

Levels of Polycyclic Aromatic Hydrocarbons and Total Hydrocarbon Contents in Boreholes Water from Some Communities in Obio-Akpor Local Government Area of Rivers State, Nigeria

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Abstract:- The study focused primarily on the assessment of Polycyclic Aromatic Hydrocarbons (PAHs) and Total Hydrocarbon content of groundwater in Obio-Akpor. Groundwater (boreholes) samples were randomly collected from 21 sampling locations in six different communities and Rivers State University in Obio-Akpor Local Government Area of Rivers State. Standard analytical techniques were employed in the investigation. The study showed that in all the 21 stations, Polycyclic Aromatic Hydrocarbons (PAHs) had concentrations below the SON (0.007ppm) limit. The study recommended regular monitoring of the water from the area.

Keywords:- Boreholes, Groundwater, Polycyclic Aromatic Hydrocarbons, Total Hydrocarbon Contents, Obio-Akpor, Nigeria.

I. INTRODUCTION

Groundwater (Boreholes or Well water) constitutes an important source of water for domestic supply and agriculture in Nigeria. The Sedimentary basins form the best Aquifers. An aquifer is a saturated rock formation, bed or group of formations, from which water can be readily abstracted in significant quantities. To be an aquifer, a geologic formation must contain pores or open spaces (interstices) that are filled with water. These interstices must be large enough and interconnected to transmit water towards wells at useful rate. (Ngah, 2018).

Groundwater is water contained in the subsurface of the earth in the pore spaces of the regolith; flowing within the aquifers of the water table. Ground water is abundant and constitutes 97% of the world fresh water sources while fresh surface water supply provides the rest 3%. In shallow groundwater evaluation, the quality and quantity is of utmost importance; hence beyond the physical aesthetics of water, the physicochemical and bacteriological characteristics must be amenable to its domestic, industrial and agricultural utilization. Ground water quantity and quality in shallow aquifers is an indication of the interaction between anthropogenic activities and interconnection

between surface water; ground water movement, flow and storage; type of aquifer and its hydrological characteristics. The extent and seriousness of ground water quality degradation depend largely on the geohydrology setting, nature of contaminants, climate of the area and the interplay of physico-chemical processes that operate in the subsurface environment (Ngah and Abam, 2016).

Two billion people globally lack access to safely managed drinking water at home and only 1.2 billion people have basic drinking water service.(WHO and UNICEF progress report on house hold drinking water, sanitation and hygiene 2000-2020; Geneva, 2021). Groundwater alone constitutes 97% of the world fresh water; hence conducting groundwater quality assessment to ascertain the suitability of the groundwater is only imperative and requisite for adequate advocacy.

Water borne diseases are increasing by the day due to inadequacy of potable water sources in developing countries and these crises has forced people to resort to boreholes for drinking water sources (Agbaire and Obi, 2009). Water quality assessment therefore focuses on solving problems caused by conflicts between the various demands placed on water resources, particularly in relation to their ability to assimilate pollution (WHO, 2006). In Nigeria, access to safe drinking water has become a cause for concern. The United Nations household definition of access to basic safe water is consumption capacity of 100litres, 80litres and 50litres per capita for Urban, Small Town and Rural within a maximum 30mins round trip. According to Oluwasanya (2009), low access to safe water in Nigeria has influenced socio-economic development, planning, industrial growth and all these due to haphazard implementation and insufficient funding.

The assessment of the suitability of water for domestic, agricultural, and industrial purposes is of great concern all over the globe (Akakuru et al., 2021a, 2021b, Eyankware et al., 2021, Urom et al., 2021). Monitoring and assessing groundwater quality is of high priority for insuring good health (Eyankware et al., 2020; Mohamed et al., 2021; Obasi et al., 2020).

II. MATERIALS AND METHODS

➤ Description of Study Area

The study area is Obio-Akpor Local Government Area in Rivers State in the Niger Delta region of Nigeria. Niger Delta is in the Southern part of Nigeria with a total land area of 29,000km² excluding the continental shelf (NDES, 1997).

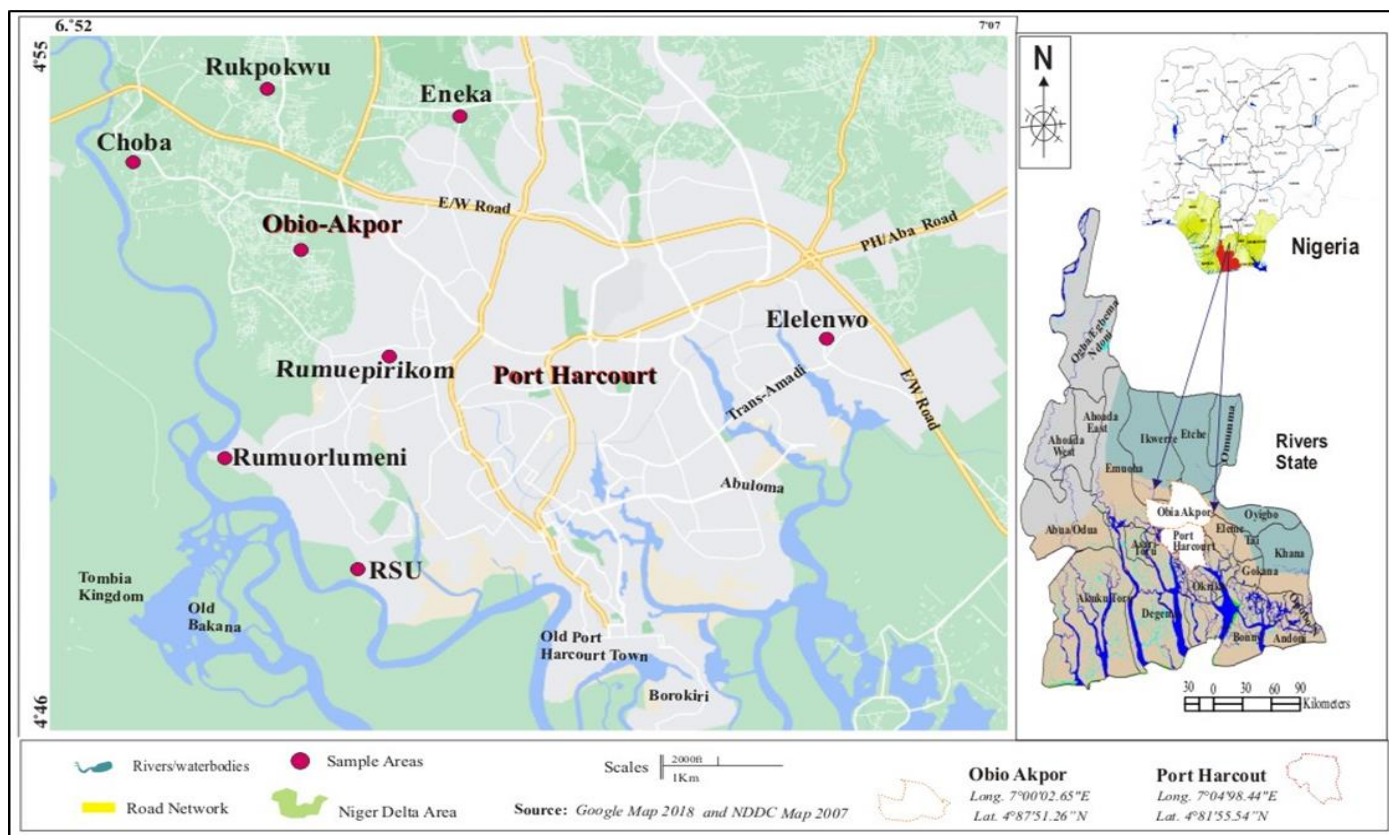


Fig 1 Map Showing Sampling Locations in Study Areas

➤ Collection of Samples

The Twentyone (21) ground water samples were collected from twenty-one (21) existing shallow boreholes in seven (7) communities of Obio-Akpor Local Government Area using sterilized containers; glass bottles for Poly Aromatic Hydrocarbons (PAHs) and Total Hydrocarbon Content (THC). The containers were rinsed severally with the borehole water to be collected before collection and ensuring air free sampling especially for the microbiology container. The containers were labeled and each borehole parameters in terms of location, coordinates, depths, static water level etc. will be recorded. Standard methods were adopted for field and laboratory studies (APHA, 1998). The coordinates of the boreholes were determined using Global Positioning System (GPS) tools.

➤ Total Hydrocarbons Content (THC)

Exactly 250ml of sample was measured into a separating funnel and 25ml of hexane added as extractant. Thorough shaking of the mixture was done to enhance extraction efficiency. The organic extract was collected into a receiving sample vial after passing it through a glass filter funnel packed with cotton wool and anhydrous Sodium Sulphate (Na₂SO₄); to aid the dehydration of excess moisture which may escape with the organic extract of interest in the process of eluting the organic phase from the

aqueous phase in the separating funnel. 10ml of the organic extract was transferred into a 10ml sample curvet and placed in the sample cell holder compartment of a HACH DR 890 colorimeter and concentration of THC was read. A blank of hexane was used to zero the instrument.

➤ Polycyclic Aromatic Hydrocarbons (PAHs)

Exactly 250ml of sample water was measured into a separating funnel, the sample container was rinsed with Dichloromethane, 250ml of Dichloromethane was added to 250ml part of the water sample and shaken thoroughly to achieve good extraction with the organic solvent. The organic extract was collected into a receiving container (vial), passing the organic extract through a column container cotton wool, silica-gel and anhydrous sodium sulphate. The Silica-gel aided the cleaning of the extract while the anhydrous sodium sulphate acted as a dehydrating agent to rid the extract of every form of moisture. The collected organic extract was injected into a Gas Chromatograph. 1µl of the concentrated sample extract was injected by means of a hypodermic syringe through a rubber septum into the column. The various fractions of the aromatic compounds was automatically detected as it emerged from the Flame Ionization Detector (FID) whose response is dependent upon the composition of the vapour.

III. RESULTS

➤ The Results Obtained in this Study are Presented in Figs. 2 – 9.

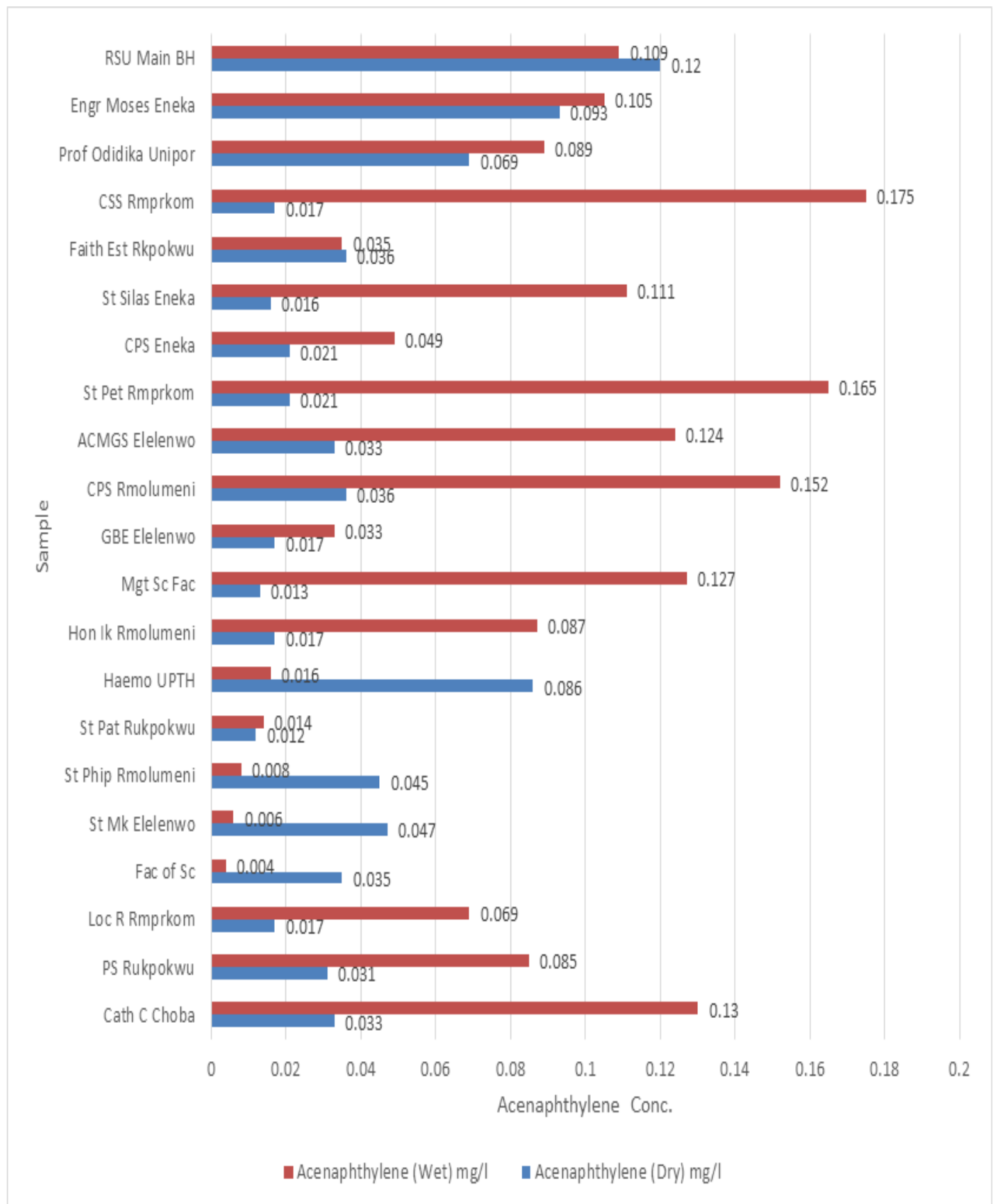


Fig 2 Spatial Distribution of Acenaphthylenein Borehole

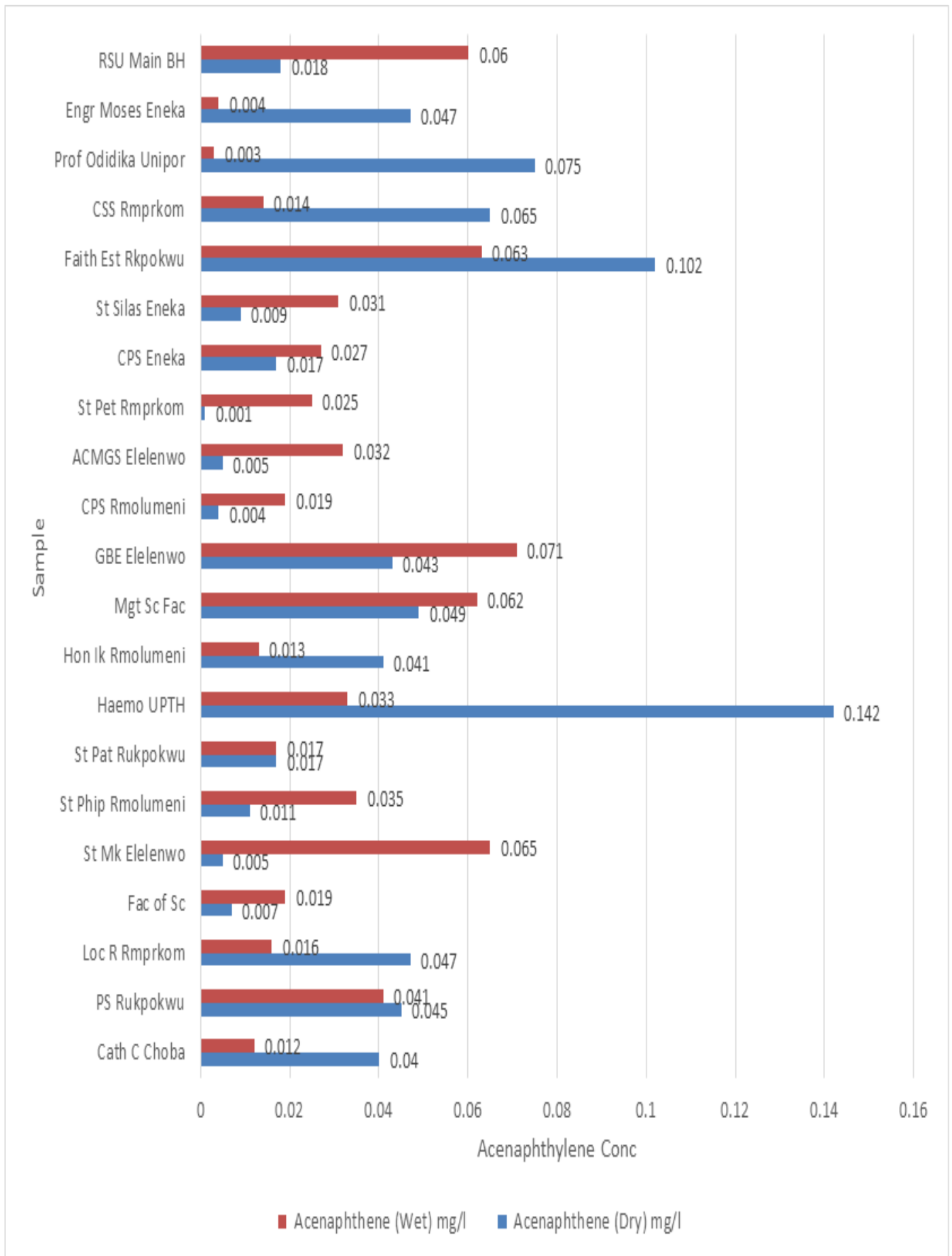


Fig 3 Spatial Distribution of Acenaphthene in Borehole

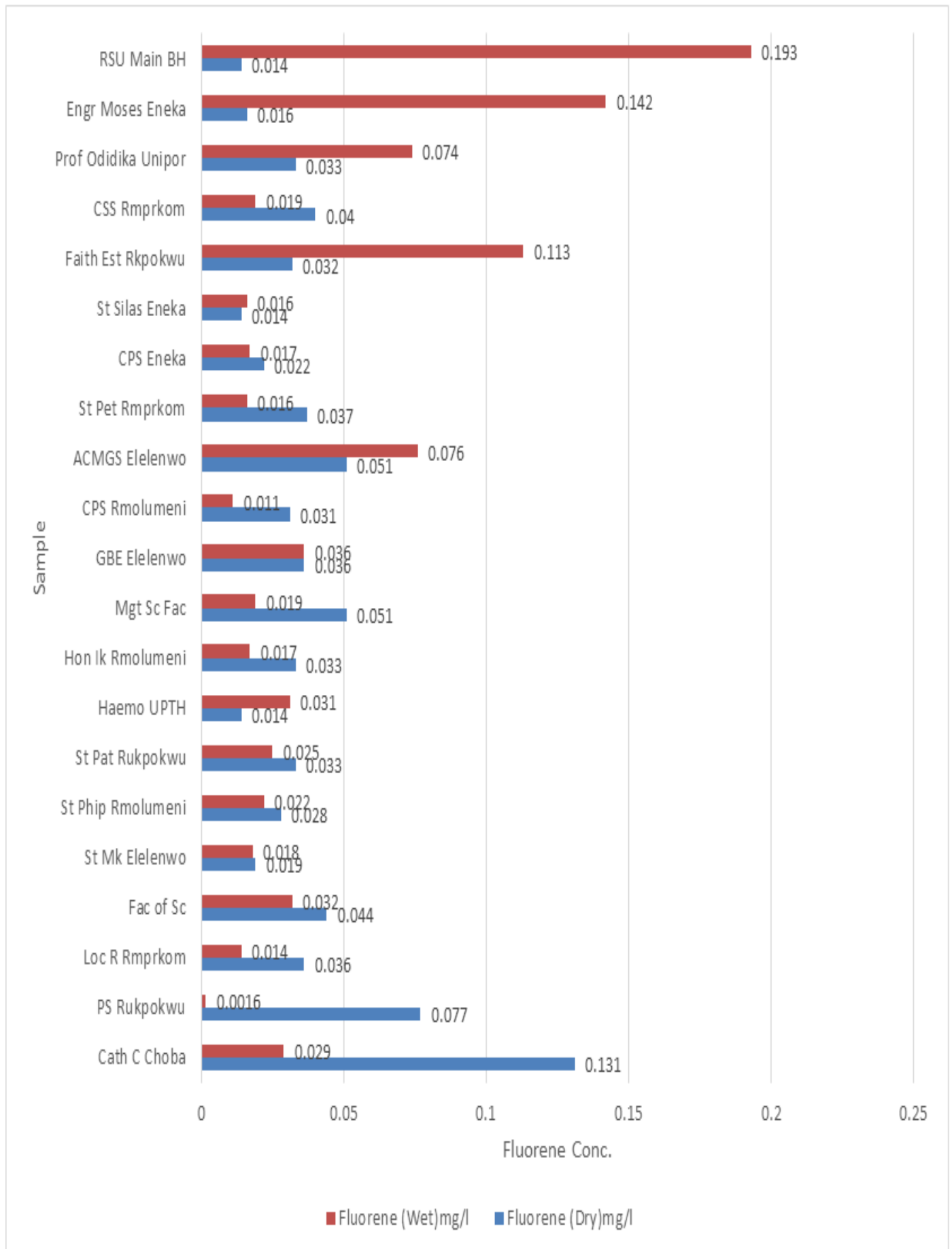


Fig 4 Spatial Distribution of Fluorine Borehole

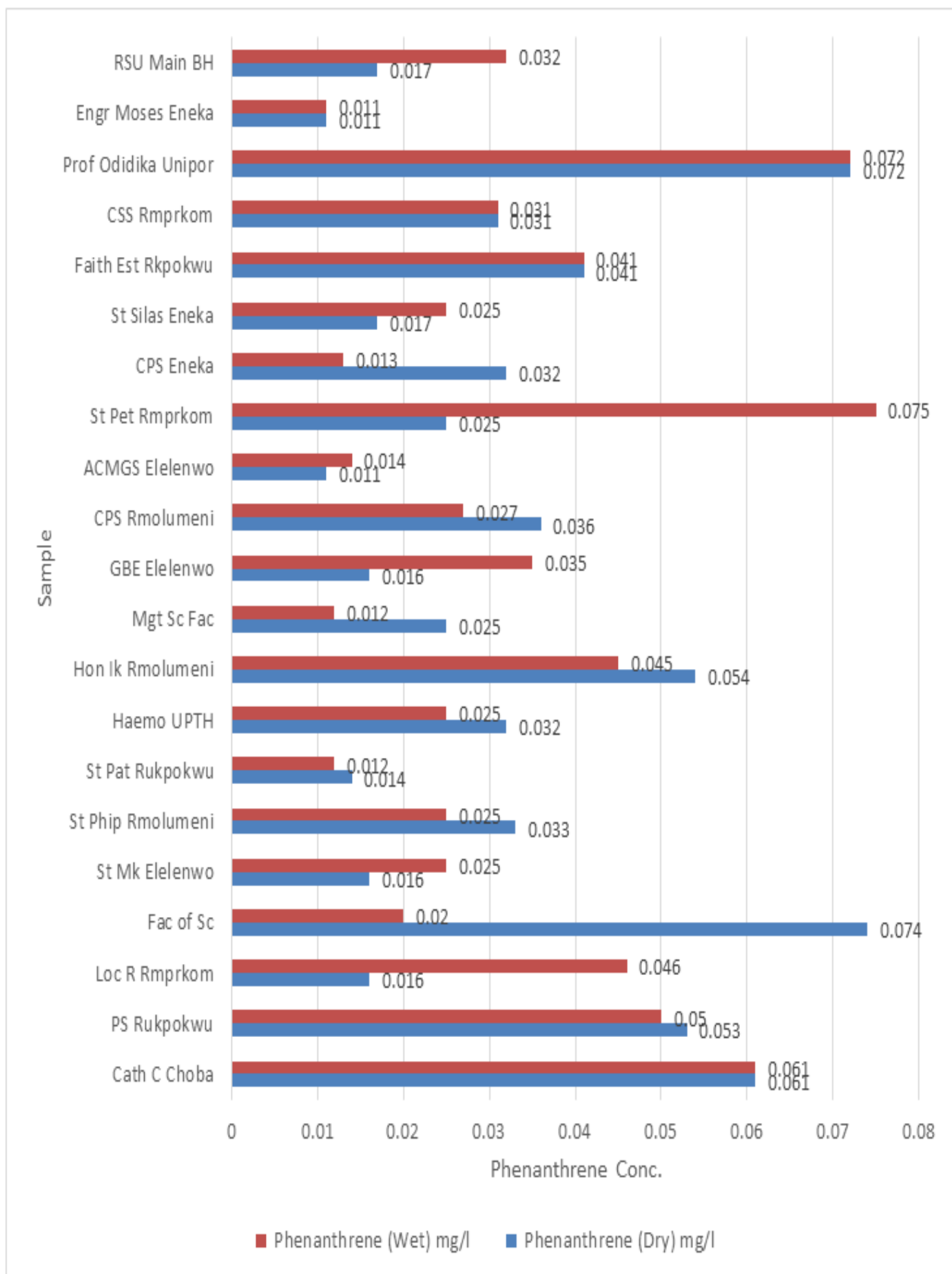


Fig 5 Spatial Distribution of Phenanthrene in Borehole

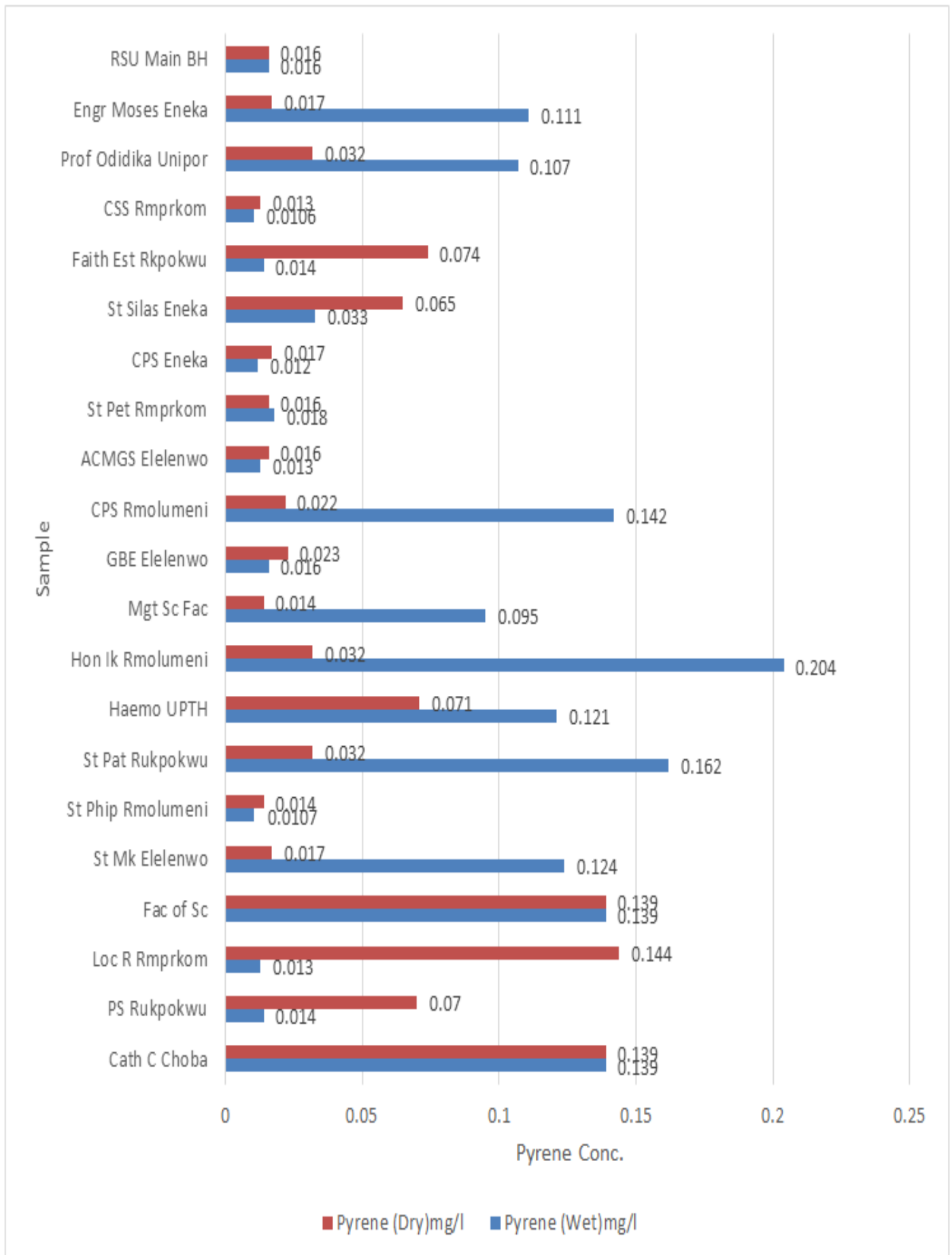


Fig 6 Spatial Distribution of Pyrene in Borehole

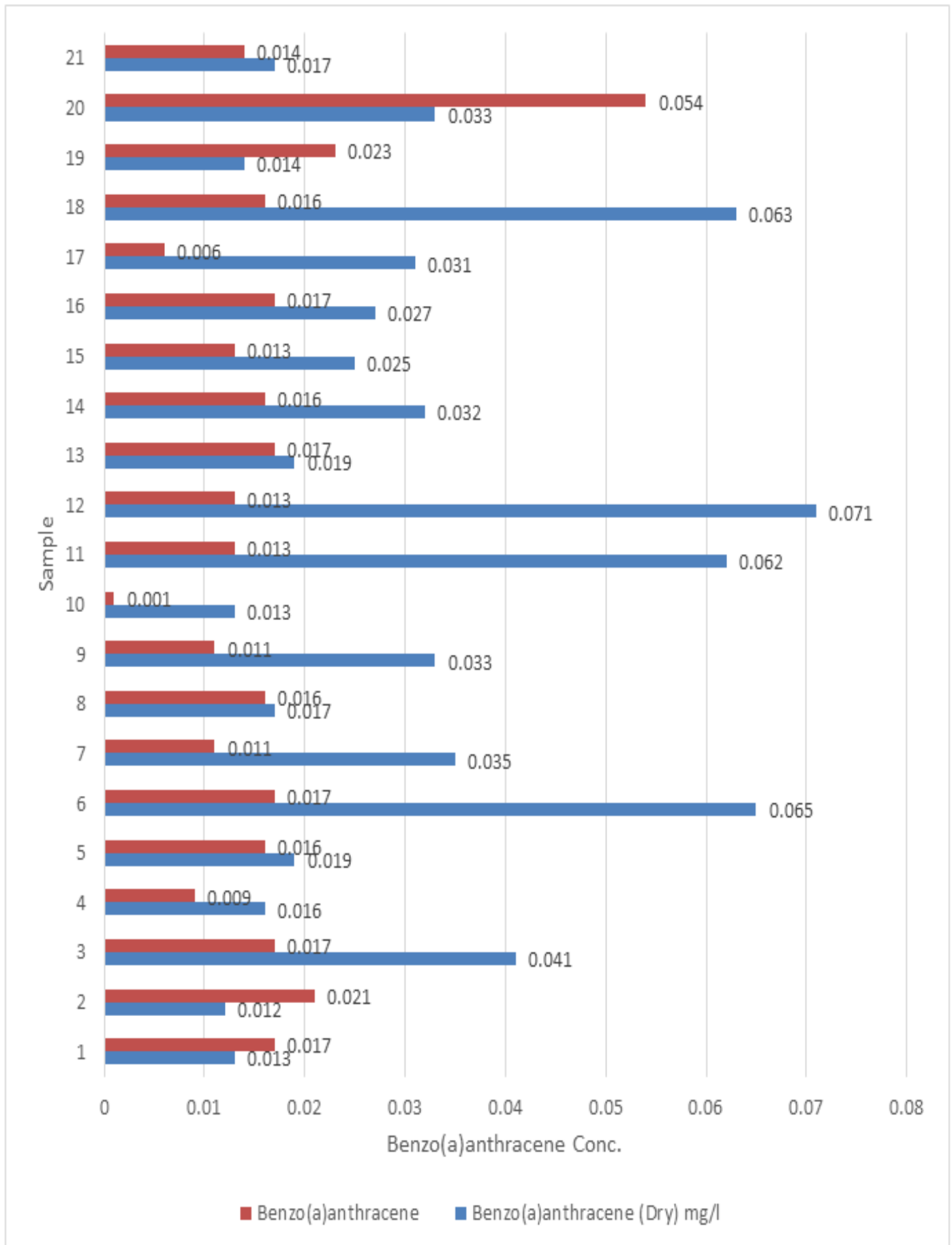


Fig 7 Spatial Distribution of Benzo(a)anthracene in Borehole

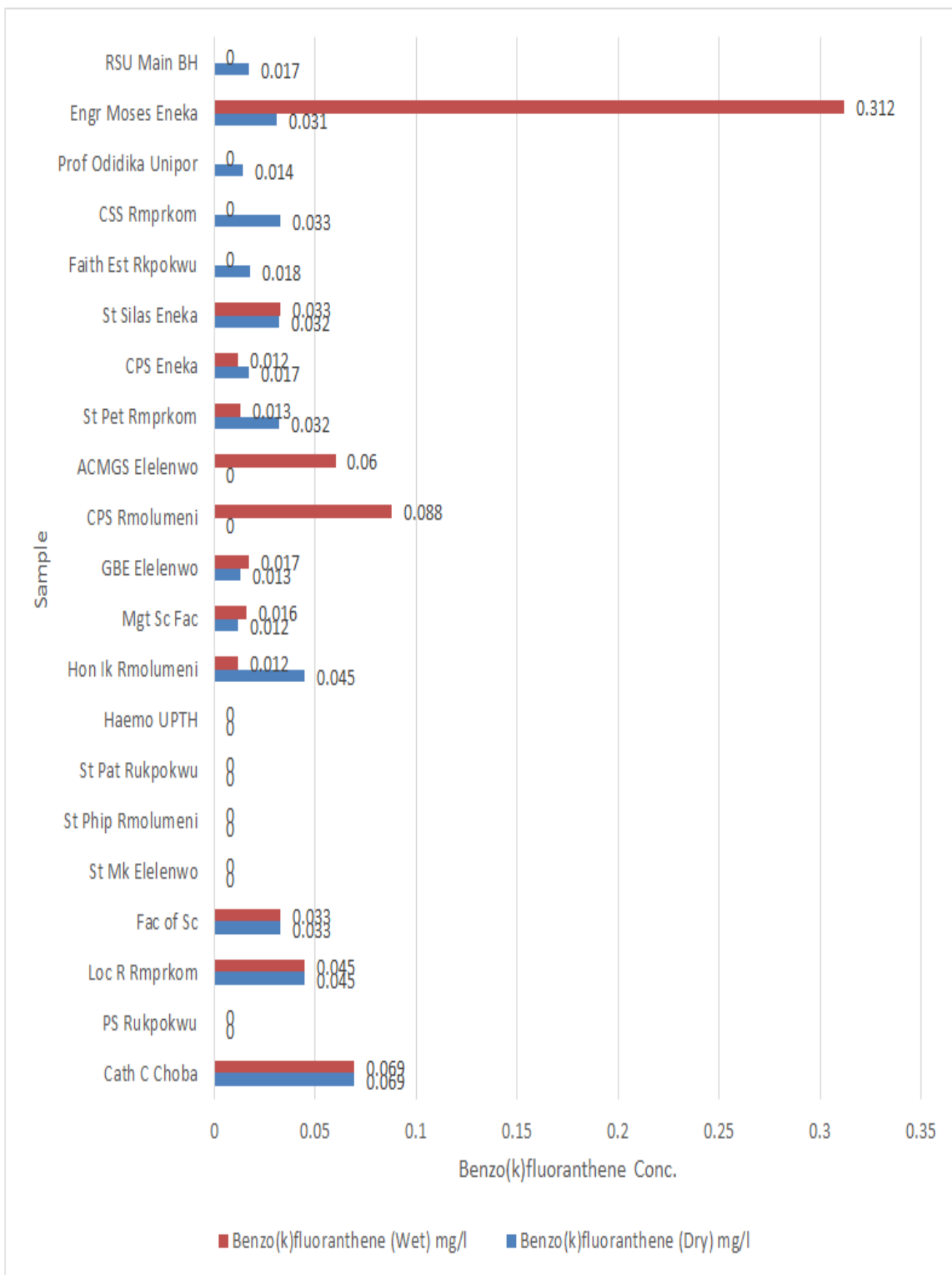


Fig 8 Spatial Distribution of Benzo(k)fluoranthene in Borehole

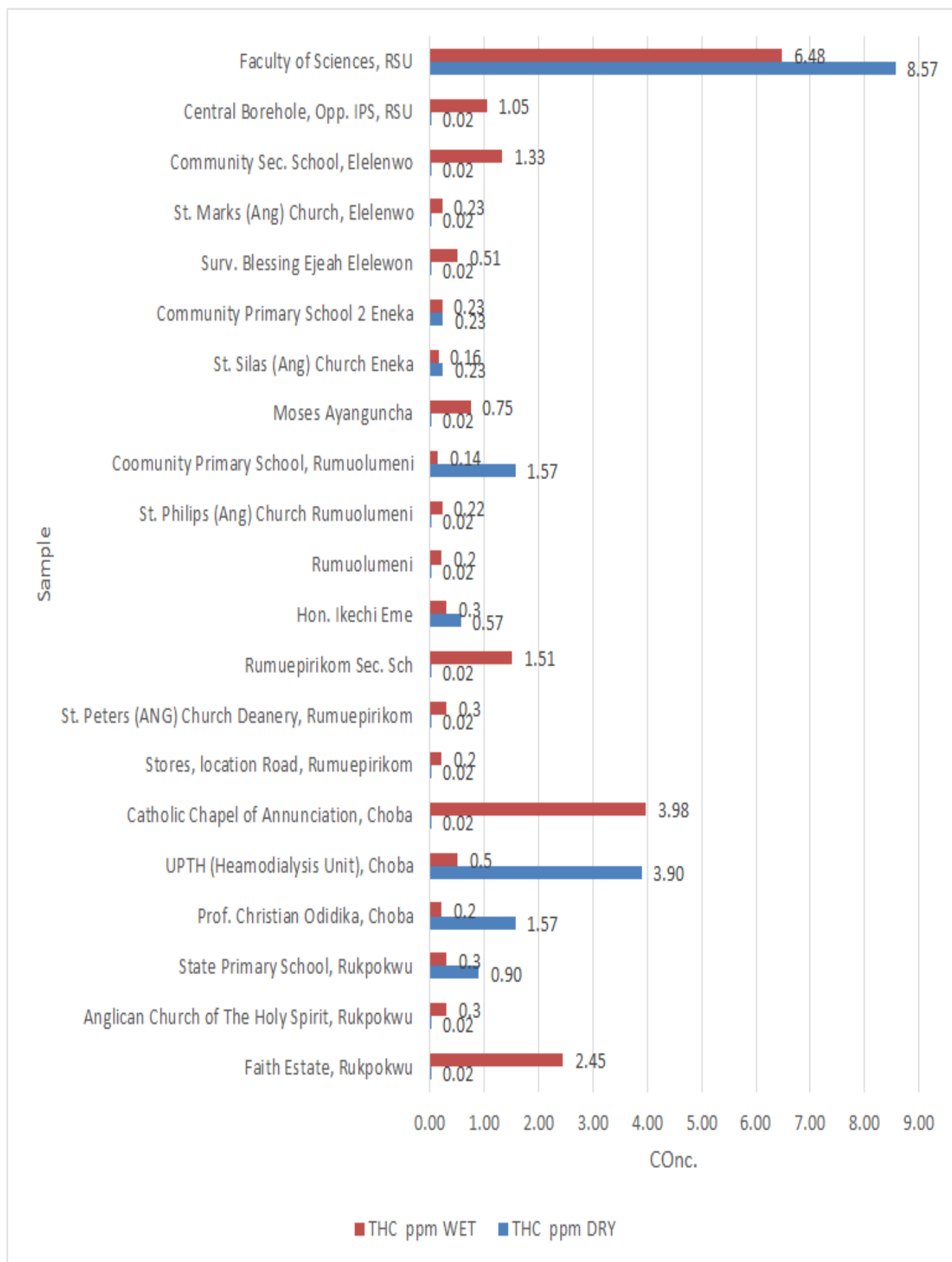


Fig 9 Spatial Distribution of THC in Borehole

➤ *Polycyclic Aromatic Hydrocarbon (PAH) Results*

Monitoring the concentrations of specific PAH compounds, such as Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Fluoranthene, Pyrene, Benzo(a)anthracene, Benzo(k)fluoranthene, Benzo(a)pyrene, and Benzo(a,b)pyrene, in water samples from different boreholes during both dry and wet seasons provides valuable insights into the environmental impact and distribution of these compounds in the studied area.

➤ *Acenaphthylene*

The spatial distribution of Acenaphthylene was presented in Figure 4.18, showing different levels for both dry and wet seasons. In the dry season, the concentrations varied from 0.012 to 0.124 mg/l, with the highest value observed in BHS2 and the lowest in BHS3. While in the wet season, concentrations ranged from 0.004 to 0.175 mg/l, with BHS18 recording the highest and BHS21 the lowest. The parameter showed variability across samples in both seasons.

➤ *Acenaphthene*

The spatial distribution of Acenaphthene was presented in Figure 4.19, showing different levels for both dry and wet seasons. During the dry season, Acenaphthene concentrations ranged from 0.004 to 0.142 mg/l, with BHS12 exhibiting the lowest and BHS6 the highest concentration. In the wet season, levels varied from 0.003 to 0.142 mg/l, with BHS11 having the highest value and BHS21 the lowest. Acenaphthene displayed fluctuations in concentrations across borehole samples.

➤ *Fluorene*

The spatial distribution of Fluorene was presented in Figure 4.20, showing different levels for both dry and wet seasons. In the dry season, Fluorene concentrations varied from 0.011 to 0.131 mg/l, with BHS15 exhibiting the lowest and BHS6 the highest concentration. In the wet season, levels ranged from 0.011 to 0.076 mg/l, with BHS11 recording the highest and BHS3 the lowest. Fluorene concentrations demonstrated sample-specific variations.

➤ *Phenanthrene*

The spatial distribution of Phenanthrene was presented in Figure 4.21, showing different levels for both dry and wet seasons. Phenanthrene concentrations in the dry season ranged from 0.011 to 0.075 mg/l, with BHS6 having the highest and BHS12 the lowest value. In the wet season, levels varied from 0.011 to 0.072 mg/l, with BHS17 exhibiting the highest and BHS16 the lowest concentration. Phenanthrene displayed variability across samples in both seasons.

➤ *Pyrene*

The spatial distribution of Pyrene was presented in Figure 4.22, showing different levels for both dry and wet seasons. In the dry season, Their concentrations ranged from 0.0107 to 0.204 mg/l, with BHS16 having the highest and BHS5 the lowest value. In the wet season, levels varied from 0.006 to 0.054 mg/l, with BHS12 exhibiting the

highest and BHS21 the lowest. Pyrene displayed sample-specific variations in concentrations.

➤ *Benzo(a)anthracene*

The spatial distribution of Benzo(a)anthracene was presented in Figure 4.23, showing different levels for both dry and wet seasons. The water samples concentrations during the dry season ranged from 0.012 to 0.065 mg/l, with BHS7 exhibiting the highest and BHS9 the lowest concentration. In the wet season, levels varied from 0.011 to 0.312 mg/l, with BHS12 recording the highest and BHS9 the lowest. Benzo(a)anthracene demonstrated variability in concentrations across borehole samples in both seasons.

➤ *Benzo(k)fluoranthene*

The spatial distribution of Benzo(k)fluoranthene was presented in Figure 4.24, showing different levels for both dry and wet seasons. During the dry season, Benzo(k)fluoranthene concentrations ranged from 0.001 to 0.215 mg/l, with BHS17 having the highest and BHS2 the lowest concentration. In the wet season, levels varied from 0.0 to 0.069 mg/l, with BHS6 recording the highest and BHS2 the lowest. Benzo(k)fluoranthene displayed variability in concentrations across samples in both seasons.

➤ *Total Hydrocarbon Content (THC)*

The spatial distribution of THC showed different levels for both dry and wet seasons. THC concentrations in the borehole samples revealed notable differences between the dry and wet seasons. In the dry season, THC levels ranged from 0.02 to 8.57 ppm. The highest concentration was observed in BHS21 (8.57 ppm), while several samples, including BHS1, BHS2, BHS6, and others, showed minimal THC levels at 0.02 ppm. Notably, BHS5 exhibited a relatively higher THC concentration of 3.90 ppm during the dry season. In the wet season, THC concentrations ranged from 0.14 to 6.48 ppm. The highest THC concentration was recorded in BHS21 (6.48 ppm), and BHS6 exhibited a notable increase in THC compared to the dry season, reaching 3.98 ppm. Several samples, including BHS4, BHS7, BHS8, BHS11, BHS14, BHS15, and others, showed minimal THC levels at 0.14 ppm or 0.2 ppm during the wet season.

IV. DISCUSSION

➤ *Polycyclic Aromatic Hydrocarbon (PAHs)*

PAHs are environmental contaminants that pose great health risk and are known as carcinogens, mutagens and teratogens. PAH originates from dry and wet deposits, runoffs and industrial waste. The mean values for the Polycyclic Aromatic Hydrocarbons (PAHs) were ± 0.0045 ppm which is well within the limits of WHO (2004) and SON (2007). According to Ogbuagu, et al., (2011), the concentrations of PAHs detected in the water samples they studied showed fluoranthene, pyrene, and benzo(a)anthracene to vary between 0.0006 – 0.3289 mg/l, 0.0002 – 0.2476 mg/l and 0.0002 – 0.2197 mg/l respectively which far exceeded the standard for total PAHs in drinking water.

➤ *Total Hydrocarbon (THC)*

The total hydrocarbon content of the 21 samples showed that BHS21 had the highest THC value of 6.57ppm and 6.48ppm in both dry and wet season. The values fall within the Department of Petroleum Resources maximum value of 10mg/l for ground water (DPR 2002). The total hydrocarbon content for the dry season ranged from 0.02ppm – 8.57ppm while the wet season values ranged from 0.14ppm – 6.48ppm. The statistical mean values for dry and wet seasons are 0.85ppm and 1.02ppm respectively. Therefore, the quality of borehole water from some communities in Obio Akpor L.G.A is unsatisfactory, unacceptable and not fit for drinking. They need treatment for THC and PAHs before use.

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