# MEASUREMENTS OF CARBON MONOXIDE CONCENTRATIONS AND THE CREATION OF A UNIQUE GEOGRAPHICAL INFORMATION SYSTEM (GIS) LAYER MAP FOR CARBON MONOXIDE POLLUTION IN MINNA, NIGER STATE

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## Abstract

*Air pollution arising from the release of toxic gases during the process of combustion is commonly encountered in most households because the use of coal-powered and wood-fire hearths is widespread; the use of petrol- and diesel- powered generators is also becoming very popular. This study was undertaken in order to determine the trend of carbon monoxide concentrations in Minna, Niger State. Data acquisition procedure was facilitated by the use of the carbon monoxide meter, and about 6000 households were visited for this exercise. The data acquisition procedure was basically a house-to-house exercise whence the GPS unit and the CO meter were employed to gather geo-referenced data and CO pollution level data. The north-south axis of Minna from Maikunkele to Chanchaga and the east-west axis from Maitumbi to Kpakungu were covered in this investigation. All of the stations of interest occupied for this investigation showed insignificant levels of ambient concentrations of carbon monoxide, explaining the green dotted colour coding on the result maps. The major neighbourhoods of Minna township like Chanchaga, Maitumbi, Minna Central, Bosso, and Tunga have high green dot densities because of the high residence density of those areas. The insignificant values of carbon monoxide observed for this work is due to the fact the nearly all of the sources surveyed were outdoor sources that encourage rapid dispersion of the CO gas into the atmosphere. By use of the Geographical Information System (GIS) platform, a carbon dioxide pollution layer for Minna has been created, a novelty in itself. The final pollution map is a perfect guide to the overall CO pollution trend of Minna.*

Keywords: Environmental pollution, geo-referencing, GIS, pollution map

## Introduction

There is no doubt that air pollution arising principally from the release of toxic gases during the process of combustion is commonly encountered in most households. As a way out of the economic crunch, householders have now resorted to the use of coal-powered and wood-fire hearths thereby exposing families to pollution when these hearths are in use. Also the use of petrol- and diesel- powered generators by householders to generate their own electricity is a major source of air pollution. It is with this fact in mind that this project was undertaken in order to determine the trend of carbon monoxide concentration in Minna, Niger State.

Carbon monoxide (chemical formula CO) is a colourless, odourless, tasteless, yet highly toxic gas. Its molecules consist of one carbon atom and one oxygen atom, connected by a covalent double bond and a dative covalent bond. It is the simplest oxo-carbon, and can be viewed as the anhydride of formic acid ($CH_2O_2$). Carbon monoxide is produced from the partial oxidation of carbon containing compound; it forms in preference to the more usual carbon dioxide ($CO_2$) when there is a reduced availability of oxygen, such as when operating a stove or an internal combustion engine in an enclosed space. Carbon monoxide has significant fuel value, burning in air with a characteristic blue flame, producing carbon dioxide. Despite its serious toxicity, it was once widely used (as the main component of coal gas) for domestic lighting, cooking and heating, and in the production of nickel. Carbon monoxide still plays a major role in modern technology, in industrial processes such as iron smelting and as a precursor to myriad products (www.carbon monoxide emission.com).

Environmental pollution is the disruption of the natural equilibrium between the living species and their natural environment. The degradation of the environment has resulted in increase in diseases, reduction of the average life spans and growth in infant mortality rates. Civilization appears to have gone berserk and the future of planet earth has never been in greater jeopardy than it is today (www.wikipedia.com).

Sources of carbon monoxide are numerous and prevalent in everyday life. In its natural state, carbon monoxide will usually dissipate quickly over a large area without posing any significant threat to human health. However, non-natural carbon monoxide emissions produced as a result of incomplete burning of carbon-containing fuels, including coal, wood, charcoal, natural gas, and fuel oil, are harmful to the body. The three main areas of carbon monoxide emissions are residential, industrial, and in the field of transportation.

Carbon monoxide concentration is measured in parts per million (ppm), a standard measurement unit in which zero is the lowest level on the scale. Typical concentrations are given below:

- 0.1ppm - natural background atmosphere level
- 0.5 to 5ppm - average background level in homes
- 5 to 15ppm - levels near properly adjusted gas stoves in homes
- 5,000ppm - chimney of a home wood fire

- 7,000ppm - undiluted warm car exhaust - without catalytic converter

The natural background atmosphere level is 0.1ppm (parts per million) which is very convenient to life in the environment. The average carbon monoxide levels in homes without gas stoves vary from 0.5 to 5ppm (parts per million). Levels near properly adjusted gas stoves in homes are often 5 to 15ppm (parts per million) and those near poorly adjusted stoves are 30ppm or higher.

For healthy adults, carbon monoxide becomes toxic when it reaches a level higher than 50ppm (parts per million) with continuous exposure over an eight hour period. When the level of carbon monoxide becomes higher than that, a person will suffer from symptoms of exposure. Mild exposure over a few hours (a carbon monoxide level between 70ppm and 100ppm) include flu-like symptoms such as headaches, sore eyes and a runny nose. Medium exposure (a carbon monoxide level between 150ppm to 300ppm) will produce dizziness, drowsiness and vomiting. Extreme exposure (a carbon monoxide level of 400ppm and higher) will result in unconsciousness, brain damage and death.

Inhaled carbon monoxide will rapidly accumulate in the blood and deplete its ability to carry oxygen throughout the body. Depending on the amount of CO inhaled, the significant harmful effects caused by this gas can lead to carbon monoxide poisoning. Carbon monoxide can poison or kill an individual with little warning. There are a number of symptoms that are indicators of possible carbon monoxide poisoning. These symptoms vary depending on the amount of exposure to the actual poison. Recently, studies have been performed to show that chronic carbon monoxide poisoning can result in long term, residual effects on our bodies.

Because carbon monoxide is odorless and colorless it is not always evident when it has become a problem in the home. Often people who have a mild to moderate problem will find they feel sick while they spend time at home. They might feel a little better outside in the fresh air but will have re-occurring symptoms shortly after returning home. If other members of the family have re-occurring bouts with flu-like symptoms while fuel-burning appliances are being used it may be time to have the house checked by a professional. Besides having a professional come into your home to check your appliances a carbon monoxide detector can be used to keep a constant watch over the levels of carbon monoxide in the home throughout the year.

Persily (1996) has studied carbon monoxide (CO) dispersion in residential buildings. He noted that studies involving measurements of carbon monoxide concentrations in residential buildings have been concerned chiefly with single-family residences. These studies include CO exposure studies in which personal exposure monitors were used to determine CO concentrations associated with various activities and micro environments. There have also been a number of indoor air quality surveys of large numbers of residential buildings in which multiple indoor pollutants were sampled, including CO. While these surveys have generally employed only a single CO sampling location in each building, they provide information on indoor levels and the sources associated with indoor CO. A limited number of studies have involved multi-point sampling of CO. Finally, there have been a number of investigations of the factors that impact CO concentrations and the spatial and temporal variation in these concentrations. While not all of the studies indicate where and at what height the CO concentration was measured, this information is provided when it is available.

There have been a number of studies designed to determine the levels of human exposure to CO. These studies have included personal monitoring studies in which occupants wore personal exposure monitors for 24 hours or more and recorded their activities and locations in diaries (Akland et al., 1985; Nagda and Koontz, 1985). These studies have provided information on CO exposure as a function of activity and micro environment, such as parking garages, motor vehicles, outdoors, and residential buildings. Some studies have focused on CO exposure in buildings, and in some cases on exposure in specific locations within buildings. One of these studies focused on men with ischemic heart disease, in which they wore personal CO monitors that recorded one minute average CO concentrations (Colome et al., 1992). The study participants also maintained written diaries of their activities, locations and symptoms. In addition to information on health symptoms, the results of this study included information on CO exposure as a function of occupant activity and location. The highest personal exposures were associated with driving automobiles and using small gasoline appliances for lawn care or cutting wood, and CO concentrations are reported for a number of indoor spaces including residential buildings by room type, e.g. kitchen, living room, and bedroom. In residential buildings, mean one-minute CO exposures ranged from 4mg/m$^3$ to 4.6mg/m$^3$ (3.5ppm and 4.0ppm) in family rooms, kitchens, dining rooms and living rooms, from 2.4mg/m$^3$ to 3.4mg/m$^3$ (2.1ppm and 3.0ppm) in bedrooms, bathrooms and laundry rooms, and 4.5mg/m$^3$ (3.9ppm) in garages or enclosed carports. However, maximum concentrations were above 100mg/m$^3$ (87ppm) in family rooms, kitchens and garages/carports.

A relatively recent study focused specifically on the factors that affect indoor CO levels in residential buildings (Colome et al., 1994; Wilson et al., 1993; Wilson et al., 1995). In this study, 48-h and 8-h average CO concentrations were monitored in about 300 homes in California and were related to a number of variables including the concentrations of other pollutants, house characteristics, ventilation rates, appliance type, and occupant activities. Statistical analyses were performed to determine the relationship between indoor CO concentrations and these variables. Of the 277 homes for which CO was reported, 13 had 8-h average concentrations above 10mg/m$^3$ (9ppm), and one house had a 1-h average of about 40mg/m$^3$ (35ppm). These two values correspond to the EPA ambient air quality standard. The findings of this study include that indoor CO levels are correlated with outdoor levels, and that high indoor CO is associated with cigarette smoking, gas fuel for cooking, wall furnaces and smaller houses. Some high levels were also associated with using gas ranges for heating and with attached garages.

There have been a number of studies in which CO concentrations were measured in residential buildings, some of which have addressed the impact of specific sources on indoor CO concentrations. In a study in manufactured houses less than 10years old, CO exposure was monitored at a single location in each house during potable kerosene heater operation (Williams et al., 1992). The sampling locations were about 0.5m (1.6ft) above the floor and about 2m to 4m (7ft to 13ft) from the heaters. The measurement showed that three of the eight houses studied had 8-h average concentrations above or near 10mg/m$^3$ (9ppm), the EPA 8-h ambient air quality standard. Seven of the houses had significant increases in indoor CO levels during heater operation, and one routinely had levels of 34mg/m$^3$ to 57mg/m$^3$ (30ppm to 50ppm) for prolonged periods.

In one of the few studies of CO in multifamily buildings, concentrations were monitored in 60 small apartments with kitchen ovens operating continuously (Tsongas and Hager, 1994). Carbon monoxide was monitored every 5min over the oven exhaust port, in the kitchen, and in adjacent rooms, until the concentrations reached steady state, which in some cases took more than one hour. The sampling locations in the kitchen were about 1.5m (5ft) above the floor, and about 0.9m (3ft) above the floor in adjacent rooms. In about half of the kitchens, the steady-state CO levels were about 10mg/m$^3$ (9ppm). With respect to the maximum steady-state levels at any measurement locations in each apartment, about 15% were above 40mg/m$^3$ (35ppm), 5% were above 230mg/m$^3$ (200ppm) and the highest concentration was 400mg/m$^3$ (350ppm). A similar study was conducted in 87 randomly-selected households in Chicago (Conibear et al., 1995). About one-half of the sites were single-family residences, half were apartments, and three were town houses. In this study, indoor CO was monitored during the operation of various combustion appliances including ovens, stoves, furnaces, boilers, water heaters, clothes dryers and space heaters. Initial peak and steady-state CO concentrations were analysed. The results revealed that 89% of the initial readings were below 1.1mg/m$^3$ (1.0ppm) and all were below 17mg/m$^3$ (15ppm). Of the steady-state levels, with all appliances operating, 48% were below 1.1mg/m$^3$ (1.0ppm), 92% were below 11mg/m$^3$ (10ppm), and all were below 25mg/m$^3$ (22ppm).

In a study of ventilation and indoor air quality in multi-family buildings, Parker (1986) measured CO in three apartments in a two- story, four-unit buildings. Carbon dioxide concentrations were measured in the main living areas of each apartment, away from windows and outside doors. The measured CO concentrations were all 1mg/m$^3$ (0.9ppm) or less except when there was cigarette smoking, in which case they were below about 5mg/m$^3$ (4ppm). Another study of air movement and indoor air quality in several multi-family buildings in Canada, ranging from four to twenty-one stories, included CO measurements. The measured levels were generally below 5mg/m$^3$ (4ppm) (Gulay et al.,1993). Levels above 5mg/m$^3$ (4ppm), up to 13mg/m$^3$ (11ppm), appeared to be associated with underground parking garages. The report on this study did not include much detail on the measurements, such as the sampling duration and location. These studies of CO levels in residential buildings have shown that indoor concentrations are generally low compared to ambient and occupational standards, which are based on averages over several hours. However, under some circumstances and in a relatively small number of buildings, these average values and short-term peak values can be significantly above the values in these standards.

## Objectives of Study

The principal objectives of this project work are as follows:

(i) To help prepare the framework for a carbon monoxide pollution database for Minna; this project will be the substratum upon which subsequent studies would be laid.

(ii) To help build the nucleus for an environmental awareness advocacy programme to be funded and executed by the Niger State Government.

## Methodology

**Co-ordinate Identification:** Whilst it would have been inconvenient doing full-scale house-to-house identification in the traditional manner because a significant portion of Minna town still remains in haphazard condition and street identifiers are conspicuously missing, co-ordinate identification for this project exercise was facilitated by the use of hand-held Global Positioning System (GPS) units. A GPS unit measures the geographical location (and elevation) of a place in terms of its longitude and latitude in units of degrees, minutes and seconds. The operation of this device is done in open spaces, away from trees, tall buildings, and high tension cables which could be sources of interference of the signals transmitted to satellites in space. As soon as the device is switched on, signals are sent from the device to a special network of geostationary satellites. When at least three or four of these satellites are located, the location or elevation of any point on the surface of the earth could be fixed within an acceptable margin of error. A typical GPS device is shown in Fig.1.

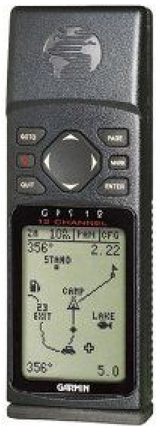



Fig.1: Typical GPS device

**Field Equipment:** The carbon monoxide gas meter was the core sampling equipment employed in the course of this project work. It is used to determine the ambient level of carbon monoxide concentration in the atmosphere. The sampling equipment is a potable handheld device which is easily carried around and used both indoors and outdoors, and measures the gas in a unit of parts per million (ppm). The device is powered by the use of two dry cell batteries; the power button is used to switch it on which later the screen is displayed with the manufacture brand name then the menu. When asked to display the reading the entre button is pushed and the reading is displayed which initially fluctuates until a steady value is gotten. A typical Carbon monoxide gas meter device is shown in Fig.2.


Fig. 2: Typical carbon monoxide gas meter device

Data Collection Procedure: The data acquisition procedure was basically a house-to-house exercise whence the GPS unit and the CO meter were employed together to gather geo-referenced data and CO pollution level data. In all about 6000 homes were covered in this exercise. The north-south axis of Minna from Maikunkele to Chanchaga and the east-west axis from Maitumbi to Kpakungu were covered in this investigation.

Dataset of Study: About 6000 households strations were occupied for this study. The dataset collected from the field are usually presented in conformance with the Geographic Information System (GIS) protocol in terms of single static source representing a point shape, their numerical IDs, latitude, longitude, conventional locations on the ground, sources of carbon monoxide, rated output of sources (where applicable), measured carbon monoxide values, and the presence or absence of carbon monoxide (determined from a comparison of the measured values with the threshold value). An abridged form of the dataset is presented as Table 1.

Table 1: Abridged form of dataset of study

| *Shape* | *ID* | *Coordinates* | | *Location* | *Pollution Sources* | *Power Rating* | *CO Value* | *Remarks* |
|---|---|---|---|---|---|---|---|---|
| Point | 1 | 9.6406 | 6.5292 | Okada Road | Charcoal Hearth | | 2 | Absent |
| Point | 2 | 9.6407 | 6.5295 | Okada Road | Charcoal Hearth | | 2 | Absent |
| Point | 3 | 9.6394 | 6.5292 | Okada Road | Firewood Hearth | | 3 | Absent |
| Point | 4 | 9.6389 | 6.5299 | Okada Road | Firewood | | 3 | Absent |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Hearth | | | |
| Point | 5 | 9.6388 | 6.5299 | Okada Road | Generator | | 2 | Absent |
| Point | 6 | 9.6385 | 6.5299 | Okada Road | Generator | | 3 | Absent |
| Point | 7 | 9.6384 | 6.5300 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 8 | 9.6385 | 6.5302 | Okada Road | Generator | 1.5kw/220v/50Hz | 1 | Absent |
| | | 9.6377 | 6.5303 | Okada Road | Firewood | | 3 | Absent |
| Point | 9 | | | | Hearth | | | |
| Point | 10 | 9.6375 | 6.5303 | Okada Road | Generator | 7.5kw/220v/50Hz | 2 | Absent |
| | | 9.6371 | 6.5305 | Okada Road | Firewood | | 3 | Absent |
| Point | 11 | | | | Hearth | | | |
| Point | 12 | 9.6366 | 6.5307 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| | | 9.6362 | 6.5308 | Okada Road | Firewood | | 3 | Absent |
| Point | 13 | | | | Hearth | | | |
| | | 9.6361 | 6.5309 | Okada Road | Charcoal | | 2 | Absent |
| Point | 14 | | | | Hearth | | | |
| | | 9.6361 | 6.5309 | Okada Road | Milling | 1200w/220v/50Hz | 0.5 | Absent |
| Point | 15 | | | | Machine | | | |
| Point | 16 | 9.6362 | 6.5309 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 17 | 9.6492 | 6.5229 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 18 | 9.6492 | 6.5230 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 19 | 9.6491 | 6.5231 | Okada Road | Generator | 1.5kw/220v/50Hz | 1 | Absent |
| | | 9.6490 | 6.5232 | Okada Road | Firewood | | 3 | Absent |
| Point | 20 | | | | Hearth | | | |
| | | 9.6489 | 6.5233 | Okada Road | Charcoal | | 2 | Absent |
| Point | 21 | | | | Hearth | | | |
| | | 9.6488 | 6.5233 | Okada Road | Firewood | | 3 | Absent |
| Point | 22 | | | | Hearth | | | |
| Point | 23 | 9.6488 | 6.5235 | Okada Road | Stove | | 3.5 | Absent |
| | | 9.6486 | 6.5236 | Okada Road | Firewood | | 3 | Absent |
| Point | 24 | | | | Hearth | | | |
| | | 9.6485 | 6.5238 | Okada Road | Milling | 1200w/220v/50hz | 0.5 | Absent |
| Point | 25 | | | | Machine | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Point | 26 | 9.6478 | 6.5244 | Okada Road | Generator | 1.5kw/220v/50Hz | 1 | Absent |
| Point | 27 | 9.6477 | 6.5245 | Okada Road | Generator | 1.5kw/220v/50Hz | 1 | Absent |
| Point | 28 | 9.6476 | 6.5246 | Okada Road | Firewood Hearth | | 3 | Absent |
| Point | 29 | 9.6475 | 6.5247 | Okada Road | Charcoal Hearth | | 3 | Absent |
| Point | 30 | 9.6472 | 6.5243 | Okada Road | Firewood Hearth | | 3 | Absent |
| Point | 31 | 9.6469 | 6.5241 | Okada Road | Charcoal Hearth | | 3 | Absent |
| Point | 32 | 9.6468 | 6.5238 | Okada Road | Firewood Hearth | | 3 | Absent |
| Point | 33 | 9.6472 | 6.5249 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 34 | 9.6467 | 6.5252 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 35 | 9.6466 | 6.5253 | Okada Road | Generator | 2.0kw/220v/50Hz | 2 | Absent |
| Point | 36 | 9.6464 | 6.5254 | Okada Road | Firewood Hearth | | 3 | Absent |
| Point | 37 | 9.6459 | 6.5251 | Okada Road | Stove | | 3.5 | Absent |
| Point | 38 | 9.6459 | 6.5249 | Okada Road | Stove | | 3.5 | Absent |
| Point | 39 | 9.6460 | 6.5245 | Okada Road | Generator | 11.5kw/220v/50Hz | 1 | Absent |
| Point | 40 | 9.6461 | 6.5242 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 41 | 9.6458 | 6.5236 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 42 | 9.6457 | 6.5235 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 43 | 9.6478 | 6.5891 | Mypa Road | Generator | 7.5kw/220v/50Hz | 2 | Absent |
| Point | 44 | 9.6479 | 6.5293 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 45 | 9.6507 | 6.5334 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 46 | 9.6509 | 6.5334 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 47 | 9.6482 | 6.5302 | Mypa Road | Generator | 7.5kw/220v/50Hz | 2 | Absent |
| Point | 48 | 9.6487 | 6.5309 | Mypa Road | Firewood Hearth | | 3 | Absent |
| Point | 49 | 9.6488 | 6.5309 | Mypa Road | Generator | 7.5kw/220v/50Hz | 2 | Absent |
| Point | 50 | 9.6509 | 6.5335 | Mypa Road | Motor | | 3 | Absent |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | cycles | | | |
| Point | 51 | 9.6479 | 6.5295 | Mypa Road | Generator | 11.5kw/220v/50Hz | 3 | Absent |
| | | 9.6479 | 6.5293 | Mypa Road | Firewood | | 3 | Absent |
| Point | 52 | | | | Hearth | | | |
| | | 9.6492 | 6.5314 | Mypa Road | Motor | | 2 | Absent |
| Point | 53 | | | | cycles | | | |
| | | 9.6465 | 6.5266 | Mypa Road | Firewood | | 3 | Absent |
| Point | 54 | | | | Hearth | | | |
| | | 9.6469 | 6.5264 | Mypa Road | Charcoal | | 2 | Absent |
| Point | 55 | | | | Hearth | | | |
| Point | 56 | 9.6469 | 6.5271 | Mypa Road | Generator | 2.0kw/220v/50Hz | 2 | Absent |
| | | 9.6467 | 6.5265 | Mypa Road | Charcoal | | 1 | Absent |
| Point | 57 | | | | Hearth | | | |
| | | 9.6472 | 6.5269 | Mypa Road | Charcoal | | 3 | Absent |
| Point | 58 | | | | Hearth | | | |
| Point | 59 | 9.6468 | 6.5264 | Mypa Road | Generator | 1.5kw/220v/50Hz | 3 | Absent |
| | | 9.6473 | 6.5266 | Mypa Road | Firewood | | 3 | Absent |
| Point | 60 | | | | Hearth | | | |
| Point | 61 | 9.6471 | 6.5271 | Mypa Road | Generator | | 2 | Absent |
| | | 9.6472 | 6.5261 | Mypa Road | Charcoal | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 62 | | | | Hearth | | | |
| Point | 63 | 9.6474 | 6.5290 | Mypa Road | Generator | | 2 | Absent |
| Point | 64 | 9.6474 | 6.5266 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 65 | 9.6475 | 6.5268 | Mypa Road | Stove | | 3.5 | Absent |
| Point | 66 | 9.6474 | 6.5267 | Mypa Road | Generator | 7.5kw/220v/50Hz | 2 | Absent |
| Point | 67 | 9.6419 | 6.5264 | Mypa Road | Generator | 7.5kw/220v/50Hz | 2 | Absent |
| | | 9.6418 | 6.5266 | Mypa Road | Charcoal | | 2 | Absent |
| Point | 68 | | | | Hearth | | | |
| Point | 69 | 9.6417 | 6.5272 | Mypa Road | Stove | | 3.5 | Absent |
| Point | 70 | 9.6419 | 6.5267 | Mypa Road | Stove | | 3.5 | Absent |
| | | 9.6420 | 6.5267 | Mypa Road | Firewood | | 3 | Absent |
| Point | 71 | | | | Hearth | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Point | 72 | 9.6421 | 6.5267 | Mypa Road | Stove | | 3.5 | Absent |
| Point | 73 | 9.6424 | 6.5268 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 74 | 9.6425 | 6.5268 | Mypa Road | Charcoal Hearth | | 2 | Absent |
| Point | 75 | 9.6427 | 6.5268 | Mypa Road | Firewood Hearth | | 3 | Absent |
| Point | 76 | 9.6428 | 6.5268 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 77 | 9.6431 | 6.5268 | Mypa Road | Firewood Hearth | | 3 | Absent |
| Point | 78 | 9.6432 | 6.5268 | Mypa Road | Firewood Hearth | | 3 | Absent |
| Point | 79 | 9.6435 | 6.5269 | Mypa Road | Charcoal Hearth | | 2 | Absent |
| Point | 80 | 9.6438 | 6.5269 | Mypa Road | Firewood Hearth | | 3 | Absent |
| Point | 81 | 9.6438 | 6.5270 | Mypa Road | Firewood Hearth | | 3 | Absent |
| Point | 82 | 9.6429 | 6.5277 | Mypa Road | Firewood Hearth | | 3 | Absent |
| Point | 83 | 9.6417 | 6.5285 | Okada Road | Diesel Engine | 14.kw/220v/50Hz | 1 | Absent |
| Point | 84 | 9.6414 | 6.5288 | Okada Road | Firewood Hearth | | 3 | Absent |
| Point | 85 | 9.6411 | 6.5289 | Okada Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| Point | 86 | 9.6476 | 6.5277 | Mypa Junction | Firewood Hearth | | 3 | Absent |
| Point | 87 | 9.6472 | 6.5278 | Mypa Junction | Charcoal Hearth | | 2 | Absent |
| Point | 88 | 9.6496 | 6.5219 | Mypa Junction | Generator | 1.5kw/220v/50Hz | 1 | Absent |
| Point | 89 | 9.6471 | 6.5278 | Mypa unction | Charcoal Hearth | | 2 | Absent |
| Point | 90 | 9.6483 | 6.5303 | Mypa Junction | Charcoal | | 2 | Absent |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Hearth | | | |
| | | 9.6502 | 6.5326 | Mypa unction | Firewood | | 3 | Absent |
| Point | 91 | | | | Hearth | | | |
| Point | 92 | 9.6476 | 6.5276 | Mypa unction | Generator | | 3 | Absent |
| Point | 93 | 9.6494 | 6.5314 | Mypa unction | Stove | | 3.5 | Absent |
| Point | 94 | 9.6413 | 6.5336 | Mypa unction | Stove | | 3.5 | Absent |
| | | 9.6475 | 6.5278 | Mypa unction | Charcoal | | 2 | Absent |
| Point | 95 | | | | Hearth | | | |
| Point | 96 | 9.6476 | 6.5271 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| | | 9.6477 | 6.5265 | Mypa Road | Charcoal | | 2 | Absent |
| Point | 97 | | | | Hearth | | | |
| Point | 98 | 9.6473 | 6.5261 | Mypa Road | Generator | 2.0kw/220v/50Hz | 3 | Absent |
| | | 9.6472 | 6.5264 | Mypa Road | Firewood | | 3 | Absent |
| Point | 99 | | | | Hearth | | | |
| | | 9.6458 | 6.5273 | Mypa Road | Charcoal | | 2 | Absent |
| Point | 100 | | | | Hearth | | | |

Creation of a Unique GIS Layer of Carbon Monoxide Pollution Level Map for Minna

Concept of GIS: A Geographical Information System also known as GIS is a computer based system which is used to digitally reproduce and analyse the features present on the earths surface and the events that take place on it. It doesn't really matter whether the organisation is a small business, a multinational conglomerate, a governmental department or local authority, two very important facts stand out:

(a) A lot of the information will be geographically referenced and

(b) The more information one has, the harder it becomes to manage and interpret them.

Bearing in mind that up to 70% of all information in circulation possesses a common denominator of geography, it is now clear that GIS must be incorporated to help in decision-making based upon geographical information. Unlike any other type of information handling tool, GIS can understand the concept of location. GIS is a computer system capable of assemblying, manipulating and displaying geographically referenced information (i.e. data identified closely to their location). Also the GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps.

Practitioners also regard the total GIS as including operating personal and the data that go into the system. A GIS would allow emergency planning to easily calculate emergency responsiveness in the event of a natural disaster.

## Digitisation of Analogue Map of Study Area

Digitisation is a simplification process that converts all spatial data to a point (e.g., a well), a line (e.g., a stream), a polygon formed by a closed, complex line (e.g., a lake), or a grid cell. Digitisation reduces all spatial entities to these simple forms because they were easy to store in the computer. A GIS database cannot readily recognize features or entities as human map users do. For example, we cannot enter the entity "lake" into a GIS. Rather, we entered the spatial data coordinates for the lake's shoreline as a polygon. Later, the attributes of the lake will be entered into the GIS database and will be associated with the polygon. Following the digitization of map features, the user completes the compilation phase by relating all spatial features to their respective attributes, and by cleaning up and correcting errors introduced as a result of the data conversion process. The end results of compilation was a set of digital files, each accurately representing all of the spatial and attribute data of interest contained on the original map manuscripts. These digital files contained geographic coordinates for spatial objects (points, lines, polygons, and cells) that represent mapped features. Although we conceptualize the GIS as a set of registered map layers, the GIS actually stores these data at a much more primitive level. The digitised map of the study area on ArcView3.3 is shown in Fig.3.

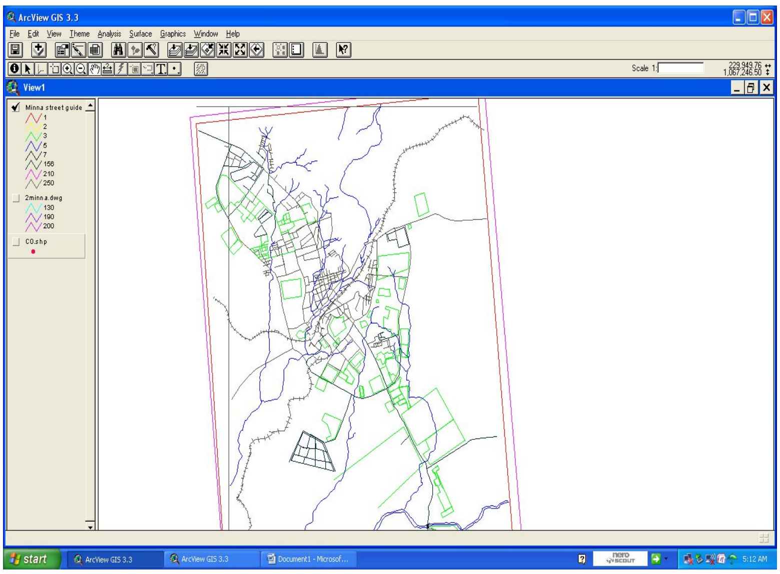
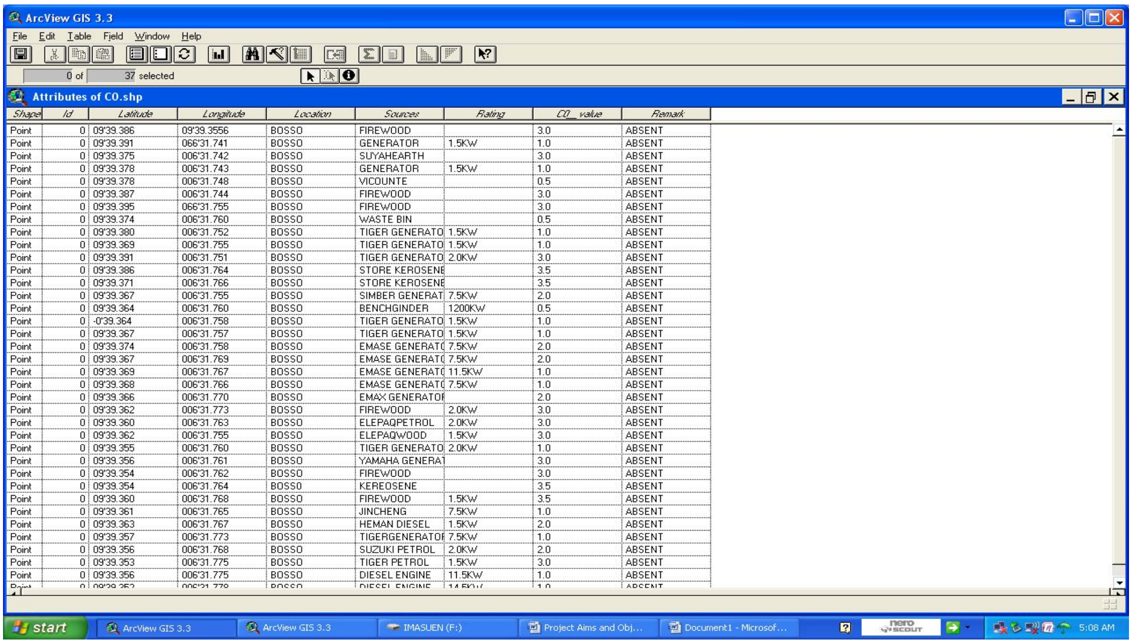



Fig.3: Digitised map of study area

## Creation of a Database and Carbon Monoxide Pollution Layer Map ArcView3.3 Platform

The conventional database contains rows and columns, geographical coordinates of the locations of noise, sources of noise, rating, noise level, and pollution status (see Table 1). This same dataset on the ArcView3.3 is shown in Fig.4.




| Shape | Id | Latitude | Longitude | Location | Sources | Rating | CO_value | Remark |
|---|---|---|---|---|---|---|---|---|
| Point | 0 | 09'39.386 | 09'39.3556 | BOSSO | FIREWOOD | | 3.0 | ABSENT |
| Point | 0 | 09'39.391 | 066'31.741 | BOSSO | GENERATOR | 1.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.375 | 006'31.742 | BOSSO | SUYAHEARTH | | 3.0 | ABSENT |
| Point | 0 | 09'39.378 | 006'31.743 | BOSSO | GENERATOR | 1.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.378 | 006'31.748 | BOSSO | VICOUNTE | | 0.5 | ABSENT |
| Point | 0 | 09'39.387 | 006'31.744 | BOSSO | FIREWOOD | | 3.0 | ABSENT |
| Point | 0 | 09'39.395 | 066'31.755 | BOSSO | FIREWOOD | | 3.0 | ABSENT |
| Point | 0 | 09'39.374 | 006'31.760 | BOSSO | WASTE BIN | | 0.5 | ABSENT |
| Point | 0 | 09'39.380 | 006'31.752 | BOSSO | TIGER GENERATO | 1.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.369 | 006'31.755 | BOSSO | TIGER GENERATO | 1.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.391 | 006'31.751 | BOSSO | TIGER GENERATO | 2.0KW | 3.0 | ABSENT |
| Point | 0 | 09'39.386 | 006'31.764 | BOSSO | STORE KEROSENE | | 3.5 | ABSENT |
| Point | 0 | 09'39.371 | 006'31.766 | BOSSO | STORE KEROSENE | | 3.5 | ABSENT |
| Point | 0 | 09'39.367 | 006'31.755 | BOSSO | SIMBER GENERAT | 7.5KW | 2.0 | ABSENT |
| Point | 0 | 09'39.364 | 006'31.760 | BOSSO | BENCHGINDER | 1200KW | 0.5 | ABSENT |
| Point | 0 | -0'39.364 | 006'31.758 | BOSSO | TIGER GENERATO | 1.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.367 | 006'31.757 | BOSSO | TIGER GENERATO | 1.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.374 | 006'31.758 | BOSSO | EMASE GENERATO | 7.5KW | 2.0 | ABSENT |
| Point | 0 | 09'39.367 | 006'31.769 | BOSSO | EMASE GENERATO | 7.5KW | 2.0 | ABSENT |
| Point | 0 | 09'39.369 | 006'31.767 | BOSSO | EMASE GENERATO | 11.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.368 | 006'31.766 | BOSSO | EMASE GENERATO | 7.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.366 | 006'31.770 | BOSSO | EMAX GENERATOR | | 2.0 | ABSENT |
| Point | 0 | 09'39.362 | 006'31.773 | BOSSO | FIREWOOD | 2.0KW | 3.0 | ABSENT |
| Point | 0 | 09'39.360 | 006'31.763 | BOSSO | ELEPAQPETROL | 2.0KW | 3.0 | ABSENT |
| Point | 0 | 09'39.362 | 006'31.755 | BOSSO | ELEPAQWOOD | 1.5KW | 3.0 | ABSENT |
| Point | 0 | 09'39.355 | 006'31.760 | BOSSO | TIGER GENERATO | 2.0KW | 1.0 | ABSENT |
| Point | 0 | 09'39.356 | 006'31.761 | BOSSO | YAMAHA GENERAT | | 3.0 | ABSENT |
| Point | 0 | 09'39.354 | 006'31.762 | BOSSO | FIREWOOD | | 3.0 | ABSENT |
| Point | 0 | 09'39.354 | 006'31.764 | BOSSO | KEREOSENE | | 3.5 | ABSENT |
| Point | 0 | 09'39.360 | 006'31.768 | BOSSO | FIREWOOD | 1.5KW | 3.5 | ABSENT |
| Point | 0 | 09'39.361 | 006'31.765 | BOSSO | JINCHENG | 7.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.363 | 006'31.767 | BOSSO | HEMAN DIESEL | 1.5KW | 2.0 | ABSENT |
| Point | 0 | 09'39.357 | 006'31.773 | BOSSO | TIGERGENERATOR | 7.5KW | 1.0 | ABSENT |
| Point | 0 | 09'39.356 | 006'31.768 | BOSSO | SUZUKI PETROL | 2.0KW | 2.0 | ABSENT |
| Point | 0 | 09'39.353 | 006'31.775 | BOSSO | TIGER PETROL | 1.5KW | 3.0 | ABSENT |
| Point | 0 | 09'39.356 | 006'31.775 | BOSSO | DIESEL ENGINE | 11.5KW | 1.0 | ABSENT |

Fig. 4: Database of study area on ArcView3.3

The database was inputted and hot-linked to the spatial data (map and coordinate). Colour coding was specified whence red dots indicate presence of pollution and green dots points indicate insignificant pollution levels. The result of the process of hot-linking the database and the digitised map on ArcView3.3 to produce the pollution status map is shown in shown in Fig.5.

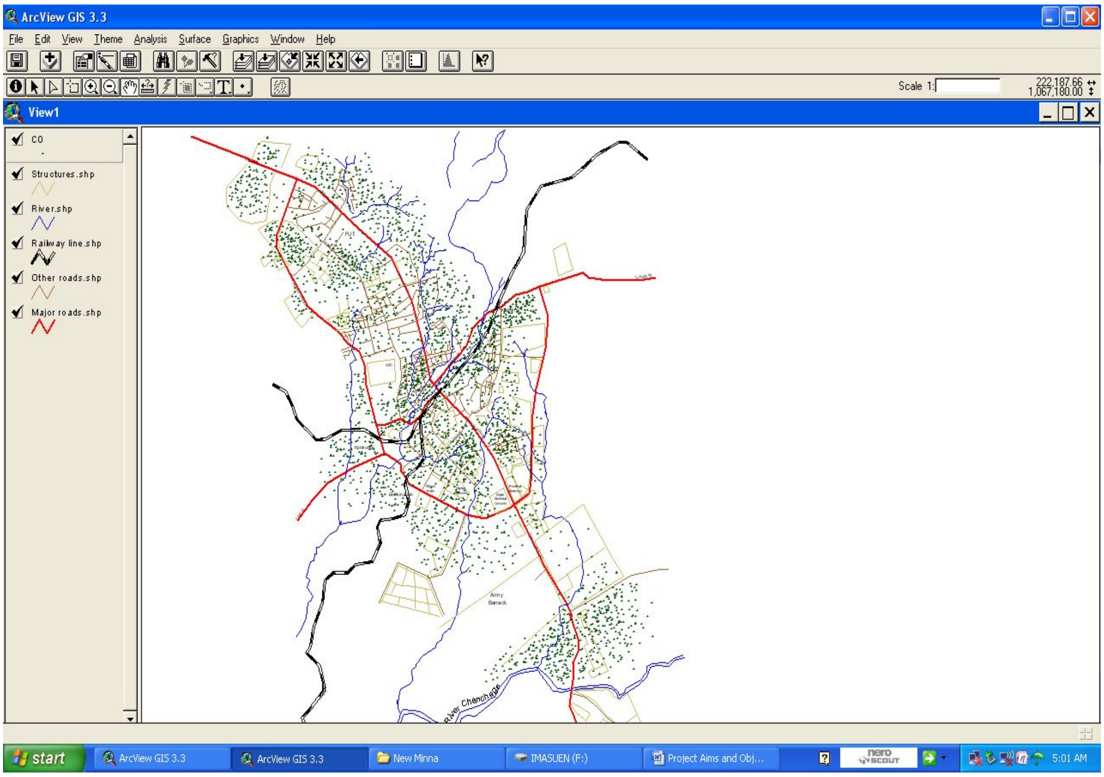



Fig.5: Result of hot-linking the database and the digitised map on ArcView3.3 to produce the pollution status map

Presentation of Carbon Monoxide Emission Layer Map

The CO emission layer map for Minna is shown in Fig.6.

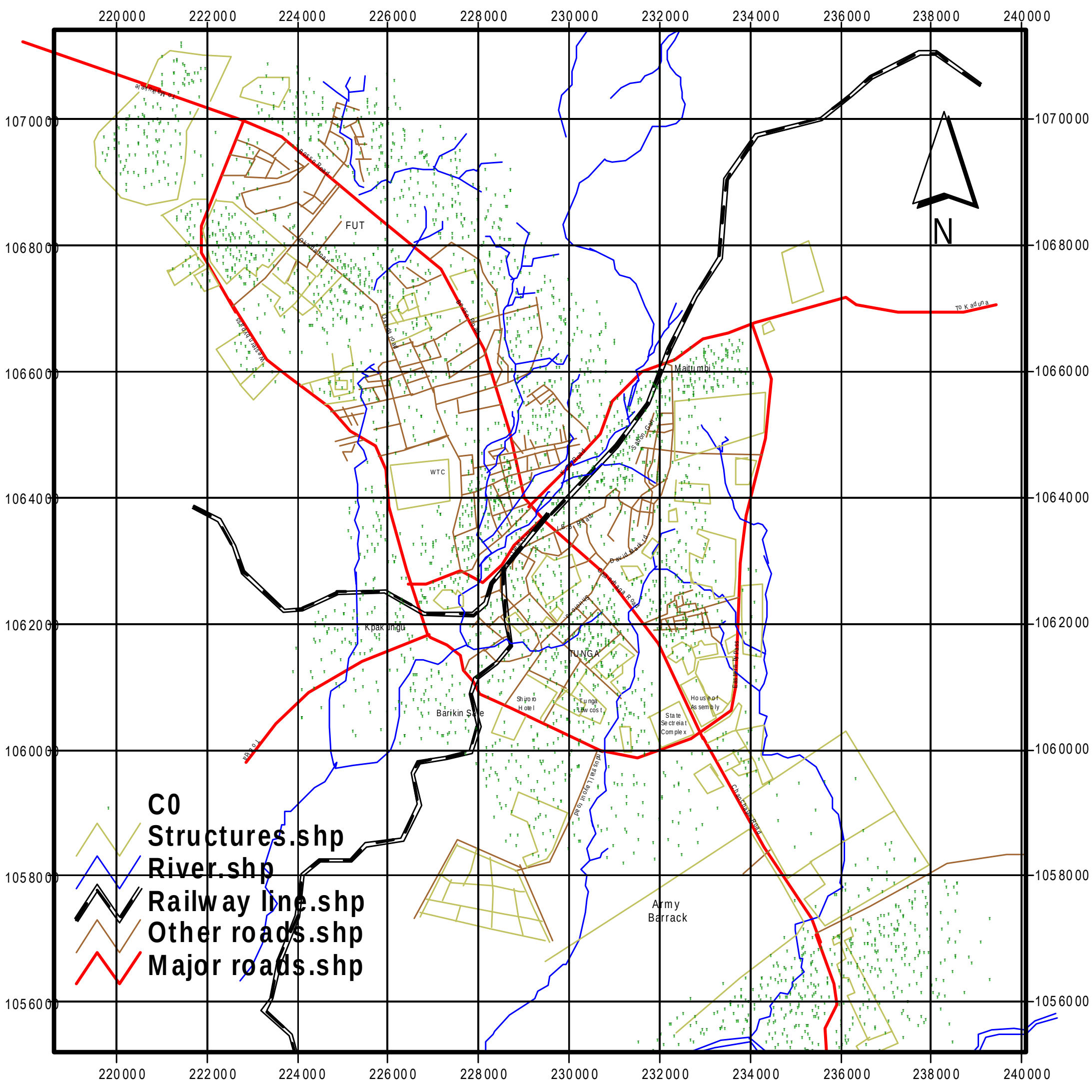



Fig. 6: The carbon monoxide emission layer map for Minna

## Results and Conclusion

All of the stations of interest occupied for this project work show insignificant level of ambient concentration of carbon monoxide, explaining for the green dotted colour coding. However, from Fig.6 we see that the major neighbourhoods of Minna township like Chanchaga, Maitumbi, Minna Central, Bosso, and Tunga have high green dot densities because of the high residence density of those areas. It also observed that the green dots are spread over the central region of Minna territory corresponding to residency patterns.

The insignificant values of carbon monoxide observed for this work is due to the fact the nearly all of the sources surveyed were outdoor sources that encourage rapid dispersion of the CO gas in the atmosphere. Nevertheless, the final pollution map is a perfect guide to the overall air pollution trend of Minna.

## Recommendations

In spite of the fact that CO pollution is absent in all the household surveyed in Minna, the study group members recommend that public health awareness campaign should nevertheless be initiated to better educate the populace on the hazards of over-exposure to combustion products.

The result of this study is actually futuristic in its outlook, thus it is strongly recommended that a GIS host platform for Minna be created so that the interactive nature of the carbon monoxide pollution map of Fig.6 can be fully exploited.

It is also recommended that novelty studies of this kind be replicated in the major towns and cities of Nigeria.

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