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Assessment of environmental impact of telecommunication base transceivers stations in residential areas

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Abstract. This paper assessed the environmental impact of a telecommunication base transceiver stations (BTS) located at Cardoso Close, Apapa, Lagos State, Nigeria with the coordinates 6°4392'N, 3°3126'E. The ambient air quality parameters: SO_2, NO, CO, CH_4 and total suspended particulates (TSP) were measured using the ITX Emission Analyzer at four sampling points within the base station. The concentrations of SO_2, NO, CO and TSP atthe base station ranged between 0.3-0.5 ppm, 1.9-2.2 ppm, 5.5-7.5 ppm, 101-110 µg/m^3 respectively for 24-hour averaging period. CH_4 was not detected at any of the sampling points. A digital Realistic Sound Level Meter was used in measuring the noise level. The measured average noise levels in all the four sampling points at the BTS studied ranged between 83.1-88.7 dB (A). Samples of water were collected from boreholes around the base station and were subjected tophysico-chemical examinations using the 'standard methods for water and waste water' 14th edition prepared by American Public Health Association (APHA). The analyses of the water samples showed that all the parameters are within limits. To measure the electromagnetic radiation emitted from the station during the field study, the SPECTRAN HF-4049 RF, an in-situ dosimeter for radio frequency measurement was used. The results obtained showed that, the measured averageradiation levels in all the four sampling points within the BTS studied ranged between 0.051-0.054 µW/m^2. All the measured parameters are within safety margins apart from SO_2 and NO. SO_2 was not traceable to the BTS while NO was only partly connected with the fossil-fuelled electricity generating sets. The parameters of the physico-chemical analysis of the borehole water were significantly below limits.
Keywords: Telecommunication base; Transceivers;Residential areas; Environmental Impacts

1. Introduction

Basically, a telecommunication system requires equipment and devices that transfer and receive information (transceivers) using electronic codes which rely on radio frequency. The recent advancement in radio frequency coding allowed for internet telephony and tele-conferencing [1]. According to [2], developing countries, like Nigeria, are undergoing rapid development in information and communication technology (ICT) to bridge the digital gaps through the introduction of global system of mobile communication (GSM). The benefits include access to reliable, open and widespread system for transmitting information, access to educational opportunities (e-learning and distance education), cheaper and better telecommunication services, telemedicine, change in the way people conduct businesses (e-commerce), change in banking transactions (e-banking) and e-governance around the globe [3]. ICT have also aided many rescue operations by providing information on early warning signals based on geological and climatic information [4]. The worldwide system of mobile communication (GSM) however requires infrastructure such asbase trans-collector stations, which are utilized in flaunting correspondence inclusion. Base trans-recipient stations (BTSs) are intended to improve correspondence radio-frequency organized signals for the quickly extending computerized media transmission clients both in urban and rustic networks [5]. A run of the mill BTS comprises of media transmission pole on which are introduced radio-frequencytransmitters and collectors, fueled by advanced electronic blowhards which are introduced in covers inside the BTS.

Numerous natural issues are related with this innovation. This incorporates the unpredictable siting and erection of base trans-recipient stations all over Nigeria. A significant number of the BTSs are sited inside private, business, mechanical and travel courses. As indicated by most recent World Health Organization and 13 nation interphone study exploits, cell phones can add to well-being insufficiency, including the expanded danger of mind tumors, eye malignancy, salivary organs tumors, testicular disease, non-Hodgkin's lymphoma and leukemia [6]; and however so far no investigation has connected BTSs with human well-being dangers, it is smarter to take preventive estimates, for example, occasional appraisals of the electromagnetic discharges at them and even attempt to alleviate the radiation levels to give more prominent assurance to the overall population. Aside from the danger of incessant human and natural introduction to radiation outflows and other condition and security matters, air quality harm, additionally seems, by all accounts, to be of majour issue [7], since a considerable lot of the base trans-collector stations are controlled by fossil-fuelled power producing sets. Fossil-fuelled power creating sets are known to discharge criminal emanations and other air contaminations as clear in crafted by Dürkop and Englert [8]. Along these lines, the environment gets gaseous and particulate emissions from BTSs tasks. The wellbeing implication of gaseous and particulate discharge are of extraordinary concern [9]. Some vaporous discharges likewise have malicious results, for example, the demolition of ozone layer, a dangerous atmospheric deviation and occurrence of corrosive downpour [10]. Accordingly, barometrical emanations coming about because of BTSs activities are of natural concern. Subsequently the portrayal of air quality in regions around working base trans-collector station destinations is significant so as to determine the human and natural hazard related with base trans-recipient station operation.

This study investigated the ambient air quality, the radiation emissions and the physico-chemical analysis of water used domestically, around a base transceiver station site in Lagos State, Nigeria, in order to determine the health and safety of the operations of the base transceiver stations in residential and commercial areas. The stipulated FMENV limitswere used to define the measured air quality data.

2. Materials and Methods

2.1 General Experimental Procedures

The experimental work carried out in this study includes: determining the ambient air quality, noise levels, physico-chemical analysis of surrounding sources of domestic water and radiation emissions.

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2.2 Description of the Base Station

The base station (LAG 723) is located at No.13, Cardoso Close, Kirikiri Close, Apapa, Lagos with the coordinates 6^{o}4392'N, 3^{o}3126'E.

Basic landmark features within the base station site are: the gate house, the tower or mast, two SDMO 20KVA electricity generators, a 5000-litre diesel surface tank and the control room/unit. The picture of a typical base station is shown (Plate 1).

Plate 1: Picture of typical base transceiver station.

2.3 Measurements of Air Quality Parameters

The gases determined are Carbon II oxide (CO), Nitrogen II oxide (NO), Sulphur IV oxide, oxygen and combustible gases measured as methane. These gases were measured around the base station.

The determination of concentrations of these gases was carried out using the ITX Emission Analyzer. The Emission Analyzer with appropriate sensors of interest was zeroed and the monitor was set at the 'run mode' in order to measure the exact concentrations of the gases. The concentrations of the gases in the particular area of interest were taken at ground level and then read-off the screen of the monitor directly. In order to measure the total suspended particulates (TSP), Met-One dust monitor (Model GT-331) was used. The monitor is a battery operated portable device with an LCD interface for display of measured concentrations. The sampler was simply switch on at breathing height at the ground level.

2.4 Measurement of Noise Levels

A digital Realistic Sound Level Meter was used in measuring the noise level. The equipment is capable of reading noise levels between 50dB and 120dB with A and C weighting at fast or slow response. For the purpose of these particular measurements, the 'A' weighting at slow response was chosen. The sound meter was placed close to the point being measured and the measurement value was displayed on the screen of the meter after 120 seconds. The noise levels in and around the base station were measured.

2.5 Physico-chemical Analysis of Water Samples

Samples of water were collected from boreholes around the base station for analysis. The samples were subjected tophysico-chemical and microbiological examinations using the 'standard methods for water and waste water' 14th edition, 1993 prepared by American Public Health Association (APHA), American Water Works Association (AWWA) and Water Pollution Control Federation (WPCF), as indicated in Table 1.

Table1:mMethods for the Physico-chemical Analysis of Liquid Effluents (11)

S/N	Parameters	Methodology
1.	Ph	Potentiometer method
2.	Total Dissolved & Suspended Solids (TDS &TSS)	Gravimetric method
3.	Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)	Ttrimetric method
4.	Sulphate	Turbimetric method
5.	Chlorides	Argentometric method
6.	Oil/Grease	Extraction
7.	Detergent	Methylene-Blue
8.	Heavy metals	Colometric method
9.	Phosphate, Sulphate, Chlorine, Nitrogen	Colometric method

2.6 Measurement of Radiation Emissions

To measure the electromagnetic radiation emitted from the station during the field study, the SPECTRAN HF-4049 RF, an in-situ dosimeter for radio frequency measurement was used. When evaluating conformance of exposure limit, the maximum signal was considered. This value was found using SPECTRAN and the HyperLOG antenna using the so-called 'panning approach'. The panning approach is already officially approved in many countries.

3. Results and Discussion

3.1 Air Quality Parameters

The measured average concentrations of the air quality parameters at each sampling point of the base station are summarized in Table 2. The concentrations of SO_2, NO, CO and TSP, the base station ranged between 0.3-0.5 ppm, 1.9-2.2 ppm, 5.5-7.5 ppm, 101-110 µg/m^3 respectively at 24-hour averaging period. CH_4 was not detected at any of the sampling points. When compared with standards of the Federal Ministry of Environment (FMENV), 250 µg/m^3 for TSP was not breached at the base station [10]. The detected levels may not be BTS generated due to the intractable nature of atmospheric current, diffuse sources far from the BTS location. The detected concentration levels of SO_2 exceeded the FMENV ambient air limit of 0.1 ppm in all the sampling points at the BTS. These levels may be attributed to traffic and the presence of a petrol filling station near the study site. Sulphur dioxide in air generally comes from a known source like combustion of coal or sulphur-contaminated fuels and ores, paper mills and from non-ferrous smelters and others [12].The detected concentration levels of COdid not exceeded the FMENV ambient air limit of 20 ppm. Carbon monoxide in air is the product of incomplete combustion, which is primarily released from the emissions of the operating fossil-fuelled electricity generators. The detected concentration levels of NO exceeded the FMENV ambient air limit of 0.04-0.06 ppm. The average concentration of NO detected during studies measurements is attributed to the traffic and running of fossil-fuelled electricity generators but majourly from the generators.

Table 2: Results of Ambient Air Measurements

Sampling Point	SO_2, ppm	NO, ppm	CO, ppm	CH_4, ppm	TSP, µg/m
S1	0.5	2.1	7.5	0.0	110
S2	0.4	2.2	6.0	0.0	112
S3	0.5	2.0	6.5	0.0	109
S4	0.31.9		5.5	0.0	101
FMENV Limits	0.1	0.04-0.06	10	NS	250

NS = Not Specified

3.2 Noise Level

The measured average noise levels in all the four sampling points at the BTS studied ranged between 83.1- 88.7 dB (A) are summarized in Table 3. Comparing with the standards, the Federal Ministry of Environment (FMENV) limit of 90 dB (A) for noise levels was not breached at the base station. The likely sources of noise detected at Base Station location are the fossil-fuelled electricity generating sets and noise influenced by heavy traffic.

Table 3: Results of Day Time 24- Hour Noise Level Measurement

Sampling Point	*N_{MIN} Level dB (A)	$^{+}N_{MAX}$ Level dB (A)	$^{x}N_{AVE}$ Level dB (A)
S1	87.8	88.7	88.3
S2	85.9	88.1	87.0
S3	78.2	88.0	83.1
S4	83.6	87.8	85.7

*N_{MIN}: Minimum noise; $^{+}N_{MAX}$: Maximum noise; $^{x}N_{AVE}$: Average noise

3.3 Physico-chemical Analyeis of Water Samples

The results of the physico-chemical analysis of the borehole water taken from the nearby residential buildings are presented in Table 4. This analysis was carried out to assess, if there is any impact on the underground water by the operations of the base station. The analyses of the water samples showed that all the parameters are within limits as indicated in Table 1.

Table 4: Results of Physico-chemical Analysis of Water Samples

Parameter	Limit	Results
General Appearance	-	Clear
Odour	-	Unobjectionable
Electrical Conductivity, ohms/cm	-	315.3
pH, 25^{o}	6.5 – 8.5	5.1
Total Dissolved Solids, mg/L	-	18.0

Total Hardness-EDTA, $mgCaCO_3/L$	100	10.2
Total Alkalinity, $mgCaCO_3/L$	200	17.5
Total Acidity, $mgCaCO_3/L$		Nil
Residual Chlorine, mg/L	0.3	Not Detected
Chlorine, mg/L	200	12.7
Phosphate (Total), mg/L	-	2.2
Calcium, mg/L	70	31.0
Copper, mg/L	1.0	0.022
Iron (Total), mg/L	0.3	0.0031
Lead, mg/L	0.05	Not Detected
Magnesium, mg/L	30	16.1
Manganese, mg/L	0.05	0.027
Zinc, mg/L	5.0	0.008
Dissolved Oxygen, mg/L		5.0

3.4 Radiation Measurements

The measured averageradiation levels in all the four sampling points within the BTS studied ranged between 0.051-0.054 $\mu W/m^2$Table 5. The result of the radiation measurement shows values of several thousand times below the International Commission on Non-ionising Radiation Protection (ICNIRP) allowable exposure limit of 0.001 W/m^2 at 8-hour averaging period [13]. The electromagnetic exposure on the ground is much less than exposure very close to the antenna and in the path of the transmitted radio signal. In fact, ground-level exposure from such antennas is typically far less than the exposure levels recommended as safe by ICNIRP and other expert organizations. So, exposure to nearby residents would be well within safety margins.

Table 5: Results of Radiation Measurements

Sampling Point	Irradiance ($\mu W/m^2$)
S1	0.054
S2	0.052
S3	0.054
S4	0.051

4. Conclusion

The project area was well secured and the tower was properly structured, thus very stable. The results of the gaseous emissions showed that the operation of the base station transceivers is within the regulations. All the measured parameters were within safety margins apart from SO_2 and NO. SO_2 was not traceable to the BTSs while NO was only partly connected with the fossil-fuelled electricity generating sets. The parameters of the physico-chemical analysis of the borehole water were significantly below limits.

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