Research Article

URF PUBLISHERS
connect with research world

Journal of Petroleum & Chemical Engineering

https://urfpublishers.com/journal/petrochemical-engineering

Vol: 4 & Iss: 2

Emerging Polychlorinated Biphenyls (PCBS) Contaminants in Soils Around Flyover Road Construction Sites

Glory Eromosele[1,2], Leo C. Osuji[1,2,3]* and Mudiaga C. Onojake[1,2,3]

[1]World Bank Africa Centre of Excellence for Oilfield Chemicals Research, University of Port Harcourt, Choba, PMB 5323, Port Harcourt, Nigeria

[2]Department of Pure and Industrial Chemistry, University of Port Harcourt, East-West Road, Choba, PMB 5323, Port Harcourt, Nigeria

[3]Institute of Natural Resources, Environment and Sustainable Development (INRES), University of Port Harcourt, Choba, PMB 5323, Port Harcourt, Nigeria

Citation: Eromosele G, Osuji LC, Onojake MC. Emerging Polychlorinated Biphenyls (PCBS) Contaminants in Soils Around Flyover Road Construction Sites. *J Petro Chem Eng* 2026;4(2):366-371.

Received: 02 June, 2026; **Accepted:** 26 June, 2026; **Published:** 29 June, 2026

***Corresponding author:** Leo C. Osuji, World Bank Africa Centre of Excellence for Oilfield Chemicals Research, University of Port Harcourt, Choba, PMB 5323, Port Harcourt, Nigeria

ABSTRACT

Soil samples were collected from Ada George Location and Rumuokwuta flyover sites in Port Harcourt and taken to the laboratory for polychlorinated biphenyl (PCB) analysis. PCB levels in the samples were measured using a gas chromatograph (Agilent Model 7890A) connected to a mass spectrophotometer detector (Agilent 5972) (GC-MS). The concentrations of PCBs across all samples at the AG1L and RUA1 sites as well as the average values were found not to exceed the regulatory limit of 0.5-33mg/kg (500 - 33000 ng/g). This variability suggests localized sources of contamination, linked to industrial discharges or improper disposal of PCB-containing materials. The low concentrations of PCBs determined align with the controlled usage and regulatory restrictions on PCBs in recent decades. The toxic equivalence (TEQ) values calculated for the dioxin-like PCBs further highlight the importance of congener composition in determining environmental risk, although all the TEQ values recorded in this work were well below international guideline limits. Generally, our findings highlight the importance of monitoring urban soil contamination and aligning land-use planning with human health assessment criteria to manage chronic exposure risks effectively. Regular, multi-seasonal monitoring of PCBs should be established at construction sites and surrounding areas. This will allow for the detection of temporal trends, early identification of contamination hotspots and better understanding of pollutant dynamics of the study areas.

Keywords: Polychlorinated biphenyls (PCBs); Soil; Toxic equivalence (TEQ); Monitoring; Pollution

Introduction

Research continues to identify unexpected contamination sites, such as flyover construction sites, hitherto unconsidered as worthy of remediation. One contaminant of note is polychlorinated biphenyl. Polychlorinated biphenyls (PCBs) are group of synthetic organic compound with 209 distinct chemicals, all of which have variable levels of chlorination[1-3]. The structure of PCB compounds consists of a biphenyl ring that features a carbon-carbon connection between the carbon 2 on one ring and the carbon 2′ on the other ring **(Figure 1)**.

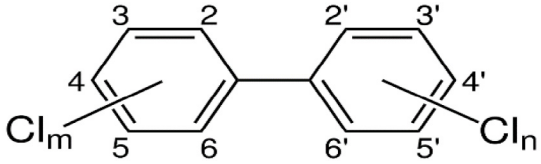

Figure 1: Chemical structure of PCBs (m and n denote number of chlorine atoms on each ring).

The Stockholm convention on Persistent Organic (POPs) defines PCBs as groups of aromatic compounds formed in a manner that the hydrogen atoms on the biphenyl molecule may be replaced by up to 10 chlorine atoms[4,5]. PCBs exhibit a high degree of chemical and biological stability, as the degree of chlorination increases, melting point and lipophilicity increase and vapor pressure and water solubility decrease. Due to their chemical stability and high flash point, they are known to reduce the risk of fire hazards; however, they have also proved to be environmentally hazardous. They are lipid soluble thus tend to accumulate in the food chains[6]. PCBs are technically very attractive as they have been used for variety of industrial purposes because they are non-reactive and are resistant to combustion.

Despite being banned, PCBs persist in the environment as one of the emerging contaminants with long-term effects. The source of PCBs in developing countries like Nigeria has been attributed mainly to the importation of PCB-containing materials such as transformers, capacitors of electrical equipment and some everyday products. The widespread use of PCBs in different commercial and industrial applications along with their inappropriate disposal has created severe environmental contamination. PCB and several other organic and inorganic contaminants are released into soil and other environmental compartments. Its degradation products, such as Hydroxylated Polychlorinated Biphenyls (OH-PCBs) are highly toxic to workplaces and ecosystems with potential human risks. PCBs move from the environment to humans through different routes; the dominant pathway is the ingestion of contaminated foods (fish, seafood and dairy products), followed by inhalation (both indoor and outdoor air).

There are many unreported uses of PCBs that are currently unaccounted for and the extent of production and ignored use makes it difficult to effectively quantify or trace[1]. Construction materials at commercial and industrial sites that include PCBs have also recently begun to draw more attention[7,8]. According to Giola, et al., processes associated with construction activities can be pretty damaging to the environment in and of themselves; however, if this inherent threat is combined with poor environmental regulation and the use of substandard materials, the environmental pollution tendencies are significantly increased. the Nigerian construction industry is not exempted from the second -hand pollution that plagues most African countries.

Soils around the world is threatened by PCB contamination, with about 20,000 tons of PCBs in global soil and an uncountable range of site contamination. In the United States, more than 300 sites have contained or still contain PCB pollution; in Europe, there are more than 242,000 sites of PCB pollution; in Canada, there are more than 100 PCB pollution sites[9]. The contamination concentrations of PCBs in the soil of developed countries such as the United Kingdom and the United States has reached 50 mg/kg. Due to improper disposal of waste transformer facilities and equipment in many developing countries like Nigeria, PCBs have leaked and caused great damage to local soil resources and water resources, affecting people's normal work and life[9-11].

PCBs in the soil can remain in place with no action required when concentrations in the soil are less than 1 mg/kg, but when the concentration reaches or exceeds 1 mg/kg the soil will have to be removed or covered with an engineered control such as "clean" soil or pavement. If the PCB concentration in the soil exceeds 10 mg/kg, then it may have to be removed and appropriately disposed of. As the largest receptor of PCBs, it is difficult for soil to degrade them naturally. Therefore, large amounts of PCBs remaining in soil often cause serious soil pollution. Research shows that a whole-body PCB concentration of about 150 ppm appears to be the threshold concentration above which acute mortality is observed. It is for this reason that this study sought to quantify the PCBs in soils around the road construction sites in Port Harcourt because of the potential for their presence in these areas.

Materials and Methods

The research was quantitative in nature. The Analysis involved both field and laboratory components. In the field study, Soil samples were obtained from the study sites of interest according to standard procedures. The Laboratory analysis involved the testing the concentration of PCBs in the soils.

Study area

The areas of focus for the study **(Figure 2)** were some flyover sites in Port Harcourt metropolis in Rivers State Nigeria. The geographical coordinates for the location of Port Harcourt city are within latitude 40 47' 30" N and 40 54' 30" N and longitude 60 54' 00" E and 70 04' 30" E. Port Harcourt consists of two Local Government Areas which are the Port Harcourt Local Government Area (PHALGA) and Obio-Akpor Local Government Area. Our specific sampling locations were distributed between both local government areas.

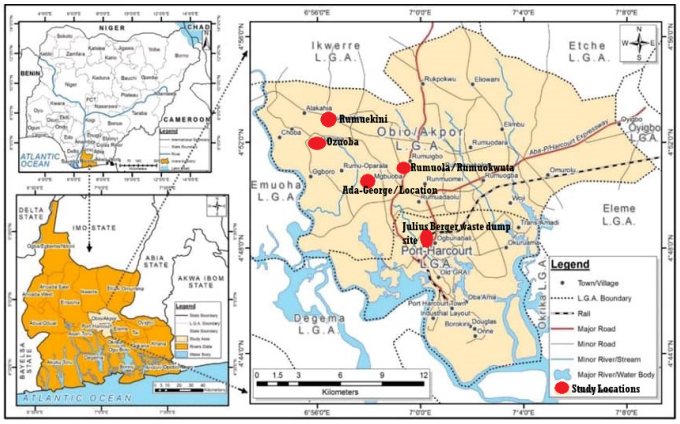

Figure 2: Map of the Study Area showing locations from where samples were collected.

Sampling technique

For the first stage of Analysis, three (3) soil samples each were randomly collected from three sample points at AGL1 and RUA2. The samples were collected at depths of 0-15cm and wrapped in aluninium foil, stored in ice coolers and then transported to the laboratory for analysis. A control soil sample was also collected from soil around the Ozuoba residential area of Port Harcourt city where there was no ongoing construction activity at the time.

For the second stage analysis which took place after 2 seasons, one water sample was collected from JS2. One composite sample each of soil was also collected from the initial sample sites at Ada George Location (AGL2) and Rumuokuta (RUA2) for re-evaluation. One composite soil sample each was also collected from two ongoing flyover construction projects at RUK2 and ROA2. In all sampling instances, the collected samples were stored in aluminium foil and transported to the laboratory in ice coolers.

Instrumentation and determination of PCB

PCB concentrations in the samples were measured using a gas chromatograph (Agilent Model 7890A) connected to a mass spectrophotometer detector (Agilent 5972) (GC-MS). A HP-5 fused silica capillary column (5% phenyl-95% dimethyl polysiloxane) (30 m length; 0.25 mm i.d.; 0.25 m film thickness) was employed for the separations. The column temperature was first set at 120 °C (holding time 1 min) and then raised to 190 °C at 20 °C min1, then to 230 °C at 5 °C min1 and eventually to 300 °C at a rate of 25 °C min1 (holding time 10 min). The injector and transfer line were set to temperatures of 280 and 300 °C, respectively. The carrier gas was high purity helium, flowing at a constant rate of 0.8 mL per minute. The sample was injected into the GC-MS in splitless mode with a volume of 1 µL. The mass spectrometer used automatic gain control in conjunction with electron impact ionization (EI) as its mode of operation.

The selective ion monitoring (SIM) mode was employed for data gathering and the storage window was set to full scan mode in the m/z 200–500 range. To determine the identities of the PCBs in the samples, the abundance of the quantification and confirmation ions was combined with the retention periods of the genuine PCB standards.

Validity of instrument

To ensure the integrity of all samples collected, data for the samples were recorded on a field datasheet during sampling. Additionally, a standard chain of custody form was completed once sampling was finished to ensure proper storage, identification and processing for instrumentation. Before running the samples, procedural blanks were used to ensure the validity of the instruments results from processing the samples in the GC-MS. Analyses of procedural blanks were performed to ensure that the reagents were pure and free of interference and possible laboratory contamination. To do this, the analytical process was carried out on the reagents in the absence of the samples. The procedure blank samples were found to contain none of the identified PCB compound being determined. Known concentrations (standards) of PCBs were added (spiked) to selected samples prior to extraction and all analytical procedure was repeated. The percentage recoveries were then calculated.

Toxic Equivalent Factor (TEF) and Toxic Equivalent Quotient (TEQ)

TEF is used to estimate the specific toxicity of a particular compound relative to the toxicity of 2,3,7,8- tetrachlorodibenzo-p-dioxin (TCDD). To calculate this for an individual compound (i) the product of the concentration of that compound and it's assigned standard TEF value are calculated. To calculate the TEQ value, the individual TEF obtained for all dioxin like compounds (DLC) that are present in a sample are then summed together. The TEQ may be compared to the dose-response slope for TCDD and used to assess the risk posed by exposures to mixtures of DLC. The TEF for TCDD is 1.0. The TEQ is the product of the concentration of dioxin-like PCB in an environmental mixture and the corresponding TCDD TEF for that compound[12].

The TEQ was evaluated using the expression: TEQ = $\sum ni=1 \; TEFi \; x \; Ci$, where Ci is the determined concentration of dioxin-like PCBs (dl-PCBs) and TEFi is the toxic equivalency factor for humans and animals (Van den Berg et al. 2006). The TEF values of dl-PCB congeners used in this study. For the purpose of the analysis, the TEF values utilized for the calculation of the TEQ of the dioxin like PCBs are 0.0003 for PCB 81, 0.00003 for PCB 114 and 0.00003 for PCB 189 which were the only two dioxin-like PCBs detected. Concentration values were converted from ppm to ng/g (i.e mg/kg to ng/g by multiplying by 1000) before calculation. All non-detected PCB concentrations (<0.001) are computed as zero (0).

Results and Discussion

Results of GC-MS and toxity analysis

The results of the distribution of PCBs in the soil samples from the study sites are collected in **(Tables 1 and 2)**, while the quantification of the toxic equivalent quotient (TEQ) for the PCBs is contained in **(Table 3)**. The chromatograms are shown in **(Figures 3,4).**

Table 1: PCBs for soil samples from Ada Geoge Location (AGL1) and Rumuokwuta (RUA1).

PCB	AGL1				RUA1				CTL1
	Sp 1	Sp 2	Sp 3	Avrg	Sp 1	Sp 2	Sp 3	Avrg	
15	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
28	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
33	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
52	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
77	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
81	<0.001	0.10	<0.001	0.033	0.02	0.03	<0.001	0.017	<0.001
101	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
105	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

114	0.05	<0.001	<0.001	0.017	0.02	0.06	<0.001	0.027	<0.001
118	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
123	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
126	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
129	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
137	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
138	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
153	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
156	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
157	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
167	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
169	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
171	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
180	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
183	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
185	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
189	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
191	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
198	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
199	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
200	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
201	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
203	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
206	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
209	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total	0.05	0.10	<0.001	0.05	0.04	0.09	<0.001	0.044	<0.001

Table 2: PCB Results from Second Stage Analysis.

PCB	JB2	ROA2	RUK2	AGL2	RUA2
15	0.00	0.03	0.01	0.03	0.00
28	<0.001	<0.001	<0.001	<0.001	<0.001
77	<0.001	<0.001	<0.001	<0.001	<0.001
81	<0.001	<0.001	<0.001	<0.001	<0.001
101	<0.001	<0.001	<0.001	<0.001	<0.001
105	<0.001	<0.001	<0.001	<0.001	<0.001
114	0.08	0.02	0.01	0.02	0.03
118	<0.001	<0.001	<0.001	<0.001	<0.001
123	<0.001	<0.001	<0.001	<0.001	<0.001
126	<0.001	<0.001	<0.001	<0.001	<0.001
129	0.03	<0.001	0.02	<0.001	0.03
137	0.01	<0.001	0.02	<0.001	0.01
138	<0.001	<0.001	<0.001	<0.001	<0.001
153	0.01	0.02	0.02	0.01	0.02
156	<0.001	<0.001	<0.001	<0.001	<0.001
157	<0.001	<0.001	<0.001	<0.001	<0.001
167	<0.001	<0.001	<0.001	<0.001	<0.001
171	0.06	0.01	0.01	0.04	<0.001
180	<0.001	<0.001	<0.001	<0.001	<0.001
183	0.03	0.03	0.01	0.03	0.02
185	0.03	0.02	0.03	0.04	0.05
189	0.03	0.03	<0.001	0.02	0.01
191	0.02	0.02	0.03	0.01	0.04
198	0.04	<0.001	<0.001	<0.001	<0.001
199	<0.001	<0.001	0.03	0.01	0.04
200	0.02	<0.001	<0.001	<0.001	<0.001
201	<0.001	0.03	<0.001	0.02	0.03
203	<0.001	0.02	0.02	0.02	<0.001
206	0.04	<0.001	0.01	<0.001	<0.001
209	0.03	0.02	<0.001	0.03	0.01
Total	0.41	0.25	0.21	0.28	0.26

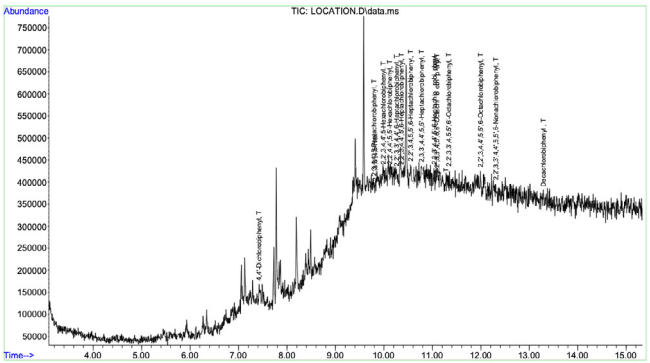

Figure 3: AGL2 PCB Sample Chromatogram.

Table 3: Quantification of PCB TEQ values for AGL1, RUA1 and CTL1 (ngTEQ/g).

PCB TEQ	AGL1				RUA1				CTR1
	Sp1	Sp 2	Sp3	AGL1 Avrg	Sp1	Sp 2	Sp3	AGL1 Avrg	
$TEF_{81} \; x \; C_{81}$	0.000	0.030	0.000	0.010	0.006	0.009	0.000	0.005	0.000
$TEF_{114} \; x \; C_{114}$	0.002	0.000	0.000	0.001	0.001	0.002	0.000	0.001	0.000
TEQ	0.002	0.030	0.000	0.010	0.007	0.011	0.000	0.006	0.000
CTEQ	1.50E-06	3.00E-05	0.00E+00	1.04E-05	6.60E-06	1.08E-05	0.00E+00	5.91E-06	0.00E+00

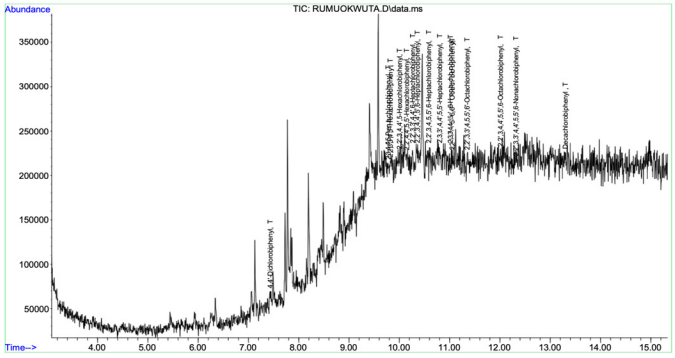

Figure 4: RUA 2 PCB Sample Chromatogram.

Discussion

Across all sample points at the sites of AGL1 and RUA1, only two detectable PCB congeners were identified: PCB 81 and PCB 114. Both congeners are classified as dioxin-like PCBs, with PCB 81 being a non-ortho substituted congener and PCB 114 a mono-ortho substituted congener. These classes of PCBs are known for their high persistence, resistance to environmental degradation and tendency to bioaccumulate in lipid-rich tissues of organisms, thereby posing long-term ecological and human health concerns.

The control site at Ozuoba, CTL1 did not record any detectable PCB congeners, as all concentrations were below the detection limit. In contrast, both AGL1 and RUA1 exhibited measurable PCB contamination, with concentrations approximately an order of magnitude higher than the control, confirming anthropogenic input at both locations. However, no indicator PCBs were detected at any of the sites, suggesting that while contamination exists, it may not be associated with typical commercial PCB mixtures.

At the AGL1 site, PCB concentrations across the three sampling points ranged from not detected (N.D) to 0.1 mg/kg (100 ng/g), with one sample point falling below the detectable range of concern. The average total PCB concentration across the site was 0.05 mg/kg (50 ng/g). Although one sampling point showed complete dominance of PCB 114, the overall congener distribution across the site indicated a dominance of lower chlorinated congeners, with PCB 81 contributing approximately 66% of the total PCB concentration and PCB 114 contributing 34%. The predominance of lower chlorinated PCBs suggests that contamination at AGL1 may be influenced by diffuse or non-point sources, as these congeners are more volatile and more readily transported over long distances via environmental processes such as wind and water movement. However, the localized dominance of PCB 114 at one sampling point indicates the potential presence of a site-specific point source of contamination.

At the RUA1 site, PCB concentrations ranged from N.D to 0.09 mg/kg (90 ng/g), with an average total concentration of 0.043 mg/kg (43 ng/g), which is comparable to that observed at AGL1. However, in contrast to AGL1, the congener distribution at RUA1 showed a higher prevalence of PCB 114, which accounted for approximately 61% of the total PCB concentration, while PCB 81 contributed 39%. This dominance of a higher chlorinated congener suggests a greater likelihood of a localized point source of contamination at the RUA1 site. When compared to findings from Inaighe and Kpomah[12], who reported PCB concentrations ranging from 5.34 to 16.1 ng/g in sediments from the Udu River, the concentrations observed at AGL1 and RUA1 (N.D – 100 ng/g) are significantly higher. The relatively low concentrations reported in the Udu River study were attributed to the absence of industrial activities and PCB-related inputs. Therefore, the elevated concentrations observed in this study likely reflect anthropogenic influences such as construction activities, industrial emissions and environmental waste deposition at the flyover sites.

Despite the absence of indicator PCBs, the exclusive detection of dioxin-like congeners (PCB 81 and PCB 114) is of particular significance. According to Yao, et al., such congeners are often associated with paint additives and construction-related materials, suggesting that ongoing construction activities or the leaching of materials from demolished structures may have contributed to their presence in the soil.

Toxic equivalence, ILCR and Implications for risk

The toxic equivalence (TEQ) values calculated for the dioxin-like PCBs further highlight the importance of congener composition in determining environmental risk. At AGL1, TEQ values ranged from 0.0 to 0.03 ng TEQ/g, with an average of 0.011 ng TEQ/g, while at RUA1, TEQ values ranged from 0.0 to 0.00108 ng TEQ/g, with an average of 0.006 ng TEQ/g. PCB 81 was identified as the primary contributor to TEQ at both sites due to its higher toxic equivalency factor. All TEQ values recorded were well below international guideline limits, including the 0.09–1.2 ng TEQ/g range established by the New Zealand Ministry for the Environment, indicating that toxic burden from dioxin-like PCBs remains relatively low. However, the presence of measurable TEQ values confirms that even low concentrations of highly toxic congeners can contribute meaningfully to overall risk.

The calculated Incremental Lifetime Cancer Risk (ILCR) values provide a more comprehensive understanding of potential human health implications. At the AGL1 site, the total ILCR was 1.76×10^{-6}, while RUA1 recorded a total ILCR of 1.00×10^{-6}. These values fall within the acceptable risk range of 10^{-6} to 10^{-4}, but AGL1 slightly exceeds the lower threshold of 10^{-6}, indicating a potentially elevated carcinogenic risk. Across both sites, the dominant exposure pathway was ingestion, followed closely by dermal contact, while inhalation contributed negligibly

to overall risk. At AGL1, ingestion ILCR was 9.17×10^{-7}, while dermal ILCR was 8.47×10^{-7}, demonstrating that both pathways contribute almost equally to total risk. A similar trend was observed at RUA1, where ingestion and dermal pathways accounted for the majority of exposure.

Importantly, despite the relatively low total PCB concentrations at both sites, the ILCR values were comparatively elevated. This highlights a critical observation: Carcinogenic risk is driven more by the presence of highly toxic dioxin-like congeners than by total PCB concentration. This is consistent with the TEQ findings, where PCB 81, despite its relatively low concentration, contributed disproportionately to toxicity due to its high toxic equivalency factor.

Comparison of PCBs to guideline values

Although the study was carried out in Nigeria, at the moment there are currently no regulatory limits that have been set by the Nigerian government for the monitoring of environmental PCBs, as such the values are compared to guidelines from other countries. Upon evaluation, the concentrations of PCBs across all samples at the AG1L and RUA1 sites as well as the average values were found not to exceed the regulatory limit of 0.5-33mg/kg (500 - 33000 ng/g) stipulated for different kinds of land use by the Canadian council of ministers of Environment which has a concentration limit of 0.5 and 1.3mg/kg particularly being stipulated specifically for agricultural and residential area land use respectively[13]. The values were also below the stipulated US EPA guideline of 1mg/kg (1000ng/g) in soil around areas of busy occupancy[14]. Values were also low when compared to the standard set by the National Oceanic and Atmospheric Administration of the USA which range from 0.5- 5mg/kg (500-5000ng/g) with 0.5mg/kg being the stipulated standard for agricultural use and 5mg/kg being the limit for soils in residential areas. In comparison to the values set by the New Zealand Ministry for the environment, total PCB concentration at the AGL1 and RUA1 sites were also below the regulatory limit of 0.22mg/kg (220 ng/g) for residential areas[15,16]. The detection of the 7 indicator PCBs across all samples were all below the regulatory limit of 0.02 mg/kg (20ng/g) set by the german environmental legislative body for individual indicator samples present in a sample[12].

Conclusion

PCB congeners were found to be present in soils around flyover construction site and its surrounding environs. The concentrations of PCBs were highly variable, ranging from below the detection limit to higher-than-normal concentrations. The concentrations of PCBs across all samples at the AG1L and RUA1 sites as well as the average values were found not to exceed the regulatory limit of 0.5-33mg/kg (500 - 33000 ng/g). This variability suggests localized sources of contamination, likely linked to industrial discharges, urban runoff or improper disposal of PCB-containing materials. Generally, the low concentrations of PCBs detected align with the controlled usage and regulatory restrictions on PCBs in recent decades. In terms of toxic potency and probabilistic health impact, the presence of measurable TEQ values confirms that even low concentrations of highly toxic congeners can contribute to severe health risk. These findings highlight the importance of monitoring urban soil contamination and aligning land-use planning with human health assessment criteria to manage chronic exposure risks effectively. Implementation of Routine Monitoring Programs. Regular, multi-seasonal monitoring of PCBs should be established at construction sites and surrounding areas. This will allow for the detection of temporal trends, early identification of contamination hotspots and better understanding of pollutant dynamics of the area.

References

1. Erickson MD, Kaley RG. Applications of polychlorinated biphenyls. Environ Sci Pollution Res 2011;18:135-151.
2. Aganbi E, Iwegbue CM, Martincigh BS. Concentrations and risks of polychlorinated biphenyls (PCBs) in transformer oils and the environment of a power plant in the Niger Delta, Nigeria. Toxicology reports 2019;6:933-939.
3. Adesina OA, Ezengwa I, Abdulraheem KA, et al. Soil concentrations of Polychlorinated Biphenyl in a typical Nigerian University environment and its risk assessment. Case Studies in Chem Environ Eng 2023;7:100343.
4. UNEP. Chemicals of concern in the building and construction sector, project ID: 977. UNEP 2021.
5. Montano L, Pironti C, Pinto G, et al. Polychlorinated Biphenyls (PCBs) in the Environment: Occupational and Exposure Events, Effects on Human Health and Fertility. Toxics 2022;10(7);365.
6. Bamidele A, Kuton MP, Iniobong AD, et al. Bioaccumulation of polychlorinated biphenyls (PCBs) in fish host-parasite bentho-pelagic food chain in Epe Lagoon, Lagos, Nigeria. Bulletin of environmental contamination and toxicology 2020;105(5):770-776.
7. Scott M, Snyder R. PCBs in construction materials: old chemical, new context. Environ Claims J 2015;27(3):244-263.
8. Herrick RF, Stewart JH, Allen JG. Review of PCBs in US schools: a brief history, an estimate of the number of impacted schools and an approach for evaluating indoor air samples. Environ Sci Pollution Res 2016;23:1975-1985.
9. Li M, Sun S. Technological Developments and Remediation Mechanisms for Phytoremediation of PCB-Contaminated Soils. Sustainability 2022;14(20):13582.
10. Paine JM, McKee MJ, Ryan ME. Toxicity and bioaccumulation of soil PCBs in crickets: Comparison of laboratory and field studies. Environ Toxicology Chem 1993;12(11):2097-2103.
11. Deng Z, Han X, Chen C, et al. The distribution characteristics of polychlorinated biphenyls (PCBs) in the surface sediments of Ross Sea and Drake Passage, Antarctica: A 192 congeners analysis. Marine pollution bulletin 2020;154:111043.
12. Iniaghe PO, Kpomah ED. Polychlorinated biphenyls (PCBs) in water and sediments from the Udu River, Niger Delta, Nigeria: concentration, distribution and risk assessment. Journal of Environmental Exposure Assessment 2022;1(3):20.
13. CCME (Canadian Council of Ministers of the Environment). Canadian soil quality guidelines for the protection of environmental and human health: Summary tables. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg 2007.
14. USEPA. Steps to Safe PCB Abatement Activities. United Nations Environmental Protection Agency 2023.
15. New Zealand Ministry for the Environment. Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health [PDF]. Wellington: Ministry for the Environment 2011.
16. Kumar B, Verma VK, Singh SK, et al. Polychlorinated biphenyls in residential soils and their health risk and hazard in an industrial city in India. J Public health Res 2014;3(2).