Assessment Of Air Quality And Noise Around Some Telecommunication Base Transceiver Stations In Ibadan South West Nigeria

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Abstract

The ambient air quality and noise level around some base trans-receiver stations (BTSs) in Ibadan, South West Nigeria were investigated, in order to determine the health and safety of emission from BTSs operations. The atmospheric levels of carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), ammonia (NH_3), total hydrocarbons (THC) and suspended particulate matter (SPM) were measured at selected sampling points (upwind and downwind) in twenty base trans-receiver stations spread over nine Local Government Areas within Ibadan and its suburbs. A Honeywell and 3M hand-held air quality meter and gas detectors were used to detect the parameters at intervals of three hours for forty eight hours. A hand-held Extech sound level meter with measuring range of 30–130 dB (A), accuracy of ±1.5 dB (A) was used for the monitoring noise levels. The atmospheric concentrations of CO, NO_2, SO_2, THC and SPM were <0.0001-1.0, <0.000-0.3, <0.0001-0.6, <0.0001-27.1 ppm respectively, while H_2S, NH_3 were not present at measurable levels. The detected SPM and noise level were 80.9-165.9 $\mu g/m^3$ and 43.4-77 dB. The measured air quality parameters did not exceed the Federal Ministry of Environment (FMENV) stipulated threshold concentrations for potential air contaminants in the ambient air, except for SO_2 at S1, S5, S7, S12, S14, and S17 and THC at S1, S5, S6, S7, S8, S9, S12, S14, S15, S16, and S19 which measured higher than limit set by FMENV. Apparently, the detected levels are not a threat to the environment since the atmospheric density of the pollutants shows a distance disintegration pattern, which result in concentration reduction farther away from the BTSs.

Key words: air quality, atmospheric levels, radio frequency, concentration, Base trans-receiver stations

Introduction

Telecommunication processes requires equipment and devices that transfer (transmitters) and receive (receivers) information using electronic codes which rely on radio frequency. Advancement in telecommunication allowed for enhanced radio frequency coding which facilitated internet and ethernet communication technology. The recent advancement in radio frequency coding allowed for internet telephony and tele-conferencing (Alabi, 1996). Developing countries and countries with economies in transition are undergoing rapid advancement in information and communication technology (ICT) to bridge the digital gaps through the introduction of global system of mobile communication (GSM) (Osibanjo, 2009). The benefits include access to reliable, open and widespread system for transmitting information, drastic revolutions in communication psyche of people in developing countries, 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 (Wilson and Wong, 2003). ICT have also aided many rescue operations by providing information on early warning signals based on geological and climatic information (Grasso, 2008). The global system of mobile communication (GSM) however requires infrastructure such as base trans-receiver stations, which are used in boasting communication coverage. Telecommunication Base trans-receiver stations (BTSs) are designed to enhance communication radio-frequency network signals for the rapidly expanding digital telecommunication users both in urban and rural communities (Turletti et al., 1999) It also facilitates the extension of communication network accessibility to sub-urban and rural communities lacking access to telecommunication services. Typical BTS consists of telecommunication mast on which are installed radio frequency transmitters and receivers, powered by digital electronic boasters which are installed in shelters within the BTS site.

A number of environmental issues have attended the introduction of this technology. This includes the indiscriminate siting and erection of base trans-receiver stations all over Nigeria. A conservative estimate of over 20,000 Base trans-receiver stations are scattered around the country. Many of the BTSs are sited within residential, commercial, industrial and transit routes. Aside from the risk of chronic human and environmental exposure to radiations and other environment and safety matters, air quality damage appears to be of priority (IFC, 2007), since many of the base trans-receiver stations are powered by diesel run power generating sets. Diesel run combustion engines are known to release fugitive emissions and other air pollutants (Dürkop and Englert, 2004). Thus, the atmosphere receives gaseous and particulate pollutants from BTSs operations. The health related implications of gaseous and particulate release are of great concern (Sarnat, 2011). Some gaseous releases also have detrimental consequences such as the destruction of ozone layer, global warming and incidence of acid rain (Sivasakthivel and Siva Kumar Reddy, 2011). As a result, atmospheric emissions resulting from BTSs operations are of environmental concern. Hence the characterization of air quality in vicinities around operating base trans-receiver station sites is important in order to ascertain the human and environmental risk associated with base trans-receiver station operation.

This study investigates the ambient air quality around some base trans-receiver station sites in Oyo State, South west Nigeria, in order to determine the health and safety of the operations of the base trans-receiver stations in residential, commercial and transit routes environments in twenty BTS spread in nine Local Government Areas. The measured air quality data were defined with respect to the FMENV stipulated threshold concentrations.

Materials and method

Study area

Ibadan the largest city in West Africa is the seat of government and capital of Oyo State. An estimate of over six hundred base trans-receiver stations exists in the State. The city of Ibadan and its peri-urban areas is made up of about nine Local Government Areas, with over three hundred telecommunication base trans-receiver stations scattered all around. The Local Government Areas include Akinyele Iga, Egbeda, Ido, Ibadan Municipal, Ibadan North, Ibadan North East, Ibadan South West, Oluyole and Lagelu, as shown in the map of Oyo State (Figure 1). It was not possible to evaluate the air quality status around all the base trans-receiver stations hence the evaluated BTSs were randomly selected as representative. Measurements were therefore conducted in twenty BTSs spread over nine Local Government Areas within and around Ibadan city and its environs.

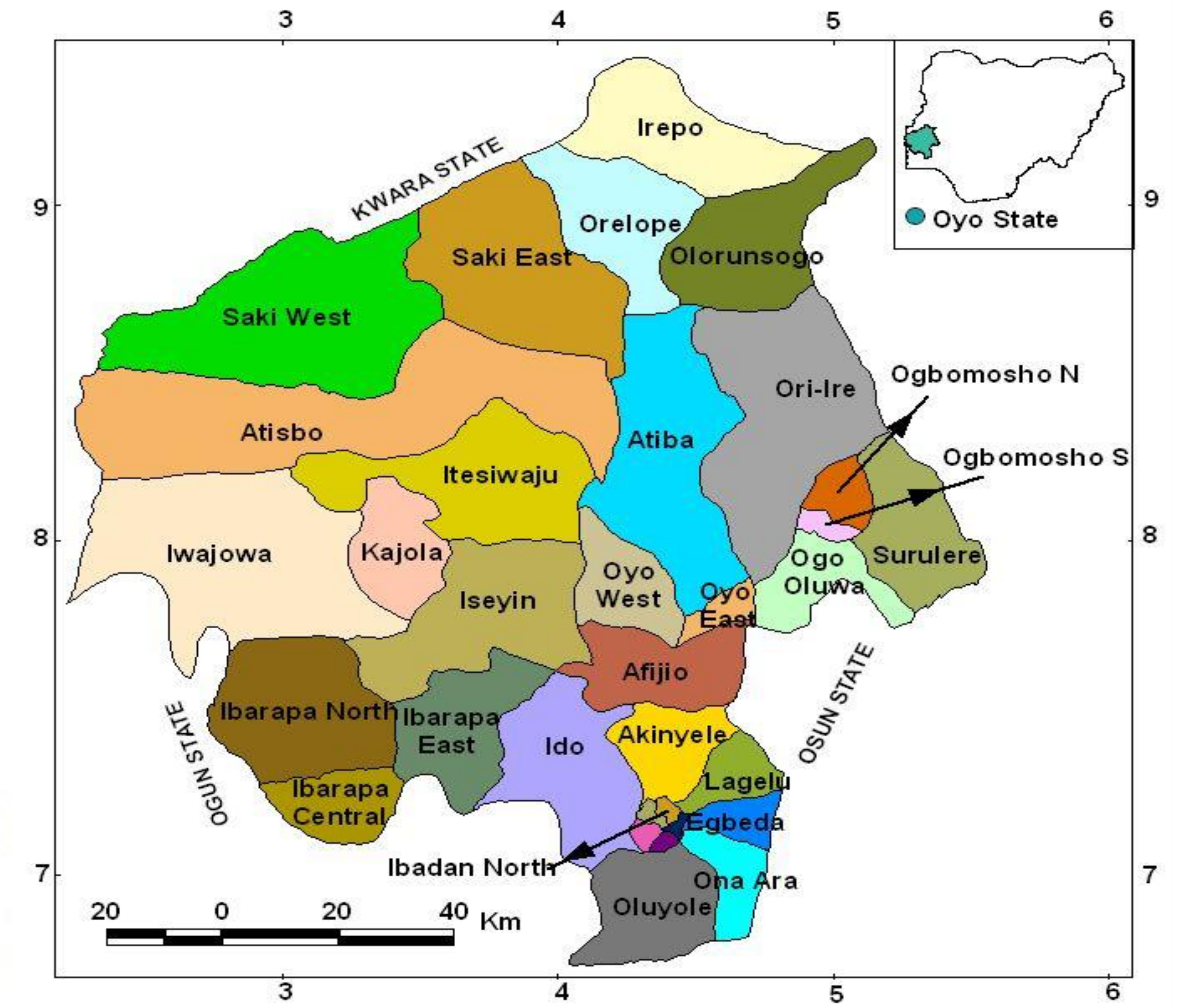

Figure 4.2: Map showing the delineation of Local Government Areas in Oyo State

Air quality and Noise measurement

Sampling points were carefully selected in the peripheral of each evaluated base trans-receiver station sites. Measurements were carried out during wet season and dry seasons of 2011. The ambient qualities of air were measured at the selected sampling points (upwind and downwind) at each of the Base trans-receiver study sites. A Honeywell and 3M hand-held air quality meter and Gas detector were used to measure air concentrations of: CO, NO_2, SO_2, H_2S, NH_3, THC and suspended particulate matter (SPM) at intervals of three hours for each parameter for forty eight hours. The measured air quality data were defined with respect to the FMENV stipulated threshold concentrations for potential air contaminants in the ambient air. Noise levels were also determined using hand-held noise meter. A TESTO 815 Sound level meter with a measuring range of 30 – 130 dB (A), accuracy of ±1.5 dB (A) was used for the monitoring.

Results and Discussion

The results of air quality, noise level and radiation measurements carried out around the twenty base trans-receiver stations study sites within and around Ibadan city, compared with Federal Ministry of Environment in Nigeria (FMNENV) stipulated limit are presented in Table 1.

Table 1: Ambient air quality and noise level measured at selected base trans-receiver stations in Ibadan and environs in Oyo State

Site Identification Number	Sampling Location	Coordinates Northing	Coordinates Easting	Noise Level (dB)	SPM ($\mu g/m^3$)	THC (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	H_2S (ppm)	NH_3 (ppm)
S1	AQ1	07^0 26.509’	003^0 52.803’	66.1	105.4	12.4	0.4	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 26.509’	003^0 52.805’	50.4	80.9	6.0	0.1	0.2	<0.0001	<0.0001	<0.0001
S2	AQ1	07^0 22.997’	003^0 51.027’	58.4	153.8	10.0	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 22.994’	003^0 51.039’	53.4	128.2	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S3	AQ1	07^0 21.282’	003^0 49.911’	47.6	97.8	2.0	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 21.274’	003^0 49.919’	46.4	91.2	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S4	AQ1	07^0 21.991’	003^0 51.191’	54.4	130.8	8.0	0.4	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 21.989’	003^0 51.191’	64.1	109.6	3.0	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S5	AQ1	07^0 24.122’	003^0 56.471’	77.4	165.7	12.0	1.0	0.4	<0.0001	<0.0001	<0.0001
	AQ2	07^0 24.130’	003^0 56.470’	63.4	152.8	2.0	<0.0001	0.1	<0.0001	<0.0001	<0.0001
S6	AQ1	07^0 19.634’	003^0 56.159’	65.2	142.9	14.6	0.4	0.2	0.1	<0.0001	<0.0001
	AQ2	07^0 19.648’	003^0 56.164’	46.8	134.2	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S7	AQ1	07^0 19.566’	003^0 54.144’	66.3	131.7	23.5	0.3	0.2	0.1	<0.0001	<0.0001
	AQ2	07^0 19.544’	003^0 54.141’	52.0	126.8	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S8	AQ1	07^0 25.534’	003^0 59.681’	75.8	102.8	16.0	0.4	0.1	<0.0001	<0.0001	<0.0001
	AQ2	07^0 25.544’	003^0 59.684’	57.9	94.0	2.0	0.6	<0.0001	<0.0001	<0.0001	<0.0001
S9	AQ1	07^0 27.641’	004^0 03.913’	69.0	10.3.2	12.6	0.6	0.1	0.3	<0.0001	<0.0001
	AQ2	07^0 27.639’	004^0 03.910’	50.4	97.8	3.0	0.2	<0.0001	0.1	<0.0001	<0.0001
S10	AQ1	07^0 32.147’	004^0 05.623’	60.8	95.2	8.0	0.6	0.1	<0.0001	<0.0001	<0.0001
	AQ2	07^0 32.152’	004^0 05.633’	46.0	91.8	<0.0001	0.2	<0.0001	<0.0001	<0.0001	<0.0001
FMENV Limits				90	250	10	10	0.1	0.04-0.06	0.02	0.02

Codes: AQ1-down wind; AQ2-up wind

Table 1 continued: Ambient air quality and noise level measured at selected base trans-receiver stations in Ibadan and environs in Oyo State

Site Identification Number	Sampling Location	Coordinates		Noise Level (dB)	SPM ($\mu g/m^3$)	THC (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	H_2S (ppm)	NH_3 (ppm)
		Northing	Easting								
S11	AQ1	07^0 26.284’	003^0 54.096’	43.4	85.2	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 26.285’	003^0 54.088’	48.5	90.8	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S12	AQ1	07^0 23.040’	003^0 52.768’	68.4	151.9	19.4	0.3	0.2	0.1	<0.0001	<0.0001
	AQ2	07^0 23.049’	003^0 52.759’	58.4	164.8	10.4	0.2	0.1	<0.0001	<0.0001	<0.0001
S13	AQ1	07^0 37.844’	003^0 50.952’	50.4	97.8	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 37.834’	003^0 50.944’	48.4	92.4	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S14	AQ1	07^0 24.027’	003^0 59.790’	70.0	120.3	24.5	0.2	<0.0001	0.1	<0.0001	<0.0001
	AQ2	07^0 24.018’	003^0 59.771’	52.0	105.7	6.0	0.2	0.2	0.1	<0.0001	<0.0001
S15	AQ1	07^0 25.113’	003^0 51.569’	67.8	136.4	13.4	0.4	<0.0001	0.1	<0.0001	<0.0001
	AQ2	07^0 25.103’	003^0 51.565’	71.4	124.8	<0.0001	0.2	<0.0001	<0.0001	<0.0001	<0.0001
S16	AQ1	07^0 23.440’	003^0 45.259’	73.2	133.8	24.8	0.6	<0.0001	0.2	<0.0001	<0.0001
	`AQ2	07^0 23.455’	003^0 45.284’	54.3	119.4	10.4	0.4	<0.0001	<0.0001	<0.0001	<0.0001
S17	AQ1	07^0 23.785’	003^0 47.158’	72.2	95.0	26.7	0.4	0.6	0.2	<0.0001	<0.0001
	AQ2	07^0 23.792’	003^0 47.143’	55.7	96.8	<0.0001	<0.0001	0.1	<0.0001	<0.0001	<0.0001
S18	AQ1	07^0 15.430’	003^0 50.079’	55.2	81.4	5.0	<0.0001	<0.0001	0.2	<0.0001	<0.0001
	AQ2	07^0 15.415’	003^0 50.084’	54.6	87.7	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S19	AQ1	07^0 22.296’	004^0 05.061’	48.2	82.8	27.1	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 22.312’	004^0 05.068’	52.1	90.4	26.8	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
S20	AQ1	07^0 32.141’	004^0 05.628’	56.8	97.4	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	AQ2	07^0 32.145’	004^0 05.642’	58.1	94.3	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
FMENV Limits				90	250	10	10	0.1	0.04-0.06	0.02	0.02

Codes: AQ1-down wind; AQ2-up wind

Suspended Particulate Matters (SPM)

The atmospheric concentrations of suspended particulate matter (SPM) measured at the different sampling stations ranged 80.9 – 165.7 $\mu g/m^3$. The measured levels of SPM were below the FMENV guideline permissible limit of 250 $\mu g/m^3$. This implies that the ambient air around the Base Station sites are low and not of imploratory concentrations. The detected levels may not be BTS generated due to the intractable nature of atmospheric current, diffuse sources and the BTSs locations. Study result indicated higher atmospheric SPM levels in high density residential such as S4, S12, S16, and S6; commercial areas such as S15 and near major traffic routes such as S5 and S7 area.

Nitrogen Dioxide (NO_2)

The atmospheric concentrations of NO_2 measured were <0.0001-0.3 ppm in all the BTSs locations. Nitrogen dioxide was detected in only about 25% of the sampling points at level between 0.1 - 0.3 ppm, while it was not detectable in 75% other sampling points. Aside from S9 and S18 which are in rural setting, but along transit routes, NO_2 appeared to be associated with residential density where detected. Hence traffic rather than BTSs operations may account for their atmospheric presence. This is consistent with the World Health Organization report which states that the differences in the NO_X (Nitric oxide and Nitrogen dioxide) emissions of various countries are mainly due to differences in fossil fuel consumption (WHO, 1987). Consequently, the average concentration of NO_2 detected during studies measurement NO_2 in 75% of sampling points were below the World Health Organization (WHO) reported NO_2 annual concentrations range of 0.01 – 0.05 ppm NO_2 in urban areas throughout the world (WHO, 1987).

Ammonia (NH_3) and Hydrogen Sulphide (H_2S)

The concentrations of ammonia and hydrogen sulphide were below the instrument detection limit i.e. < 0.0001 ppm. Hence study result showed that NH_3 and H_2S were not detected in any of the sampling point around the studied base trans-receiver station (BTSs). This implies that the concentration levels of NH_3 were well below the set FMENV ambient air limit of 0.02 ppm and the levels of values H_2S did not exceed the FMENV limit of 0.008 ppm in ambient air.

Sulphur Dioxide (SO_2)

Sulphur dioxide levels in 67% of the BTSs studies sampling points were below the instrument detection limit (<0.0001 ppm). The concentrations of SO_2 detected in the other 33% were ranged 0.1-0.6 ppm. The highest concentration of 0.6 ppm was detected in S17 along a transit route. 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 (USEPA, 1990). The detected concentration levels of SO_2 did not exceed the FMENV ambient air limit of 0.1 ppm in 33/40 of the sampling points at the BTSs studied. Thus in all measurement cases, SO_2 concentrations at all sampling points were below the lower limit of the FMENV guideline concentration range of 0.01 – 0.1 ppm for ambient air except at S1 (0.2 ppm), S5 (0.4 ppm), S7 (0.2 ppm), S12 (0.2 ppm), S14 (0.2 ppm), and S17 (0.0 ppm) measurement points.

Carbon Monoxide (CO)

The measured concentrations of CO in air around the BTSs investigated were ranged < 0.0001 – 1.0 ppm. Carbon monoxide ranged 0.1 – 1.0 ppm were detected in about 53% (21/40) of the sampling points, while the remaining 47% were below the instrument detection limit. Carbon monoxide in air is the product of incomplete combustion, which is primarily released from the emissions of vehicles and generators. Although CO was detected around more than half of the BTSs, it sources is not solely from the exhaust of the operating power generating set, since air current may contain intractable concentration from diffuse sources. Carbon monoxide values were expected to be high due to high traffic flow and continuous releases of vehicular emissions in around most of the BTSs. Although the measured concentration levels of CO were well below the set FMENV ambient air limits of 10 ppm, atmospheric CO is of concern because of its obvious human health and climatic effects. This is because most of the BTSs are located within residential and commercial areas. Carbon monoxide inhalation causes muscular reflexes, impairs thinking and causes drowsiness by reducing the oxygen carrying capacity of the blood. It is also associated with increase in the likelihood of exercise related pain in people with coronary heart disease.

Total Hydrocarbons (THC)

Total Hydrocarbon content (THC) in air is primarily due to generators and vehicular emissions. The total hydrocarbon content measured in air around the BTSs studied ranged < 0.0001 – 27.1 ppm. Total hydrocarbons were measured at 65% (26/40) of the studied BTSs, and ranged 2 - 27.1 ppm. Results showed that the BTSs sited in residential, commercial and along transit routes have measurable levels of THC, while those located off the mentioned areas were either not of measurable levels or of very low concentrations. The measured THC levels did not exceed the FMENV ambient air guideline limit of 10 ppm except in 35% of the tested BTSs namely S1, S5, S6, S7, S8, S9, S12, S14, S15, S16, and S19 which measured > 10 ppm limit set by FMENV.

Noise Level:

The measured noise levels in all the sampling points at the BTSs studied were ranged between 43.4-77.4 dB. The noise levels were variable from one BTS to another with all the observed levels measuring below the FMENV limit of 90 dB. Noise is an undesired or unwanted sound. It produces waves of very high pitch that is offensive to hearing. Public advertisements, engineering works, industrial processes, vehicular traffic, etc. may produce noise at the levels that could be irritating and damaging to hearing. Experimental evidence showed that unprotected exposure to noise can cause constriction of blood vessels and decreased blood flow to the organs. The likely sources of increased noise at Base Stations locations are power generating sets, from factories, noise influenced by light or heavy traffic, noise from commercial and artisan activities and local noise coming from residential quarters.

Air quality

The atmosphere receives gaseous and particulate pollutants from various sources. While Base Station emissions can be regarded as a point source which can be controlled by the use of alternative energy sources, diffuse sources which are difficult to track can release substantial amount of air pollutants, and this can cause deleterious consequences at chronic and sub chronic levels. Principal component analysis showed that air quality around BTSs located in high density residential has similar characteristics with those measured at BTSs site along major traffic roads, and are not significantly ($p > 0.05$) different from each other. Air quality characteristics of BTSs located in Ibadan suburbs were significantly ($p < 0.05$) lower than those measured at BTSs located along high traffic roads and high density residential. This may be because of low population and activities, as well as low BTSs cluster population. Consequently the low noise levels, and low concentrations of CO, NO_2, SO_2, H_2S, NH_3, THC and SPM measured at the BTSs.

The health related implications of gaseous and particulate release are of great concern. Some gaseous releases also have detrimental consequences such as the destruction of ozone layer, global warming and incidence of acid rain. The potential for air and environmental contamination through operation of BTSs is apparent due to the detected levels of SO_2 and THC in some BTSs, when compared with measurement taken at the control measurement points. The detected levels are not a threat to the environment since the atmospheric density of the pollutants shows a distance disintegration pattern, which result in concentration reduction farther away from the BTSs. Continuous emission of air quality pollutants may result in chronic environmental pollution except if sources of energy powering BTSs operations are change to an environmentally friendly one, or there is a change in telecommunication technology.

Conclusion

Atmospheric concentrations of CO, NO_2, SO_2, THC and SPM measured in the BTSs investigated were low and did not exceed the Federal Ministry of Environment (FMENV) stipulated threshold concentrations for potential air contaminants in the ambient air, except for SO_2 and THC which measured higher than limit set by FMENV in some BTSs, while NH_3 and H_2S were not present at detectable levels. The measured noise levels were below the 90 dB FMENV. There is likelihood of air and environmental contamination through operation of BTSs. This is apparent from the SO_2 and THC exceedance in some BTSs.

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