POLYCHLORINATED BIPHENYL (PCBs) LEVELS AND ECOLOGICAL RISK ASSESSMENT IN AMBIENT AIR OF AN URBAN ENVIRONMENT WITH INTENSIVE GAS FLARE

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INTRODUCTION

- Polychlorinated biphenyl (PCBs) are persistent organic pollutants (POPs) and comprises a light yellow or deep yellow oily liquid with unique properties such as extreme stability, chemical inertness, resistant to heat, high dielectric constant and therefore good insulator.

- They are widely used in transformers and power capacitors (Fitzgerald *et al.,* 2007).

- Other applications include: hydraulic fluids, plasticizers, surface coatings, adhesives, pesticides, dyes, carbonless copy and waxes.

JUSTIFICATION

- **Yenagoa** located in Bayelsa State is known for oil and gas production with intensive gas flaring in many communities.
- It is generally believed that Niger Delta region especially Bayelsa State has suffered all forms of pollution resulting from exploration, production and distribution of oil and gas.
- Most of the studies are focused on pollution arising from crude oil production.
- Literature on PCBs levels, distribution and ecological risk assessment in Niger Delta region is scanty, where is available is centred on soil, sediment and river.
- Despite these, air remains the most important component of the environment.

JUSTIFICATION CONT'D

- Therefore, the objectives of this study are to investigate the **concentrations** and **distribution** of PCBs in ambient air of oil and gas producing communities with intensive gas flaring with view to ascertain the **sources**, **distribution** and **ecological risk assessment** in the area.

MATERIALS AND METHODS

STUDY AREA:

- The study area is Yenagoa and its environs located in Bayelsa State South-South Nigeria, geographically located within Latitude 04°15' North, 05°23' South and longitude 05°22' West and 06°45' East.

Table 1. Study Area Description

S/N	Locations	Location Code	Coordinates	Description of Activities
1	FUO gate	AQ OT	4⁰'47'40.18"N 6⁰18'52.28"E	Commercial activities, Farming.
2	Shell flow station Imiringi	AQ IM	4⁰51'06.18"N 6⁰22'16.50"E	Industrial/commercial area
3	Shell flow station Otuabagi	AQ OG	4⁰40'01.92"N 6⁰18'29.81"E	Industrial/commercial area.
4	Bayelsa Palm	AQ BP	4⁰51'50.18N 6⁰18'52.74E	Industrial, vehicular and farming.
5	LNG Gbaran-ubie	AQ GU	5⁰0'44.73N 6⁰17'50.6E	Industrial activities and Gas flaring
6	Tombia Roundabout	AQ TR	5⁰57'13.88N 6⁰21'29.57E	Commercial activities and vehicular movements

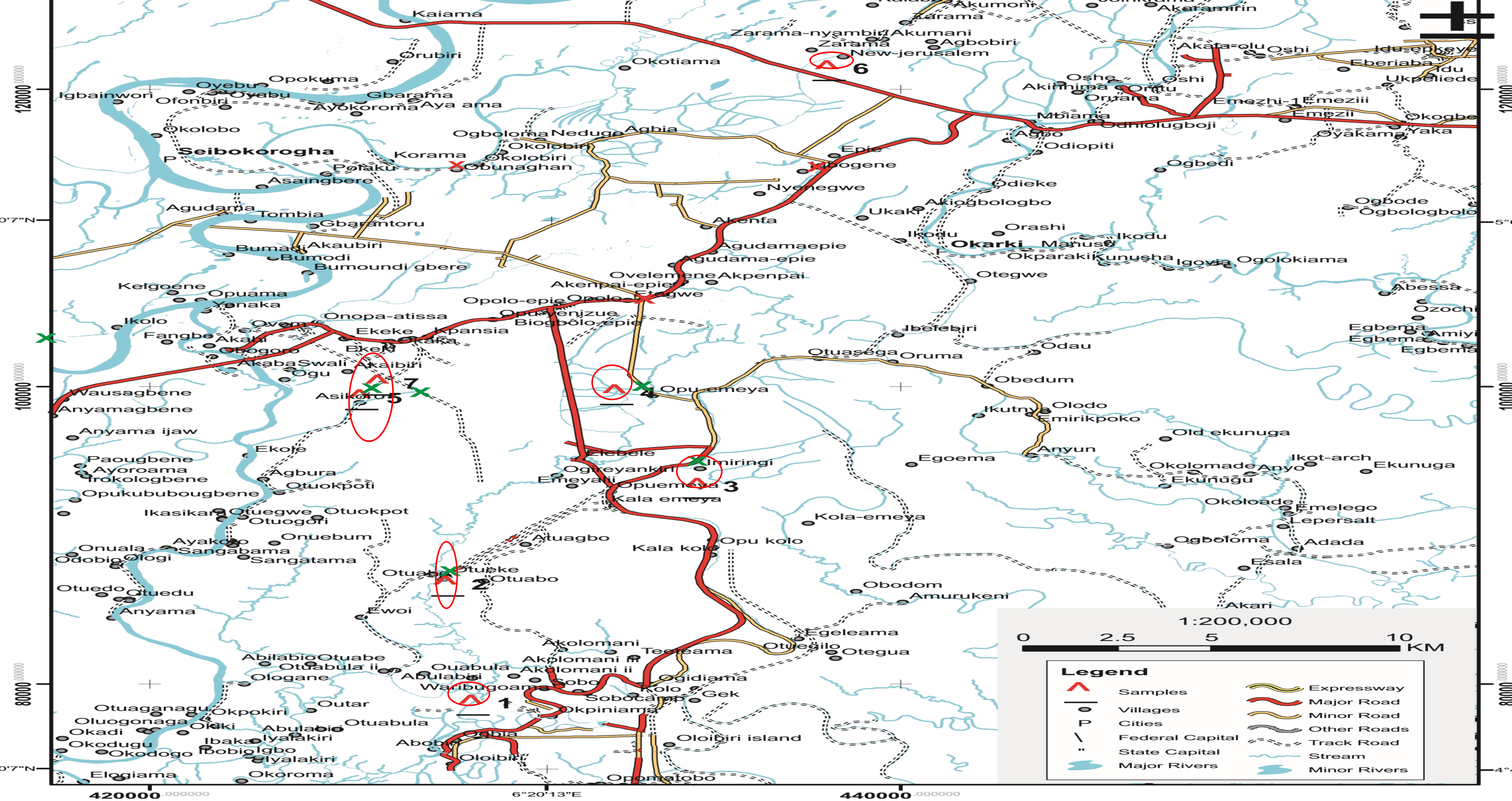

Figure 1. Niger Delta communities Bayelsa state showing sampling stations

MATERIALS AND METHODS CONT'D

Sampling

•Moss plant *Orthodicranum flagella* samples were collected in six (6) determined sampling stations in Bayelsa State between December 2016 to November 2017 in a pre-cleaned amber glass bottles using Spatula.

•The bottles were covered with teflon lured cap and transported to the laboratory in an ice chest for further analysis.

MATERIALS AND METHODS CONT'D

Sample Extractions and Analysis (ASTM D6160-98, 2013)

- Samples was washed and separated from particles of soil and debris.
- Cleaned samples were placed on a 24mm filter paper and air dried first and later placed in a dryer at 120°C until a constant weight was obtained.
- The samples using piston were grounded in a mortar to obtain a powdered form which was then inserted in clean borosilicate container.
- **The standard reference method employed in the PCB analysis was ASTM D6160-98(2013).**

MATERIALS AND METHODS CONT'D

Sample Analysis

- The PCB congeners were analyzed using gas chromatography (Shimadzu, 2010 Japan) on fused silica capillary column (HP-5MS, Agilent) 60m x 0.25mm x 0.25mm film with nitrogen gas as the carrier at a flow rate of 1.0mLmin^{-1}.
- The temperature program of the column oven was set at 170^0C for 1 min, then further increased by 3^0C min^{-1} to 270^0C, kept for 1 min, then further increased by 10^0C min^{-1} to 290^0C, and maintained at 225^0C and 300^0C respectively.

MATERIALS AND METHODS CONT'D

Quality Assurance and Control

- A certified reference standard of Sigma-Aldrich was used for the instrument calibration and quantification of PCBs congeners.

- The PCBs congeners were identified in the samples extract by comparing the accurate retention time from the standard mixture and quantified using the response from five level calibration curves from the standards.

- The accuracy of the procedure was determined using a procedural blank and samples spiked with PCBs standards. Each sample was analysed monthly in triplicate (n=3) and the average was used for calculations.

MATERIALS AND METHODS CONT'D

•Calculated concentration was reported as less than the limit of detection if the peak area did not exceed the specified threshold (three times the noise).

•Concentration below the limit was assigned zero value for the statistical analysis.

STATISTICAL ANALYSIS

- Basic statistical analysis was performed to determine whether the concentrations of PCBs varied significantly between locations. Also using statistical package (SPSS 21.0) the factors responsible for the concentrations measured were determined.

RESULTS AND DISCUSSION

Table 2. Annual Average PCBs Congeners' Concentrations (μgkg^{-1}) in six sampling locations

Components	AQ OT	AQ IM	AQ OG	AQ BP	AQ GU	AQ TR	Total		Mean	SD	Median
Di-PCB CN 7*	0.001	0.001	0.007	0.00	0.008	0.012	0.029		0.005	0.005	0.004
Tri-PCB CN 28*	0.007	0.003	0.004	0.001	0.002	0.007	0.024		0.004	0.003	0.0035
Tetr-PCB CN 60*	0.013	0.00	0.00	0.001	0.003	0.000	0.017		0.003	0.005	0.0005
Pent-PCB CN 105*	0.00	0.000	0.000	0.000	0.008	0.000	0.000		0.001	0.003	0.00
Pent-PCB CN 123*	0.002	0.006	0.008	0.004	0.009	0.000	0.029		0.005	0.004	0.005
Tetr-PCB CN 77**	0.010	0.008	0.011	0.001	0.009	0.003	0.043		0.007	0.004	0.0085
Pent-PCB CN 126**	0.008	0.009	0.008	0.000	0.006	0.018	0.049		0.008	0.006	0.008
Tetr-PCB CN 18***	0.003	0.004	0.002	0.000	0.00	0.006	0.015		0.003	0.002	0.0025
Tetr-PCB CN 43***	0.011	0.010	0.008	0.001	0.008	0.008	0.046		0.008	0.004	0.008
Tetr-PCB CN 52***	0.005	0.005	0.004	0.002	0.005	0.010	0.031		0.005	0.003	0.005
Pent-PCB CN 101***	0.008	0.008	0.009	0.001	0.013	0.000	0.039		0.007	0.005	0.008

Table 2 cont'. Annual Average PCBs Congeners' Concentrations (µgkg^{-1}) in six sampling locations

Hexa-PCB CN 128* **	**0.007**	**0.002**	**0.012**	**0.003**	**0.007**	**0.014**	**0.045**		**0.008**	**0.005**	**0.007**
Hexa-PCB CN 137* **	0.004	0.003	0.000	0.003	0.008	0.003	0.021		0.004	0.003	0.003
Hexa-PCB CN 154* **	0.004	0.000	0.000	0.003	0.007	0.009	0.023		0.004	0.004	0.0035
Hept-PCB CN 170* **	0.002	0.003	0.002	0.00	0.004	0.000	0.021		0.002	0.002	0.002
Hept-PCB CN 180* **	0.005	0.001	0.003	0.001	0.004	0.000	0.014		0.002	0.002	0.002
Hept-PCB CN 185* **	0.002	0.005	0.002	0.001	0.003	0.002	0.015		0.003	0.001	0.002
Octa-PCB CN 195* **	0.00	0.004	0.002	0.00	0.001	0.001	0.008		0.001	0.002	0.001
Octa-PCBCN 200* **	0.001	0.001	0.003	0.001	0.001	0.001	0.008		0.001	0.001	0.001
Deca-PCB CN 209* **	0.004	0.00	0.001	0.00	0.002	0.004	0.011		0.002	0.002	0.0015
∑20PCBs	0.097	0.073	0.085	0.023	0.109	0.096					

***Mono-ortho PCBs, **Non-ortho PCBs, ***Di-ortho PCBs**

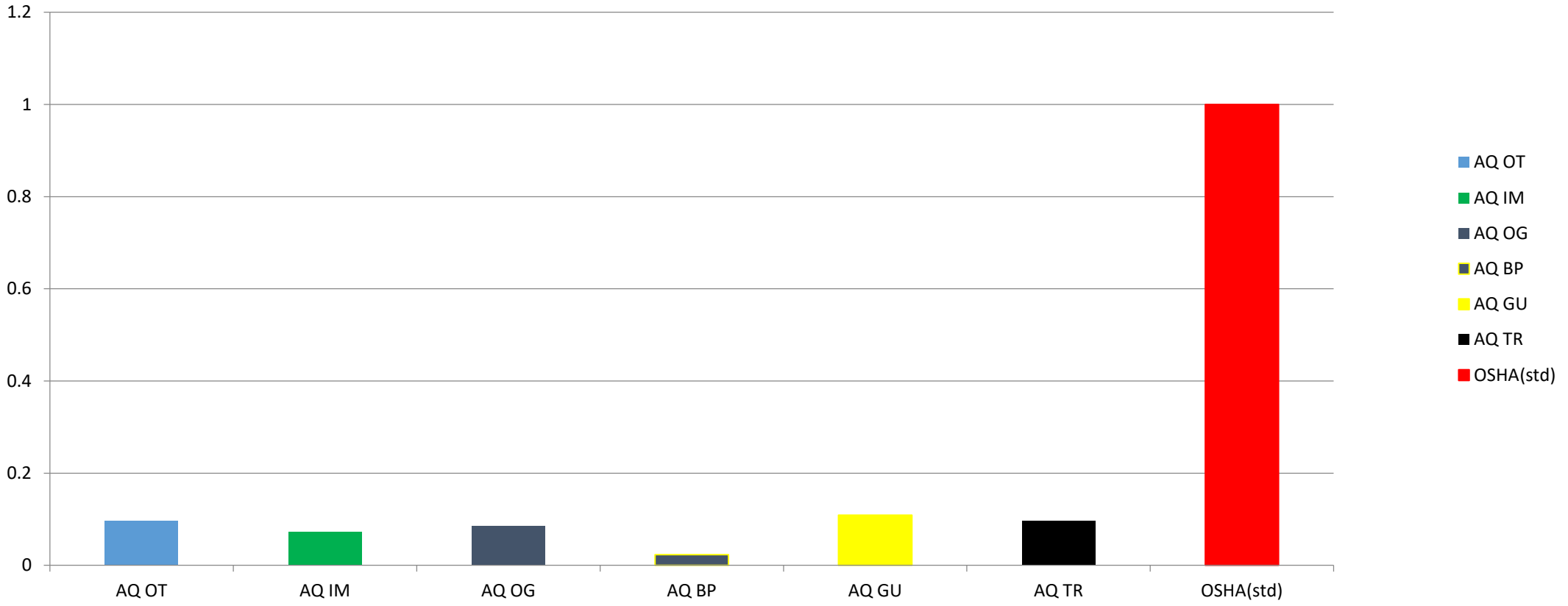

Figure 2. Comparison of total PCBs concentration with set standard (OSHA, 1998)

Table 3. Principal Component Analysis

Variables	Factor 1	Factor 2
AQ OT	.617	-
AQ IM	.756	-
AQ OG	.874	-
AQ BP	-	0.802
AQ GU	.710	-
AQ TR	-	-

Factor 1: Gas flaring
Factor 2: Industrial activities

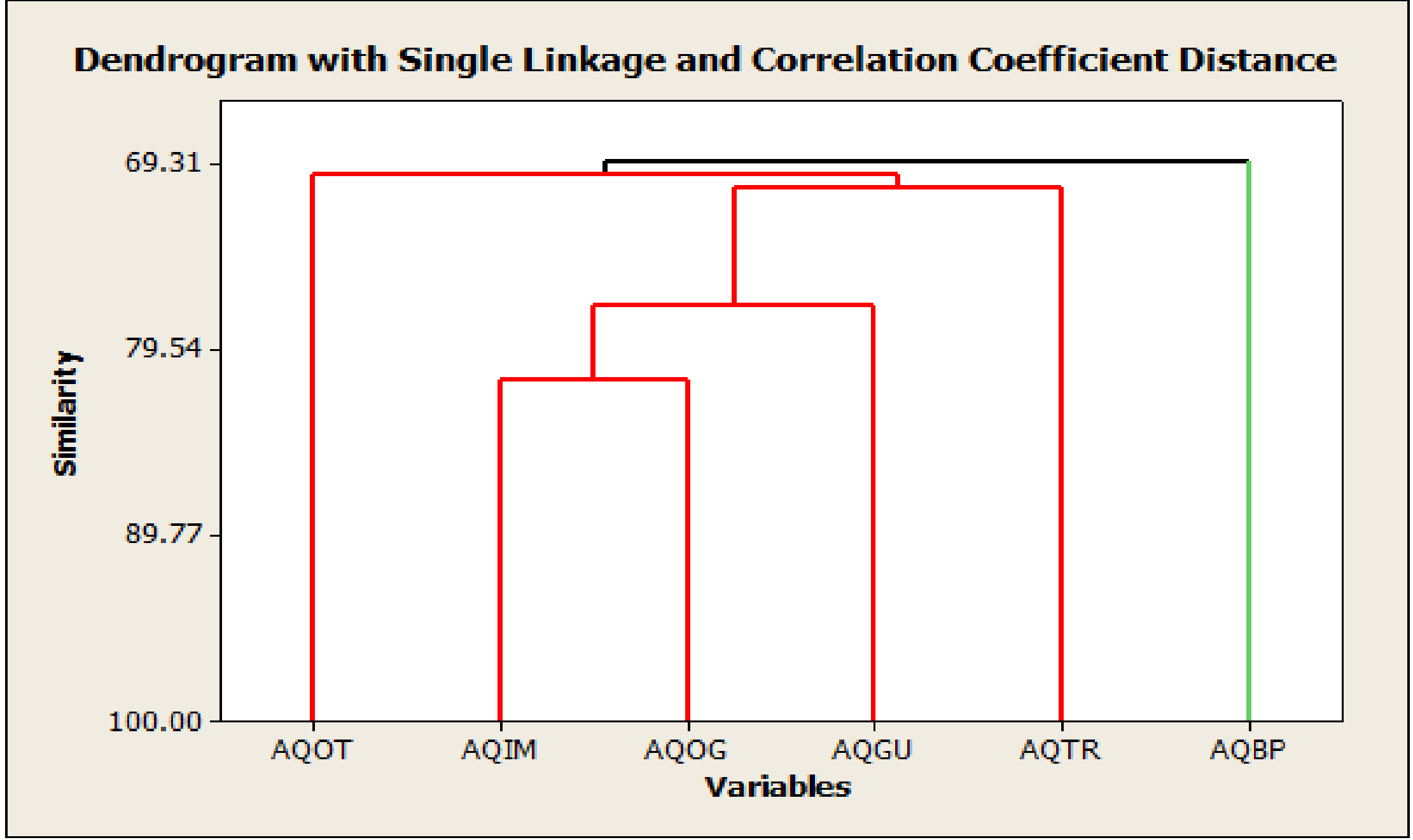

Figure 3. Result of hierarchical cluster analysis

Table 4. Concentration of Polychlorinated Biphenyl Homolog

PBC-homolog	Concentration Range $\mu g kg^{-1}$	%
2 – 4 Chlorinated PCBs	0 – 0.013	36
5 – 7 Chlorinated PCBs	0 – 0.018	49
8 – 10 Chlorinated PCBs	0 – 0.004	15

Table 5. Average Value for Toxicity Equivalent (TEQ) for dioxine-like PCBs (Van den Berg, *et al.*, 2006)

Component	TEF	TEQ
Tetra – PCB CN77	0.0001	4.2×10^{-6}
Penta- PCB CN105	0.00003	2.4×10^{-6}
Penta- PCB CN126	0.1	4.9×10^{-3}
Hepta – PCB CN 170	-	-
Hepta – PCB CN 180	-	-

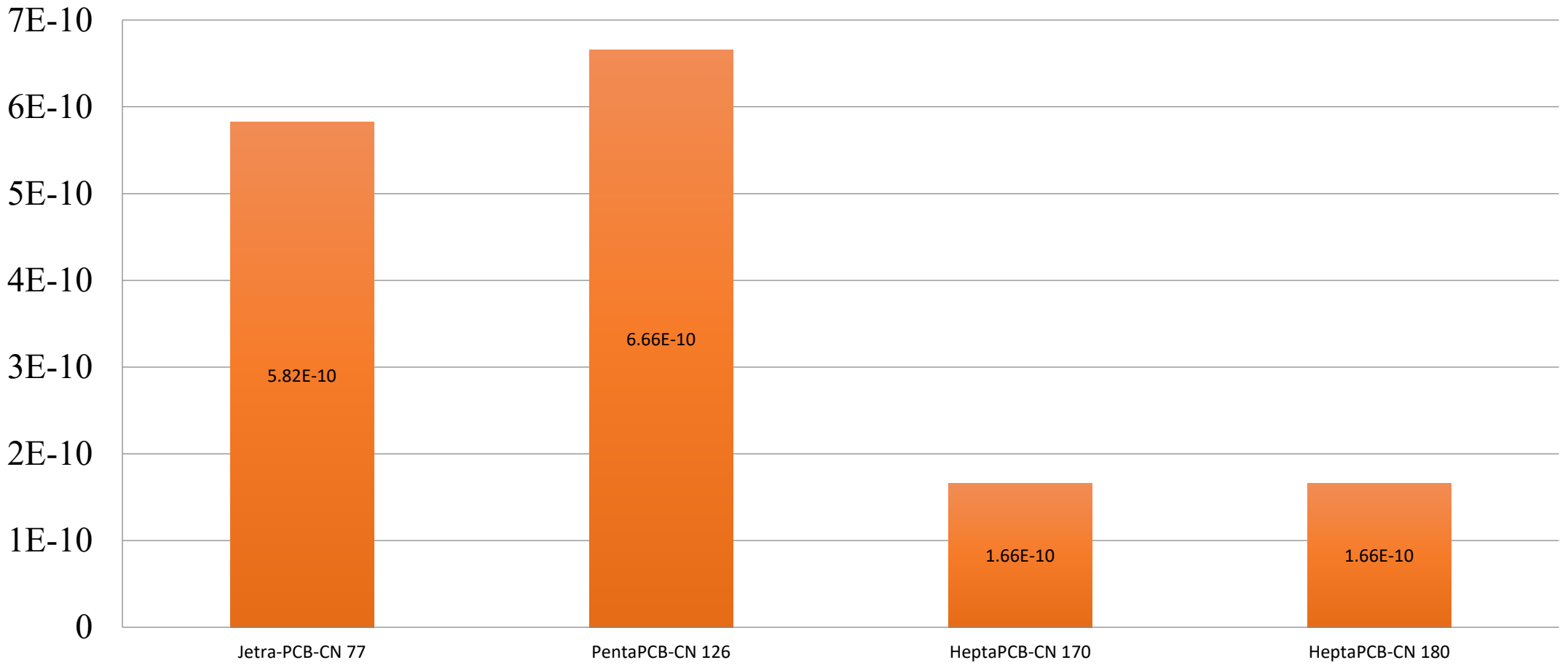

Figure 4. Calculated Cancer Risk (CR) For Various PCB Congeners

CONCLUSION

- The levels and distribution of PCBs concentrations are influenced by gas and crude oil production activities.
- The distribution of the congeners according to the chloro substitution is significant from location to location.
- The study recorded dominance of 5-7 chloro substitution, of which over 65% PCB congeners are di-ortho substituted.
- The results of factor analysis and cluster analysis seems to suggest that two main sources are responsible for the levels and distribution recorded.
- Based on proposed toxicity equivalent guideline, the levels of PCBs measured in the ambient air of Yenagoa and its environ does not possess both ecotoxicological risk (ER) and cancer risk (CR) to human by inhaling PCBs congeners in the studied area.

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Thank
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