Current Journal of Applied Science and Technology

24(3): 1-8, 2017; Article no.CJAST.33104
Previously known as British Journal of Applied Science & Technology
ISSN: 2231-0843, NLM ID: 101664541

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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Authors' contributions

This work was carried out in collaboration between all authors. Authors UNF and OAG designed the study, performed the statistical analysis and wrote the protocol. Authors OAG and EEO wrote the first draft of the manuscript and managed the analyses of the study. Authors EEO and AC managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2017/33104
Editor(s):
(1) Luigi Maxmilian Caligiuri, Professor, Faculty of Science, University of Calabria, Italy and Foundation of Physics Research Center (Director)- FoPRC, Italy.
Reviewers:
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Complete Peer review History: http://www.sciencedomain.org/review-history/21889

Original Research Article

Received 30th March 2017
Accepted 3rd June 2017
Published 13th November 2017

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. Clusters of 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 1.0 m above the ground. The power

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density obtained ranged between 0.121 μW/cm^2 and 10.847121 μW/cm^2. The highest total power density and specific absorption rate were recorded at mile 1 location as 10.847 μW/cm^2 and 3,639.17 μW/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 W/m^2, and general public is 4.5 W/m^2 for 900 MHz. This means that at a distance of 5 m to 400 m away from the mast is safe according to these recommend permissible limit though there could be a long term effect on those residing at such distance permanently.

Keywords: Human health; correlation; hazard; telecommunication; radiation.

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 communication in Nigeria has made communications easy for people as they can now communicate with their distant relatives, friends and business partners easily. These clusters of telecommunication base stations are located around residential areas, schools, market places and office premises all around Port Harcourt and the populace living in such environment 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 [1]. In spite of the numerous advantages of telecommunication, there have been significant concerns about possible negative health effects from exposure of the public to radiofrequency (RF) electromagnetic fields mainly due to the proximity of the base stations (masts) to residential areas, office premises etc [2].

Some of the possible negative health effects from radiofrequency (RF) fields shown in scientific reviews have been related to an increase in body temperature from exposure at very high field intensity [3]. There is also a concern about the effect of cumulative RF radiation resulting from continuous exposure. This has 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 [4] Various researches have shown that there may be an association between some health effects and living very close to GSM base stations [5,6,7].

Port Harcout is a highly populated state headquarters that host several major and service-oriented oil companies with other industrial and manufacturing activities that demands high density network of telecommunication services that have necessitated massive deployment of telecommunication infrastructures with clusters of base stations. The need to estimate risks associated with radio-frequency radiation exposure at close proximities to mobile phone base stations in Port Harcourt, Rivers State, Nigeria and to protect the populace against side -effects of low- level non ionizing radiation lay credence to this study.

1.1 Study Area

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 43° north and 4° 45' north and Longitudes 7° 00' east and 7° 15' east in the geographical map [8]. The City occupies about four hundred and seventy square kilometers 470.00sq km of land. According to the 2006 census, the population of the city is 1,000,908 persons [8]. The locations covered are Rumuokoro, mile 3, mile 1 and Garrison.

The map of the Study area is shown in Fig. 1.

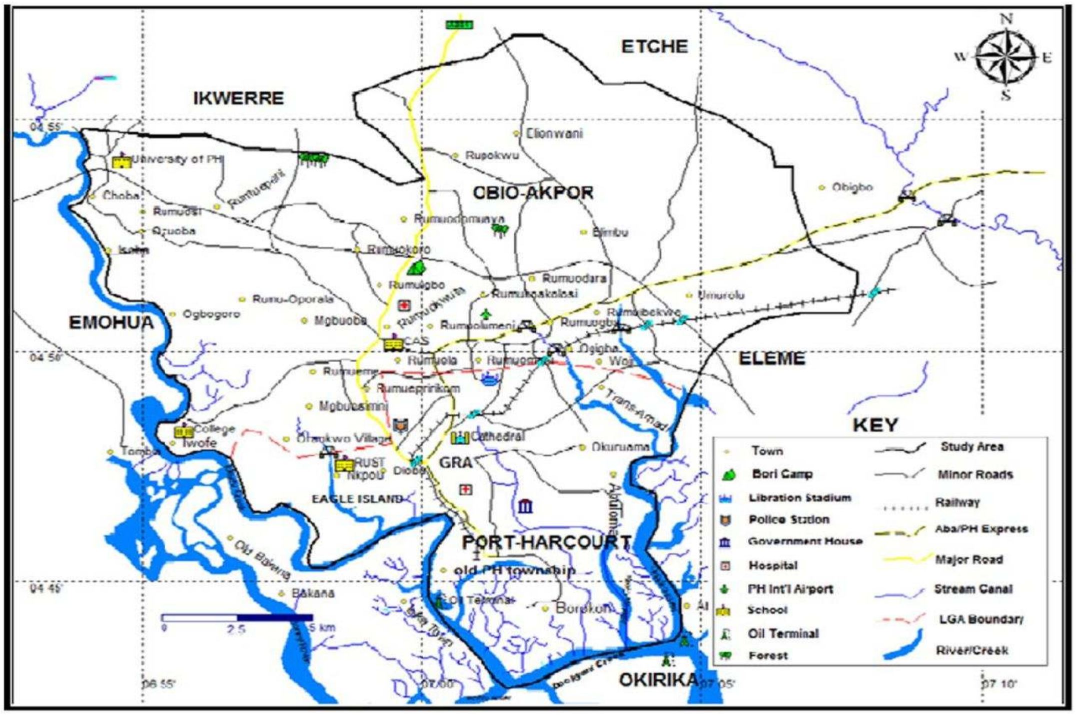

Fig. 1. Map of Port Harcourt City showing study area [9]

2. MATERIALS AND METHODS

An *in situ* measurement approach was employed using a radiofrequency field strength meter (ALRF05 Model, Toms Gadgets). The measurement of the power density were taken at strategic distances (5 m -400 m) away from the clusters of telecommunication base stations at the north, south, east and west directions at regular time daily. The GPS 76 (Garmin Model) was used to measure the geographical positions of the measured locations.

The effective power density was computed from the sum of the measured vertical and horizontal radiofrequency field densities. The specific absorption rate (SAR) is computed using the formula:

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

Where ρ_{pd} = power density, a_{hsa} = human surface area (20,128.99 cm^2), and w_{hw} = Average human weight (60 kg), [10].

3. RESULTS AND DISCUSSION

The results of the average RFR measurements and calculated values of SAR for the telecommunication base stations (masts) are presented in Tables 1–4. The total power density was plotted against distances which are shown in Figs. 2- 5.

The power density measured ranged between 0.121 µW/cm^2 and 10.847121 µW/cm^2. The highest total power density and specific absorption rate were recorded in mile 1 as 10.847 µW/cm^2 and 3,639.17 µW/kg respectively. This is probably because the telecommunication base stations in the area contain the highest number of masts. This is followed by 6.054 µW/cm^2 and 2031 µW/kg in mile 3, 4.394 µW/cm^2 and 1474.18 µW/kg in Rumuokoro and 8.265 µW/cm^2 and 2806.450 µW/kg in Garrison. This shows that the amount of radiation emitted is depend on the number of masts cluster in the telecommunication base stations. Compared to the results obtained by Enyinna and Avwiri [10], the values are quite high probably because the masts are clustered. Also, when compared to the previous values obtained by Sabah [11], 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 were 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 equipment and WiFi. Theoretically, power density is supposed to decrease linearly with distance, but this is not, as practically shown in the figures. 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 µW/cm^2 and 1000 µW/cm^2 (power density) or 1.9 x 10^5 µW/kg and 3.4 x 10^5 µW/kg (SAR) for GSM 900 and GSM 1800 respectively and also the ICNRP [12] standards which are 4.5 W/m^2 for GSM 900 and 9.0W/m^2 for GSM 1800 or 0.08 W/kg (SAR). The ICNRP standards are also adopted by the Nigeria Communications Commission [13] 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 result showed that there is no immediate health hazards between exposure of RF radiation and human health, but may cause long-term health hazard to the residents of Port Harcourt City due to increase with longer period of exposure. This is in line with the results obtained by Shalangwa, [14] using the same method of analysis.

Table 1. Average Total Power Density (TPD) and Specific Absorption Rate (SAR) For the north, south, east and west direction for Rumuokoro

Distance (m)	Average TPD (µW/cm^2)	Average SAR (µW/kg)
5	2.978	999.231
10	4.295	1441.085
20	2.849	955.840
30	2.359	791.333
40	1.501	503.474
50	0.591	198.415
60	0.610	204.767
70	0.838	281.261
80	0.797	267.282
90	0.751	251.961
100	1.120	375.760
150	1.165	390.969
200	1.410	473.167
300	0.670	224.897
400	0.541	181.394

Table 2. Average Total Power Density (TPD) and Specific Absorption Rate (SAR) for the north, south, east and west direction for Mile 3

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

Table 3. Average Total Power Density (TPD) and Specific Absorption Rate (SAR) for the north, south, east and west direction for Mile 1

Distance (m)	Average TPD (µW/cm^2)	Average SAR (µW/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

Table 4. Average Total Power Density (TPD) and Specific Absorption Rate (SAR) for the north, south, east and west direction for Garrison

Distance (m)	Average TPD (µW/cm^2)	Average SAR (µW/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

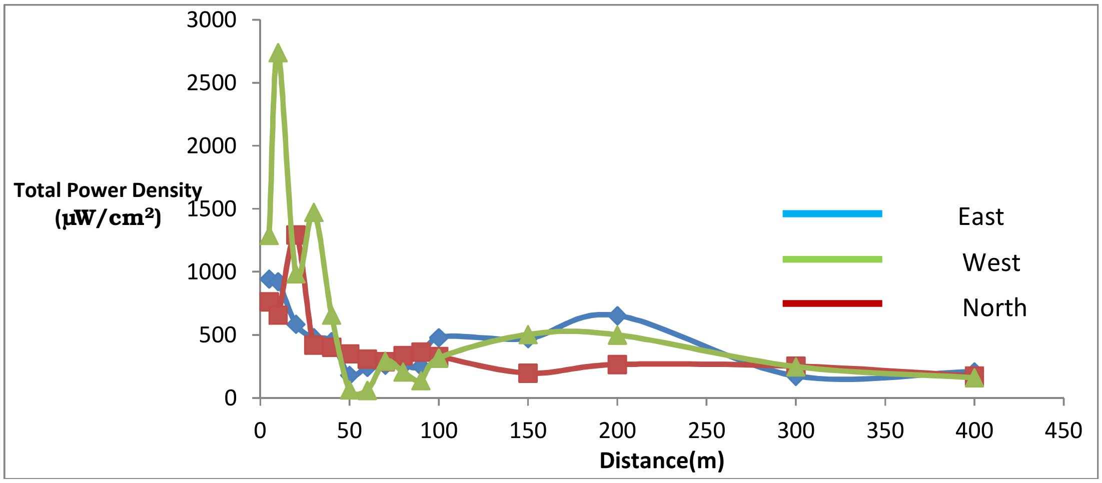

Fig. 2. Graph of total power density against distance for the cluster at Rumuokoro for the north, south, east and west directions

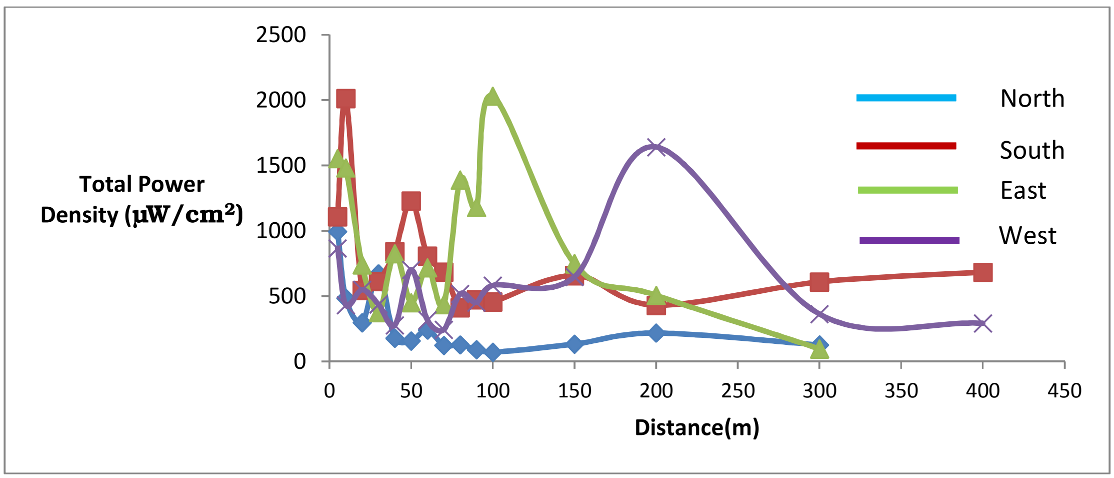

Fig. 3. Graph of total power density against distance for the cluster at mile 3 for the north, south, east and west directions

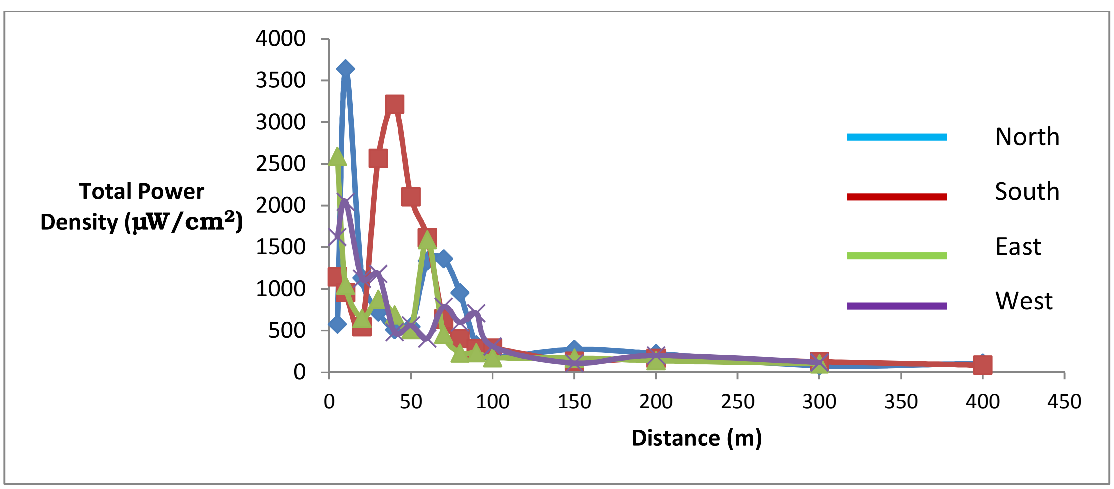

Fig. 4. Graph of total power density against distance for the cluster at mile 1 for the north, south, east and west directions

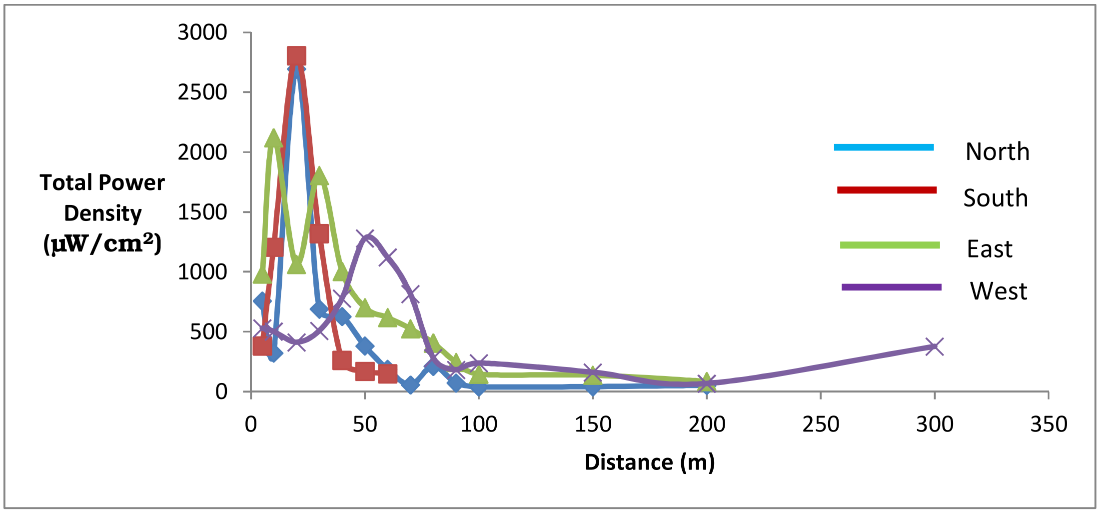

Fig. 5. Graph of total power density against distance for the cluster at Garrison for the north, south, east and west directions

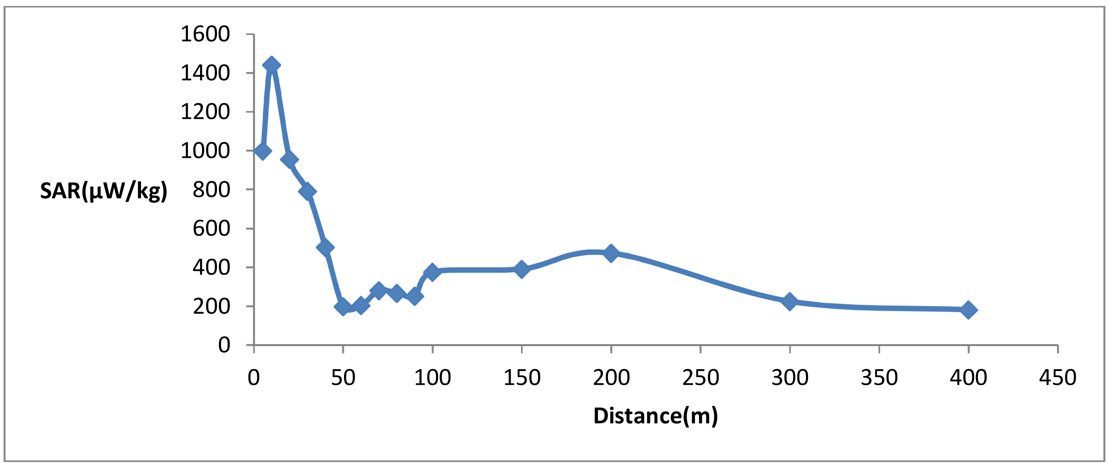

Fig. 6. Graph of average SAR against distance for the cluster at Rumuokoro

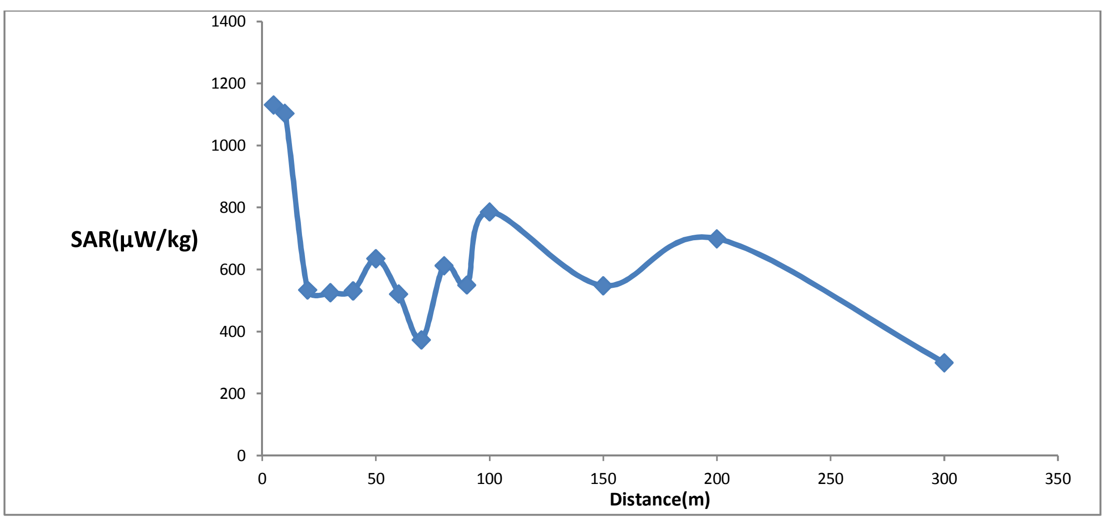

Fig. 7. Graph of average SAR against distance for the cluster at Mile 3

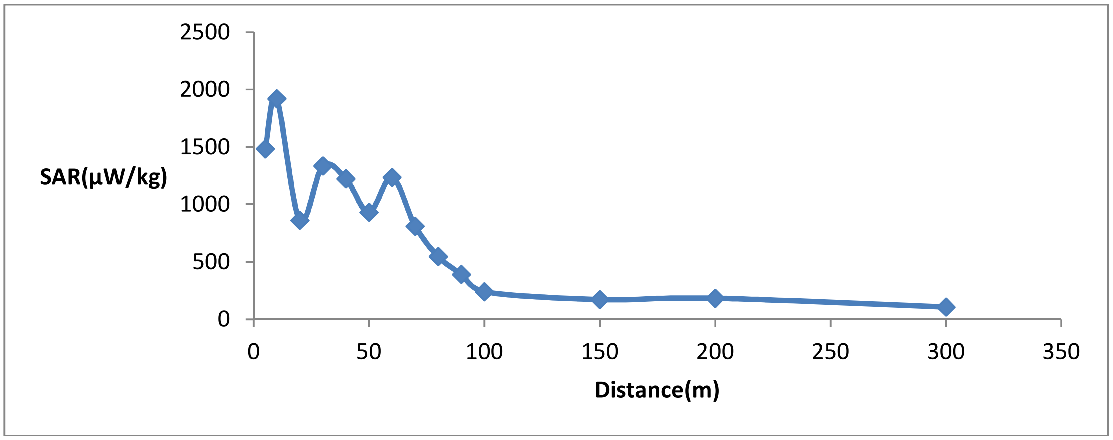

Fig. 8. Graph of average SAR against distance for the cluster at Mile 1

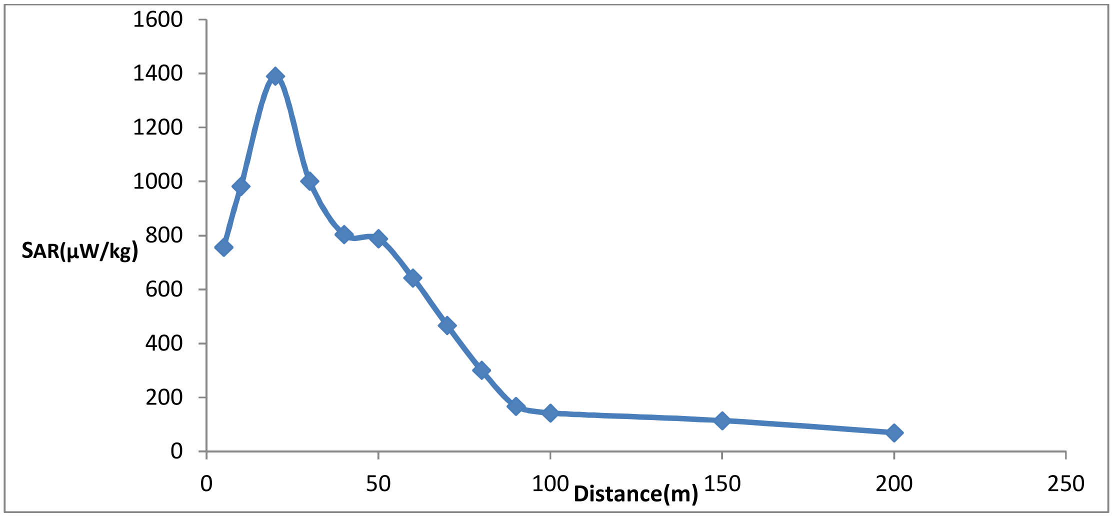

Fig. 9. Graph of average SAR against distance for the cluster at Garrison

4. CONCLUSION

Conclusively, the results of radiation density and 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Santini R, Seigne M, Bonhomme-Faibre L. Danger des téléphones cellulaires et deleurs stations relais. Pathol. Biol. 2000;48:525–528.
2. Wolf R, Wolf D. Increased incidence of cancer near a cell-phone transmitter station. International Journal of Cancer Prevention. 2004;1:1-19.
3. W.H.O. Electromagnetic Fields and Public Health. Media Centre fact sheet 304; 2006. (Retrieved 4 June 2016) Available:www.who.int/mediacentre/factsheets/fs304/en
4. EM Watch: 2011, Electromagnetic Radiation Health Effects EM Watch Network. (Retrieved 12 May 2016) Available:www.emwatch.com/EMF
5. Ayinmode Bolaji O, Farai Idowu P. Risks associated with low level radiofrequency exposure at close proximities to mobile phone base stations. The Pacific Journal of

Science and Technology. 2012;13(2):330–335.
Available:http://www.akamaiuniversity.us/PJST.htm
6. Hutter HP, Moshammer H, Waller P, Kundi M. Subjective, sleeping problems, and cognitive performance in subjects living near mobile phone base station. Occup. Environ. Med. 2006;63:307-313.
7. Santini R, Santini P, Danze JM, Le Ruz P, Seige M. Symptoms experienced by people living in vicinity of cell phone base station: Incidence of distance and sex. Pathol. Biol. 2003;50:369-373.
8. Hart L, Jackson KP, Akpee D, Moka EC. Land use planning and telecommunication facilities locations in Port Harcourt, Rivers State. Research Journal in Engineering and Applied Sciences. 2012;1(3):184-189.
9. Google Maps; 2015.
Available:www.google.com
10. Enyinna PI, Avwiri GO. Characterization of the radiofrequency radiation potential of Alakahia and Choba Communities, Nigeria. Working and Living Environmental Protection. 2010;7(1):25-31.
11. Sabah H. Theoretical estimation of power density levels around mobile telephone base stations. Journal of Science & Technology. 2008;13(2):101-112.
12. International Commission on Non-Ionizing Radiation Protection. Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz) Health Physics. 1998;74(4):494-522.
13. NCC. Nigerian Telecommunication Communication; 2014.
Available:http://www.ncc.gov.ng.,2014
(Date accessed 19/9/2015)
14. Shalangwa DA. Measurement of exposure of radio frequency field (RF) radiation from global system for mobile communication (GSM) masts. Journal of Electrical and Electronics Engineering Research. 2010;2(3):75-84.

Peer-review history:
The peer review history for this paper can be accessed here:
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