

Risks Associated with Radio-frequency Radiation Exposure at Close Proximities to Mobile Phone Base Stations in Port Harcourt, Rivers State, Nigeria.

ABSTRACT

This paper evaluates risks associated with Radio-frequency radiation exposure at close proximities to Mobile Phone Base Stations in Port Harcourt, Rivers State, Nigeria. It involved the use of RF field strength meter, a portable meter with a GPS. Telecommunication Base Stations in Port Harcourt were selected for this study, which are located in Rumuokoro, Mile 3, Garrison and Mile 1. The readings were taken from 5 m to 400 m from the telecommunication base stations (masts) in the north, south, east and west directions at about 1.6m above the ground. The power density obtained ranged between $0.121\mu\text{W}/\text{cm}^2$ and $10.847121\mu\text{W}/\text{cm}^2$. The highest total power density and specific absorption rate was recorded in mile 1 as $10.847\mu\text{W}/\text{cm}^2$ and $3,639.17\mu\text{W}/\text{Kg}$ respectively. These results are below the standards stipulated by the International commission on non-ionizing radiation which is adopted by the Nigeria Communication Commission (NCC). The recommended permissible limits guidelines for safe frequencies between 400 and 2000 MHz, for occupational exposure is $22.5\text{W}/\text{m}^2$, and general public is $4.5\text{W}/\text{m}^2$ for 900 MHz. This means that at a distance of 5m to 400m away from the mast is safe according to these standards though there could be a long term effect on those residing at such distance permanently.

1.1 Introduction

The use of mobile phones in the transmitting of information have being of immense benefit to the 21st century society. Mobile phone usage in Nigeria started in 2001 after Nigeria Communications Commission gave licence to private telecommunication companies to establish in Nigeria. This also prompted the erection of Mobile Phone Base Stations (masts) to meet the communication demand. Mobile phone Base Stations (masts) communication in Nigeria has made life easily for people as they can now communicate with their distant relatives, friends and businesses patterns easily. Telecommunication based stations are located in residential area, school, market place and office premises all around Port Harcourt. However, in Port Harcourt both man and living organisms living in the area may be exposed to variable levels of electromagnetic fields (radiofrequencies), with respect to the distance from the telecommunication base stations (masts), the presence of passive structures to either amplify the wave or to shield them, the number of transmission calls within the transmitters and their position with relationship to the orientation of the antenna (Santini et al., 2000). In spite of the advantages of mobile phones Base Stations (masts) to man, there have been significant concerns about possible negative health effects from exposure of the public to radiofrequency (RF) electromagnetic fields mainly over the proximity of telecommunication base stations (masts) to both residential and official residence (Wolf and wolf, 2004).

Some of the possible negative health effects from radiofrequency (RF) fields shown in scientific reviews has been related to an increase in body temperature from exposure at very high field intensity (W.H.O., 2006). There is also a concern about the effect of cumulative RF radiation resulting from continuous exposure. This have led to serious debates that this long-

term EM radiation exposure may lead to some diseases like cancer and leukemia. Reported effects resulting from EM radiation also include symptoms of sleep-disorders, headaches, nervousness, fatigue, and concentration difficulties (EM Watch, 2011) Researchers as shown that there may be and may not be an association between some health effects and living very close to GSM base stations (Hutter, et al., 2006; Santini, et al., 2003 and Ayinmode and Farai, 2012).

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Since telecommunication base stations (masts) emit radiofrequency (RF) electromagnetic fields, it has become a necessity to make sure that the radiofrequency (RF) around these base stations (masts) be known with respect to standards provided by national and international radiation agencies, so as to make sure that the public are not unnecessarily exposed to harmful radiations. In this study we estimate risks associated with Radio-frequency radiation exposure at close proximities to mobile phone base stations in Port Harcourt, Rivers State, Nigeria.

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1.2. Study Area

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The study area is Port Harcourt which is the capital of Rivers State, Nigeria. The city is located in the oil rich Niger Delta region, southern part of Nigeria. Port Harcourt is situated between Latitudes $4^{\circ}30'$ north and $4^{\circ}45'$ north and Longitudes $7^{\circ}00'$ east and $7^{\circ}15'$ east in the geographical map (Hart et al., 2012). The City occupies about four hundred and seventy square kilometers 470.00sq km of land. According to the 2006 census, the population of the area is 1,000,908 persons (Hart et al., 2012). The area covered are Rumuokoro, mile 3, mile 1 and Garrison.

The study area contain at least two telecommunication base stations (masts) within a distance less than 200m. The map of the Study area is shown in figure 1.

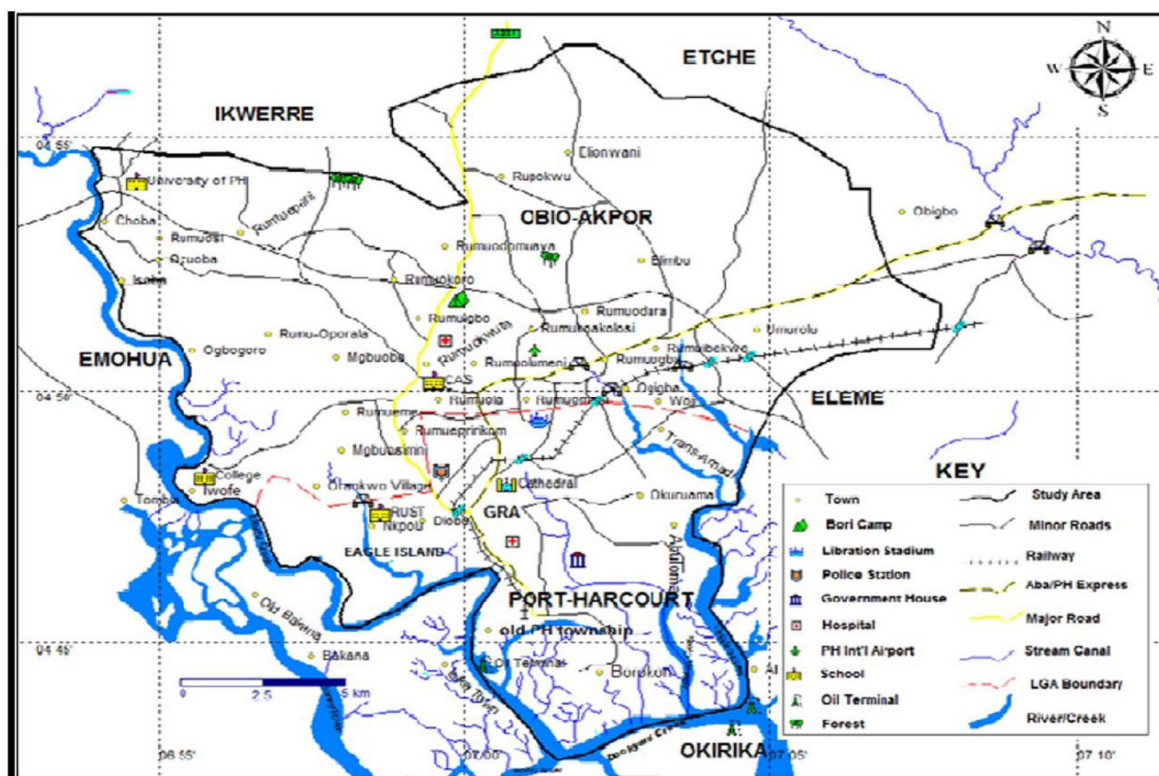


Fig. 1. Map of Port Harcourt City Showing Study Area (Google Maps, 2015)

2. Materials and Method

In this work, field measurement approach was employed to analyze radiations emitted from telecommunication base stations (masts) in the studied area. The radiofrequency field strength meter (ALRF05 Model, Toms Gadgets) was used in the measurement of the power density at strategic distances (5m - 400 m) away from the telecommunication base stations (masts). Radiation was measured at the north, south, east and west direction for a particular telecommunication base station (mast) at distances between 5m - 400 m, at a height of about 1.5m. The distances covered were 400 m for Rumuokoro, 300 m for mile 3, 300 m for mile 1 and 200 m for Garrison. These distances were considered because EMF radiations obtained at these distances were minimal and relatively steady. The GPS 76 (Garmin Model) was used to measure the geographical positions of the measured locations. The bandwidth of the radiofrequency field meter was set to "wide" so that a wider range of radiation can be measured.

The effective power density was computed from the sum of the measured vertical and horizontal radiofrequency field densities.

Calculations

Specific absorption rate is a measure of the rate at which electromagnetic energy is absorbed in the body. The specific absorption rate (SAR) is computed using the formula

93
$$SAR = \rho_{pd} \times a_{hsa} / w_{hw} \quad 1$$

 94 Where ρ_{pd} = power density, a_{hsa} = human surface area (20,128.99 cm²),
 95 and w_{hw} = human weight (60kg), (Enyinna and Avwiri, 2010) .

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97 3. Results and Discussion

98 The results of the average RFR measurements and calculated values of SAR for the
 99 telecommunication base stations (masts) are presented in Tables 1– 4. The total power
 100 density was plotted against distances which are shown in Figures 1- 4, and figures 5-8 shown
 101 the plot of Specific Absorption Rate (SAR) against distances.

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104 Table 1: Average Total Power Density (TPD) and Specific Absorption Rate (SAR)
 105 for the North. South, east and west direction for Rumuokoro
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Distance(m)	Average TPD (μW/cm ²)	Average SAR (μW/Kg)	FCC Standard (μW/cm ²)
5	2.978	999.231	570
10	4.295	1441.085	570
20	2.849	955.840	570
30	2.359	791.333	570
40	1.501	503.474	570
50	0.591	198.415	570
60	0.610	204.767	570
70	0.838	281.261	570
80	0.797	267.282	570
90	0.751	251.961	570
100	1.120	375.760	570
150	1.165	390.969	570
200	1.410	473.167	570
300	0.670	224.897	570
400	0.541	181.394	570

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109 Table 2: Average Total Power Density (TPD) and Specific Absorption Rate (SAR)
 110 for the North. South, east and west direction for Mile 3
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Distance(m)	Average TPD(μW/cm ²)	Average SAR(μW/Kg)
5	3.372	1131.306
10	3.290	1103.711
20	1.592	534.116
30	1.566	525.225
40	1.584	531.264
50	1.894	635.269

60	1.554	521.283
70	1.113	373.244
80	1.827	612.791
90	1.640	550.136
100	2.342	785.573
150	1.633	547.788
200	2.084	699.266
300	0.893	299.518

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113 Table 3: Average Total Power Density (TPD) and Specific Absorption Rate (SAR)
114 for the North. South, east and west direction for Mile 1

Distance(m)	Average TPD($\mu\text{W}/\text{cm}^2$)	Average SAR($\mu\text{W}/\text{Kg}$)
5	4.427	1485.175
10	5.728	1921.577
20	2.573	863.074
30	3.985	1336.968
40	3.649	1224.240
50	2.779	932.438
60	3.688	1237.241
70	2.419	811.575
80	1.634	548.039
90	1.167	391.529
100	0.719	241.057
150	0.517	173.286
200	0.550	184.525
300	0.322	108.031

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116 Table 4: Average Total Power Density (TPD) and Specific Absorption Rate (SAR)
117 for the North. South, east and west direction for Garrison

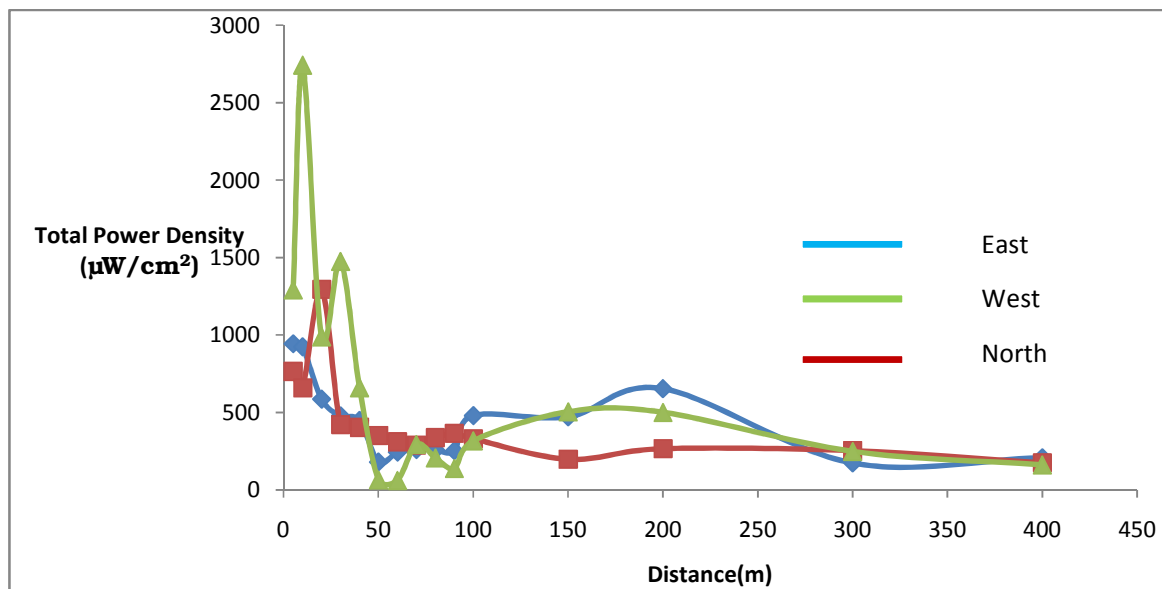
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Distance(m)	Average TPD($\mu\text{W}/\text{cm}^2$)	Average SAR($\mu\text{W}/\text{Kg}$)
5	2.255	756.441
10	2.928	982.232
20	4.145	1390.536
30	2.986	1001.691
40	2.396	803.746
50	2.349	787.978
60	1.917	643.042
70	1.391	466.681
80	0.896	300.720

90	0.498	167.191
100	0.423	142.028
150	0.339	113.846
200	0.206	69.113

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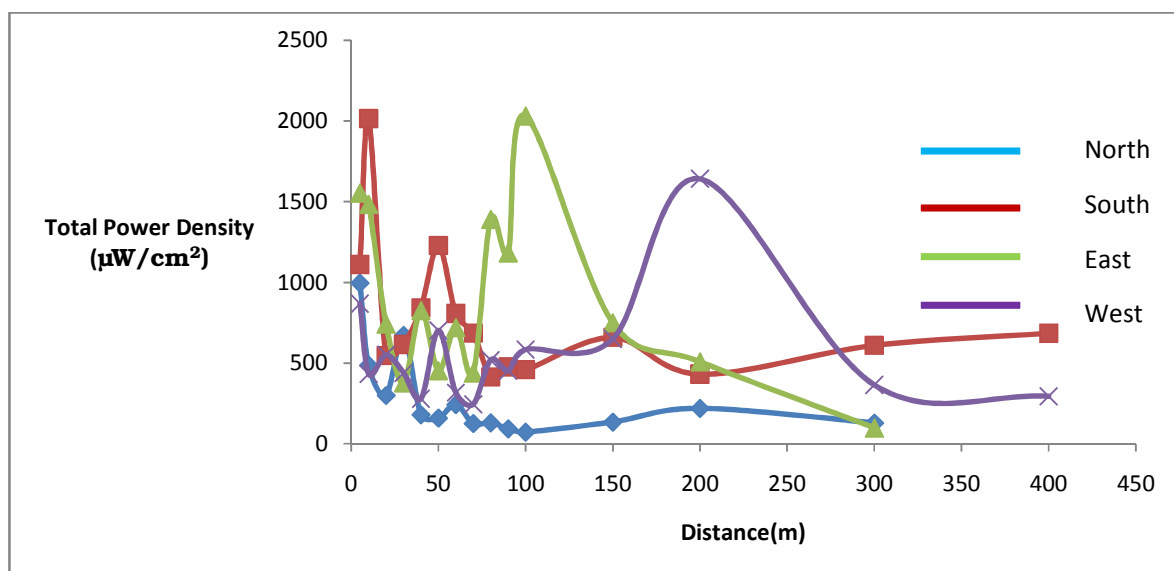
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122 Fig 1: Graph of SAR against distance for the cluster at Rumuokoro for the north, south, east
123 and west directions

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Fig 2: Graph of SAR against distance for the cluster at Mile 3 for the north, south, east and west directions.

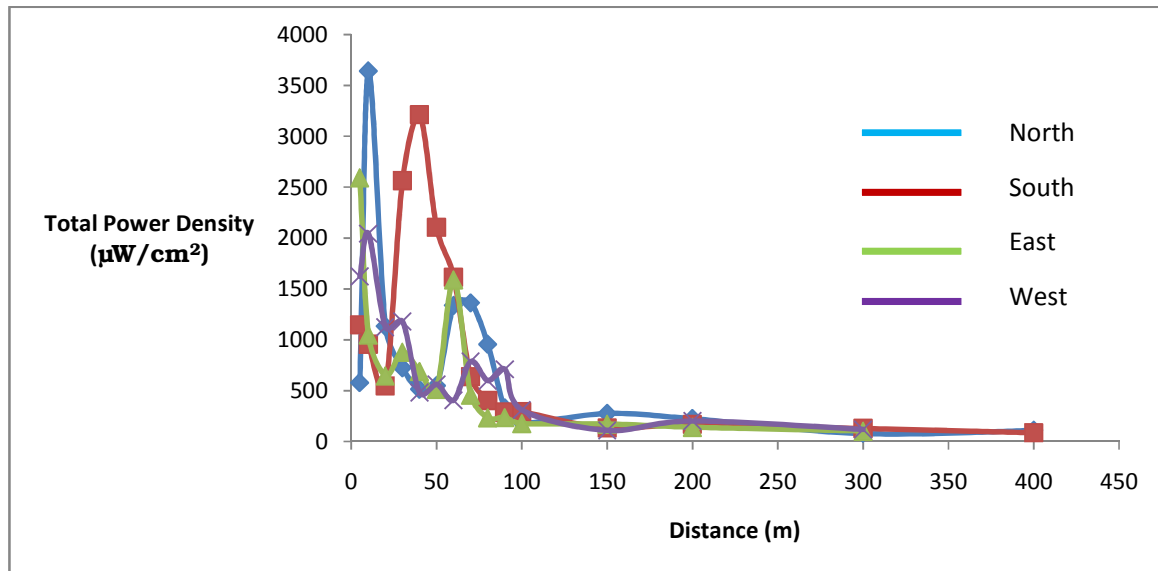


Fig 3: Graph of SAR against distance for the cluster at Mile 1 for the north, south, east and west directions.

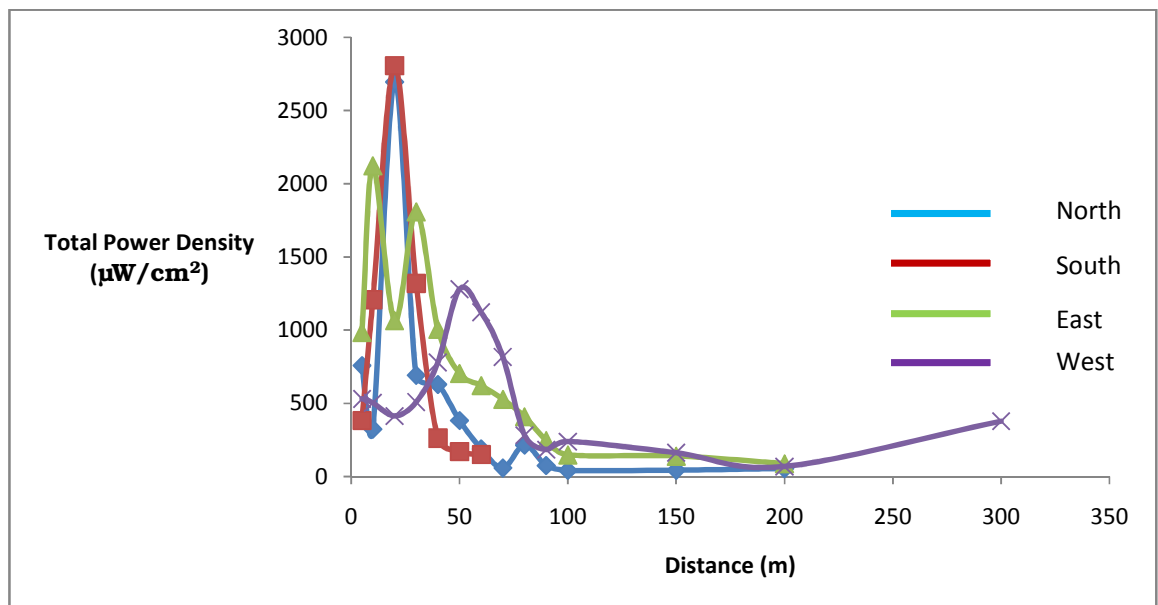


Fig 4: Graph of SAR against distance for the cluster at Garrison for the north, south, east and west directions.

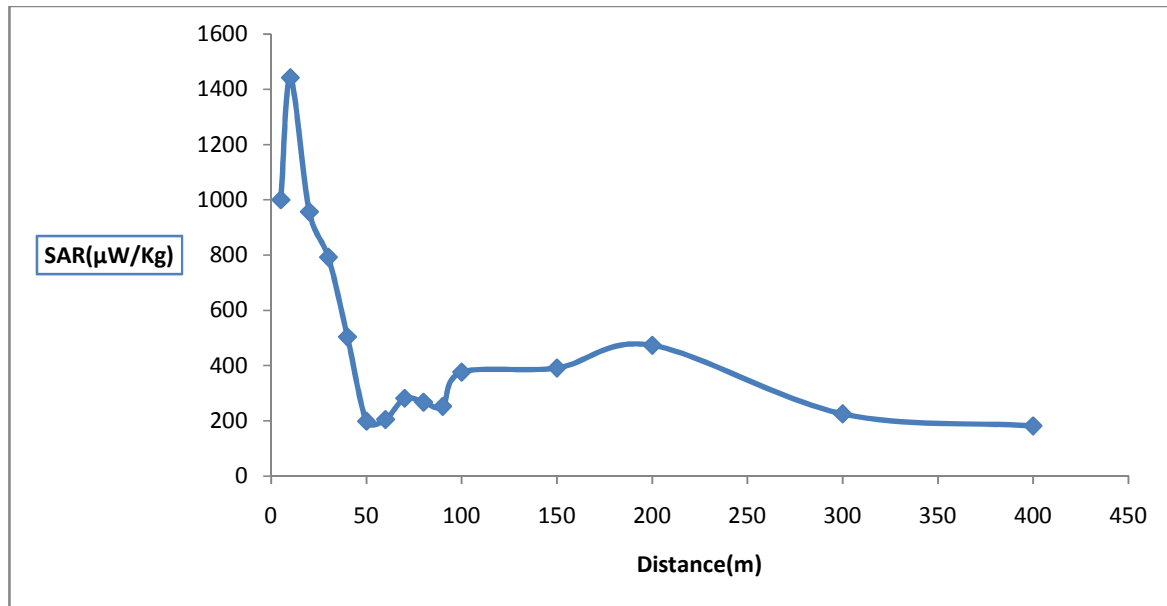


Fig 5: Graph of average SAR against distance for the cluster at Rumuokoro

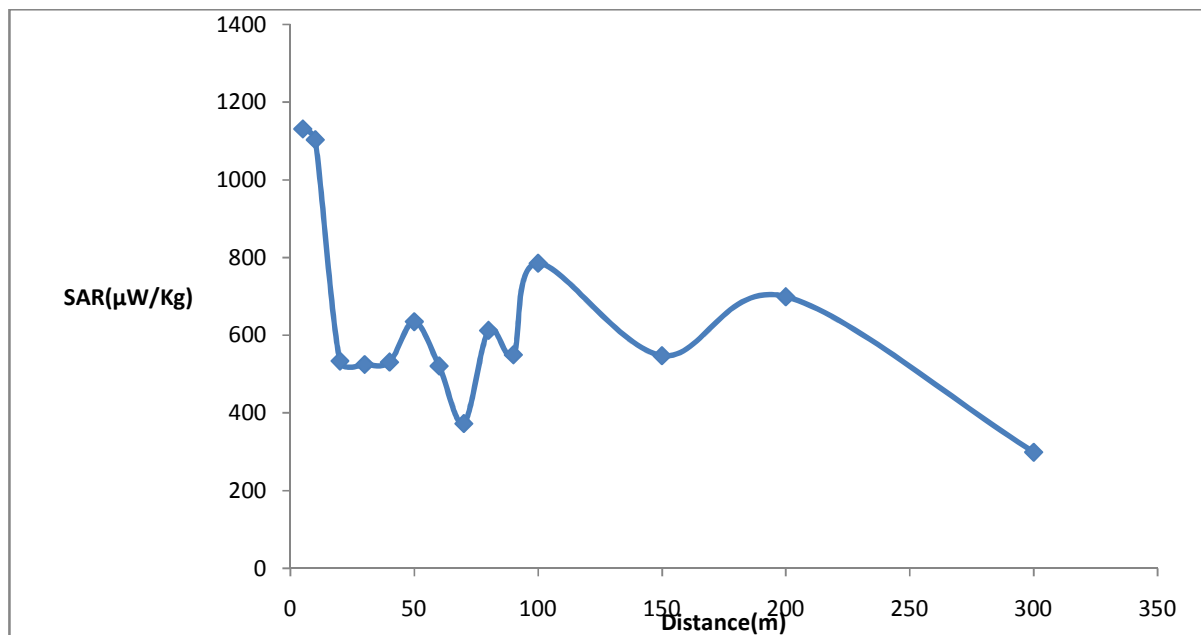


Fig 6: Graph of average SAR against distance for the cluster at Mile 3

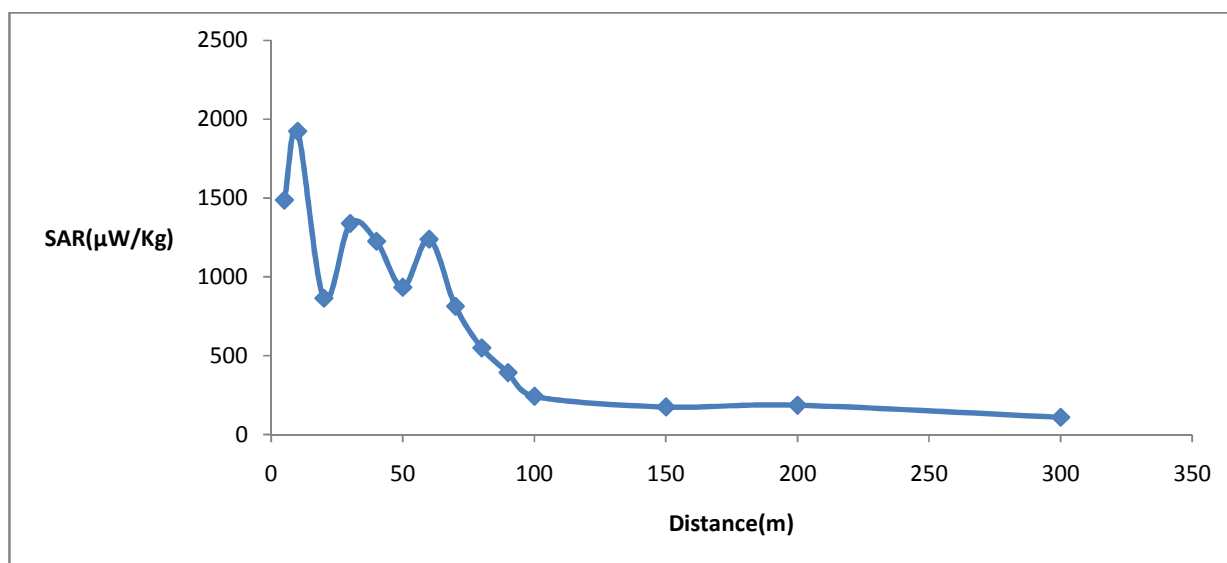


Fig 7: Graph of average SAR against distance for the cluster at Mile 1

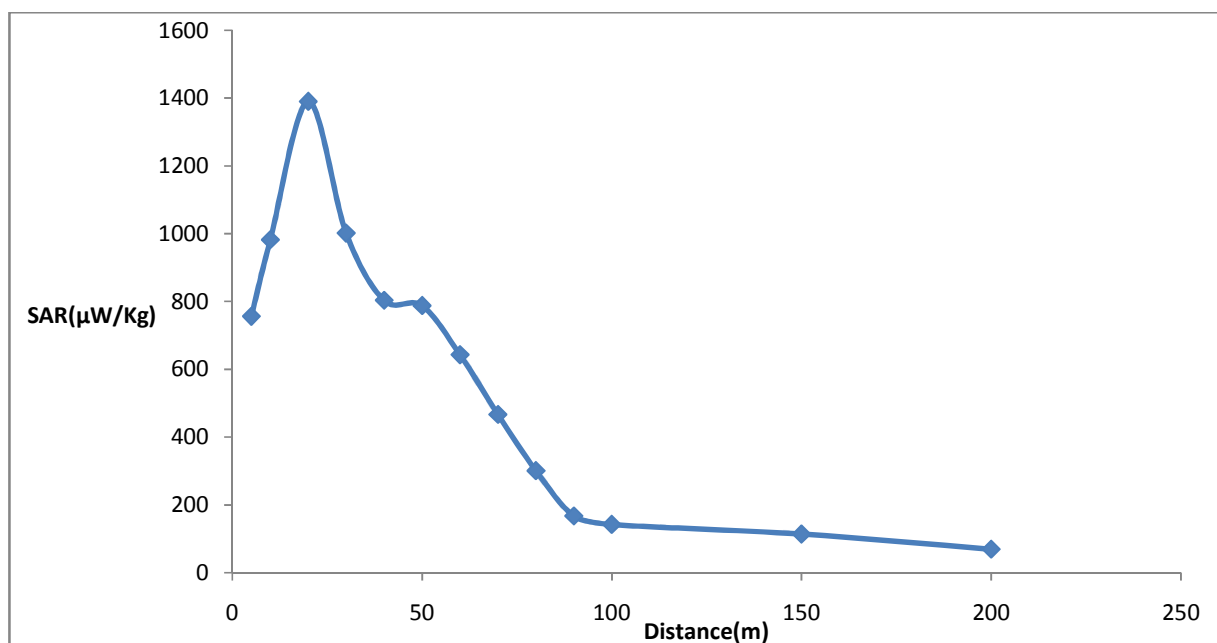


Fig 8: Graph of average SAR against distance for the cluster at Garrison

The power density measured ranged between $0.121 \mu\text{W}/\text{cm}^2$ and $10.847121 \mu\text{W}/\text{cm}^2$. The highest total power density and specific absorption rate was recorded in mile 1 as $10.847 \mu\text{W}/\text{cm}^2$ and $3,639.17 \mu\text{W}/\text{Kg}$ respectively. This is probably because the telecommunication

base stations contains the highest number of masts. This is followed by 6.054 $\mu\text{W}/\text{cm}^2$ and 2031 $\mu\text{W}/\text{Kg}$ in mile 3, 4.394 $\mu\text{W}/\text{cm}^2$ and 1474.18 $\mu\text{W}/\text{Kg}$ in Rumuokoro and 8.265 $\mu\text{W}/\text{cm}^2$ and 2806.450 $\mu\text{W}/\text{Kg}$ in Garrison. This shows that the amount of radiation emitted is directly proportional to the number of mast. Compared to the results obtained by Enyinna and Avwiri (2010), the values are quite high probably because the masts are clustered. Also, when compared to the theoretical values obtained by Sabah 2008, the results are higher. This can be attributed to the fact that there may be other sources of RF radiation apart from the masts which was not taken into consideration. These other sources include power lines, banks and other companies that provide their own network, companies that make use of RF emitting equipments. The graph of measured total power density (TPD) against distance shows that RF radiation from mast decreases with distance, though with some degree of irregularity. This is due to interference from other sources of radiation around the masts such as transformers, uv radiations, domestic/ industrial /medical equipments and WiFi. Theoretically, power density is supposed to decrease linearly with distance, but this is not so practically as shown with the result. This can be due to the interference from these other sources of RF radiation. The results showed that the RF radiations emitted by telecommunication masts clusters in Port Harcourt are below the Federal Communication Commission's recommended permissible limits of 570 $\mu\text{W}/\text{cm}^2$ and 1000 $\mu\text{W}/\text{cm}^2$ (power density) or $1.9 \times 10^5 \mu\text{W}/\text{kg}$ and $3.4 \times 10^5 \mu\text{W}/\text{kg}$ (SAR) for GSM 900 and GSM 1800 respectively and also the ICNRP standards which is 4.5W/m² for GSM 900 and 9.0W/m² for GSM 1800 or 0.08W/kg (SAR). The ICNRP standards are also adopted by the Nigeria Communications Commission (NCC) and National Environmental Standards and Regulations Enforcement Agency (NESRAE). This means that these masts clusters in Port Harcourt are far below the NCC and NESRAE recommended standards. The results showed that there is an insignificant and negative correlation between exposure of RF radiation, human health and long period of time. This is in line with the results obtained by Shalangwa, 2010 using the same method of analysis. This means that there is no effect on human health because the low power emission has no sufficient ionization energy to destroy any part of cell in human body.

4. Conclusion

The radiation density obtained varied sinusoidally with distance which could be as a result of interference from other sources of radiation. The results of the SAR obtained support the fact that telecommunication masts have no negative effect on the environment since they were far below the limits of exposure. Even though people are concerned with the implication of having telecommunication base stations (masts) within residential and business premises, there has not been a conclusive research supporting any adverse effects on human health. This means that the mast clusters does not pose any health hazard to the general public.

We therefore recommended the following:

- ❖ Therefore, telecommunications base stations should be located hundreds of meters away from residential and business premises..
- ❖ Manufactures of telecommunication base station antennas should consider the principle of ALARA (As Low as Reasonably Achievable).

- ❖ Government (both NCC and town planners) should enforce laws to ensure total compliance by telecommunication service providers.
- ❖ Government and NGO should embark on enlightenment campaign at regular interval to sensitize the public on the implications of RF radiation exposure and safety measures.

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