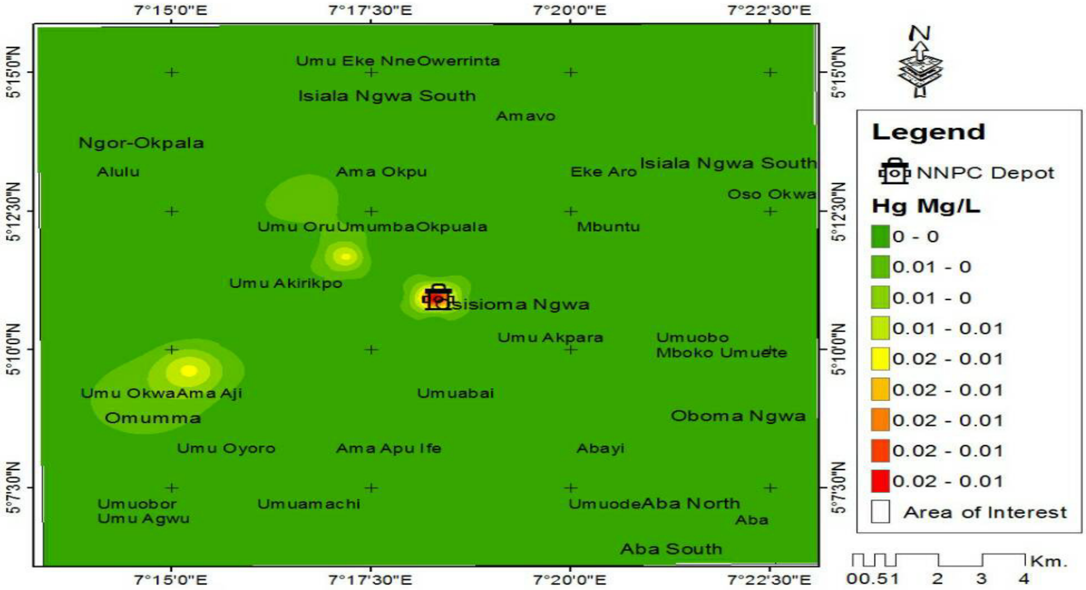

Fig. 4: Spatial distribution of Mercury in the study area

3.4 Lead concentration

Lead concentration (mg/l) ranges between 0-0.4 in the study area. The observation of Pb in the study area is not far-fetched since Pb are employed as an anti-knocking agent in petroleum products and other heavy metals are constituents of crude oil. The values of Pb in this study area calls for serious attention because elevated value of Pb result in kidney damage, impair skeletal and reproductive system, other health related problems while Pb at elevated level is known to affect intellectual performance in children, increase in blood pressure as well as impairment of cognitive development in adults problems (Adewuyi and Olowu. 2012)

. Fig. 5 shows the spatial distribution of Lead in the study area.

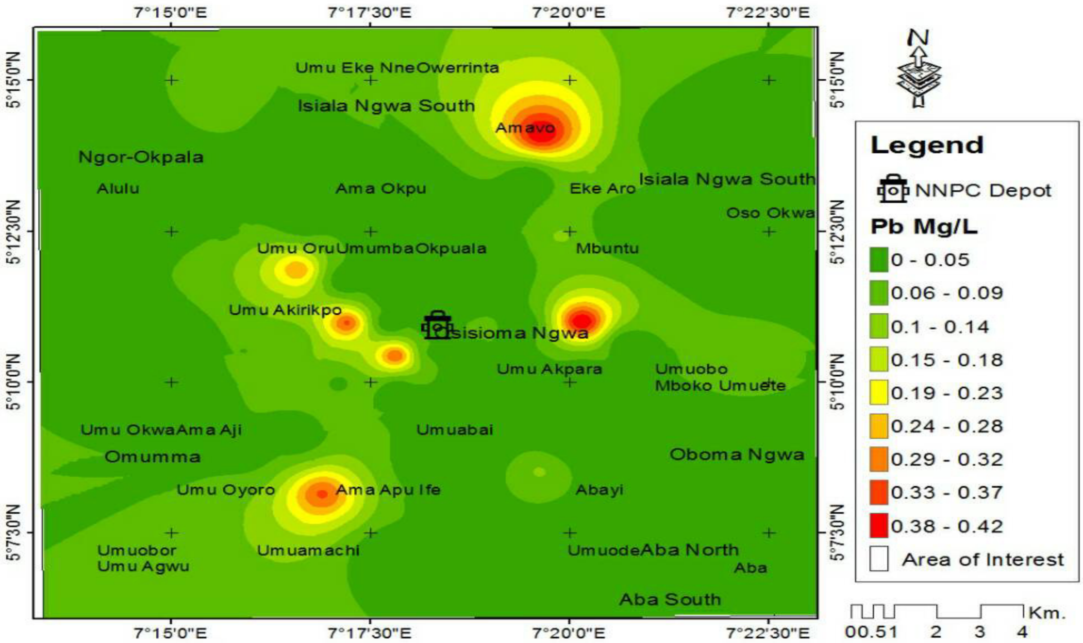

Fig. 5: Spatial distribution of Lead in the study area

3.5 Benzene concentration

Benzene concentration (mg/l) ranges between 0-0.5. The observed variation in Benzene values in the study area could be attributed to textural and physical nature of the soil. Equally, the hydrogeology of the area might as well account for the variation at different depths. Alinnor *et al.,* (2014) noted that as oil infiltrates into the soil, it has a considerable effect on the structure and wetting ability of soil. Also, surface runoff may probably form the major dispersing mechanism of organic pollutants. The more volatile or soluble hydrocarbons will be, the most susceptible it will be changed by volatilization, reaction, leaching or biodegradation. Fig. 6 shows the spatial distribution of Benzene in the study area.

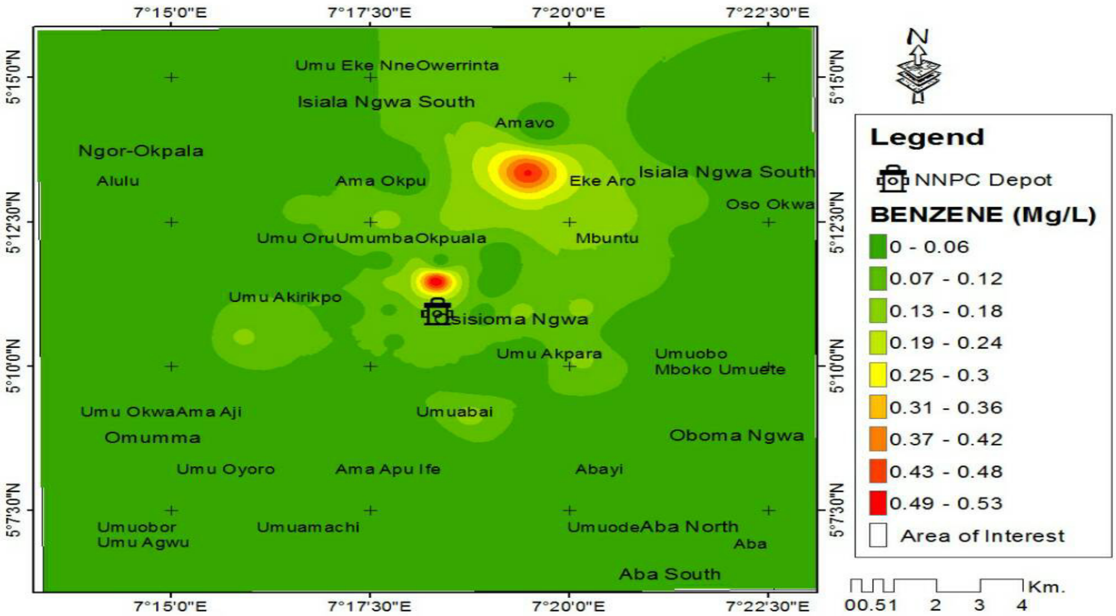

Fig. 6: Spatial distribution of Benzene in the study area

3.6 Toluene concentration

Toluene concentration (mg/l) ranges between 0-0.66 and 0–0.62, for wet and dry seasons respectively. Makaya, (2016) observed that most Toluene (in the form of benzene–toluene–ethylbenzene–xylene mixtures) are used in the blending of petrol. He maintained that Toluene is absorbed completely from the gastrointestinal tract and rapidly distributed in the body, with a preference for adipose tissue, excess exposure can lead to central nervous system impairment. Fig. 7 shows the spatial distribution of Toluene in the study area

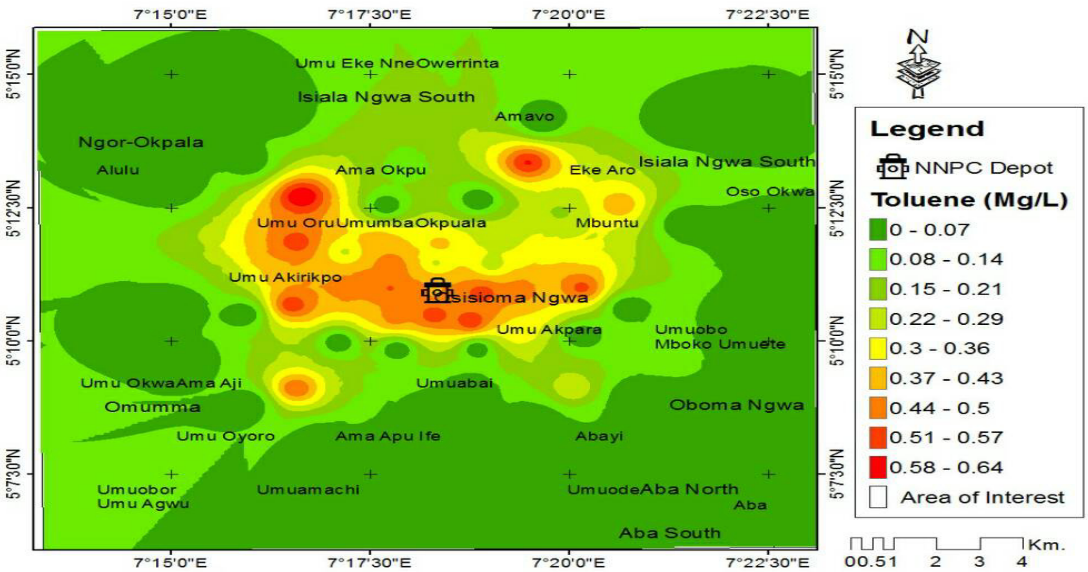

Fig. 7: Spatial distribution of Toluene in the study area

3.7 Ethlybenzene concentration

Ethlybenzene concentration (mg/l) ranges between 0-1.3. The major source of the ethylbenzene could be from tanks and pipelines, since the tanks and pipelines are subjected to structural failures such that subsequent leakage becomes a source of groundwater pollution. Petroleum and petroleum products are responsible for much of the pollution. Alinnor *et al.,* (2014) noted that Ethylbenzene is found in trace amounts in surface water, groundwater, drinking water and food, the primary sources are the petroleum industry and the use of petroleum products. Fig. 8 shows the spatial distribution of Ethlybenzene in the study area.

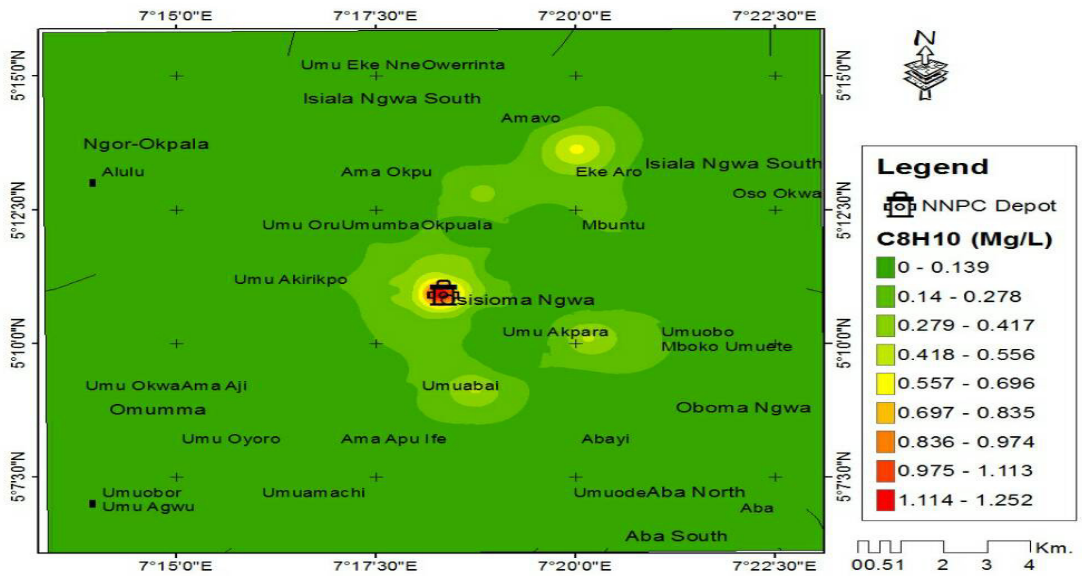

Fig. 8: Spatial distribution of Ethlybenzene in the study area

3.8 Xylene concentration

Xylene concentration (mg/l) ranges between 0-0.32. Xylenes are used in blending petrol, as a solvent and as a chemical intermediate. They are released to the environment largely via air. Exposure to xylene is mainly from air, and exposure is increased by smoking. Fig. 9 shows the spatial distribution of Xylene in the study area.

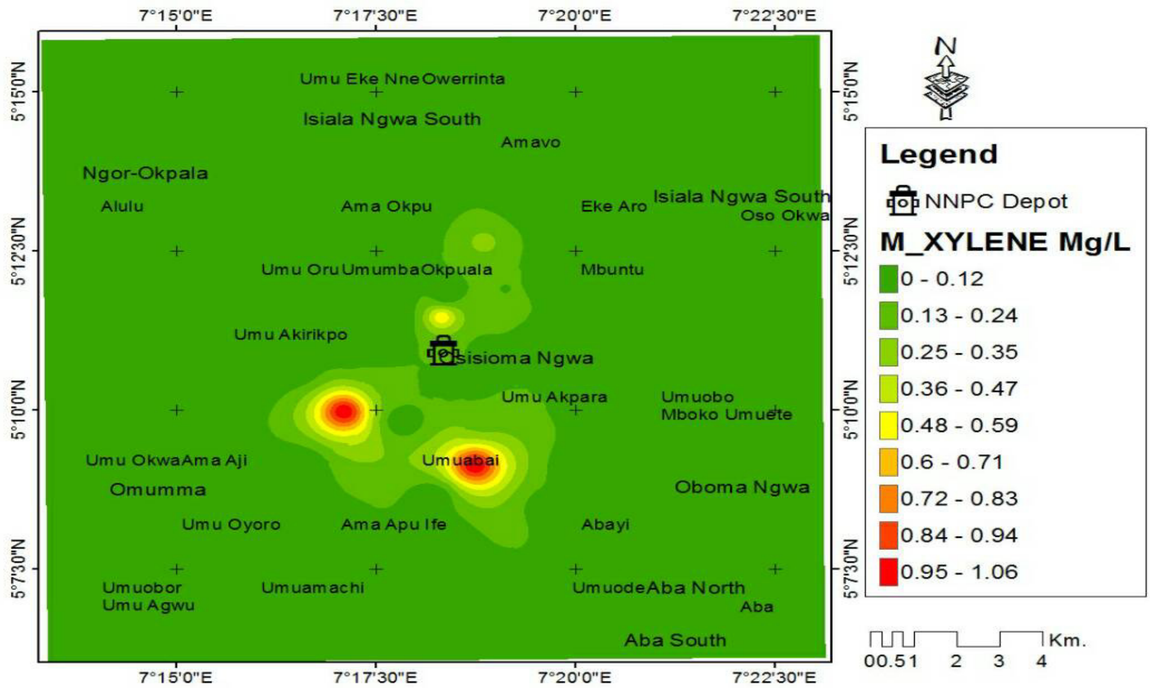

Fig. 9: Spatial distribution of Xylene in the study area

4.0 Conclusion and Recommendation

Organic and heavy metal assessment of groundwater sources around NNPC oil depot Aba, South-Eastern Nigeria has been done, the results of the investigation revealed certain attributes;

1. Arsenic, Copper, Mercury and Lead concentrations in the study area were above the WHO (2011) values, and require pre-use treatment before use, because of the associated health concerns. Ethlybenzene, Xylene, and Benzene were above the WHO (2011) standard. Toluene concentrations in the study area were within the WHO (2011) permissible limit, but it is not of health concern at levels it was found in drinking water. However, serious care should be taking because of the accumulative effect it may have on humans over time.
2. Most of the BTEX and heavy metals pollution were not principally from the NNPC oil depot, but are majorly from old petroleum storage tanks from petrol stations within the study area.
3. The activities in NNPC depot should be of environmental concern, as adverse effects arising from the heavy metals and BTEX cannot be over-emphasized. Hence, it is fundamentally important that standard environmental management and appropriate environmental regulations should be established and enforced within the vicinity of the depot.

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