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Noise level assessment of Mobile Telecommunication Base Stations Proximate to Residential areas in Accra, Ghana

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Abstract: The public is opposed to base stations being installed in Accra and other cities to increase the coverage of mobile phone networks. The purpose of this study was to evaluate the noise levels produced by the generators used at mobile phone base stations. Specifically, the study focused on the noise levels produced by these base stations solely at night, from 22.00 to 06.00, in residential zones. Simple compliance coefficient data analysis was used quantitatively as part of the data collection process. The study's findings demonstrated that even at a distance of 50 meters from base stations, noise levels from generator sets at residential base stations were not usually below the 48 dB threshold imposed by the Environmental Protection Agency (EPA) between the hours of 22.00 and 06.00. As a result, this perimeter which has been designated as a residential region with minimal or sporadic transportation has noise pollution. District assemblies should, therefore, firmly enforce a minimum setback distance of at least 50 meters between telecommunication base stations and the next residential building.
Keywords: Noise pollution; Compliance coefficient; Threshold, Residential area; Base station

1. Introduction

Mobile telecommunication technology (MTT) has significantly improved people's capacity to interact with one another and has made it easier to send police, emergency medical care, and relief supplies to people in both urban and rural areas [14, 16]. However, long-term exposure to the noise produced by various mobile telecommunication devices might have unfavorable spillover consequences from investments in telecommunications infrastructure, such as obesity, peptic ulcers, nausea, high blood pressure, deafness, and stomach spasms [5, 21]. [11] believed that there is a risk that ICT-based products may become counterproductive and environmentally unfriendly because their effects are typically disregarded or even undetected.

Over 10,000 telecommunication base stations (BSs) have been deployed erratically over Ghana [1], with up to 2000 of them located in Accra alone. Notwithstanding mobile phone providers' insistence that BSs are secure, complaints against this technology are still rising. However, the general public does not find this claim to be persuasive. For instance, the Environmental Protection Agency [12] maintains a record of grievances from people and organizations. Concerns about electromagnetic radiation emissions, noise, smell, and vibration from generators at BSs, masts collapsing on buildings, BSs built without neighbourhood approval, and masts close to homes and schools are among the issues.

Decibels (dB) are used to quantify permissible noise levels, which differ depending on the location [5, 9]. For instance, under Act 490, the Ghanaian EPA is required to establish regulations and guidelines regarding noise pollution. As a result, the EPA established the following acceptable noise limits for residential zones: 55 dB during the day (06.00–22.00) and 48 dB at night (22.00–06.00). It is important to remember that a typical conversational volume falls between 50 and 60 dB. As a result, the purpose of this study was to evaluate the noise levels caused by the generators utilized in mobile telecom base stations in residential zones at night (22.00–06.00).

2. Material and Methods

2..1 Determination of noise level from the study area

The sound levels were measured using a digital sound level meter (model number AZ8928), which has four ranges of measurement: 40-70dB, 60-90dB, 80-110dB, and 100- 130 dB. To make sure the generator at the BS was the only source of noise, noise levels were recorded at 16 BSs in residential zonings from 22.00 to 23.30 at night. At certain distances from base stations (20, 50, 100, and 150 meters), the digital sound level meter was used to measure the exact levels or intensities of noise. The sound level meter was held at arm's length toward the source of the sound using the ISO (1975) technique, which reduced body reflection of sound and increased uniformity.

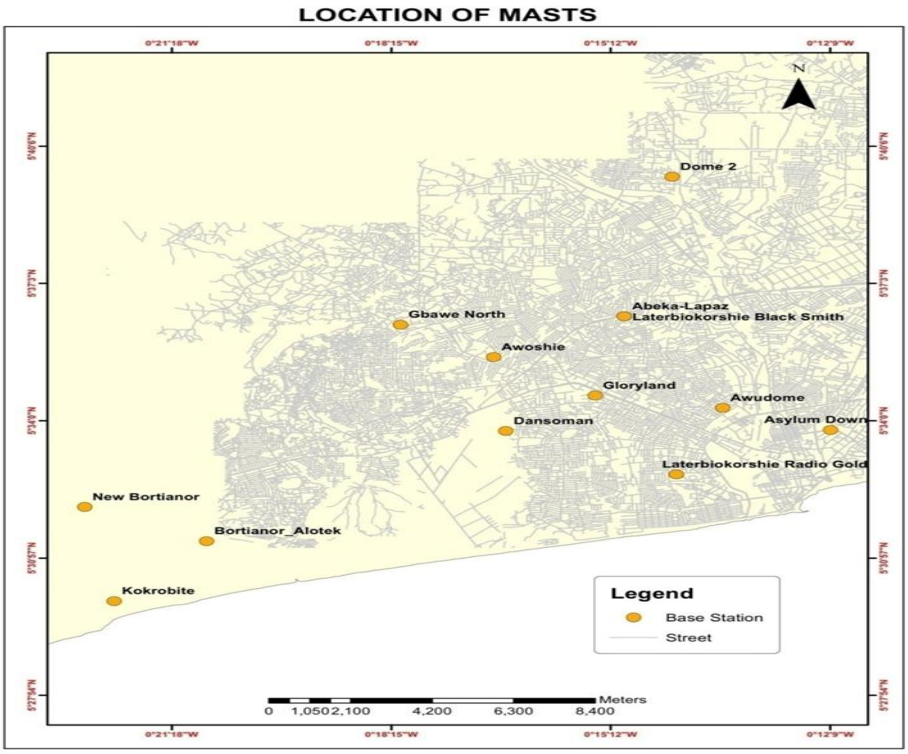

Figure 1: BSs at Accra neighbourhoods where noise levels were recorded

2.2 Determination of wind direction and speed

According to the American Medical Association (2010-2013), all measures were deemed acceptable since the wind direction (WSW) and average wind speed (8–16 km/hr) were measured using a Kestrel 1000 combination instrument at the time of measurement, which is less than 24 km/h. Four (4) readings were taken at each particular radius, roughly at the geographic locations of N, S, E, and W (Figure 2). Only when steady minimum and maximum noise levels were observed were measurements taken. The study excluded BSs with starting levels (within a 20-meter radius) below the 48dB allowable noise threshold established by the EPA between 22.00 and 06.00. The main goal of noise level measurement was to ascertain how much generator set noise complies with EPA regulations.

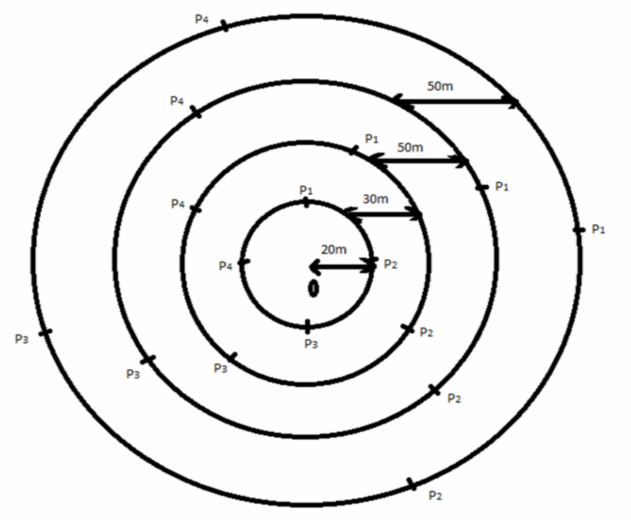

Figure 2: Approximate positions on a radius where noise levels were measured

Therefore, the compliance coefficient (θ) at a point was calculated as;

$$\therefore \theta = \frac{x}{y}$$

Where x represents the noise level measured, and y represents the threshold (maximum acceptable level)

3. Results and Discussion

3.1. Mean noise levels recorded at BSs

Table 1 displays the mean noise levels that were measured at the different base stations during the night of December 2021, from 22.00 to 23.00. Although there are many different sources of noise in the communities, this study only looked at noise levels produced by single generator sets at base stations at times when residential areas should record noise levels of 48 dB or lower. The mean noise level at 20 meters was 51 dB at Dome 2, the lowest at 76 dB in Bortianor, and Kokrobite in second place. At 50 meters, the maximum noise level was measured by BSs at Bortianor Alotek and Achimota Alhaji at 60 dB apiece, followed by BSs at Dansoman at 58 dB and Laterbiokoshie (Radio Gold) at 41 dB.

Table 1: Average noise levels (dB) measured from BSs at various distances

BS site	20m	50m	100m	150m
Laterbiokoshie (Black Smith)	66	52	**	**
Kokrobite	68	50	**	**
Bortianor Alotek	76	60	44	**
New Bortianor	70	58	42	**
Adabraka	61	45	**	**
Abeka-Lapaz	67	47	**	**
Achimota Alhaji	70	60	44	**
Gloryland	56	46	**	**
Dome 2	51	48	**	**
Awudome	62	50	44	**
Gbawe North	65	48	**	**
Haatso	54	45	**	**
	58	50	43	**
N	60	48	**	**
Laterbiokoshie (Radio Gold)	57	41	44	**
Dansoman	65	58	44	**
Mean	62.9dB	51dB	43.6dB	**

Source: Field Survey Data, 2021. ** indicates values < 40

Overall, Kokrobite had the highest wind speed (5 km/h), and the sound level at 50 m was 50 dB. In contrast, New Bortianor had a wind speed of 2 km/h, but the sound level at 50 m was 58 dB. The computed compliance coefficients for noise levels were 0.9 and 1.3 at 20- and 50-meter radiuses from base stations, respectively. Even though the compliance coefficient at a 50 m radius was less than 1, several BSs at that distance reported noise levels that were higher than 48 dB, therefore there is reason for concern. Populations may be in danger of noise pollution if there is a compliance coefficient >1 within a radius of 20 m, and in some cases, 50 m [2, 22, 10]. This implies that a higher number of residents living far away from BSs will be affected in neighborhoods where physical structures may not be enough to obstruct the direction of noise [10]. The compliance coefficient being less than one beyond 50 meters may be explained by physical structures reflecting sound. In contrast to New Bortianor, where the wind speed was 2 km/h but the noise level was measured at 50 dB, a glaring example was seen in Korobite, where the wind speed was 5 km/hr. Similar findings were found in this investigation, where some regions exceeded the suggested limit of 48 dBA. This is comparable to the changing noise level in tested base stations in Abuja, Nigeria, where some areas exceeded the allowed limit of 90 dBA [8]. As this study [3] shows, several factors have been observed in numerous studies to influence the propagation of noise, including the type of source (point or line), distance from the source, atmospheric absorption, wind, temperature, and temperature gradient, obstacles like buildings and barriers, ground absorption, reflections, and humidity.

This study critically evaluates the conditions in some residential areas as concerning since adult sleep disturbance can lower the secretion of melatonin, [4] an endogenous hormone produced by the pineal gland and released exclusively at night [24] which controls and regulates the sleep-wake cycle. It can also suppress the growth of breast cancer and prevent depression [20,18, 19]. πr2d can be used to determine how many residents within a given radius of a BS will be impacted. When the population density of Accra (23, 000 people/km2) is represented by d, all r values (20, 50, 100, and 150 meters) are translated to kilometers. As a result, this indicates that there are at least 29, 180, 723, and 1626 people within a radius of 20, 50, 100, and 150 meters, respectively. When all BSs in residential areas are taken into account, the population grows significantly within a certain radius. According to this study, noise as a variable, at the very least, defies the idea of a social dilemma as stressed by [17] and supports a strong social norm. The majority of the generators at the BSs are noisy, according to the results, which suggests the necessity for barriers. However, this research proposes the use of zoning in physical planning because of the diversity of barriers, including physical, procedural, instructions, and behaviors [15]. Accessibility to base stations for accurate positioning may have affected the results.

3.2. Mean noise level pattern recorded at the base stations

Figure 3 presents the pattern of noise levels recorded at some selected base stations from distances of 20 and 50 meters. The towns, Laterbiokoshie, and New Bortiaonor at 20m and 50m experienced an initial rise in noise levels and a study fall in noise levels at Kokrobite, and Abeka-Lapaz. Though there was a decline in noise level at 20m and 50m in Adabraka, the situation at 20m was very sharp. There was a sudden rise in noise levels for base stations in Achimota-Alhaji at both 20m and 50m (Fig. 3). In all, consistent observation of noise levels recorded at 20m from the base stations was higher than that of noise levels at 50m. The variability in the noise level from different locations concurs with the determination of the noise level of different places [5, 8] that may be a factor of several environmental conditions [3].

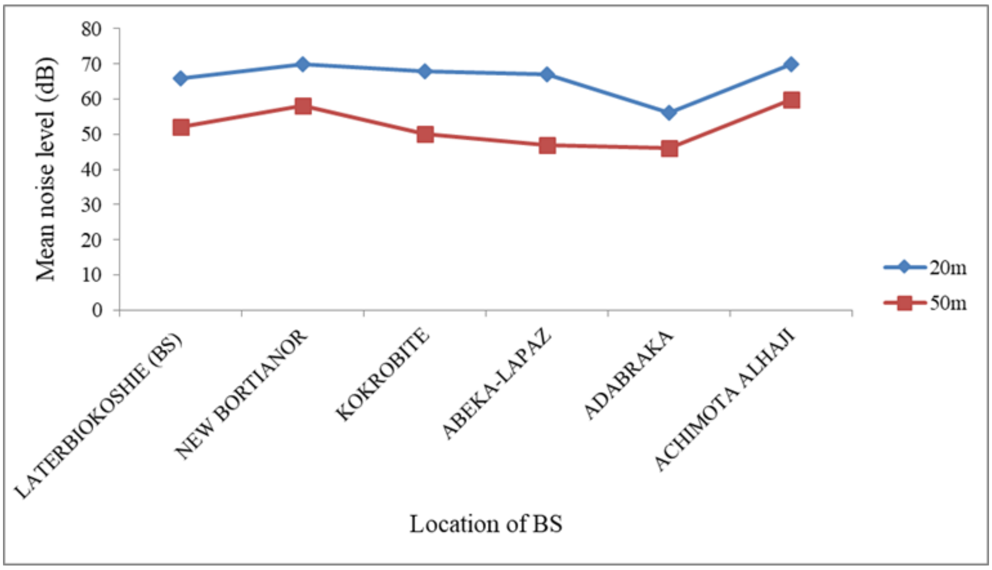

Figure 3: Mean noise level patterns at the BSs

4. Conclusion

In general, noise levels dropped with increasing distance from the generator sets (Fig. 3). People living 50 meters or less from BSs may therefore be susceptible to negative impacts from noise, as several BSs had noise levels exceeding EPA guidelines between the hours of 22.00 and 06.00. Thus, taking into account merely a BS located in a residential zone, over 180 people are consequently vulnerable to the negative impacts of noise. But as the number of BSs continues to rise, so does the number of individuals. District assemblies must firmly enforce a minimum setback distance of fifty meters or fewer between telecommunication base stations and the closest residential building in this regard. Additionally, to reduce the noise, objects that can block the propagation of noise through the reflection process could be used. Nonetheless, alternative noise mitigation models can also be a combination of barrier walls made of noise-reducing materials (concrete, brick) with plants.

Conflict of interest

The manuscript's authors affirm that they have no conflicting interests in publishing this work. Furthermore, the writers have adhered strictly to all ethical guidelines regarding plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publishing and/or submission, and redundancy.

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APPENDIX A

Four (4) positions at approximately the geographical N, S, E, and W positions on a radius

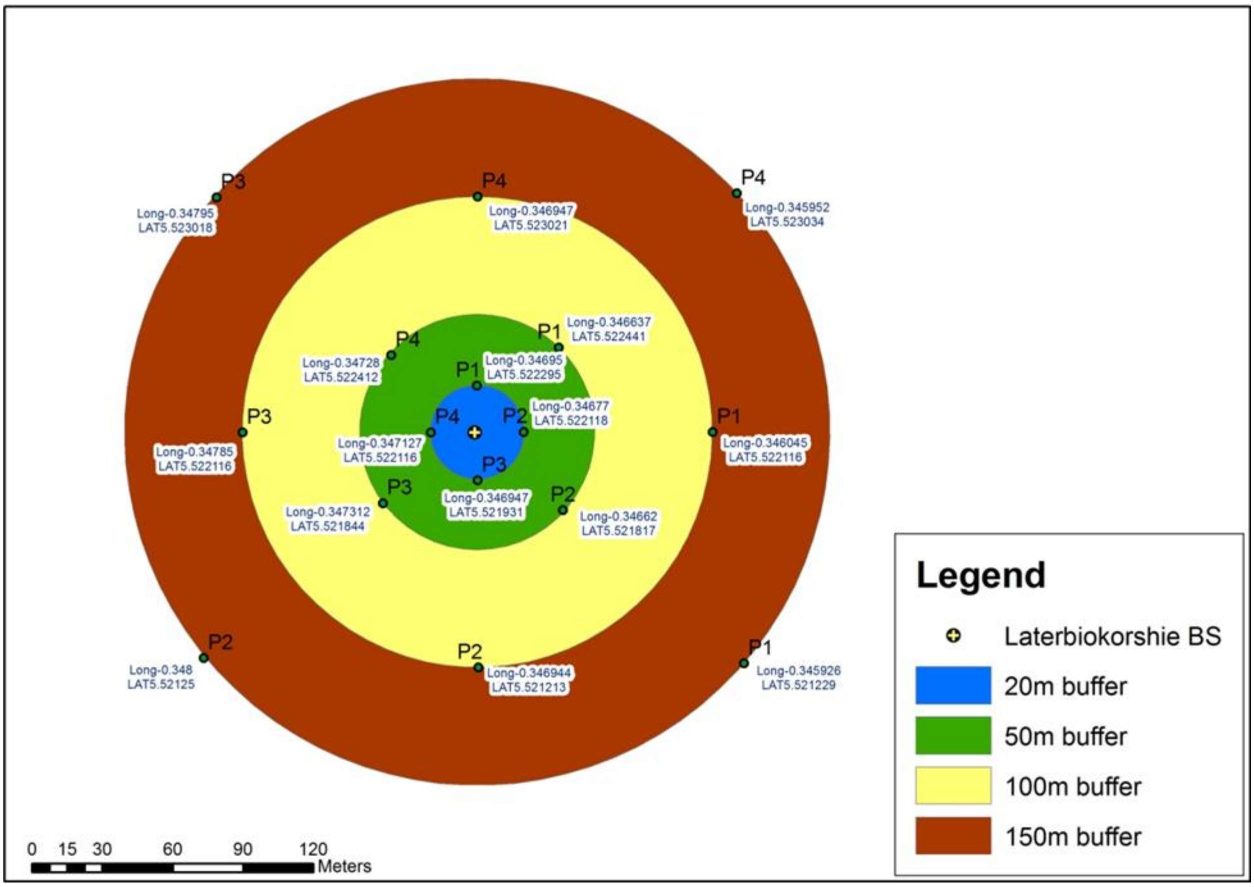

Table 2: Ambient noise level guidelines of EPA, Ghana

Zone	Description of an area of noise reception	The permissible noise level in dB (A)	
		Day (06.00-22.00)	Night (22.00-06.00)
A	Residential areas with negligible or infrequent transportation	55	48
B1	Educational (school) and health (hospital) facilities	55	50
B2	Area with some commercial or light industry	60	55
C1	Area with some light industry, places of entertainment or public assembly, and places of worship such as churches and mosques	65	60
C2	Predominantly commercial areas	75	65
D	Light industrial areas	70	60
E	Predominantly heavy industrial area	70	70

Source: Ghana EPA, 2008