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THE USE OF GEOSPATIAL TECHNIQUES IN DETECTING CARBON MONOXIDE EMISSION LEVELS FROM ELECTRIC GENERATORS IN MINNA METROPOLIS, NIGERIA

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ABSTRACT

Carbon monoxide (CO) is a colourless, tasteless, odourless, non-irritating, flammable and poisonous gas emitted from incomplete combustion of carbonaceous material used as fuels for transportation, electric generators and machines. CO emission was investigated over parts of Minna Metropolis to detect the emission levels with a view to ascertain whether or not they are within WHO set safe limits. Geospatial techniques of GIS, GPS, MSA and the use of Altair Gas Alert detector were utilized to generate data and for the analysis of the results. The result indicates that emission from the Petrol and Diesel engines exceeded the WHO set safe limits for the selected locations ranging between 13.5ppm and 250.6 ppm. Conclusively, the failure of Nigeria's electricity power supply sector is responsible for the increase and dependence on fossil fuel powered generators and thus accentuating the CO emission levels in the study area. The use of renewable sources of energy such as solar and wind to reduce dependence on fuel powered generators and continuous monitoring of the air quality to control and safeguard against secondary effects of CO emissions were recommended.

Keywords: Carbon Monoxide, Gas alert detector, Generators, Geospatial techniques, Air quality

INTRODUCTION

According to Fierro *et al.* (2001), Carbon monoxide (CO) is a colourless, odourless and non-irritating, flammable and poisonous gas emitted from incomplete combustion of carbonaceous material used as fuels for transportation sources such as cars, trucks, buses, motorcycles, aircraft, locomotives, vessels, farm equipment, industrial and construction machinery and electric generators. Carbon monoxide air concentrations levels are known to be high in areas with heavy traffic congestion as emissions from vehicles contribute about 60% of all CO emissions (Fierro *et al.*, 2001).

Stationary combustion equipment, such as coal, gas or oil-fired heating or electric generating plants emit CO as a result of inefficient combustion mechanisms. Industrial processes, solid waste and other miscellaneous sources also emit CO. Carbon monoxide emissions are substantially greater in cold weather because cars need more fuel to start at cold temperatures and some emission control devices such as oxygen sensors and catalytic converters operate less efficiently when they are cold.

Global concentrations of carbon monoxide were reported to be increasing during the late 1970s and 1980s because some 60 percent of the global emissions of CO come from anthropogenic sources which had increasing emissions over this period. Direct atmospheric observations between 1979 and 1982 in Cape Meares in Oregon U.S.A showed an increasing trend (Agostoni *et al., 1992*). Similar data from other locations world wide showed a global increase of about 1 percent per year. The likely future global-scale concentrations of carbon monoxide are completely unknown at present (Agostoni *et al., 1992*). However, in developing economies like Nigeria, reduction of CO emissions is quite unlikely due to the massive importation of used automobiles and poor domestic and industrial waste management practices.

In Nigeria, fuel combustion in cars was identified as the major source of CO emission but this has been overtaken by the use of numerous electric generating plants which dot the whole country; both in rural and urban settlements. Though there is no accurate figure of the number of fossil powered generating plant in the country, it is believed that on the average, one in every

four households in the rural areas and one in every two in the urban centers has an electric generator. It is imaginable therefore, that the number of electric generators in Nigeria with a population of over 140 million people will be outrageous. This is so mainly because of the inadequate power supply from the nation's power company - Power Holding Company of Nigeria (PHCN), which for decades has been generating less than 4,000 megawatts compared to 10,000 megawatt required by the country as at 2012 (Suleiman, 2013).

In Niger State, the assumed Power State that house the major hydroelectric power dams (Kainji. Jebba and Shiroro), little electric power is being delivered to the inhabitants. This has led to sporadic increase in the use of electric generators of different sizes and capacity, thus, resulting in corresponding increase in the CO emissions (Davids, 2014).

This work therefore applied geospatial techniques to detect the CO emission levels from electric generator in Minna Metropolis, Nigeria.

The Study Area

Minna is located on Latitude 9^0 36' 50" and Longitude 6^0 33' 25", it has an estimated population 304, 113 (NPC, 2006). It is the capital of Niger state and is connected to neighbouring cities by road. Abuja is only 150km away. Minna is linked by railway to both Kano in the North and Ibadan and Lagos in the South. The Central Business District (CBD) is the core of the Study Area encompassing areas within and along Mobil Petrol Filling Station Roundabout, Old Airport Road, Kuta Road and Bosso Road. These collectively fall within a radius 1.5 Kilometers from the Obasanjo Shopping Complex Roundabout (See Figure 1).

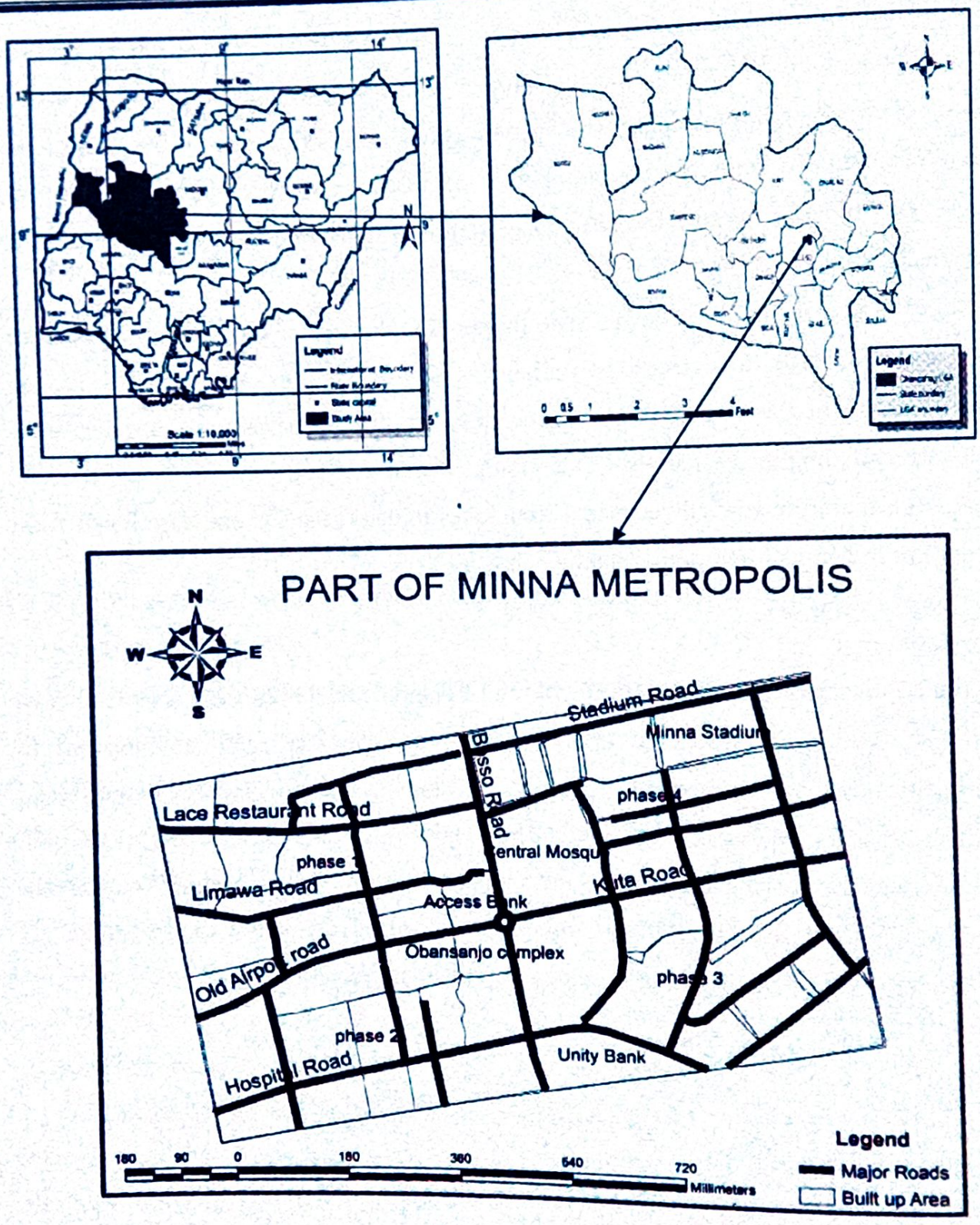


Figure 1: The Study Area Coverage (Minna) Niger State, Nigeria.

Materials and Methods

The primary data sources involve the use of GPS receiver to obtain coordinates and the Gas Alert Detector to obtain readings of CO in the study area. The secondary data used, is the Base map of Minna from Google Earth Software mapper. The base map was scanned and imported into the Arc GIS 10.1 environment and geo-referenced using a defined projection system. The dataset was projected to WGS 1984, Universal Transverse Mercator, Zone 32° N Minna, Nigeria. All the scenes were mosaic using Corel Draw Graphics Suite 12 and geo-referenced with major landmarks on the image. A Geo - database was created in Arc catalog depicting features and their classes namely; Roads, Built-up area, and CO emission in the Geo - database.

Buffer zones of specific distance were created around the location of generator plants to determine their proximity level to population concentration. Proximity analysis was performed via query to ascertain the proximity level of the people to CO emission.

The reading in part per million (ppm) of CO emission from generators was obtained using the MSA ALTAIR 4X Gas detector at the selected points. The Cadastral map of the area was used as basis for carrying out the measurements of CO.

Simple random sampling method was used in data acquisition. The digitization of the map was carried out and over laid on the satellite image from Google Earth (Spot Image 5 meter multispectral resolution).

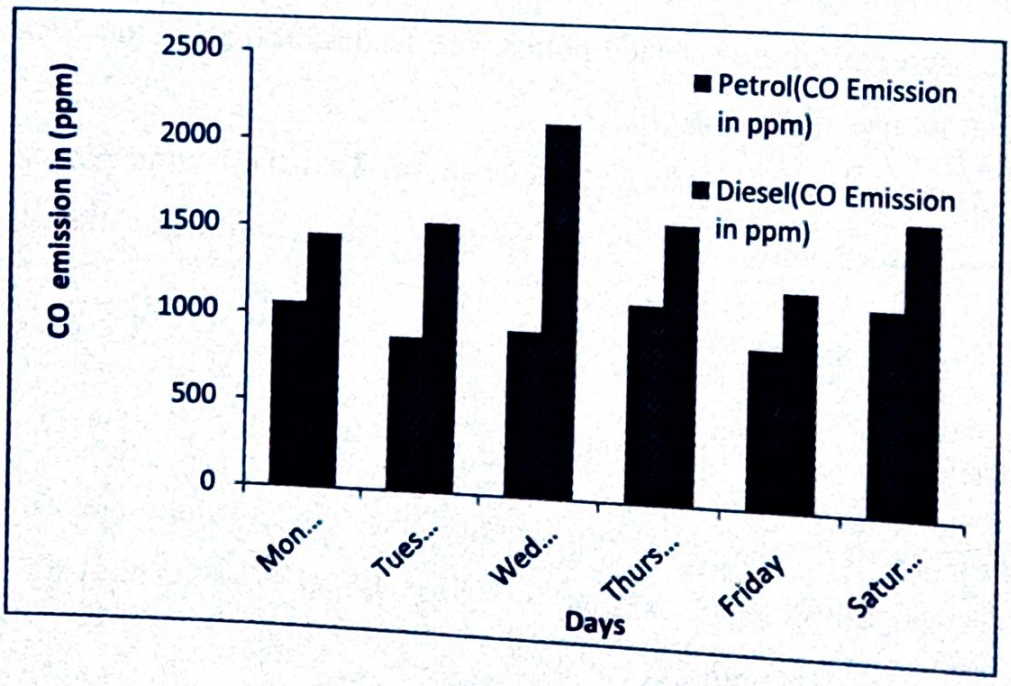
RESULTS AND DISCUSSION

Table 1 depicts the summary of the CO emission data generated in the study area. It shows that two key areas; Old Airport/Mobil Roads account for an average of 122 ppm emission and Kuta/Bosso Roads has an average of 100 ppm CO emission.

Table 1: Summary of CO Emission Data in the Study Area

Groups	Count	Mean Daily Emission (Petrol in ppm)	Mean Daily Emission (Diesel in ppm)
Old Airport/ Bosso Road	133	122	337
Kuta/ Bosso	81	100	309
Total	213	222	647

Figure 2 and 3 shows daily emission levels from petrol and diesel generators. It indicates that diesel engines emit more CO of (1224 and 2123 ppm) than petrol engines.



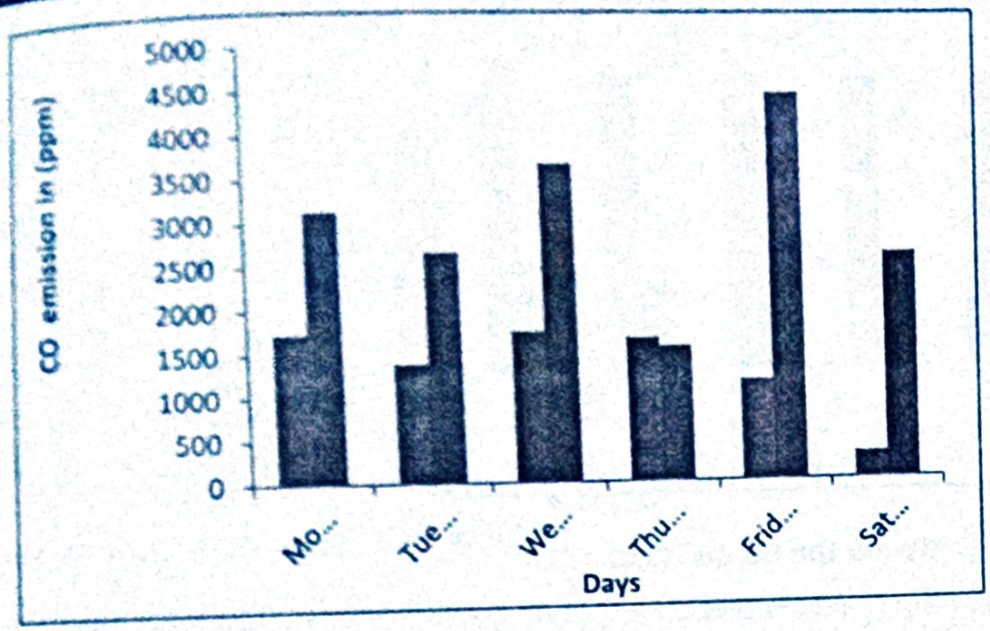


Figure 2: Daily CO Emission at Kuta road **Figure 3: Daily CO Emission at Mobil road**

At Mobil and Old Airport roads, diesel engines emit between 1579 and 4468 ppm of CO compared to petrol engines which emits between 347 and 1857 ppm. Variations in emissions amount within the weekdays indicates further decline in power supply from PHCN and increased commercial and industrial activities mostly from small scale businesses that requires continuous power supply, which the electric generators readily supply.

Figure 4 and 5 depicts the distribution of CO emissions on daily basis at the study areas. Weekend; Saturday and Sunday in particularly records lower emission levels. This is due to low commercial and industrial activities during these days (Davids, 2014)

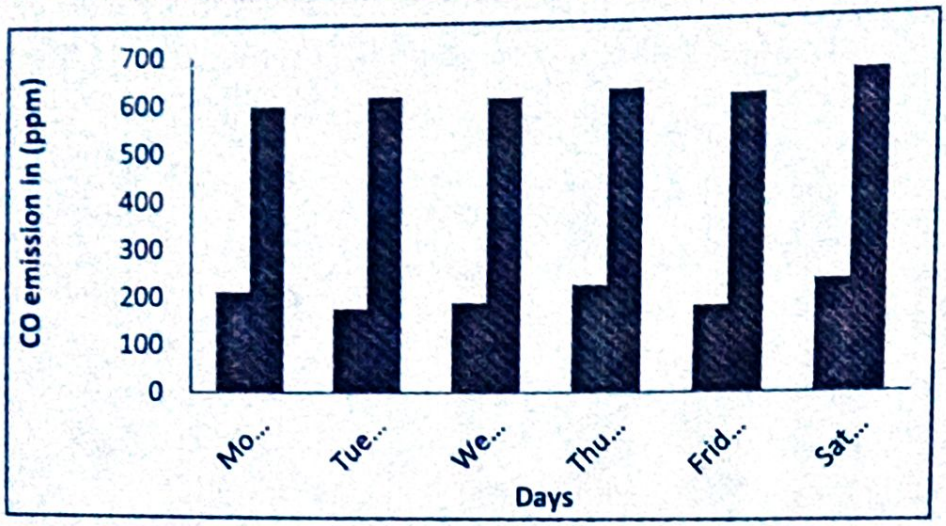


Figure 4: Mean daily CO Emission for Bosso Road

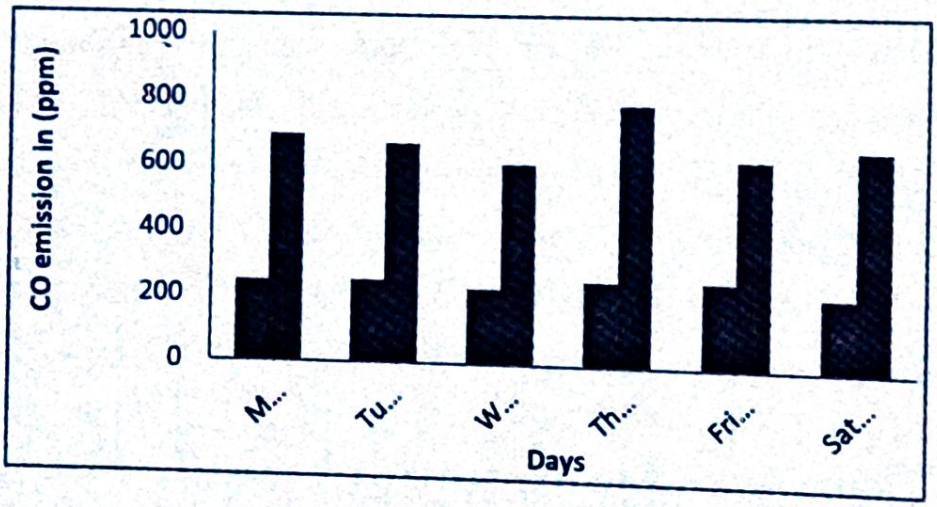


Figure 5: Mean daily CO Emission for Old Airport Roads

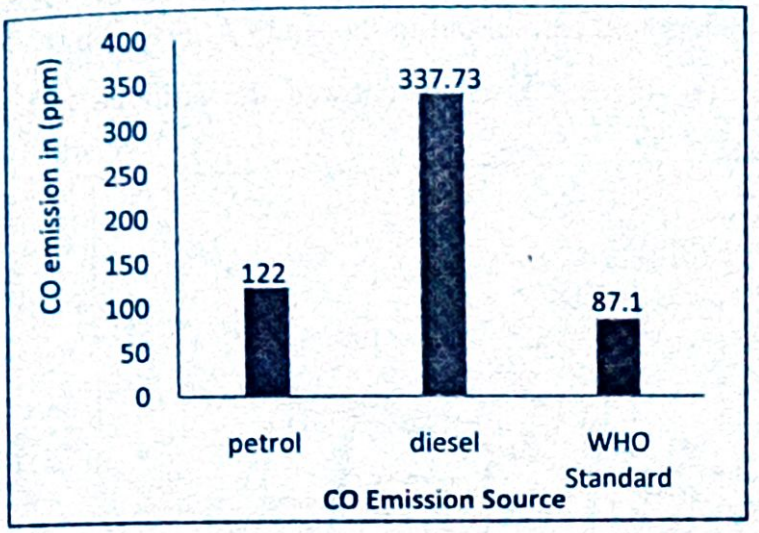


Figure 6: Average CO emission from Petrol and Diesel at Old Airport and Mobil roads.

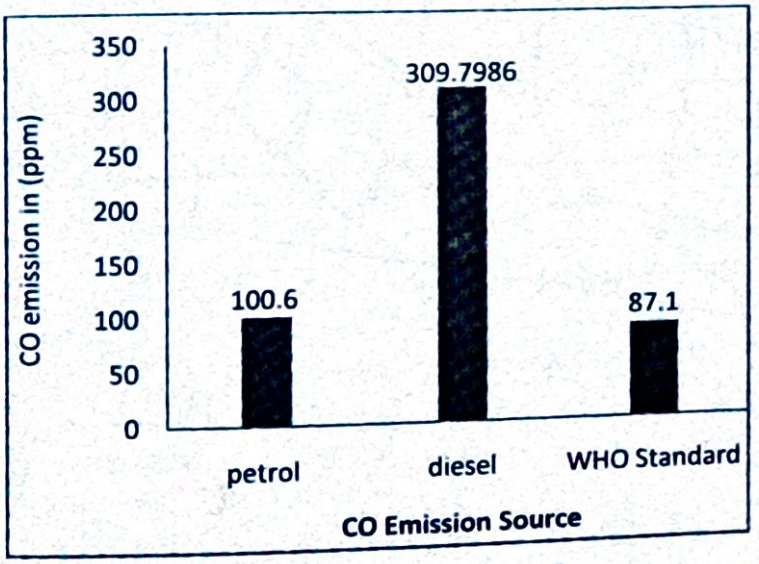


Figure 7: Average CO emission from Petrol and Diesel at Old Airport and Mobil roads.

The average recorded emissions levels were compared to the WHO Safe limit standards. Emission from both Petrol and Diesel engines exceeded the WHO standards in the region of 13.5, 34.9 ppm (Petrol powered engines at old airport/ Mobil, Kuta/Bosso roads), 222.6, 250.6 ppm (Diesel powered generators at Old Airport/ Mobil, Kuta/Bosso road) respectively.

The buffering of 100 meters and 50 meters was carried out in the study Area to can run a proximity analysis for effective data collection. Figures 8 and 9 showed the buffered zones within the study area.

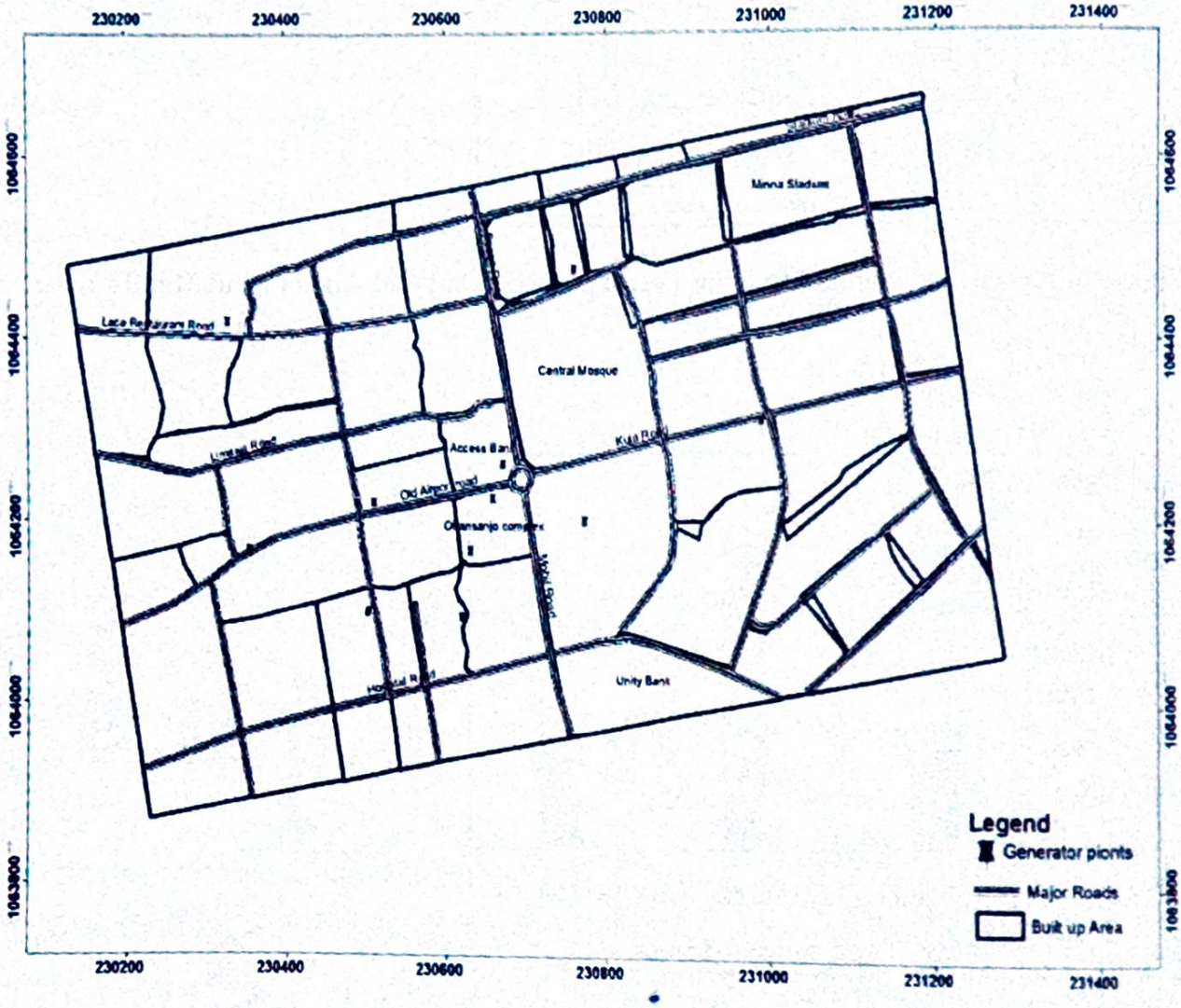


Figure 8: Spatial Distribution of CO Emission Spots in the Study Area

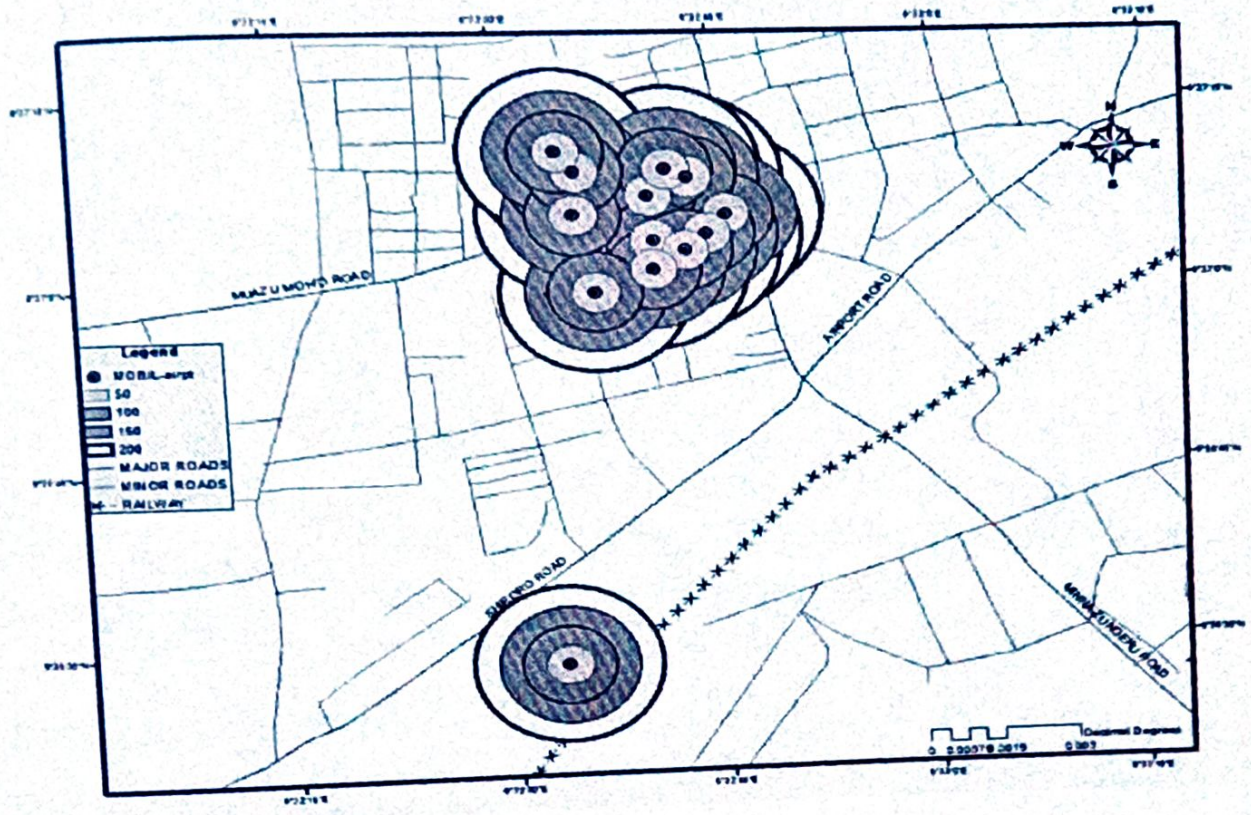


Figure 9: 50 Meter Buffer Distance

Figure 10 shows the Query analysis carried out to check the proximity of people to the generator stand.

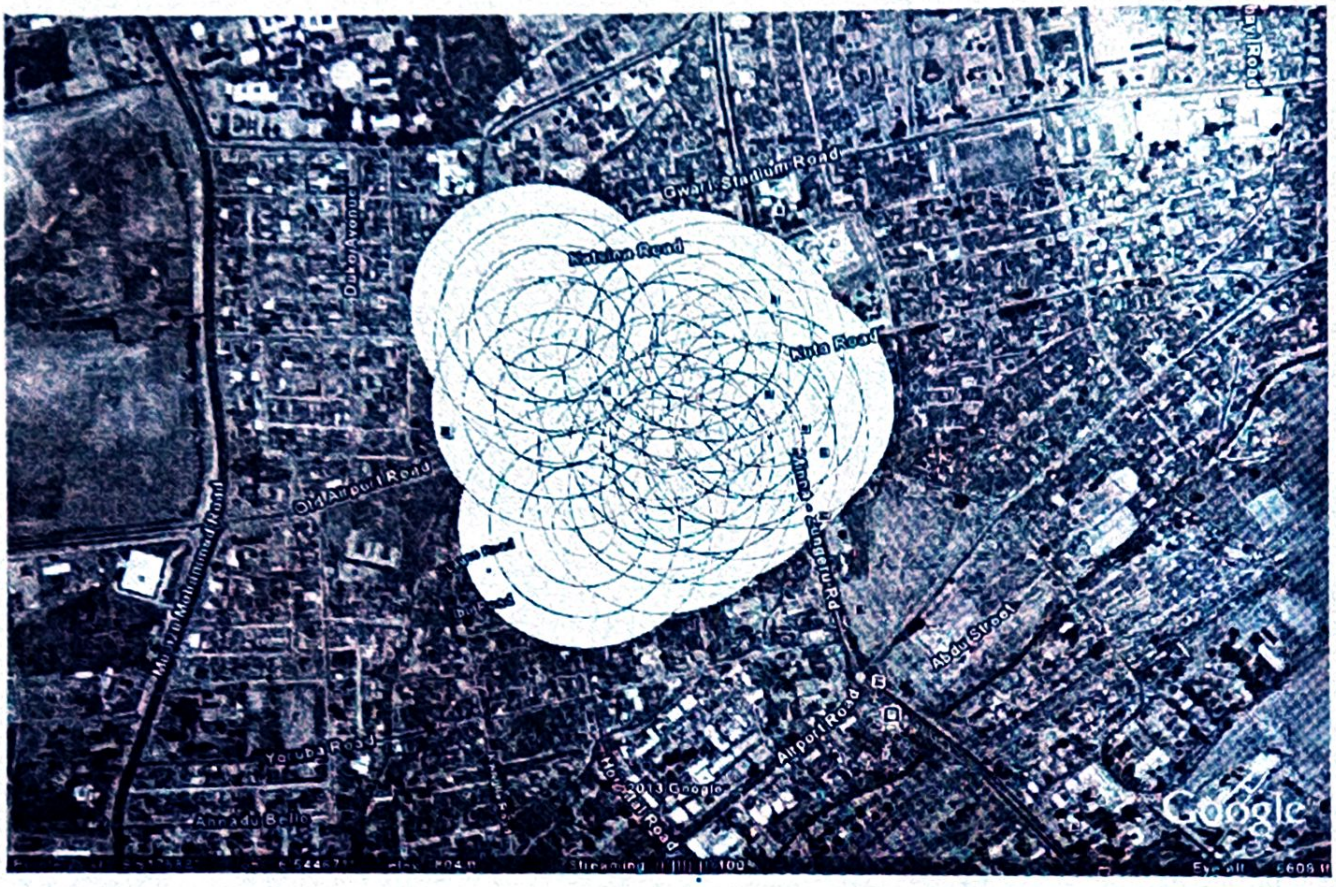


Figure 10: 100 Meter Buffer Distance

It depicts the buffered distance falls between 50 meter and 100 meters respectively, indicating that Carbon Monoxide as sources of pollution appears in a circular form showing vulnerable areas within the study area.

The locations of the study areas is at the Central Business District (CBD) where substantial number of the business activities are being carried out. Thus, there is always a scenerio of congestion of people carrying out their daily activities which requires constant power. The inability of Nigeria's PHCN to provide adequate and stable power supply makes people to exploit alternative option available to them and that is the use of power generators. The continuous usage of these power plants lead to the geometric increase in CO emission.

With the WHO internationally acceptable safe limit of CO in the atmosphere to be 87.1ppm, the average emission levels of CO in the entire study areas (Figures 6 and 7) is of great concern on the immidiate environment and global air quality at large. Furthermore, According to Townsend (2002), If this trend in the use of power generation and emission levels continues, the quality of CO to be released in the near future in the study area will be enough to produce other secondary effects like the health challenges from poor air quality.

CONCLUSION AND RECOMMENDATIONS

The inefficiency and near failure of Nigeria electricity power sector especially in term of supply to consumers compared with the desire of the population for a stable power supply for various uses, led to increase and dependence on petrol/diesel powered generators, thus, accentuating the CO emission levels in Minna metropolis. The use of renewable sources of energy such as solar and wind should be encouraged to reduce the rate at which fuel powered generators are used. There should also be continuous monitoring of the air quality to control and safeguard against secondary effects of CO emissions.

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