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# Measurements of Prevalence of Noxious Gases in Some Parts of Kontagora, Niger State, Central Nigeria

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## Abstract

Every year, thousands of people worldwide lose their lives to ailments that can be traced to environmental pollution arising principally from the release of toxic effluents into the atmosphere and surrounding ecosystems. This study was undertaken in order that the prevalence of gases that are harmful or injurious to human health in some parts of Kontagora town could be determined. Sheets 11, 13, and 21 of the Kontagora cadastral map were earmarked for survey. On each of these sheets, neighbourhoods and point locations that were prone to air pollution from stationary sources were identified; the GPS-referenced signature of each of the point source was recorded. The gas meters were employed to determine three different readings of the various gases of interest at each of those GPS-referenced points. The result of Sheet 11 shows the general trends and patterns of air pollution from fuel burning sources. The high amount of hydrogen sulphide ($H_2S$) released by the diesel generator is most likely due to the high sulphur content of diesel fuel and most of the emissions from the diesel generator and the firewood hearth exceed the safe threshold. The comparative high amount of the carbon monoxide (CO) gas released by the majority of the sources is expected because combustion in all cases involves burning of carbon compounds (hydrocarbon for the liquid fuels and cellulose for the wood fuel). The overwhelmingly dominance of the $SO_2$ gas from the petrol generator and the CO gas from the firewood hearths (of Sheet 13) must be due to high sulphur content in the former and of course the innate matter of the latter. On Sheet 21 the noxious gases posing greater risk to health from the diesel generators (with respect to the threshold) are the $SO_2$, CO, HCN, $NO_2$, and $H_2S$ gases, from the petrol generators these are the $SO_2$, $Cl_2$, and HCN gases. From the firewood hearth the noxious gases occurring in greater than acceptable amounts are the CO, $Cl_2$, HCN, $NO_2$, $NH_3$, and $H_2S$, and for the vulcaniser's pump these are the $SO_2$, CO, $Cl_2$, and the $NH_3$ gases.

**Keywords: Noxious gases, air pollution, generators, firewood hearths, respiratory diseases**

## Introduction

Every year, thousands of people worldwide lose their lives to ailments that can be traced to environmental pollution arising principally from the release of toxic effluents into the atmosphere and surrounding ecosystems (Encarta, 2007). The trend towards urbanization in Nigeria means that it becomes of academic interest to quantify and describe the levels

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and prevalence of urban "environmental pollution". Environmental pollution is the contamination of the earth's environment with materials that interfere with human health, the quality of life, or the natural functioning of the ecosystem (living organisms and their physical surroundings). Whilst some environmental pollution is a result of natural causes (such as volcanic eruptions), most are caused by human activities. Environmental pollution has been classified into different categories that include air pollution, water pollution, solid pollution, hazardous pollution, and noise pollution (Encarta, 2007). Pollution, in its different forms, degrades the environment and affects the quality of life of the organisms that depend on this environment for survival; this especially holds true for the interaction of man and his environment. As humans become more skilful and adept at exploiting their environment, it becomes obvious that certain practices are quite detrimental to the "health" of the environment. It is with these facts in mind that this study was undertaken in order that the prevalence of noxious gases in some parts of Kontagora town could be determined.

The Wikipedia (www.wikipedia.org) states that air pollution is the human introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damages the natural environment, into the atmosphere (www.merriam-webster.com). Air pollution causes deaths (www.americanheart.org) and respiratory disease (www.who.int). Air pollution is often identified with major stationary sources, but the greatest source of emissions is mobile sources, mainly automobiles (National Research Council, 2004).

In his study of vehicular emission, environmental and health implications, Enemari (2001) pointed out that vehicular emissions in typical urban centres constitute over 60% of the total pollutant emission compared to what anyone will naturally hope, think or assumed. He recommended for proper servicing of vehicles for optimal performance and this should be encouraged. Also, he recommended that the refineries in the country should be fully evaluated with the aim of redesigning them to produce entirely unleaded petrol in the very near future. Furthermore, the use of catalytic converters in vehicles that uses unleaded petrol to control photochemical seeding was recommended. Bishop and Stedman (1996) have pioneered and developed an instrument to remotely measure vehicle emissions. In several studies it has been found that about 10% of the fleet generates more than 50% of total emissions of carbon monoxide (CO). Most cars are clean but a small number of malfunctioning or tampered with vehicles produce a major amount of regulated and un-regulated emissions. Kai-Jen et al (2007) researched the question of whether biological mechanisms linking air pollution to cardiovascular events can occur concurrently in humans subjects exposed to urban air pollutants. Measurements were made in each of the participating subject of high-sensitivity C-reactive protein (hs-CRP), 8-hydroxy-2'-deoxyguanosine (8-OHdG), plasminogen activator fibrinogen inhibitor-1 (PAI-1), tissue-type plasminogen activator (tPA) in plasma, and heart rate variability (HRV). Their study found that urban air pollution is associated with inflammation, oxidative stress, blood coagulation and autonomic dysfunction simultaneously in healthy young humans with sulphate and ozone ($O_3$) as two major traffic-related pollutants contributing to such effects. A World Bank report on urban air pollution (www.worldbank.org) stated that particulate matter is made up of airborne smoke, soot, dust, and liquid droplets from fuel combustion. The amount of suspended particulate matter, usually measured in micrograms per cubic metre of air, is one of the most important indicators of the quality of the air that people breathe. According to the World Health Organisation's air quality standards, the concentration of suspended particles should be less than 90 micrograms per cubic metre (www.worldbank.org). High concentrations of suspended particulates adversely affect human health, provoking a wide range of respiratory diseases and exacerbating heart disease and other conditions. Worldwide, in 1995 the ill health caused by such pollution resulted in at least 500,000 premature deaths and 4 to 5 million new cases of chronic bronchitis (www.worldbank.org). The report pointed out further that fuel combustion by motor vehicles is another major source of suspended particulate emissions in urban areas. These emissions are particularly detrimental to human health because pollutants are emitted at ground level. Motor vehicles in developing countries cause serious air pollution because they are concentrated in a few large cities, many are in poor mechanical condition, and few emission standards exist.

**Problem Statement:** At present, there exists no database on noxious gases pollution patterns of Kontagora town, so it is hoped that this study would serve as a pointer or "roadmap" in this regard.

**Aim of Study:** The aim of this study is to determine the prevalence of noxious gases in some parts of Kontagora with a view to establishing air pollution trends in this town.

**Scope of Study:** Three cadastral sheets of Kontagora town were considered for this survey. Measurements were taken from over forty GPS-referenced points on each of the cadastral sheets. The principal sources of noxious effluents considered for this study are the diesel generators or petrol generators (herein considered under the broad category of "vehicular emitters") and the firewood hearths.

**Field Equipment**

Various gas meters specific to the measurements of gas types like sulphur dioxide ($SO_2$), carbon monoxide (CO), chlorine ($Cl_2$), hydrogen cyanide (HCN), nitrogen dioxide ($NO_2$), ammonia ($NH_3$), and hydrogen sulphide ($H_2S$) were used for this project work.

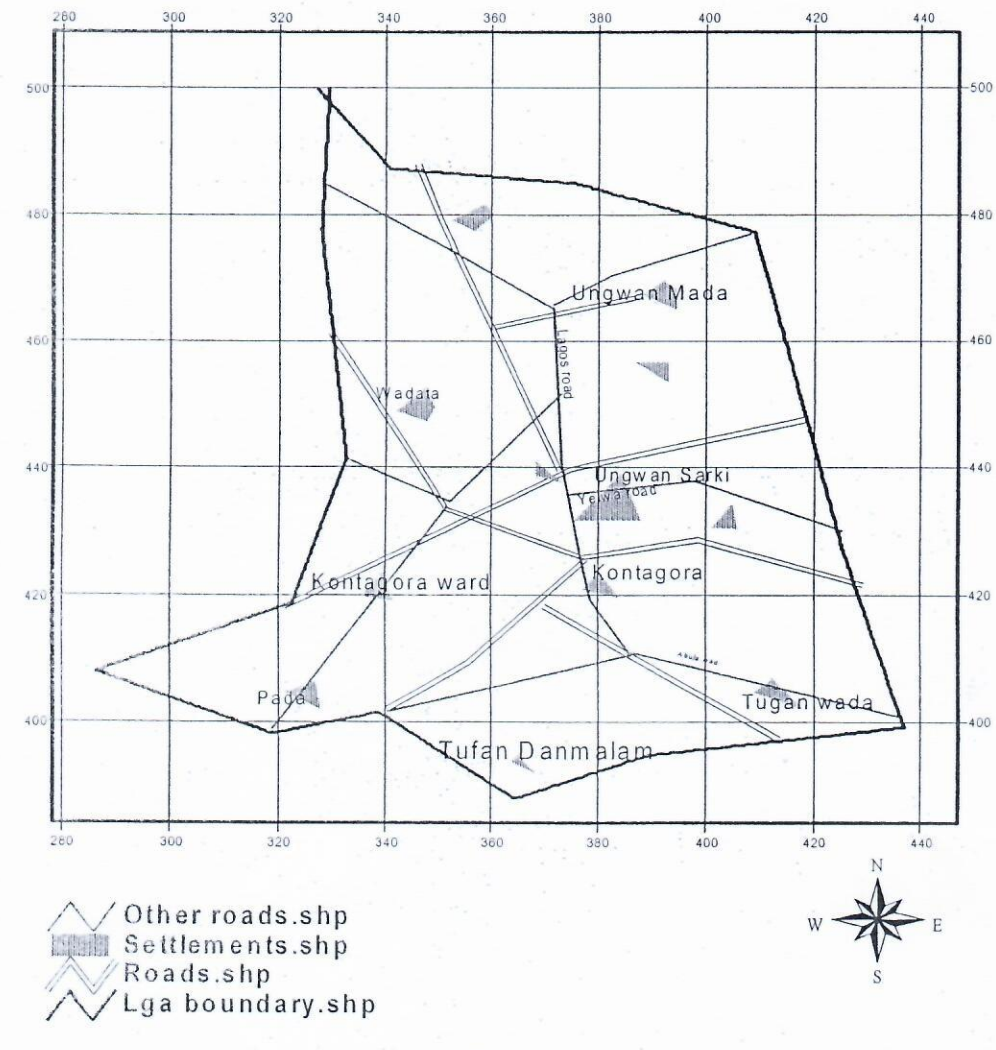


Fig.1. Map of Kontagora town

**Ingredients and Associated Risk of some Airborne Pollutants**

- **Ozone ($O_3$):** The primary ingredients in urban smog, ozone is created when hydrocarbons and nitrogen oxides ($NO_x$), both of which are chemicals released by automobile fuel combustion, react with sunlight. Though beneficial in the upper atmosphere, at the ground level ozone can irritate the respiratory system, causing coughing, chocked and reduced lung capacity.

- **Particulate Matter:** These particles of soot, metals and pollen give smog its murky color. Among vehicular pollution, fine particles (those less than one-tenth the diameter of a human hair) pose the most serious threat to human health by penetrating deep into lungs. In addition to direct emissions of fine particles, automobiles release nitrogen oxides, hydrocarbons, and sulphur dioxide, which generate additional fine particles as secondary pollution.
- **Nitrogen Oxides ($NO_x$):** These vehicular pollutants can cause lung irritation and weaken the body's defences against respiratory infection such as pneumonia and influenza. In addition, they assist in the formation of ozone and particulate matter. In many cities, $NO_x$ pollution accounts for one-third of the fine particulate pollution in the air.
- **Carbon monoxide (CO):** This odourless, colourless gas is formed by the combustion of fossil fuels such as petrol. Cars and lorries are the source of nearly two-thirds of this pollutant. When inhaled, carbon monoxide blocks the transport of oxygen to the brain, heart, and other vital organs in the human body. Newborn children and people with chronic illness are especially susceptible to the effects of carbon monoxide.
- **Sulphur Dioxide ($SO_2$):** Motor vehicles create this pollutant by burning sulphur-containing fuels, especially diesel. It can react in the atmosphere to form fine particles and can pose a health risk to young children and asthmatics.
- **Hazardous Air Pollutants (Toxics):** These chemical compounds, which are emitted by cars, heavy duty vehicles, refineries, gas pumps, and related sources have been linked to birth defect, cancer, and other serious illnesses.

## Description of Data Collection Sequences

Sheets 11, 13, and 21 of the Kontagora cadastral map were earmarked for survey. On each of these sheets, neighbourhoods and point locations that were prone to air pollution from stationary sources were identified; the GPS-referenced signature of each of the point source was recorded. The gas meters were employed to determine three different readings of the various gases of interest at each of those GPS-referenced points.

## Results and Data Analysis

Figs 2 and 3 show the bar chart representations of the various sources of pollution and their corresponding values along the Lagos/Kaduna Road and Old Sabon Gari Road neighbourhoods of Kontagora town.

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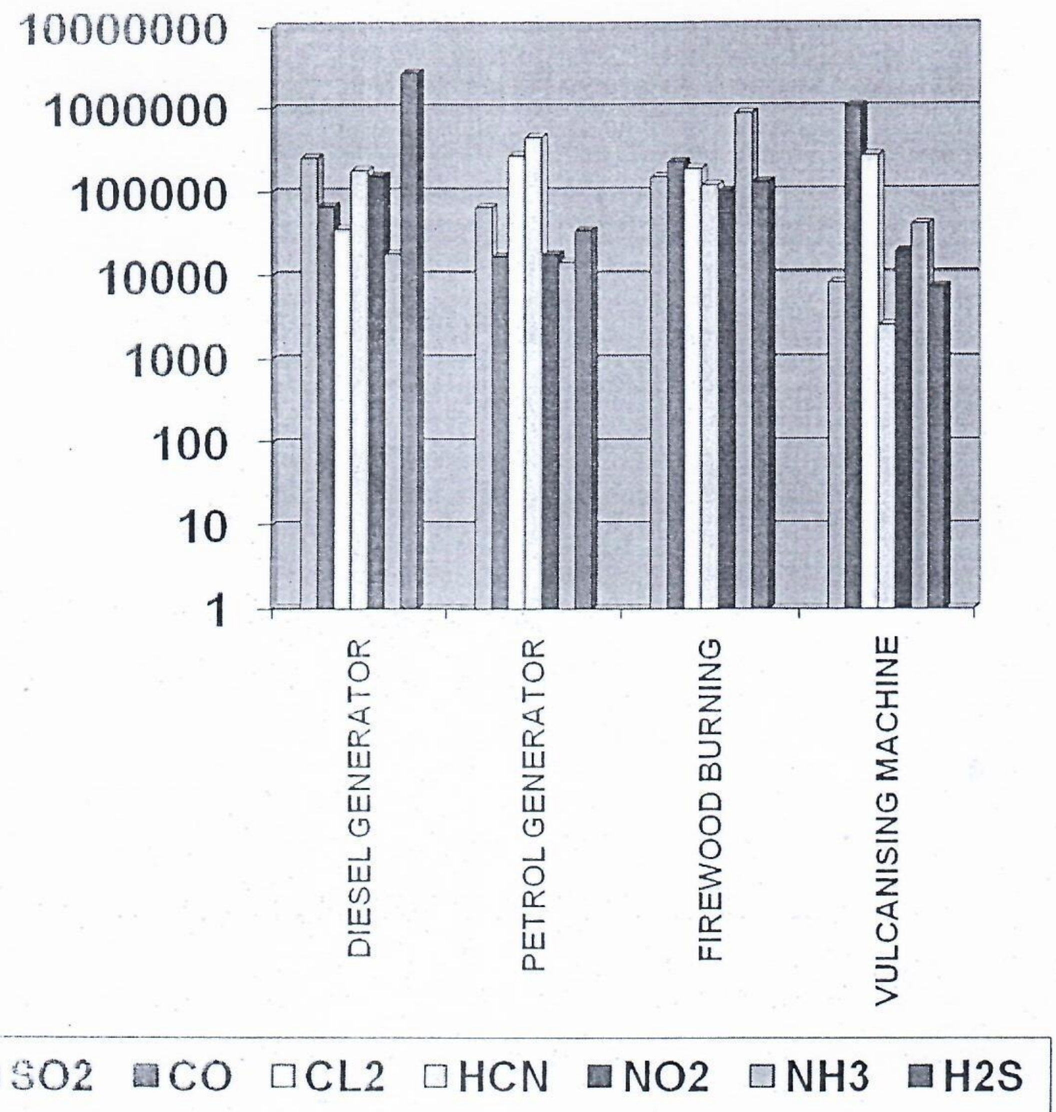


Fig.2. Bar Chart Representation of the Sources of Pollution: Lagos/Kaduna Road neighbourhood (vertical scale in $\mu g/m^3$)

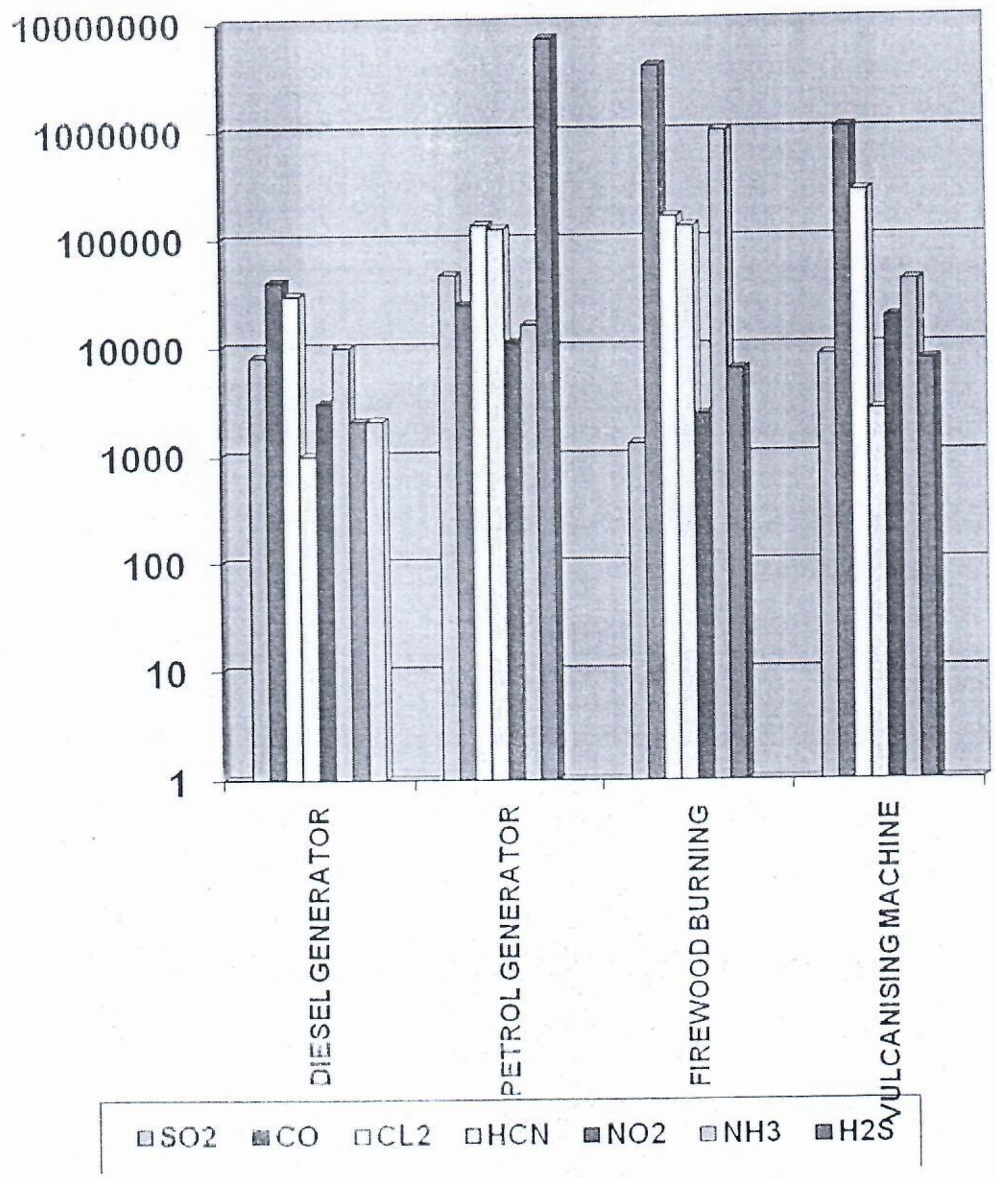


Fig.3. Bar Chart Representation of the Sources of Pollution: Old Sabon Gari Road neighbourhood (vertical scale in $\mu g/m^3$)

Table 3 presents position co-ordinates, gas type, and values for Sheet 13 of Kontagora town. Only three stations are represented here because of space. The corresponding bar chart representation with respect to the various sources of pollution is shown in Fig. 4.

Table 3 (abridged): Station Location and Values of the Different Gas Types Measured in Sheet 13

| | GPS Values | | Pollutants | | |
|---|---|---|---|---|---|
| 1 | UTM values | Local co-ordinates | Gas Samples | Av. values in ppm | Av. values in $\mu g/m^3$ |
| | X= 0771337 Y=1151183 | N=10.4053213 E=5.4781622 | $SO_2$ | 1.2 | 1200000 |
| | | | CO | 1.54 | 1540000 |
| | | | $CL_2$ | 0.40 | 400000 |
| | | | HCN | 0.05 | 50000 |
| | | | $NO_2$ | 0.53 | 530000 |
| | | | $NH_3$ | 0.007 | 7000 |
| | | | $H_2S$ | 0.007 | 7000 |
| 2 | X=0771339 Y=1151190 | N=10.4053844 E=5.478181 | $SO_2$ | 1.2 | 1200000 |
| | | | CO | 1.54 | 1540000 |
| | | | $CL_2$ | 0.40 | 400000 |
| | | | HCN | 0.05 | 50000 |
| | | | $NO_2$ | 0.53 | 530000 |
| | | | $NH_3$ | 0.007 | 7000 |
| | | | $H_2S$ | 0.007 | 7000 |
| 3 | X=0769937 Y=1150877 | N=10.4026547 E=5.4653623 | $SO_2$ | 0.032 | 32000 |
| | | | CO | 0.035 | 35000 |
| | | | $CL_2$ | 0.03 | 30000 |
| | | | HCN | 0.001 | 1000 |
| | | | $NO_2$ | 0.003 | 3000 |
| | | | $NH_3$ | 0.01 | 10000 |
| | | | $H_2S$ | 0.0014 | 1400 |

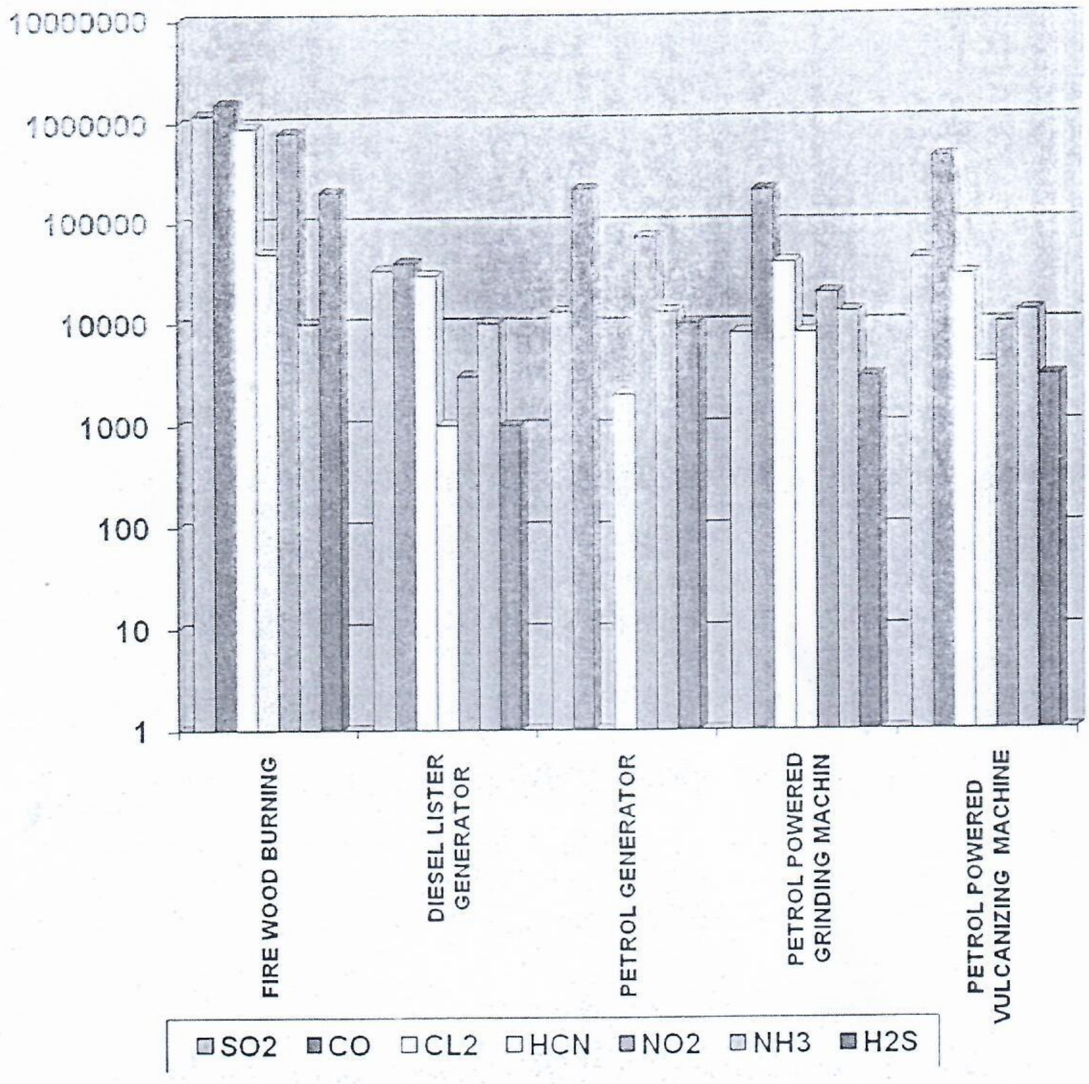


Fig.4: Bar Chart Representation Corresponding to Table 3 (unabridged). Vertical scale in $\mu g/m^3$.

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Table 4 presents position co-ordinates, gas type, and values for Sheet 21 of Kontagora town. Only three stations are represented here because of space.

Table 4 (abridged): Station Location and Values of the Different Gas Types Measured in Sheet 21

| | GPS VALUES | | Gas Samples/Mean Gas Values | | |
|---|---|---|---|---|---|
| | UTM | Local Coordinates | Gas Samples | Values in ppm | Values in $mg/m^3$ |
| 1 | X=768159.5 Y=1151276.45 | N=10 24.023 E=005 26.957 | $SO_2$ | 0.0013 | 1.3 |
| | | | CO | 005 | 5000 |
| | | | $CL_2$ | 0.16 | 160 |
| | | | HCN | 0.001 | 1 |
| | | | $NO_2$ | 0.0024 | 2.4 |
| | | | $NH_3$ | 001 | 1000 |
| | | | $H_2S$ | 0.0062 | 6.2 |
| 2 | X=768191.59 Y=1151061.53 | N=10 24.016 E=005 26.958 | $SO_2$ | 0.0013 | 1.3 |
| | | | CO | 005 | 5000 |
| | | | $CL_2$ | 0.16 | 160 |
| | | | HCN | 0.001 | 1 |
| | | | $NO_2$ | 0.0024 | 2.4 |
| | | | $NH_3$ | 001 | 1000 |
| | | | $H_2S$ | 0.0062 | 6.2 |
| 3 | X=768039.67 Y=1151029.62 | N=10 24.015 E=005 26.953 | $SO_2$ | 1.25 | 1250 |
| | | | CO | 0.25 | 250 |
| | | | $CL_2$ | 0.40 | 400 |
| | | | HCN | 0.50 | 500 |
| | | | $NO_2$ | 0.82 | 820 |
| | | | $NH_3$ | 1.00 | 1000 |
| | | | $H_2S$ | 1.50 | 1500 |

**Discussion**

Four principal sources of pollution were identified in the neighbouhoods of Sheet 11 of Kontagora, viz: the diesel generator, the petrol generator, the firewood hearth, and the vulcaniser's pump. Each of these sources emit all of the gases under measurements, i.e. $SO_2$, CO, $Cl_2$, HCN, $NO_2$, $NH_3$, and $H_2S$ because of concentrations recorded. Along the Lagos/Kaduna Road neighbourhood the diesel generator was observed to release the largest amount of $H_2S$ (2,678,000 µg/m$^3$) while the firewood hearth and vulcaniser's pump released a comparatively high amount of the CO gas (227, 000 µg/m$^3$ and 1, 053, 300 µg/m$^3$ respectively). Along the Old Sabon Gari Road neighbourhood, all of the major sources of pollution belched out a comparatively high amount of the CO gas; however, the petrol generator gave off the highest amount of the $H_2S$ gas (7, 150, 0000 µg/m$^3$) while the firewood hearth gave off the highest amount of the $NH_3$ gas (1, 000, 000 µg/m$^3$). The $Cl_2$ gas was also released in high amounts by all of the sources under condition.

On Sheet 13, the principal sources of pollution identified were the hearth, diesel generator, petrol generator, petrol engine milling machine, and the vulcanizer's pump powered by petrol engine. In all of the cases, the CO gas was released by each of the aforementioned sources in the largest amount. The $SO_2$ gas was observed in comparatively large amounts, too. Of all the gases, the diesel generator released the fewest quantities of each.

Sheet 21 comprises, predominantly, the Lagos Road neighbourhood. The diesel generator was observed to release the largest amount of the $H_2S$ gas (2, 678, 550 µg/m$^3$). The vulcaniser's pump released the highest amount of the CO gas (1, 053, 323 µg/m$^3$) and the least amount of the HCN gas (45, 903 µg/m$^3$). All the sources of pollution, except the diesel generator, were observed to belch out significant amount of the $Cl_2$ gas.

**Conclusion**

The result of Sheet 11 agrees with the general trends and patterns of air pollution from fuel burning sources. The high amount of $H_2S$ released by the diesel generator is most likely due to the high sulphur content of diesel fuel. Technical literature points out that exposure to gas concentration above a threshold value of 50 mg/m$^3$ or 50,000 µg/m$^3$ over a short period of time is injurious to health. It follows from Fig. 1 that most of the emissions from diesel generators and firewood hearths exceed the safe threshold. The comparative high amount of the CO gas released by the majority of the sources is expected because combustion in all cases involves burning of carbon compounds (hydrocarbon for the liquid fuels and cellulose for the wood fuel).

It is not a surprise that the CO gas was released in comparative large amounts by all the sources identified in Sheet 13; as was pointed out early, all fuels are, after all, carbon-based. As per the threshold of 50, 000 µg/m$^3$, most of the effluents for the diesel generators are well below this mark. The values of the $NO_2$, $Cl_2$, $NH_3$, and HCN gases from the firewood hearth exceed the safe threshold. There is also the prevalence of the $Cl_2$ gas in all of the sources observed. The overwhelmingly dominance of the $SO_2$ gas from the petrol generators and the CO gas from the firewood hearths must be due to high sulphur content in the former and of course the innate matter of the latter.

On Street 21 the noxious gases posing greater risk to health from the diesel generators (with respect to the threshold) are the $SO_2$, CO, HCN, $NO_2$, and $H_2S$ gases, from the petrol generators these are the $SO_2$, $Cl_2$, and HCN gases. From the firewood hearth the noxious gases occurring in greater than acceptable amounts are the CO, $Cl_2$, HCN, $NO_2$, $NH_3$, and $H_2S$, and for the vulcaniser's pump these are the $SO_2$, CO, $Cl_2$, and the $NH_3$ gases.

It is seen from this study that all of the primary stationary sources of pollution emit noxious gases in different degrees into the atmosphere and the ambient environment about any source is constantly inundated with all of the seven gases identified in this survey.

**Recommendation**

In addition to a suggestion for constant monitoring and evaluation of the amount of different noxious gases present in the ambient environment, it is recommended that:

- For the short-term, householders should be encouraged to convert to pressurized kerosene cookers instead of the heavy reliance on woodstoves and open hearth charcoal stoves that are a common sight in many kitchens in Kontagora The long-term solution would obviously involve the implementation of an effective nationwide domestic gas-piping policy whence most homes would be linked to a national gas distribution grid.
- To reduce the incidence of the high occurrences of the $SO_2$ and the $H_2S$ gases, petrol that are less in their sulphur content should be used at all times as the primary fuel of combustion in particular engines.
- The use of generators of very high combustion capabilities should be encouraged at all times.
- To minimize exposure to harmful fumes that are discharged from the various sources of pollution, proper ventilation procedures must be adhered to at all times; this could be in the form of smokestacks in kitchens and the safe and proper routing of exhaust fumes from all kinds of engines during their operations.

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