Assessment of the Distribution Pattern of Poly Aromatic Hydrocarbons Around Nekede Auto-mechanic Village, Imo State, Nigeria

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Abstract: Auto mechanic activity in the recent time has significantly contributed to environmental degradation partly due to poor waste management practices and weak enforcement in ensuring operators are located in designated sites. This study therefore investigated the distribution pattern of Poly Aromatic Hydrocarbon (PAH) contaminants around Nekede auto-mechanic village, Owerri. Soil samples (0-30cm) were collected at three separate points. Sediment samples were also collected from two points along the Otamiri River representing sediments (RS) 1 and 2 and a control sample where no mechanic activity existed. Physicochemical parameters were determined using standard methods and Gas Chromatographic system equipped with a single detector (Flame Ionization Detector) — GC-FID for PAHs. The results obtained showed that out of the sixteen US-EPA target PAHs (EPA-16) analysed, only eight were detected in varying concentrations. Total PAH concentrations in the samples were in the order of dibenz [ah] anthracene (29.111mg/kg) > indeno [1, 2, 3-cd] pyrene (20.178mg/kg) > anthracene (10.717mg/kg) > naphthalene (8.340mg/kg) > 1, 2-benzoanthracene (4.124mg/kg) > acenaphthene (2.784mg/kg) > benzo [ghi] perylene (2.324mg/kg) > fluorene (1.421mg/kg). The concentration of total PAH components detected in the samples ranged from 2.564mg/kg to 21.841mg/kg in the study site compared to that of the control site where no PAH component was detected. The results therefore call for public concerns as PAH levels exceeded the maximum permissible limits set by some regulatory bodies. Public health education and regulation on management of wastes in the auto-mechanic workshops are recommended for environmental sustainability.

Keywords: Poly Aromatic Hydrocarbons, Physicochemical, Auto-mechanic Village, Contaminants, Soil

1. Introduction

Poly Aromatic Hydrocarbon (PAH) compounds are group of bio-accumulative, toxic and persistent compounds. PAHs are mainly released to the environment through fossil fuel utilization and organic combustion processes. They consists at least two benzene rings and are hydrophobic in nature. They are harmful on invertebrates and mammals including humans, thus raising serious environmental concern [1]. Therefore, US EPA has designated sixteen PAHs as priority environmental pollutants [2].

An auto-mechanic village is adopted against the city-wide spread of automobile workshops; it represents several acres of land mapped out for auto-mechanics as against city-wide automobile workshop practice and this helps in proper planning and delineation of environmental resources (land) and its management. It ensures that auto-mechanic workshops are not located indiscriminately in an urban or semi-urban environment thus contributing to environmental degradation of the area. The hazard arising from disposing spent automobile oil on the ground in many developing countries is of great concern to public health and ecology [3]. Omokhodiori [4] specifically indicated that the pollution effects of auto-mechanic village activities in Nigeria have received limited attention even though these activities have been shown to
produce petroleum based wastes. These wastes are generated and dumped by individuals who may not know the potential human risks of exposure to such pollutants. Constant monitoring is therefore imperative to assess the pattern and level of spread within the ecological zone.

Nekede auto-mechanic village lies within the Otamiri river watershed. Indiscriminate disposal of spent oil raises high risk of possible contamination of PAHs downstream. Other sources of PAHs abound, such as incomplete combustion of coal, gas, fuel wood, tobacco, and charbroiled meat [5]. This study therefore assessed the distribution of PAHs around Nekede auto-mechanic village.

2. Materials and Methods

The study was carried out within the environs of Nekede auto-mechanic village. Nekede auto-mechanic village falls under the geographical coordinates of longitude 7°2'15" – 7°3'00"E and latitude 5°27'80" – 5°28'00"N (Figure 1). The automobile mechanic site was set up in 1983; it was mapped out by the government of Imo State for artisans in automobile business for the purpose of repairing and maintaining motor vehicles. It lies on an urban residential and business area (Figure 1).

Nekede auto-mechanic village is underlain by the Benin Formation as shown in the geologic map of Imo River Basin (Figure 3). This formation which is Pliocene to Miocene in age consists of coastal plain sands, which is about 0.05 – 2.0 mm in size, with minor clay beds; and this type of soil has good drainage and is well aerated, causing it to dry out quickly [6].
The incidence of high porosity and permeability as well as shallow water table makes the groundwater in the area very vulnerable to pollution in the presence of poor waste management as practiced in Nekede auto-mechanic village.

2.1. Sample Collection

The auto-mechanic village was roughly divided into five sub-sites, with Site A located at the centre of the auto-mechanic village; Site B, 50m away from the centre of the auto-mechanic village; Site C, 80m away from Site B, Site D, 70m away from Site C; and Site E, 35m from the Otamiri River (Figure. 2).

Soil samples (0-30cm) were collected with minimal disturbance, using a 30-cm marked metal soil auger (nitric acid sterilized), from each of the sub-sites within the auto-mechanic village and also from a control site situated in the outskirts of the study area. Soils were collected from 3 different spots in each subsite and bulked to make a composite sample. This was sealed properly and transported to the laboratory for analysis. All sampling points were geo-referenced.

2.2. Chemical Analysis

The samples were analyzed for soil pH using an electronic pH meter in 1:2.5 water solution, electrical conductivity using conductivity meter. The determination of soil organic carbon content was based on the Walkley-Black chronic acid wet oxidation method, in accordance with [7]. The electrical conductivity which indicates the amount of soluble (salt) ions of the soil and sediment samples was determined using a conductivity meter as reported by [8]. The total nitrogen content in soil, regular macro-Kjeldahl method [9] was used, in accordance with ISO 11261:

The bulk (total) density of soil samples was determined from core samples. The specific gravity of the soil and sediment samples were determined by density bottle method as per ISO 2720: (1980).

2.3. Poly Aromatic Hydrocarbon (PAH) Analysis of Samples

The Poly Aromatic Hydrocarbon analysis of the soil and sediment samples were carried out in accordance with ASTM D7363-07: Standard Test Method for Determination of Parent and Alkyl Polycyclic Aromatics in Sediment Pore Water Using Solid-Phase Micro-extraction and Gas Chromatography/Mass Spectrometry in Selected Ion Monitoring Mode, which describes the procedure for analysis of extractable Poly Aromatic Hydrocarbon (PAH) in surface and ground water. Poly Aromatic Hydrocarbons (PAHs) were detected in the soil and sediment samples by Gas Chromatography-Flame Ionization Detection (GC-FID).

**GC-FID analysis**

The determination and measurement of the 16 EPA priority PAHs concentrations in the purified soil and sediment sample extracts were carried out using Agilent 7890B Gas Chromatographic System, equipped with a single detector (Flame Ionization Detector), a capillary column inlet and liquid auto-sampler/injector; with hydrogen, air and helium as carrier gases — the flame comes from the burning of the air and hydrogen gas which ignites the sample extract while it elutes from the column at the FID and the response detected by the detector. Identification and quantification of the individual PAHs was based on internal calibration standard containing known concentrations of the 16 EPA target PAHs. The specificity of the 16 PAHs sought for in the samples was confirmed by the presence of transition ions (quantifier and qualifier) as shown by their retention times which corresponded to those of their respective standards. The measured peak area ratios of precursor to quantifier ion were in close agreement with those of the standards and the amount of PAHs was resolved at a particular chromatogram. This process continued for the other samples in the batch until they were all analysed and results obtained were presented as mg/kg concentration per analyte.

2.4. Statistical Analysis

The data obtained were subjected to one-way analysis of variance (ANOVA) and the significant means were separated using Tukey error family rate at 5% probability level. Variation plots were used to represent the concentrations of PAHs and physicochemical parameters across the sampling locations. Pearson’s correlation, r, analysis was carried out to test the possible relationships existing between individual PAHs in the samples and physicochemical parameters.

3. Results and Discussion

The concentrations of poly aromatic hydrocarbons (PAHs) obtained in the soil and sediment samples from the study area and the control site are presented in Table 1. The result showed that PAH values ranged from 0.34 ± 0.01mg/kg to 12.79 ± 0.01mg/kg for soils and 1.42 ± 0.004mg/kg to 7.35 ± 0.01mg/kg for sediments. Naphthalene, Acenaphthene, Fluorene, anthracene, 1, 2-benzoanthracene, fluoranthene, benzo \{ghi\} perylene, and indeno \{1, 2, 3-cd\} pyrene significantly (p < 0.05) differed amongst the sampling locations. Naphthalene (0-8.34 ± 0.01mg/kg), acenaphthene (0-2.78 ± 0.01mg/kg), and anthracene (0-10.72 ± 0.004mg/kg), and the highest value occurred in Site D (SS4). Fluorine ranged from zero to 1.42 ± 0.004mg/kg and 1, 2-benzoanthracene, from zero to 4.12 ± 0.001mg/kg which were highest in River sediment 1 (RS1) and Site E (SS5) respectively.

Furthermore, the result showed that dibenz \{ah\} anthracene, (AN) ranged from zero to 12.79 ± 0.01mg/kg, with the highest mean value recorded in SS5. Also, Sites A (SS1), C (SS3), E (SS5) and River sediment 2 (RS2) significantly differed in mean dibenz \{ah\} anthracene values. Benzo \{ghi\} perylene varied from negligible to 1.99 ± 0.02mg/kg, with the highest mean value recorded in RS1. Mean benzo \{ghi\} perylene values differed in SS5 and RS1 sampling locations.
Table 1. Concentrations of PAH components in the soil and sediment samples.

<table>
<thead>
<tr>
<th>Location</th>
<th>NA</th>
<th>ANA</th>
<th>FL</th>
<th>ANTH</th>
<th>B [α]ANTH</th>
<th>D [αH] AN</th>
<th>B [gh]PERY</th>
<th>I 1, 2, 3-cd</th>
<th>PY</th>
<th>Σ6PAHs</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>5.61 ± 0.01e</td>
<td>0.00e</td>
<td>3.09 ± 0.02e</td>
<td>8.694</td>
<td></td>
</tr>
<tr>
<td>SS2</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>2.56 ± 0.01e</td>
<td>2.564</td>
<td></td>
</tr>
<tr>
<td>SS3</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>5.86 ± 0.01e</td>
<td>0.00e</td>
<td>1.92 ± 0.01e</td>
<td>7.777</td>
<td></td>
</tr>
<tr>
<td>SS4</td>
<td>8.54 ± 0.01*</td>
<td>2.78 ± 0.01*</td>
<td>0.00b</td>
<td>10.7 ± 0.04*</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>21.841</td>
<td></td>
</tr>
<tr>
<td>SS5</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>4.12 ± 0.01e</td>
<td>12.8 ± 0.01e</td>
<td>0.34 ± 0.01b</td>
<td>20.587</td>
<td></td>
</tr>
<tr>
<td>SS6</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>RS1</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>1.99 ± 0.02e</td>
<td>7.35 ± 0.01e</td>
<td>10.759</td>
</tr>
<tr>
<td>RS2</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>0.00b</td>
<td>4.86 ± 0.004d</td>
<td>0.00e</td>
<td>1.92 ± 0.01e</td>
<td>6.777</td>
<td></td>
</tr>
</tbody>
</table>
P<0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

Means with different superscript on the same column are significantly different at 5% probability. SS = subsurface soil, RS = river sediment, NA = naphthalene, ANA = Acenaphthene, FL = fluorene, ANTH = anthracene, B [α], ANT = 1, 2-benzoanthracene D [αh], AN= dibenz [αh] anthracene, B [ghi] = benzo [ghi] perylene, I 1, 2, 3-cd, PY = indeno [1, 2, 3-cd] pyrene

Indeno [1, 2, 3-cd] pyrene ranged from zero to 7.35 ± 0.01 mg/kg, with the highest value also recorded in RS1. The result further revealed that indeno [1, 2, 3-cd] pyrene values obtained in SS3 and RS2 did not significantly differ, however, there were significant differences in mean indeno [1, 2, 3-cd] pyrene values obtained in SS1, SS2, SS5 and RS1 (Table 1).

3.1. Physicochemical Parameters Present in Soil and Sediment Samples

The result of physicochemical parameters obtained in the soil and sediment samples are presented in Table 2. Electrical conductivity (EC) and CEC recorded highest values in SS1 (256.16 ± 0.1 µS/cm) and 12.47 ± 0.01 Cmol/kg, and porosity was 40.19/ cm³ in RS1. Table 2 revealed that pH, EC, organic carbon, organic matter, nitrogen (N), CEC, moisture content, bulk density, specific gravity and porosity differed significantly (P < 0.05) amongst the sampling locations.

The subsurface soil samples in all cases had higher pH and EC values than the sediment and control sample. And they differed among the sampling locations.

Organic carbon had highest mean value of 1.84 ± 0.01% in SS2, while the least was recorded in RS2 with a mean value of 0.26 ± 0.01% and the values differed in all the sampling locations. The result for organic matter contents also responded in a similar manner table 2.

The Pearson’s correlation (r) showed that acenaphthene and indeno [1, 2, 3-cd] pyrene significantly (p < 0.05) correlated with organic carbon and bulk density (Table 3). Similarly benzo [ghi] perylene and indeno [1, 2, 3-cd] pyrene correlated with pH (p < 0.001), and organic carbon (P < 0.05). Also, naphthalene, fluorene and anthracene related with moisture, bulk density and nitrogen content.

Table 2. Physicochemical parameters measured in the soil and sediment.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sampling locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1</td>
<td>SS2</td>
</tr>
<tr>
<td>pH</td>
<td>8.12 ± 0.001d</td>
</tr>
<tr>
<td>EC (µS/cm)</td>
<td>256.16 ± 0.1i</td>
</tr>
<tr>
<td>OC (%)</td>
<td>1.54 ± 0.01e</td>
</tr>
<tr>
<td>OM (%)</td>
<td>2.64 ± 0.01i</td>
</tr>
<tr>
<td>N (%)</td>
<td>0.12 ± 0.01i</td>
</tr>
<tr>
<td>CEC (cmol/kg)</td>
<td>12.47 ± 0.01i</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>13.72 ± 0.1b</td>
</tr>
<tr>
<td>Bulk Density (g/cm³)</td>
<td>1.58 ± 0.01i</td>
</tr>
<tr>
<td>Sp. Gravity</td>
<td>2.88 ± 0.01i</td>
</tr>
<tr>
<td>Porosity</td>
<td>28.20 ± 0.1i</td>
</tr>
</tbody>
</table>

Means with different superscript on the same column are significantly different (5%). SS = subsurface soil, RS = river sediment, EC = electrical conductivity, OC = organic carbon, OM = organic matter, N = nitrogen, CEC = cation exchange capacity, MC = moisture content, BD = bulk density, Sp. gravity = specific gravity

Table 3. Correlation (r) between PAHs and physicochemical parameters measured in the soil and sediment samples of the selected sampling locations.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>NA</th>
<th>ANA</th>
<th>FL</th>
<th>ANTH</th>
<th>B [α]ANTH</th>
<th>D [αH] AN</th>
<th>B [ghi]PERY</th>
<th>I 1, 2, 3-cd</th>
<th>PY</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>0.626</td>
<td>0.402</td>
<td>0.470</td>
<td>0.485</td>
<td>0.002</td>
<td>0.192</td>
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<td>0.111</td>
<td></td>
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<tr>
<td>EC</td>
<td>0.071</td>
<td>0.283</td>
<td>0.202</td>
<td>0.185</td>
<td>0.996</td>
<td>0.621</td>
<td>0.054*</td>
<td>0.777</td>
<td></td>
</tr>
<tr>
<td>OC</td>
<td>0.392</td>
<td>0.175</td>
<td>-0.272</td>
<td>0.382</td>
<td>-0.013</td>
<td>-0.261</td>
<td>0.105</td>
<td>-0.305</td>
<td></td>
</tr>
<tr>
<td>OM</td>
<td>0.296</td>
<td>0.653</td>
<td>0.478</td>
<td>0.311</td>
<td>0.973</td>
<td>0.497</td>
<td>0.788</td>
<td>0.425</td>
<td></td>
</tr>
<tr>
<td>Na</td>
<td>0.199</td>
<td>0.742</td>
<td>0.022*</td>
<td>0.102</td>
<td>0.456</td>
<td>0.080</td>
<td>0.227</td>
<td>0.437</td>
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</tr>
<tr>
<td>OM</td>
<td>0.370</td>
<td>0.221</td>
<td>-0.372</td>
<td>0.105</td>
<td>-0.033</td>
<td>0.553</td>
<td>-0.198</td>
<td>-0.362</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>0.327</td>
<td>0.567</td>
<td>0.324</td>
<td>0.788</td>
<td>0.994</td>
<td>0.123</td>
<td>0.610</td>
<td>0.338</td>
<td></td>
</tr>
</tbody>
</table>
Poly aromatic hydrocarbons indicated that the study area but only eight of the priority PAHs were detected in all the been reported in soil, sediment and natural water samples at various locations around the world [11]-[12]. Some PAHs and their derivatives are found to show strong carcinogenicity and mutagenicity; as a result, the fate of PAHs released in the environment has attracted much attention. Poly aromatic hydrocarbons do not usually exist as separate entities in environmental media; they are often regarded as a mixture and the total concentration of their mixture is often used to describe their distribution. Sixteen PAHs recommended by the United State Environmental Protection Agencies (USEPA) were investigated in this study but only eight of the priority PAHs were detected in all the sampling locations.

The observed marked variations in concentrations of the poly aromatic hydrocarbons indicated that the study area significantly contained different levels of PAHs. The site closest to the auto-mechanic village had the highest concentrations of total PAHs. This finding maybe attributed to the discharges from the auto-mechanic activities. The poor and improper disposal of petroleum wastes in the auto-mechanic village could be a major contributor to the observed PAHs contamination.

The contributions of PAH loadings in sediments of the adjoining water body- Otamiri, must have been aided by storm runoffs from the auto-mechanic village. The possibility of contamination of adjoining segments of the environment from surface, proximal pollutants has been severally identified by [13] and [14].

### 3.2. Discussion

Poly aromatic hydrocarbons (PAHs) are recalcitrant organic pollutants which typically form during the incomplete burning of organic materials including wood, coal tar, oil, gasoline and garbage [10]. The presence of PAHs has been reported in soil, sediment and natural water samples at various locations around the world [11]-[12]. Some PAHs and their derivatives are found to show strong carcinogenicity and mutagenicity; as a result, the fate of PAHs released in the environment has attracted much attention. Poly aromatic hydrocarbons do not usually exist as separate entities in environmental media; they are often regarded as a mixture and the total concentration of their mixture is often used to describe their distribution. Sixteen PAHs recommended by the United State Environmental Protection Agencies (USEPA) were investigated in this study but only eight of the priority PAHs were detected in all the sampling locations.

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### 3.3. Distribution Pattern of Poly Aromatic Hydrocarbons (PAHs) Around the Area

Transport and biochemical transformations control the fate of PAHs in contaminated soils, however, they are not uniformly distributed in the soil profile [15]. Jarvis [16] suggests that solute transport at any site depends on various factors including abundance and activity of soil biota, soil properties as well as site factors (e.g. slope position, drying intensity, vegetation) and management (e.g. cropping, tillage, traffic). PAHs distribution in soils depend on the rates of release from the source materials, the affinity of dissolved PAHs toward soil constituents, and the composition of the solution phase [17]. Basically, inherent properties of PAH compounds and soil physicochemical characteristics are two parameters that affect PAH movement and distribution in the soil profile [18].

### 3.4. Properties of Poly Aromatic Hydrocarbon (PAH) Compounds

The physical and chemical characteristics of PAHs vary in accordance to their number of rings. The greater the number of rings, the higher the molecular weight. As molecular weight increases, the solubility of PAHs decreases with an increase in melting and boiling point [19], hydrophobicity increases, vapor pressure decreases, and the compound will be more difficult-to-degrade (recalcitrant). However, Jones et al [20] suggests that HMW PAHs persist in the environment because of low volatility, resistance to leaching and recalcitrant nature, [21]. Also, they are more persistent than LMW PAHs in the environment due to their increased resistance to oxidation, reduction and vapourisation as molecular weight increases [22].

The Otamiri River is an important water resource within Owerri and its environs. The existence of PAHs around this river raises serious ecological risk of possible human contamination. When PAHs get into the water body, they tend to attach to sediments; and once they are incorporated into sediments, they are somewhat immobile because their non-polar structures reduce their solubility in water. The presence of pore water organic colloids can increase the concentrations of PAHs beyond their aqueous solubility because PAHs will be sorbed onto these organic colloids. Generally, the HMW PAHs with ≥ 4 rings was predominant in the soil and sediment samples in this study (Table 1), which may be attributed to their low solubility, less volatility due to their molecular size and higher persistence in environment when compared to the LMW PAHs [23]. The major source of HMW PAHs can be linked to anthropogenic activities, as observed by [24] in their study on the prevalence of HMW

<table>
<thead>
<tr>
<th>Parameters</th>
<th>NA</th>
<th>ANA</th>
<th>FL</th>
<th>ANTH</th>
<th>B [α] ANTH</th>
<th>D [α]h AN</th>
<th>B [γ]h PY</th>
<th>I [1, 2, 3α-] PY</th>
</tr>
</thead>
<tbody>
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<td>N</td>
<td>0.612</td>
<td>0.331</td>
<td>-0.441</td>
<td>0.929</td>
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<td>-0.020</td>
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<tr>
<td>CEC</td>
<td>0.080</td>
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<td>0.235</td>
<td>0.000***</td>
<td>0.780</td>
<td>0.959</td>
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<tr>
<td>MC</td>
<td>0.352</td>
<td>0.304</td>
<td>0.240</td>
<td>0.150</td>
<td>0.310</td>
<td>0.374</td>
<td>0.287</td>
<td>0.372</td>
</tr>
<tr>
<td>BD</td>
<td>0.043</td>
<td>0.427</td>
<td>0.534</td>
<td>0.699</td>
<td>0.418</td>
<td>0.321</td>
<td>0.454</td>
<td>0.325</td>
</tr>
</tbody>
</table>

Cell contents: Pearson correlation; * = significant at P ≤ 0.05, ** = significant at P ≤ 0.01, *** = significant at P ≤ 0.001 P-value
PAHs in samples collected around Langkawi Island in Malaysia. Amongst the respective sampling sites, only Site D (SS4) contained LMW PAHs. The relative abundance of HMW PAHs in the study site indicates that the PAHs are of pyrolytic origin, generated mainly through incomplete combustion of organic matter at temperatures usually above 400°C over a short time interval. Furthermore, the absence of fluorene in the soil matrices indicates that its presence in the sediment sample, RS1, was not anthropogenic i.e. it was not from the auto-mechanic village, but rather believed to be from petrogenic sources, containing small (3-benzenoid) rings.

3.5. Soil Physicochemical Characteristics

The quality of any environmental matrix is governed by its physicochemical factors; therefore, the monitoring of these factors is vital for both long and short term environmental management of pollutant inputs [25]. Additionally, the distribution and productivity levels of organisms are largely determined by physicochemical factors in these ecosystems. Consequent upon this, [26] asserts that anthropogenic environmental changes affect natural biodiversity. Accordingly, several authors have investigated the direct effect of interactions of many frequently measured physicochemical variables on biotic residents of these ecosystems [27]-[28].

Soil organic carbon (SOC) is the main source of energy for soil microorganisms. The ease and speed with which SOC becomes available is related to the soil organic matter (SOM) fraction. The moderate percentage of organic carbon in the soils of the auto-mechanic village indicates the possible presence of organic matter content, and the presence of used oil and other carbonaceous substances in the auto-mechanic village can cause an increase, which may result to an increase in the presence of soil microorganisms that aid in the breakdown of organic compounds. Therefore, organic matter can affect the fate and transport of PAHs according to Raber et al. [29]. Depending on the affinity of the dissolved organic matter toward the solid phase, mobility of the PAHs may be enhanced [30] or diminished [31]. In the long run, organic matter can affect biodegradation rates and sorption constants of mobile organic pollutants [16]. In this study, the predominant PAHs are the high molecular weight (HMW) PAHs, which as a result there’s limited mobility of PAHs. Organic carbon is an index for nitrogen content in the soil, as such an increase in organic carbon results to an increase in nitrogen content, which favours soil microorganisms that breaks down PAHs in soils.

It was observed in this study that soil pH and CEC had a corresponding relationship — as soil pH tends to alkalinity, the CEC increases. Also, the organic matter content, though moderate, contributed to CEC in the samples and to the sparse distribution of PAHs in the study area. In this study, moisture content ranged from 13.68 to 23.51%. The high percentage moisture content can be pinned to insufficient aeration of the soil of the area-auto-mechanic village that encouraged water logging and reduction in microbial activities. Thereby promoting retention of PAHs in the soil.

3.6. Correlation Between Poly Aromatic Hydrocarbons (PAHs) and Physicochemical Parameters Obtained from the Study Area

The Pearson’s correlation between the Poly Aromatic Hydrocarbon (PAH) compounds and the physicochemical properties of the study area indicates that some form of relationship exists between PAHs distribution and soil physicochemical properties. It was observed from this study that soil pH correlated negatively with benzo [ghi] perylene indicating that an increase in pH decreases the concentration and possible distribution of benzo [ghi] perylene. It can also be deduced from this study that soil organic carbon (SOC) showed a positive relation with acenaphthene which indicates that there’s an increase in acenaphthene as SOC increases in the samples. Also, an increase in SOC leads to a decrease in the availability of indeno {1, 2, 3-cd} pyrene in the study area. Furthermore, there was a highly significant positive correlation between nitrogen composition and anthracene indicating that high percentage nitrogen in the samples, results to an increase in the concentration of anthracene in the area. Asignificant positive relationship existed between soil moisture content and naphthalene which indicates that increase in soil moisture favours the availability and mobility of naphthalene in the site. Also, bulk density (BD) correlated significantly and positively with fluorene and indeno {1, 2, 3-cd} pyrene respectively, and this indicates that the concentration and mobility of fluorene and indeno {1, 2, 3-cd} pyrene is highly affected by the BD of the samples; therefore, as BD increases, fluorene and indeno {1, 2, 3-cd} pyrene increases respectively in the area.

4. Conclusion

Accumulation of PAHs in subsurface soils and sediments was investigated in some locations of the Nekede auto-mechanic site and the results revealed elevated values of PAHs in the soil and sediment samples collected from the area. Proximal inputs of the pollutants gave rise to significant spatial variations in concentrations — marked spatial variations in the concentrations of the PAHs were observed across the environmental segments sampled. The sources of the PAH into the environment are mainly pyrolytic.

References


Partitioning of polycyclic aromatic hydrocarbons in three 


