

Characterization of the Radiofrequency Radiation Potential of Alakahia and Choba Communities, Nigeria

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ABSTRACT

A radiofrequency radiation (RFR) survey of Alakahia and Choba Communities of Rivers State has been carried out using a Radio Frequency Field Strength meter and a Geographical Positioning System (GPS). The measurements were carried out around twelve GSM base Stations at maximum distance of 100 metres from each base Station. The results obtained showed a range of maximum total power density (TPD) and specific absorption rate (SAR) of between $0.15\mu\text{W}/\text{cm}^2$ to $3.13\mu\text{W}/\text{cm}^2$ and $50.6\mu\text{W}/\text{kg}$ to $1050.05\mu\text{W}/\text{kg}$ respectively for the twelve surveyed base stations. These results though 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, some of the values obtained are within the range opined by previous researchers to have possible health side effects when individuals are continuously exposed to RFR and at very close ranges. The public and occupationally exposed people are therefore advised to avoid residing very close to the GSM base stations to avert excessive exposure to radio frequency radiation.

INTRODUCTION

The quest for technological innovation the world over has stimulated the construction of high voltage power lines and telecommunication antennas in order to satisfy the high industrial and domestic energy requirements of so many nations and has made provision for effective communication and information dissemination. The liberalization of the Nigerian Telecommunication market in 2001, combined with the emerging development of digital technology, has created room for the advent of several telecommunication companies, and TV and radio stations. These in turn have brought about the development of mobile phones resulting in the proliferation of new radio antenna sites. Many of these new antenna sites are close to residential homes and workplaces. Also, high voltage electric power lines criss-cross the environment and constitute what we may cajole "over head bridges to our residential and office roofs". This technological trend apart from its practical advantages has led to the concern that

radio waves, microwaves, extremely low and very low frequency waves that are being transmitted could be harmful to health [1].

Boscolo [2] studied the impact of radiofrequency radiation (RFR) from radio towers on women. He reported that “RFR” affects the immune system in women at levels as low as $5\mu\text{W}/\text{cm}^2$. Cherry [3] in an extensive and compelling scientific research reported a link in radio frequency radiation/Microwave exposures below $2\mu\text{W}/\text{cm}^2$ to severe health problems and mortality risks.

According to Goldsmith [4], the notion that Radiofrequency level is harmless is no longer tenable. He also stated that delay in protective measures for RFR is likely to lead to increases in cancer, as well as other unfavorable effects. Kwee [5] reported to the Second World Congress on Biology and Medicine of Electricity and Magnetism, in Italy, that there is an increase of cell proliferation at a SAR range of 0.000021 to 0.0021W/kg (about 0.05 to $5\mu\text{W}/\text{cm}^2$).

Lai [6] in a paper presented at Brussels conference on mobile phones concluded that low intensity RFR ($\text{SAR} < 2\text{W}/\text{Kg}$) can affect the nervous system. Magnras et al [7] reported a decrease in reproductive functions in mice exposed to radiofrequency radiation intensities of 160—1053 $\mu\text{W}/\text{cm}^2$. According to Robert [8], exposure to high intensities of RFR can result to heating of biological tissues resulting to tissue damage because of body’s inability to cope with or dissipate the excessive heat that could be generated. The eyes and the testes are particularly most vulnerable to RFR thermal effect because of relative lack of available blood flow to dissipate the excess heat load.

Alakahia and Choba communities are densely populated and play host to University of Port Harcourt Teaching Hospital (UPTH) and University of Port Harcourt respectively. There are many telecommunication antennas belonging to various service providers scattered all over the two communities with the aim of satisfying the communication needs of the numerous end users. Most of these end users are either staff of the two federal establishments, students of the

University, natives or businessmen and women who communicate frequently with the aid of Radiofrequency transmission. Scientific researches bordering on the characterization of the radiofrequency density of the surveyed area and the impact on the inhabitants of these two communities are lacking. There is need to properly document the RFR level of the surveyed area to provide a good standing for future studies. Therefore, the aim of this research is to determine the Specific Absorption Rate of RFR that residents around the surveyed GSM base stations would be exposed to, so as to evaluate the health implications of such exposure especially, when people reside within the range of a hundred meters from a GSM base station.

MATERIALS AND METHOD

Study Area: This study was conducted in June, 2008 within Alakahia and Choba communities in Obio Akpor Local Government Area of Rivers State, Nigeria. The study areas lie within the latitude range of $04^{\circ}52'$ N to $04^{\circ}54'$ N and longitude range of $06^{\circ}53'$ E to $06^{\circ}55'$ E. A lot of GSM networks operate within these areas, giving rise to numerous GSM base stations scattered all over the area. Table 1 shows the network operators of the surveyed base stations and their locations. The radiofrequency field strength meter (ALRF05 Model, Toms Gadgets) was adopted in the measurement of the power density at strategic distances away from the masts. 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 “narrow” to allow a high pass function so that only high frequency radiations such as those emanating from cell towers can be measured. The effective power density was computed from the sum of the measured vertical and horizontal radiofrequency field densities.

The specific absorption rate (SAR) was computed using the formula [9];

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

where ρ_{pd} = power density, a_{hsa} = human surface area ($20,128.99 \text{ cm}^2$) and w_{hw} = human weight (60kg).

Table 1: The Network Operators and Their Locations

S/N	NETWORK OPERATOR	LOCATION/ ADDRESS
1	MTN	A - Delta park, Uniport, Choba
2	MTN	B-University of Port Harcourt Teaching Hospital (UPTH), Alakahia
3	MTN	C- Rumuchakara, Choba
4	MTN	D- Seven Days Adventist (SDA), Choba
5	MTN	E- Alakahia
6	Globacom	F- Behind mechanic workshop, Choba
7	Globacom	G- Delta park, Uniport, Choba
8	Globacom	H- Rumuchakara, Choba
9	Zain	I- Paco estate, Choba
10	Zoom	J- Behind sammies fastfood, Choba
11	Starcomm	K- Wokems estate, Choba
12	NITEL	L- Delta park, Choba

RESULTS AND DISCUSSION

The results of the total power densities for locations A-F and G- L are presented in Figs 1 and 3 respectively. The results show that the maximum power densities for the selected GSM base stations investigated are 1.54, 2.30, 1.97, 132, 3.13, 0.34, 0.28, 0.56, 0.83, 0.20, 0.15 and $0.16\mu\text{W}/\text{cm}^2$ for locations A – L respectively. Also, the results of the specific absorption rates for locations A-F and G- L are presented in Figs 2 and 4 respectively. The maximum computed specific absorption rates (SAR) for the surveyed base stations are 516.30, 771.27, 662.24, 443.84, 1050, 05, 113.73, 93.26, 189.19, 278.78, 67.43, 50.67 and $54.35\mu\text{W}/\text{kg}$ for locations A – L respectively. These maximum power densities occurred within a distance range of between ten to hundred meters from the foot of the GSM base stations surveyed. This trend indicates that the GSM antennas mounted by the various network operators within the surveyed communities emit electromagnetic radiation with maximum power density within the aforementioned range. The implication is that an individual who finds himself within the above range from any of these base stations is likely prone to absorbing maximum radiation dose. Also, these recorded maximum power densities and specific absorption rates are above the values measured close to the foot of the base stations (less than ten meters from the foot of the base stations). This agrees with the result of Mann et al [1], where he reported that in the range of ten to hundreds of meters, sidelobes in the antenna's directional pattern give rise to series of peaks in power density.

The results of Figs 1 and 2 show that the MTN mast at Alakahia (location E) radiated the maximum power density of $3.13\mu\text{W}/\text{cm}^2$ and maximum specific absorption rate (SAR) of $1050.05\mu\text{W}/\text{kg}$ relative to other masts investigated. This could be attributed to the fact that this mast has about six sector antennas attached to the main frame and each of the antennas produces its individual radiation. Also, from the results of Figs 1- 4, seven out of the twelve surveyed base stations had their maximum power densities at distances between 10-60m. This trend is fairly in agreement with the research report that in the United Kingdom, a maximum radiofrequency radiation level of $0.83\mu\text{W}/\text{cm}^2$ was measured on a playing field, sixty meters from the foot of a GSM mast [10]. These positions of maximum power density indicate points of combination of the direct and reflected power densities (from ground) for the various masts [1]. The maximum power density and specific absorption rate of $3.13\mu\text{W}/\text{cm}^2$ and $1050.05\mu\text{W}/\text{kg}$ recorded respectively during the survey are 0.55% and 0.31% of the regulatory exposure limits of $570\mu\text{W}/\text{cm}^2$ and $1000\mu\text{W}/\text{cm}^2$ (in terms of power density) and 0.55% and 0.31% of the regulatory exposure limits of $1.9 \times 10^5\mu\text{W}/\text{kg}$ and $3.4 \times 10^5\mu\text{W}/\text{kg}$ (in terms of SAR) for GSM 900 and GSM 1800 respectively set by the *Federal Communication Commission* [11]. Also, these recorded maximum power density and SAR are 0.7% and 0.33% of the regulatory exposure limits of $450\mu\text{W}/\text{cm}^2$ and $950\mu\text{W}/\text{cm}^2$ (in terms of power density) and are 0.7% and 0.33% of the regulatory exposure limits of $1.5 \times 10^5\mu\text{W}/\text{kg}$ and $3.1 \times 10^5\mu\text{W}/\text{kg}$ (in terms of SAR) for GSM 900 and GSM 1800 respectively set by the *International Commission on Non Ionizing Radiation Protection* [12]. These maximum values of power density and SAR recorded from the surveyed areas are far below these regulatory exposure limits. The recorded values of power density from the surveyed base stations fall within the range of $0.037 - 3.13\mu\text{W}/\text{cm}^2$. This is in agreement with the results of typical power densities of between $0.1 - 0.83\mu\text{W}/\text{cm}^2$ reported by the *National Radiation Protection Board* [10].

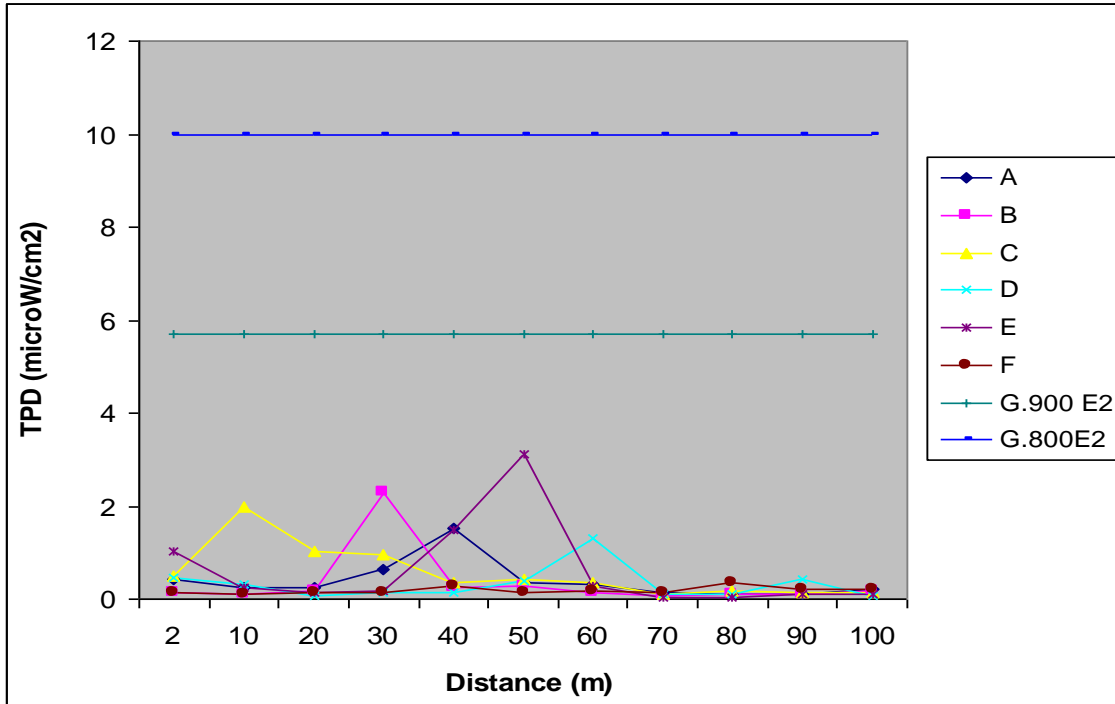


Fig.1: Total power density (TPD) for locations A- F(N/b- G.900E2 = GSM 900 x 10², G.1800E2= GSM 1800 x 10²)

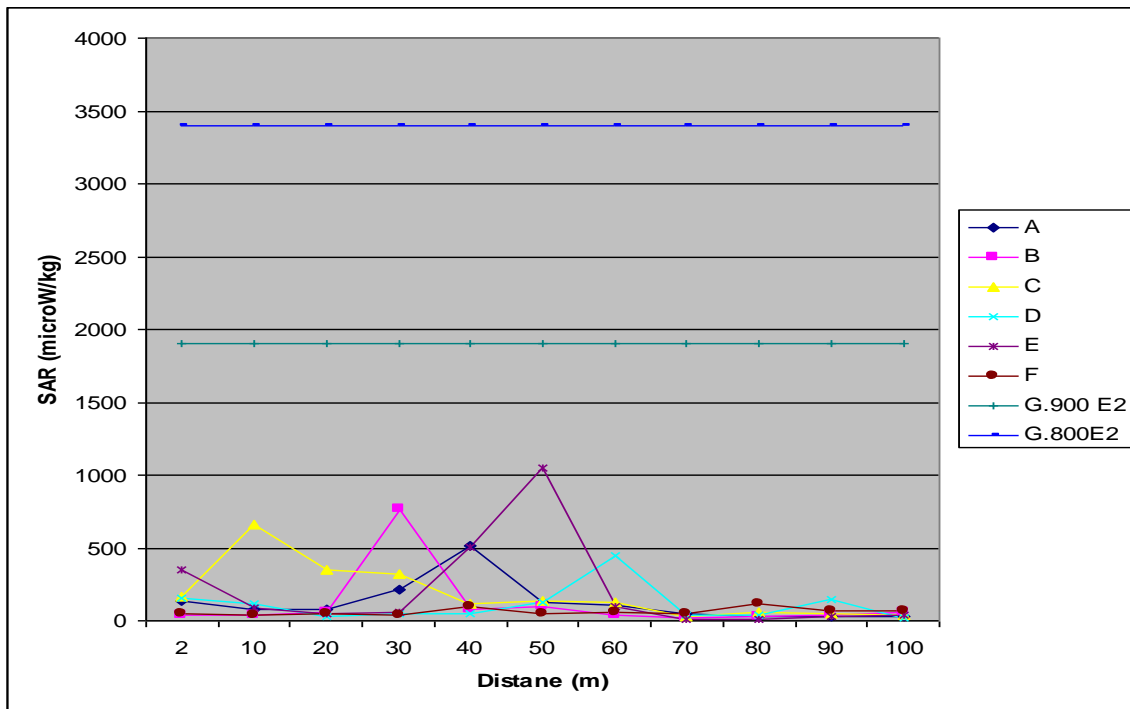


Fig.2: Specific Absorption Rate (SAR) for locations A- F (N/b- G.900E2 = GSM 900 x 10², G.1800E2= GSM 1800 x 10²)

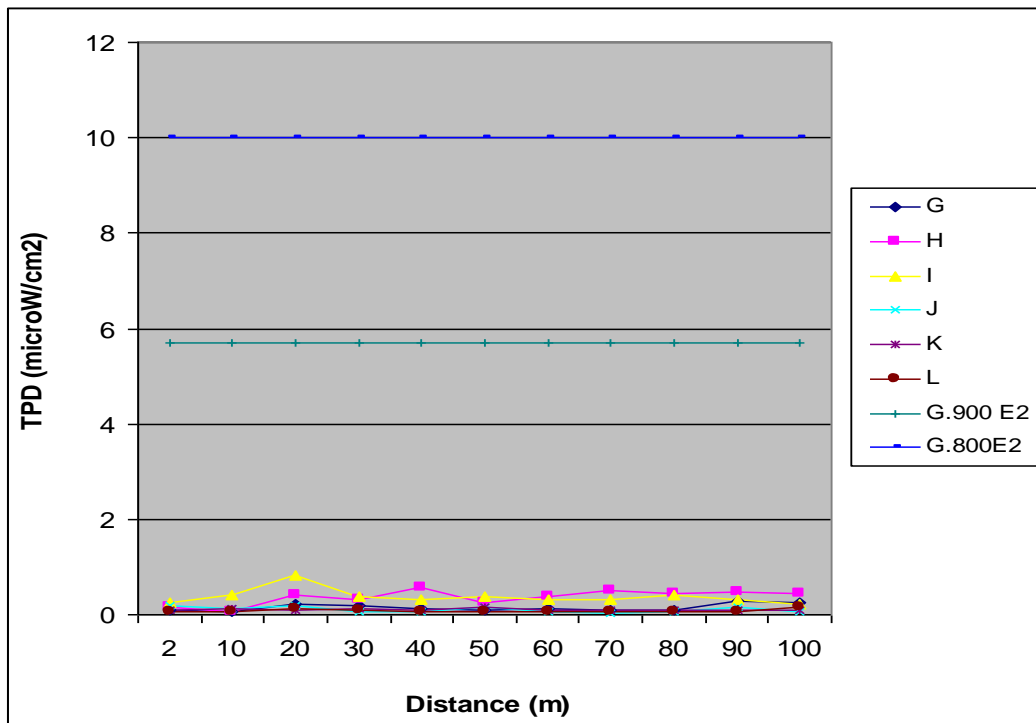


Fig.3 Total power density (TPD) for locations G- L (N/b- G.900E2 = GSM 900 x 10², G.1800E2= GSM 1800 x 10²)

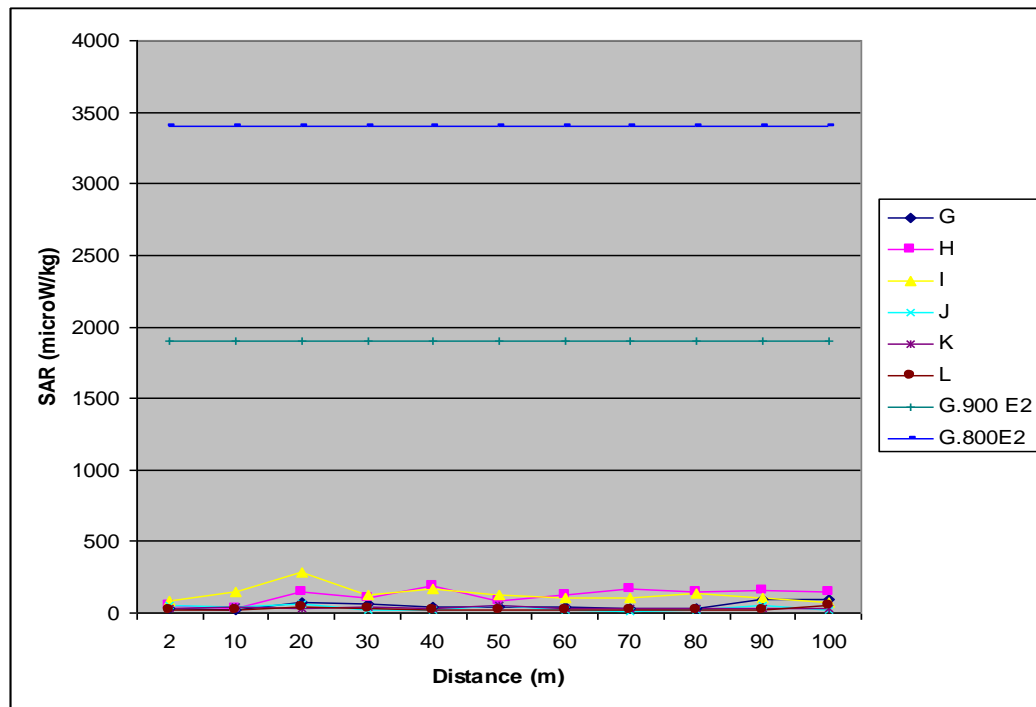


Fig.4: Specific Absorption Rate (SAR) for locations G- L (N/b- G.900E2 = GSM 900 x 10², G.1800E2= GSM 1800 x 10²)

CONCLUSIONS

The measurement of the intensity of Radio Frequency Radiation (RFR) and the computation of specific Absorption Rate (SAR) for Alakahia and Choba communities have been carried out. The results obtained are far below the FCC [11] and ICNIRP [12] recommended permissible limits. Although the RFR and SAR values obtained are low, some of the surveyed base stations have power densities within the range that has been confirmed by previous researchers to be linked with cases of fatigue, headache, sleep disruption and loss of memory as experienced by people who live within 100 meters of cell towers [13]. Therefore, residential and office buildings should be sited hundreds of meters away from base stations. There should be prudent avoidance of exposure to RFR from base stations. Manufactures of base station antennas should consider the principle of ALARA (reducing the output power intensity “As Low as Reasonably Achievable”).

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