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Appraisal of Spatial Distribution of Global System for Mobile Telecommunications (GSM) Infrastructure in Gombe Metropolis, Nigeria

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Abstract : *General System for Mobile telecommunications (GSM) masts form part of the infrastructure required for effective communication system. The objectives of the study is to appraise the conformity of existing spatial distribution of GSM masts and base stations to planning standards with a view to developing alternative proposals which will minimize potential harmful effects of GSM masts on residents and contribute to environmental sustainability, while meeting socio-economic objectives of the GSM operators. Data was collected through personal observation, interviews of residents and officials of GSM service providers.The findings reveal that (i) there is multiple overlap of Radio Frequency (RF) from towers/GSM masts because they were located close to each other and within densely populated residential areas. (ii) Non compliance with planning standards, and (iii) Non compliance with setback requirements. An interesting outcome of the study is that a proposal was developed to achieve co-location of the masts and base stations to reduce their number in the metropolis. The study recommended that the relevant authorities should enforce planning standards in GSM mast installations to remedy the situation and penalize defaulters. The study could serve as reference material for future GSM land use planning and development in similar urban centers in Nigeria.*

Keywords: *General System for Mobile Communications (GSM) mast, Gombe, infrastructure, base station, Nigeria.*

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I. Introduction

Infrastructure is at the very heart of economic and social development. They provide the foundation for virtually all modern day economic activities, constitute a major economic sector in their own right, and contribute importantly to raising living standards and quality of life. The term 'infrastructure' typically brings to mind public facilities such as roads, railway lines, airports, telecommunications, geodetic control frame work and similar physical structures or networks in which the government has played a major role in their construction or ongoing support (Nwilo and Osanwuta, 2003). The world and particularly Nigeria is becoming a global village due to great advancement in telecommunication. A major break-through is the wireless telephone system especially Global System of Mobile Communication (GSM) which currently use low intensity, pulsed microwave radiation (Hyland, 2000).

The deployment of communication infrastructure in Nigeria in recent times has been massive. This is as a result of ever increasing demand of wireless mobile services especially in Nigerian urban areas. The market for mobile telecommunication is very big and it is a major economic driver in many countries including Nigeria. In U. K. alone, over 22 billion pounds was realized on the sale of licenses to mobile phone industry (Eilean, 2005). This great technology of advanced telecommunication system is not without some demerits and one of the major disadvantages is that of environmental and health hazards of its radiation. At present time, the greatest polluting element in the earth's environment is the proliferation of electromagnetic radiation. It is considered to be greater, on global scale, than warming and chemical element in the environment (Eilean, O. C., 2005).

Telecommunications masts have become a ubiquitous feature in our metropolises and if the rate at which they 'spring' up goes unchecked, the inhabitants of our urban centers may be exposed to grave hazards and risks that these masts portray to human health, safety of property and the physical environment. With the

haphazard and unprecedented developments of Global system for mobile communications (GSM) base stations and masts, one wonders if the proponents of these sites have really satisfied the requirements of planning authorities, and have undergone the processes for approval and development of these base stations.

The choice of suitable sites for the erection of telecommunications masts and base stations depends on the earth surface relative to the surrounding area; direction of expansion of telecommunication service of the proponent; the need to preserve and conserve places and sites of monumental, architectural and historic importance, among other factors (Omole, 2006). Given the fact that quality communication is hinged on proliferation of telecommunication masts, this study seeks to examine the spatial distribution of telecommunications masts and base stations in Gombe metropolis.

Furthermore, since quality communication is hinged on installation of more base stations, there is the need for empirical responses on spatial distribution of the telecommunication infrastructure to ensure that telecommunications service providers adhere to planning standards and criteria while installing masts and base stations. Thus, the purpose of the study is to appraise the conformity of existing spatial distribution of GSM masts and base stations to planning standards with a view to developing alternative proposals which will minimize potential harmful effects of GSM masts on residents and contribute to environmental sustainability, while meeting socio-economic objectives of the GSM operators.

Given the fact that these base stations are known for noise and carbon emissions from plants, sources of pollutants, distort visual appeal as well as emission of Radio Frequency (RF) waves which might be harmful to human well being. This study is significant in that it attempts to study and document the hitherto un-researched and undocumented concerns of the residents in Gombe metropolis. The study will also serve as a guideline in determining how masts can be distributed/spatially located within residential/built areas. It will also serve as reference material for future land use planning and development in Gombe metropolis and similar urban centers in Nigeria.

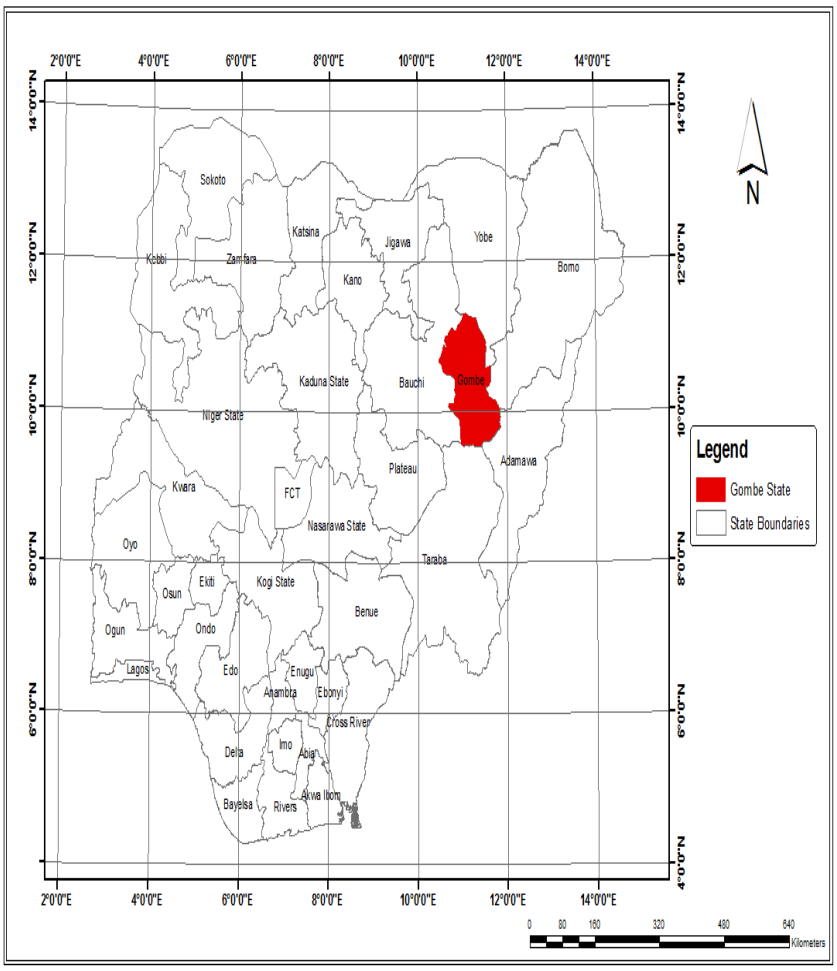

Figure 1: Map of Nigeria Showing Gombe State

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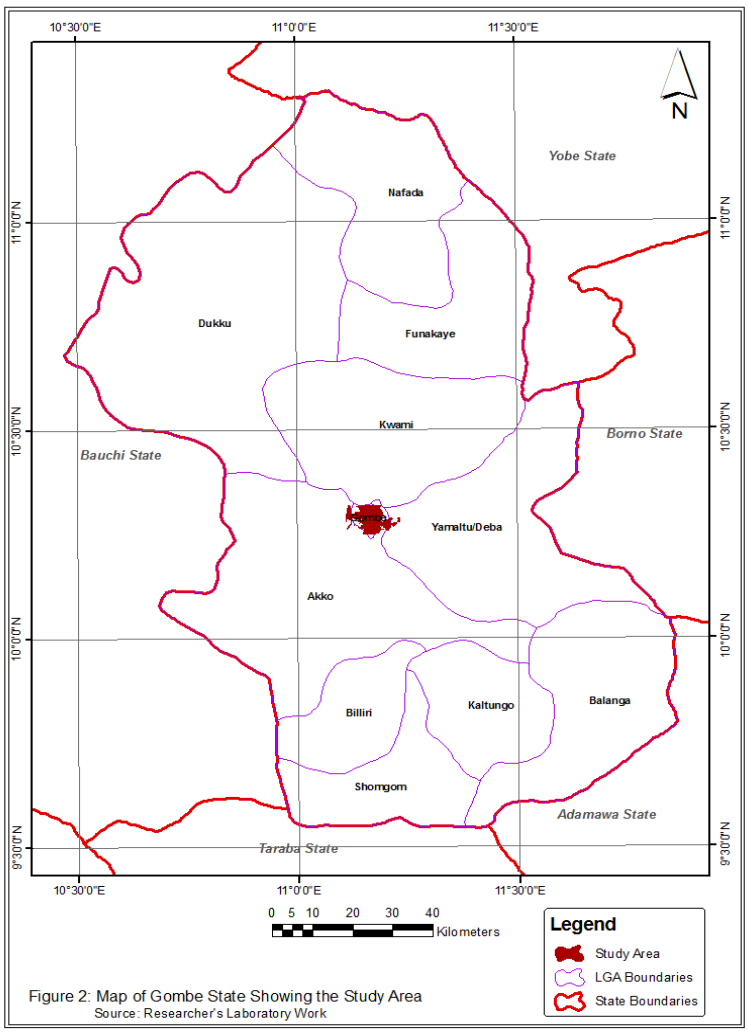

Figure 2: Map of Gombe State Showing the Study Area
Source: Researcher's Laboratory Work

Figure 2: Map of Gombe showing the study area

Literature Review

Mobile phones and other Information and Communications Technology (ICT) facilities are vital communication tools for both business and societal development. The growing demand for mobile services have necessitated the increase in communications infrastructure such as towers; which are needed to ensure that there are adequate network coverage and access that guarantee minimum quality of service (National Communications Authority, 2010). The use and deployment of cellular phones and other wireless communication facilities around the world is phenomenal. Nigeria has seen an astronomical increase in the number of telecom subscribers since 2001 hence the need for massive redeployment of masts and towers could not be overemphasized. This resulted in the erection of over 20,000 base stations across the length and breadth of the country given the fact that quality telecommunications service is hinged on proliferation of telecommunications masts (Atili, 2012).

Furthermore service providers deploy, erect and install in and around the country telecommunication masts, towers and base stations to ensure effective and efficient deployment, use and growth of telecom services to disseminate and dispense information and data services to end users of these services. In a statement Bashir Gwandu, the then Acting Executive Vice Chairman of Nigerian Communications Commission (NCC) said "we cannot have telecom services without putting masts and towers around the country because we do not have fiber optic and wired line across the country" (Otubu, 2010; The Punch, 2010, Pp. 17) . It is disheartening to note however, that in a bid to get services closer to the people, service providers mount masts indiscriminately without taking into consideration the sensitivity of the site. As a result, masts in or near schools, hospitals/clinics and residential areas are a common feature. The location of base stations in close proximity to residential homes, schools, hospitals and other critical facilities, increases exposure levels in these environments as opined by Otitoloju, Adewale, Otubanjo, and Osunkalu (2010). Details of the perception of effects of GSM infrastructure on human health in Gombe, Nigeria can be found in (Gwary, 2015).

Telecommunications masts need to be positioned optimally so the antenna can be in line of sight of the relay station as well as with the desired service area, given the fact that signal reception is based on the principle of rectilinear propagation of waves, (Edan, Idowu and Zango, 2012). When line of sight of masts is obstructed, it will create some 'dead' spots which service providers usually remedy by putting up more base stations to solve the problem of inefficient network. This might be attributed in part to be the reason why one can see multiple masts of the same service provider a few meters apart.

On the other hand, it is possible to have extensive signal coverage by increasing height of service transmitting towers, using high peaks (which abound in Gombe metropolis), or boosting transmitter power (Edan, Idowu and Zango, 2012). When this is done, the number of masts in the urban areas will be reduced. It is worthy of note that service providers in Nigeria more often than not, don't consider aesthetics of the environment judging by the way and manner base stations are placed side-by-side in contradiction of National Communication Commission (NCC) Guidelines (2009, p. 1) even when the NCC has stressed the need for co-location of towers to avoid the attendant costs and hazards associated with having multiple masts in one place (NCC Guidelines, 2009 p.1).

Overview of Some GSM Planning Guidelines and Regulations

Base station and cellular telephone masts forms part of the infrastructure required for an effective communication system. Policies and guidelines for the erection of telecommunication infrastructure consist of legal requirements which includes environmental conservation Act 1989 (Act No.73 of 1989), Local Spatial Planning Legislation and Civil Aviation Act 1962. (Act No. 74 of 1962). Others are the Health Consideration for Radio Frequency Exposure and Exclusion Zone and planning which includes the visual impact and cell mast density. The Nigerian Communications Commission (NCC) has outlined some conditions which must be fulfilled by GSM service providers before the erection of telecommunications masts. These condition bordered around safety and environmental consideration which includes but not limited to: (a) Height, (b) Space requirements, (c) Screening, (d) Removal of abandoned tower, (e) Inspections (f) Shared use of towers and masts, (g) Fencing (h) Set-backs, (i) Tower to tower spacing, (j) Nearness/proximity to power lines (NCC, 2009).Furthermore, provisions have also been made by the NCC with regards to co-location i.e the use of a single communication and/or site by more than one telecommunication service provider. The study used the conditions outlined by the standard guidelines/regulations as parameters to evaluate and assess whether the special location/distribution of General System for Mobile telecommunications (GSM) masts in Gombe metropolis is in conformity with laid down conditions as stipulated by the law/policy/relevant ACTS.

The coverage area of one transmitter/receiver base station is commonly known as a cell in urban environments the cells tends to be very small and the Radio Frequencies (RFs) are reused more often. The reason for this is that the capacity of the network required in urban areas is much greater than in rural areas. The antennae associated small cells are generally mounted on low support structures or on buildings. Larger cells are generally used in rural areas where coverage rather than capacity is the critical requirement. Higher masts are usually required in rural areas. Topography and population density will dictate to a large extent the location of the base station. While each base station has its own location requirements it must also fit into the national network (Hyland, 2000).

Standards and Regulations for GSM Masts in Nigeria

In line with the provision of the land use act, telecommunications service providers are to obtain the necessary governors consent to any lease or sublease of land on which to site telecom mast (Land use Act, 1978). They are required to apply for the state grant for land and where their interest in the land pre-dates the act as a deemed grantee, their absolute ownership is technically converted to right of occupancy of a definite period with the promulgation of the act. They are also subject to the governor's power to grant easement and other rights appurtenant to land in respect of passages, right of way and installation of telecom masts and base stations (Land use Act, 1978). The occupancy right of the service providers is also subject to the power of the governor's to revoke the right of occupancy for overall public interest of the state.

The provision of section 4(2) and (3) of the Constitution of the Federal Republic of Nigeria empowers the National Assembly to make laws on any matter exclusive legislative lists to the exclusion of the states. Telecommunication is covered under items 46, 66 and 68 of part 1in the second schedule of the constitution. Pursuant to this power, the National Assembly passed into law the Nigeria Communications Act (Cap N97 LFN 2004) to create and provide a regulatory framework for the Nigeria communication industry and all matters related hitherto.The Act detailed an elaborate and comprehensive administrative and regulatory framework for the development, growth and sustenance of the telecommunications industry in Nigeria. The National Communications Commission (NCC) Act direct licensees under the act to seek the approval of the appropriate State and or Local Authorities for necessary approvals for installations, placing, laying, or maintenance of any

General System of Mobile Communication (GSM) network facilities on, through, under or across any land in the state (Section 135, NCC Act). In a similar vein, the National Environmental Standards and Regulations Enforcement Agency (NESREA) was established by Act No. 25 of 2007. The agency is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria. There are cases of rift and discord between Federal Agencies as to who has the responsibility to set and enforce standards in this area (The Punch Newspaper,2010 p.17). On one hand NCC, sees itself as the omnibus regulator of the industry; and on the other NESREA the umbrella environmental manager and regulator in the country. NESREA had in time past shut down base stations of some telecom operators for violating the nation's environmental laws (Egesi, 2011).

It is therefore, imperative to have synergy of law and administrative process to fine tune this overlapping functions and responsibilities of the various arms of government in order to untangle the maze into which this area may fall.

Sitting of Masts and Physical Planning in Gombe State

As far as Nigeria is concerned, and Gombe in particular laws governing the sitting of GSM masts and towers have not sufficiently permeated into local debates to raise official concerns for regulatory control (Husain and Ismaila, 2007). Under the law, the Nigerian Communications Commission (NCC) created via Decree No. 75 of 1992 (amended in 2007), is the body charged with the responsibility of regulating telecommunications activities in Nigeria. However, the unchecked proliferation of masts in the country especially in densely populated cities constitutes environmental and health hazards, thus posing risks to human health, safety of property and the environment (NESREA, 2010). The indiscriminate placing of masts and base stations by telecommunications companies is a complete disregard to NESREA's EIA Act of 2004, thereby undermining environmental safety.

It is worthy of note that physical planning authorities are empowered by law to propose masts location or advise where masts could be relocated as is the case when a mast was erected at the Modibbo Adama University of Technology (MAUTECH) Yola; setback and had to be relocated (Husain and Ismaila, 2007). There was also such incidence of dismantling of masts in Okota suburb of Lagos, by the Lagos State Ministry of Physical Planning and Development through its Urban Furniture Regulatory Unit (UFRU) to address anomalies created by indiscriminate erection of towers and masts with wanton disregard for Lagos Regional Planning and Development Law of 2010.

Criteria for Approval of General System of Mobile Communication (GSM) Mast Location by Gombe State Urban Planning andDevelopment Board (GSUPDB)

The following are the preconditions to be satisfied by a GSM network operator while applying for a new site:

1. Detailed Design.
2. Site Analysis Report.
3. Sales/Lease Agreement of site.
4. Environmental Impact Assessment (EIA).

Furthermore, Development Control Department staff must inspect the site of all GSM mast to ensure that all the relevant standards are strictly adhered to and all relevant permits and clearance has been obtained. Some of the criteria to be critically assessed by Development Control Officers includes but not limited to:

A. **Location of proposed development to ascertain:**

a. Neighborhood of the proposed development.
b. Zoning location.
c. Density of location.
d. Maximum height of mast allowable at the proposed location.

B. **Physical characteristics of the site to check:**

a. Size of plot
b. Maximum area developable
c. Land form
d. Topography
e. Soil condition

C. **Accessibility of proposed site:** To establish whether the proposed project development will hinder access to future development.

D. **Proximity of proposed site to facilities and utilities in the neighborhood:** Such as **s**chools, hospitals/clinics, high tension power lines, etc.

E**. Setbacks and airspaces:** Distance of proposed project to existing buildings and roads.

G**. Characteristics of the proposed development:** With respect toproposed use.
Methodology:

Data Required

The types of data used for this study involves data related to standards and criteria for location of General System of Mobile Communications (GSM) mast, coordinates of GSM masts in the metropolis, and other attributes data of residential dwellings in close proximity to GSM masts.

The Instruments Used

The following instruments were used as part of the techniques for the task:

a. Google Earth Satellite Image of Gombe
b. Garmin E-trex GPS (Global Positioning System)
c. ArcMap 10.0 version
d. AutoCAD 2010

The Methods

A Base map on a scale of 1:50000 was obtained from the Gombe State Urban Planning and Development Board. With the map, a fieldwork was carried out to pinpoint the locations of GSM masts in Gombe metropolis as well as the location of schools and clinics. A Geographycal Positioning System (GPS) survey was then carried out using Garmin E-trex Global Positioning System (GPS) in order to obtain the geographic coordinates of GSM masts located within the Gombe metropolitan area. Name of the various operators was obtained from signs posts/boards mounted on the premises and also from offices of the various GSM operators in Gombe metropolis. Google Earth Satellite Image of Gombe was acquired and the raster image was imported into AutoCAD (2010) to create a mosaic which was then exported into ArcGIS 10.0. Geo-referencing of the data was done using tie-points. The tie-point was done using round-about, located at Nigerian National Petroleum Corporation (NNPC) site,"Jiyamere Suite" and Grain silos junctions, "Pantami ward" bye-pass junction and "Liji ward" round-about for ease of identification. After the Geo-referencing, on-screen digitization of the Geo-referenced map of Gombe was done using Arc GIS 10.0 to create spatial data of the various features such as roads, masts, schools, clinics, etc and these were divided into layers.

1. Road network layer: This contains data about the road such as road name, length, width and type.
2. General System of Mobile telecommunications (GSM) mast location layer: The GPS coordinates obtained was used to define the spatial locations of the GSM masts within the metropolis.
3. Hospitals and health facilities layer: This layer records the location of health facilities within Gombe metropolis.
4. Schools layer: This records the locations of schools within Gombe metropolis.
5. Land use layer: This layer is used to identify the various land use pattern in Gombe metropolis.

In addition, buffer and overlay analysis was used for this study, which involves the creation of a 400m buffer zone based on the precautionary principle approach as recommended by the Stewart Report tagged, Independent Expert Group on Mobile Phones;IEGMP(2004), since there is evidence that harmful radiation drops with increased distance (Ford, 2002 cited in Husain and Ismaila, 2007 and Santini *et al* 2002, cited in Bolaji and Idowu, 2012). Furthermore, the buffer around each GSM mast identifies the service area coverage and areas within the buffer zone are considered to be within the area of influence of that mast. The layers created were overlaid to find out the ratio of land uses that fall within the area of influence of each GSM mast.

II. RESULTS AND DISCUSSION

The nature of the study suggests that the results and findings can be analyzed and discussed in terms of:
A) Maps of existing situation (i.e figures; 3, 4, and 5) and
B) Maps of proposed solutions to the problems identified by the study (i.e figures; 6 and 7).

A) Analysis of Existing Situation: Location/Spatial Distribution of Global System of Mobile Telecommunications (GSM) Infrastructure in Gombe Metropolis (the Study Area)

Figures: 3, 4 and 5 shows existing situation of the location/spatial distribution of GSM infrastructure in Gombe metropolis (the study area). They were derived from the field work/survey that was carried out in 2014. It can be seen that GSM infrastructure were indiscriminately located in densely populated residential areas, and in close proximity to critical facilities such as; schools, and hospitals/clinics.

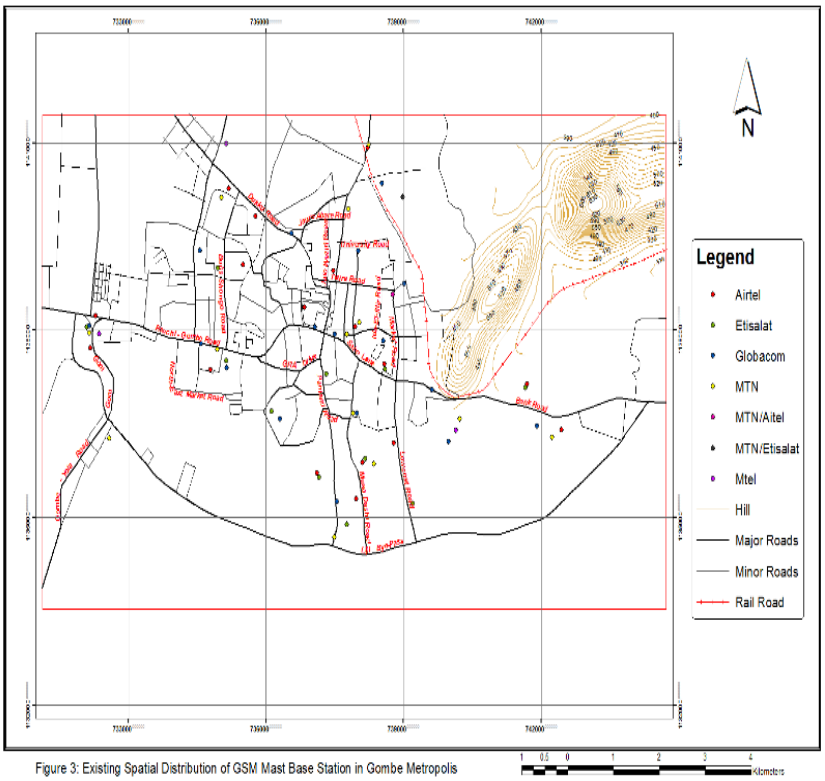

Figure 3: Map showing existing location/spatial distribution of Global System of Mobile Communications (GSM) masts Base Stations in Gombe metropolis.

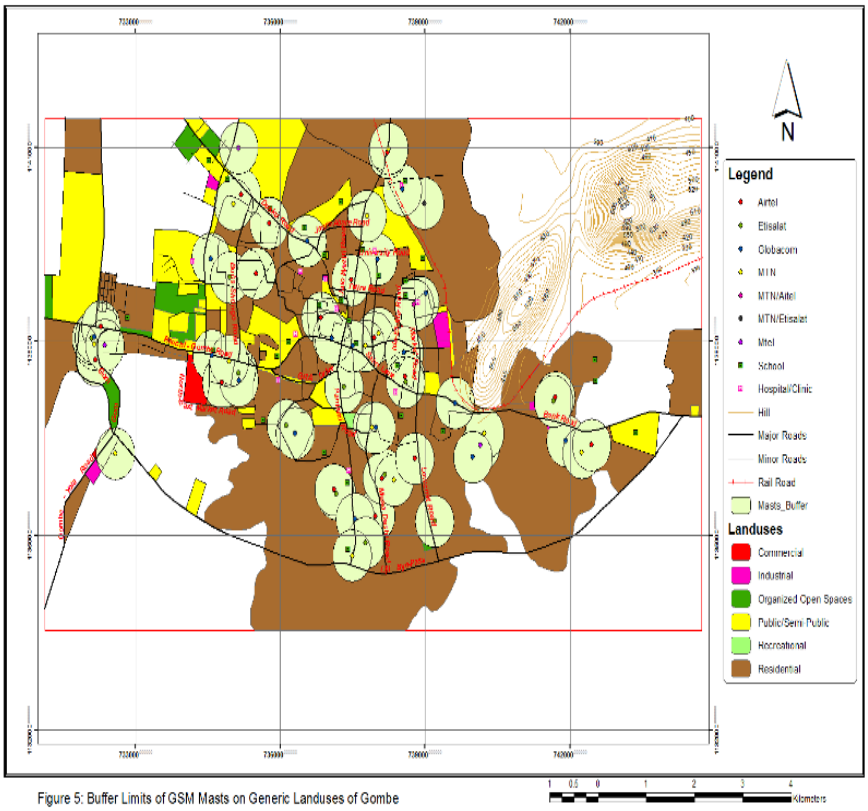

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Figure 4: map showing Buffer limits of GSM masts on generic land use in Gombe metropolis.

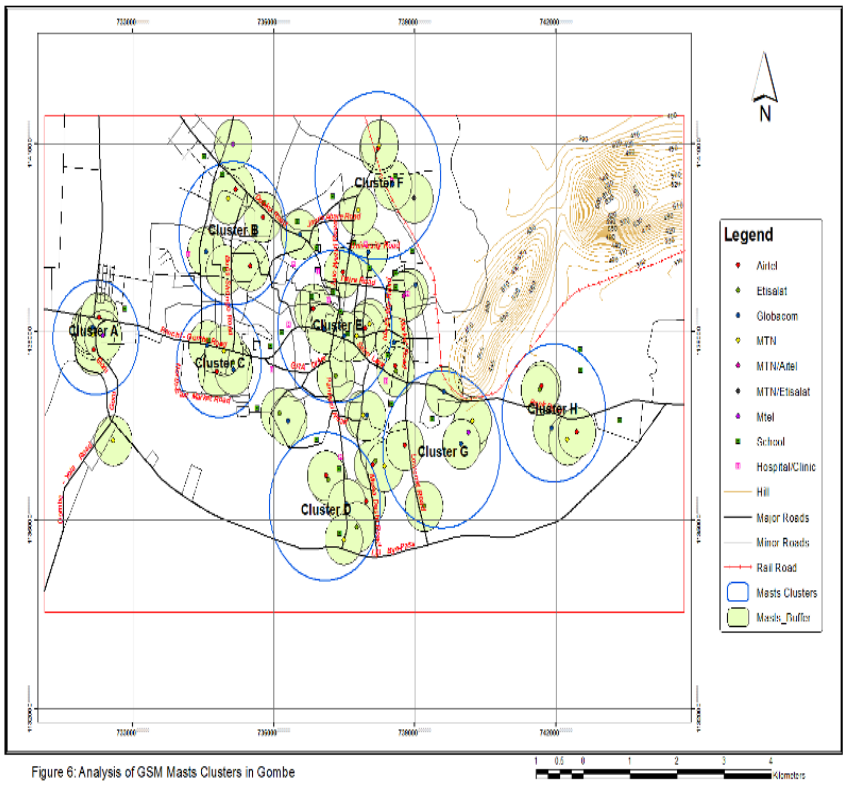

Figure 5: map showing location/spatial distribution of GSM masts clusters in Gombe metropolis.

It should be noted however, the discussion of the findings is guided by the following considerations/factors; 1) GSM masts location within Land uses, 2) RF overlap and; 3) location of GSM masts in proximity to critical facilities (schools and hospitals/clinics) within areas of RF coverage.

1. **Location within Land use:** Analysis of Figure: 3 revealed that 43 out of the total of 67 GSM masts (64.2%) in the study area (Gombe metropolis) were located in high density residential areas. This implies the possibilities of heightened concerns of the residents regarding possible collapse of mast which contravened (NCC guidelines, 2009 and NESREA Regulations, 2010) on mast location/distribution.
2. **RF Overlap:** The study also revealed that there are 51 instances of multiple incidences of Frequency Overlap with respect to location/distribution of GSM masts in residential areas in the study area (Gombe metropolis). This implies that guidelines for location/spatial distribution of Global System of Mobile Communications (GSM)masts in the study area were violated by the GSM operators.

Analysis of Figure: 4 revealed 38 cases and 10 incidents of Frequency Overlap in high density and low density residential areas respectively. These were derived after a buffer area of 400m was drawn around each mast (see Figure: 4)the implication is that, such overlap of Radio Frequency (RF) will culminate in multiplication of any adverse negative effect the masts might have on residents of the areas.

3. **Location/Spatial Distribution of GSM masts in close proximity to critical facilities within areas of RF coverage:** Analysis of the maps (Figures; 4 and 5) revealed that critical facilities such as schools and clinics fell under the areas of influence of GSM masts. In particular, Figure: 5 clearly revealed that 17 nursery/primary schools and 7 hospitals were affected.

Also, observation and analysis of Figure: 5 revealed that GSM masts and Base Stations were located/spatially distributed in clusters (A - H) which sometimes ranged from four or five GSM masts with interval between masts within the cluster ranging from 250 - 300m (see Figure: 5). This can be attributed to lack of consultation with Physical Planning Authorities before acquiring land, as well as none compliance with NCC provisions governing GSM infrastructure location/spatial distribution (NCC, 2009). Observation and analysis of Figure: 4 revealed that 21 masts RF buffer zones overlapped over 17 nursery/primary schools, while there are 8 cases of multiple overlap of Radio Frequency (RF) around the 7 hospitals (see Figure: 4). This implies that the GSM masts in the study area were not properly located/spatially distributed, as they constitute nuisance and have adverse negative effects on the environment (pollution, noise, health hazards and aesthetics) with

devastating consequences on critical facilities and the end users. The foregoing analysis of the results and discussion clearly revealed the necessity for a reduction of GSM masts to the barest minimum in such a way and manner that will ensure quality service delivery without compromising aesthetics, health and well being of inhabitants. This was achieved by using the principles of co-location of masts (whereby a single GSM mast would support at least three GSM service providers) as well as infrastructure sharing. This gave rise to the proposed alternative solutions which is discussed in details bellow.

B) Analysis of the Proposed (Alternative) Map for Collocation of Global System of Mobile Communications (GSM) Infrastructure in Gombe State

In a similar vein, Figures: 6 and 7 shows maps of the proposed (alternative) solutions to the problems identified with respect to location/spatial distribution of GSM Infrastructure inGombe Metropolis. They were also derived from the field work/survey which was carried out in 2014.

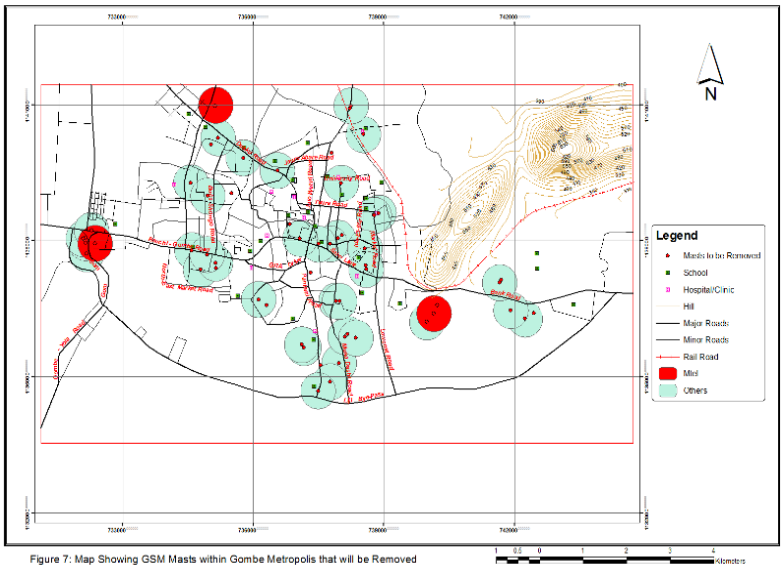

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Figure 6: map showing location of GSM masts that will be removed in Gombe metropolis.

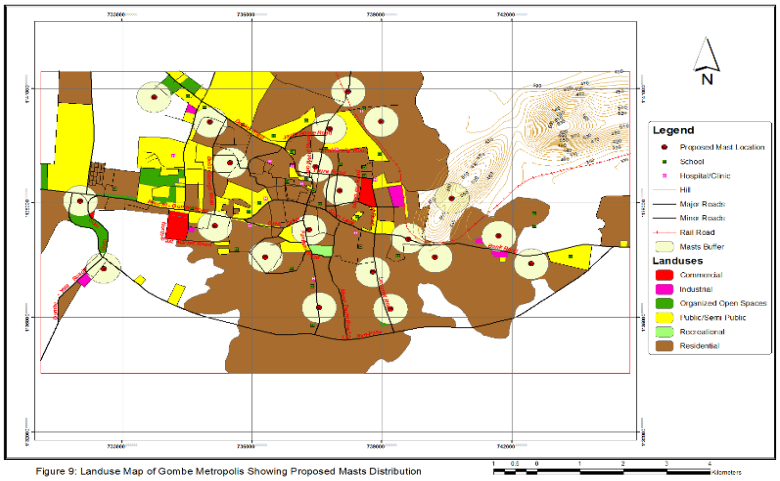

Figure 7: Land use map of Gombe metropolis showing proposed GSM mast location/distribution to address overlaps.

The proposed solution (alternative maps) for collocation of Global System of Mobile telecommunications (GSM) infrastructure in Gombe metropolis developed from field work/survey (i.e figures 6 and 7) were validated by two (2) experts; a lecturer in the Department of Urban and Regional Planning (URP) at Abubakar Tafawa Balewa University (ATBU) Bauchi, and aregistered Town Planner(Practitioner) from Gombe State Urban Planning and Development Board (UPDB) and which incorporated the principle of collocation of masts and infrastructure sharing. This can be seen in locations where masts cluster exists, collocation was proposed with a single mast to support at least three service providers (Figure: 7). Furthermore, the proposed

map sought to locate masts away from critical facilities and as a result, most of the critical facilities can be seen to be safely outside the area of influence of masts (See Figure: 7). However, some of the masts in the metropolis have been found to be in consonance with the surrounding land uses, hence they were left untouched in their respective locations (see Figure: 7). Furthermore, Figure: 7 shows the proposed masts locations with a 400m buffer,indicating the area of influence of each mast location.

In general, the proposed solution (alternative) maps of Global System of Mobile telecommunications (GSM) infrastructure location/spatial distribution advanced as possible solution (see Figures: 6 and 7) in order to solve the problems identified by the study resulted to a reduction in the total number of GSM masts in Gombe metropolis from 67 (which comprised of: MTN = 16, Globacom = 17, Airtel = 17, Etisalat = 13, and Mtel = 3) to a total of twenty one (21) GSM masts as can be seen on Figure: 7, with the attendant foreseeable benefits in the forms of: i) improved aesthetics and visual appeal, ii) human comfort in terms of reduced psychological stress and danger posed by possible collapse of masts, and iii) reduction in air pollution which will go a long way in improving the wellbeing of those living around the vicinity of GSM masts and base stations among other benefits. Sequel to the proposed (alternative) solutions advanced, two (2) new additional sites have been suggested for collocation of GSM masts: The first site is on top of the hill around the North East part of Gombe metropolis (Figure: 6) and the second site is on the fringes of Gombe metropolis in the North West part of Gombe metropolis (Figure: 7). However, Figure 7: shows map of GSM infrastructure to be removed in order to address the problem of Frequency overlaps.

III. Conclusion

The study has revealed health, environmental and logistics problems associated with the present location/spatial distribution of Global System of Mobile telecommunications (GSM) masts in Gombe metropolis (the study area). This implies the ineffectiveness of the regulatory authorities, the cutting of corners by service providers to maximize profit, and the concerns of residents who are close to the GSM masts which creates an urgent need to be addressed. The study has also revealed the possibilities and indeed the practicality of making alternative proposals with a view to making adjustments in order to remedy mistakes or errors that have been made in the location/spatial distribution of GSM infrastructure in any part of the country (Nigeria) in future. The study also revealed that although such alternative proposal may lead to distortion of existing development plan, in the long run it could remedy inconveniences and nuisance such as lack of access, and disruption of vehicular movement and other routing activities. The study has implications for Government and regulatory bodies and could serve as reference material for future land use planning for Global System of Mobile telecommunications (GSM) location/distribution and development planning in similar urban centers in Nigeria.

IV. Recommendations

Based on the findings of the study, the following recommendations were proffered;

1. Masts that have been found to be located especially in high density residential areas should be dismantled and moved to the outer fringes of the residential areas. Figure 6 shows the masts that will be affected by this action and the new location.
2. The Planning Authorities in Gombe State should partner with the National Communications Commission (NCC) and National Environmental Safety, Regulatory and Enforcement Agency (NESREA)with a view to enforcing the relevant provision for collocation and infrastructure sharing by GSM service providers along the value chain in order to remedy problems of overlap of Radio Frequency (RF) fields which posed health hazards, and prosecute all the defaulters.
3. Government should review approved development rights for the erection of Base Stations located within a radius of 15meters in the study area.
4. The Mtel masts that have been out of commission for over five years should be decommissioned as stipulated by NCC (2009) and NESREA (2010) guidelines.
5. The relevant authorities should look into cases of disregard for Planning Standards for GSM mast installations with a view to remedy the situation and penalize the culprits/offenders/defaulters.

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