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SULPHUR DIOXIDE AS INDOOR POLLUTANT IN METROPOLITAN KANO, NIGERIA

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ABSTRACT

The magnitude and spatial distribution of indoor sulphur dioxide in three population density districts of metropolitan Kano, Nigeria were investigated. The mean and standard deviation of the gas in the metropolis is 34.61 ± 22.9 μg/m^3. Its magnitude and spatial distribution in three population density districts of City, Sabongari/Brigade and Nassarawa are 43.81 ± 27.3; 39.22 ± 13.65, and 17.01 ± 20.08 μg/m^3 respectively. The distribution, which is skewed toward high frequency of low concentrations, could be attributed to the use of biomass and the combustion of high sulphur fossil fuels.

INTRODUCTION

While air quality remains a principal environmental concern affecting the health and quality of life of residents and people in urban areas across the world, few studies have been conducted on air quality in metropolitan Kano, Nigeria [1-7]. These determinations focused on outdoor air quality. Levels of volatile organic compounds (VOCs) have not been investigated for indoor pollutants. Sulphur dioxide is released into the atmosphere via the combustion of fossil fuels, firewood, and coal [8]. It constitutes one of the most problematic air pollutants

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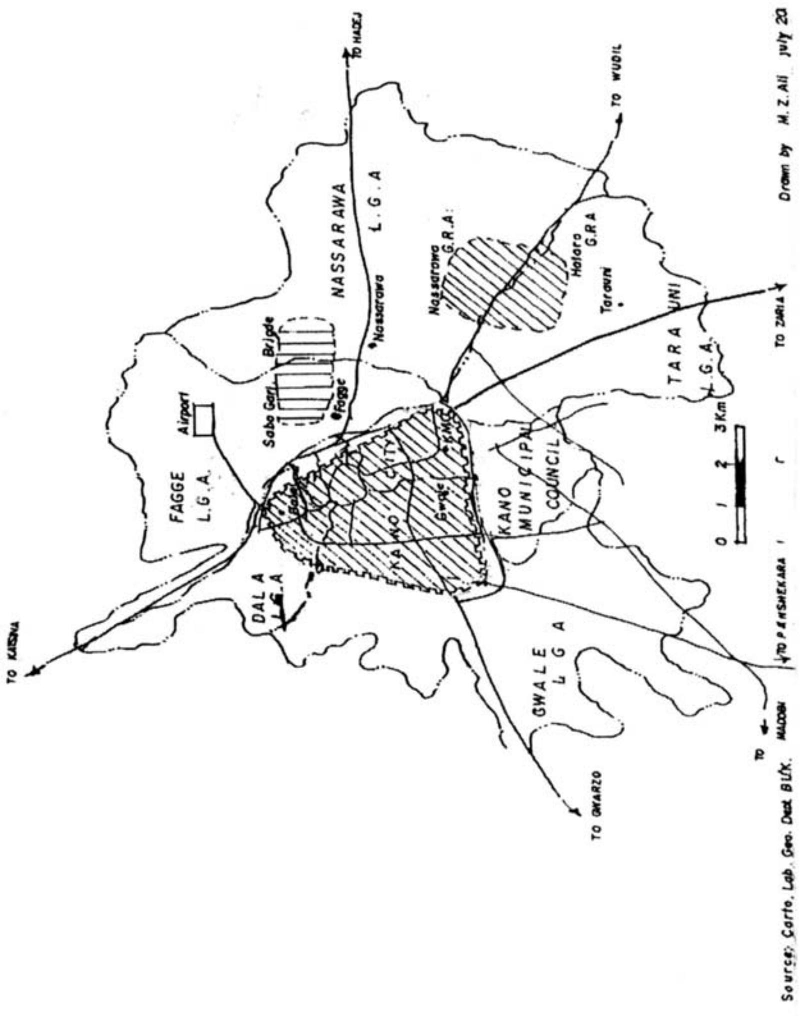
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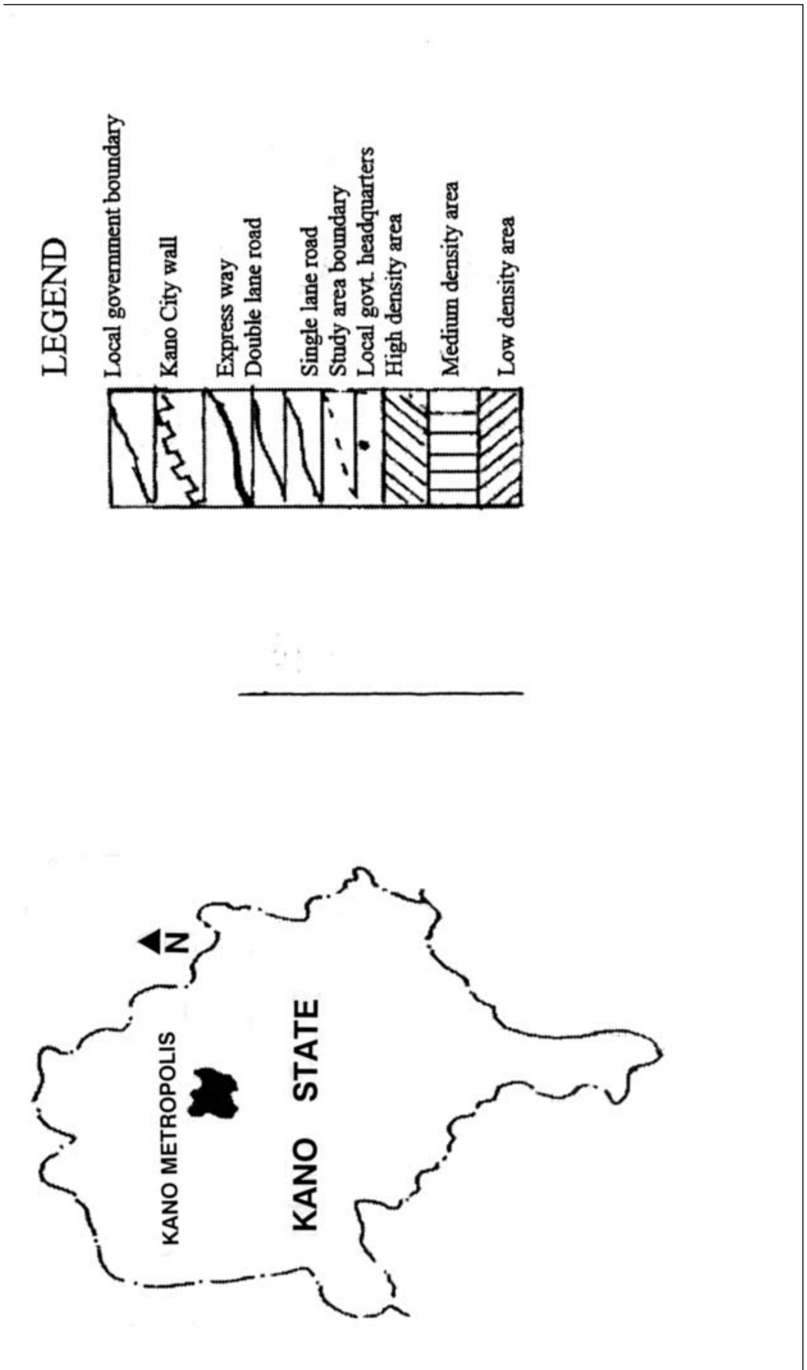

Figure 1. Map of metropolitan Kano showing sampling zones.

[9]. Its concentration in air may range from 0.01 to several parts per million, and is responsible for the decay of buildings and monuments, acid rains, and human discomfort and disability [8, 10, 11-13]. Metropolitan Kano has one of the highest population and housing densities not only in the area referred to as the "Kano close-settled zone," but in Nigeria as a whole [14].

In the area of household energy use and consumption, Silvi-consult [15] reported the average rate of wood fuel consumption in Nigeria at 70%, while Kura [16] reported that over 90% of the people in metropolitan Kano rely on wood fuel for energy. This article investigates the magnitude and spatial distribution of indoor sulphur dioxide in metropolitan Kano, with attention focused on three population density districts.

MATERIALS AND METHODS

Two hundred and seventy-five samples were taken in the metropolis between October 2005 and April 2006, coinciding with the dry season of the study area. The magnitude and spatial distribution of indoor sulphur dioxide in three districts of City (high), Sabongari/Brigade (medium), and Nassarawa (low) of metropolitan Kano were the issues investigated (Figure 1).

Instrumentation

Crowcon-Gasman "FL" Detection Instruments were used (see Figure 2). The Gasman "FL" is designed to monitor for the presence of flammable gases, and is certified to ex ia IIC T3/T4, while the Gasman "TO" is designed to monitor for the presence of specific toxic gases, and is certified to EEx ia IIC T3/T4. Temperature classification T3 applies if the unit is fitted with Crowcon rechargeable battery pack, while the T4 applies if the unit is fitted with disposable batteries. To adjust the span of the "TO" and "FL" versions, gas of known concentration and reliable delivery systems to the sensor are required. Calibration gas test kits, comprising gas mixtures, either in disposable cylinders, regulator, and tube and calibration adaptors were used. The calibration adaptor was fitted into the top of the sensor housing and the gas cylinder valve was opened. The gas flow rate was set to sensor 0.51/min and the reading on the display was allowed to stabilize. The CAL preset was adjusted so that the display indicated the concentration shown on the cylinder. With the unit now placed in normal air, the switch was turned to the GAS position. The green LED and the sounder (if factory set) operated once a second. The LCD display showed 000 for "TO" and "FL" versions. If not the black cover below the display was adjusted to ZERO preset until the display was 000 (for "TO" or "FL" versions). It was ensured that the cover was placed after adjustments were made.

RESULTS AND DISCUSSION

The magnitude and spatial distribution of indoor sulphur dioxide in the three districts of metropolitan Kano are as shown in Figure 3a. The gas is present in most

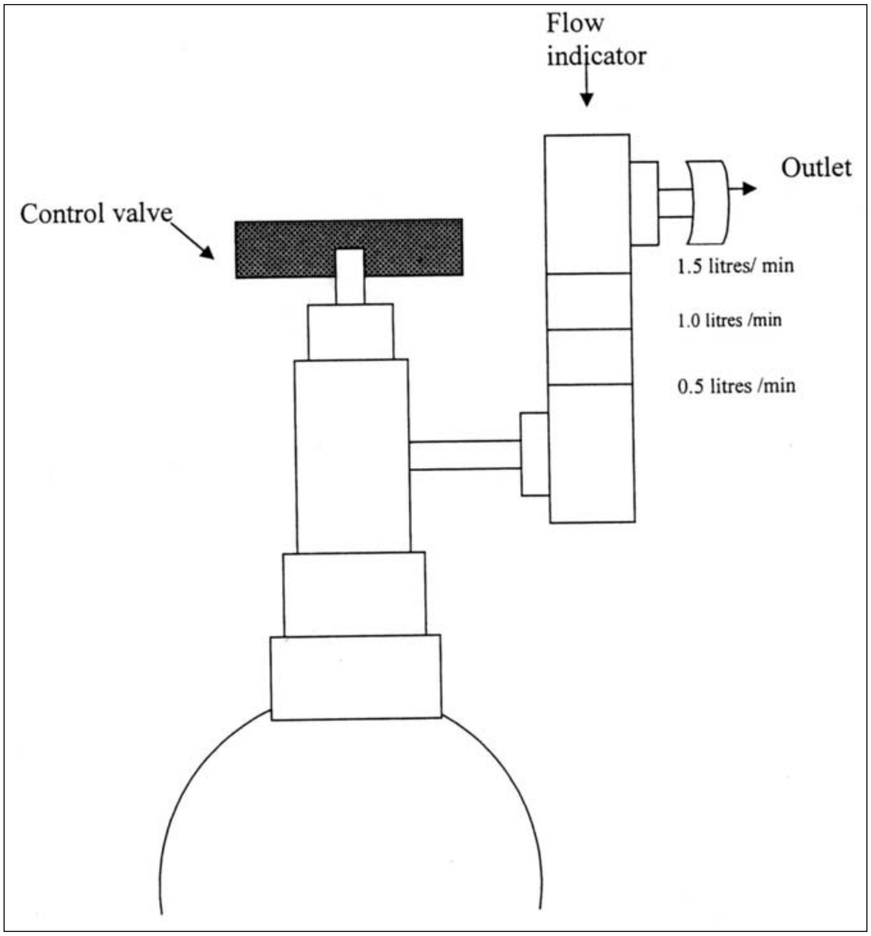

Figure 2. Schematic diagram of the automatic sampler.

homes, with a mean and standard deviation of 34.61 ± 22.9 $\mu g/m^3$ respectively. The distribution is skewed toward high frequency of low concentrations. This observed pattern may be due to the twin problems of the use of solid fuels [17] and the combustion of high sulphur fossil fuels [18].

The densely populated City has the highest sulphur dioxide indoor mean concentration and standard deviation of 43.81 ± 27.33 $\mu g/m^3$. The frequency distribution pattern for the gas in this zone is as shown in Figure 3b. The distribution is skewed toward low frequency of high concentrations. This may be attributed to the utilization of solid fuel for cooking. Furthermore, residential buildings in this zone are the compound types containing several households, with

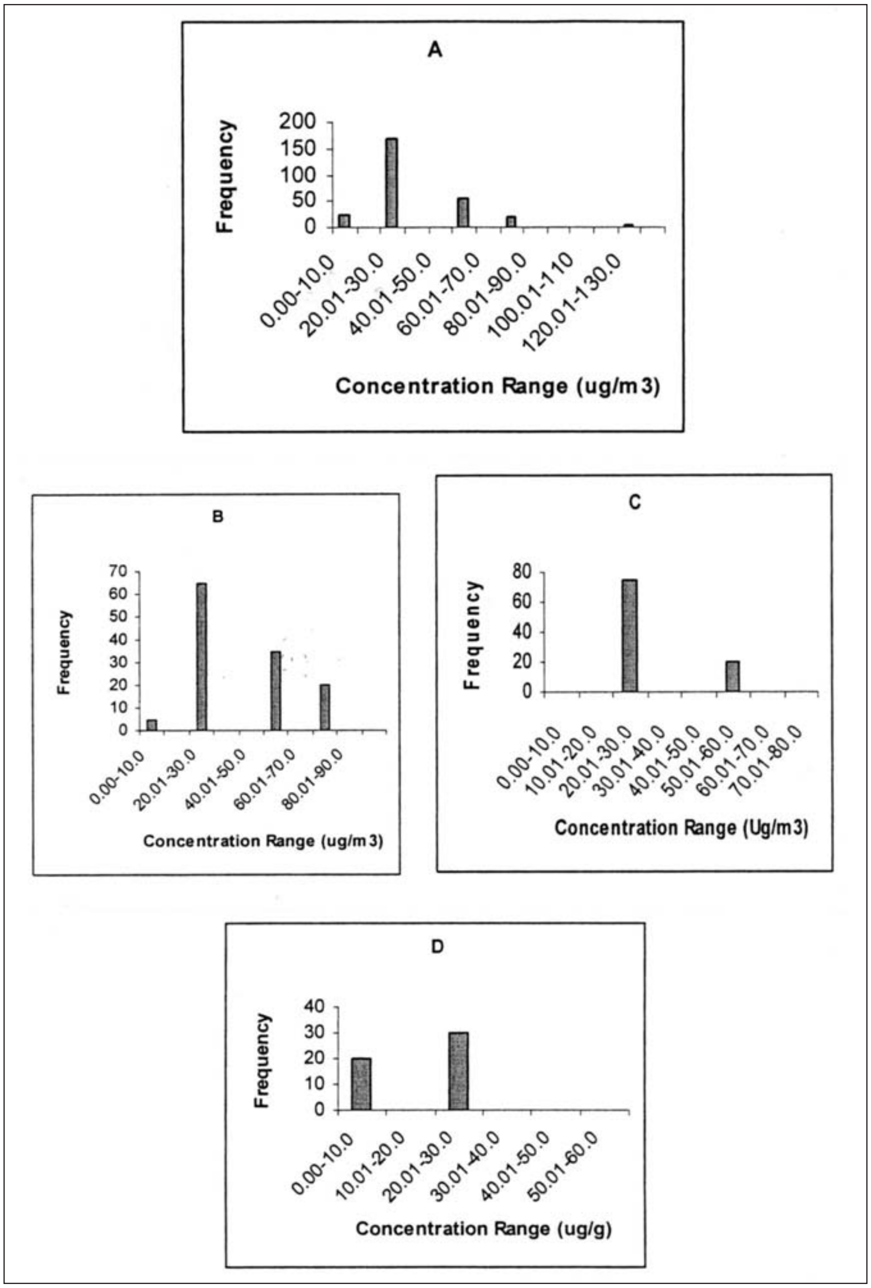

Figure 3. Frequency distribution pattern for sulphur dioxide (A) Municipality, (B) City, (C) Sabongari/Brigade, (D) Nassarawa.

separate cooking and heating arrangements. It was also observed that indoor sulphur dioxide pollution was at its peak during the cooking hours—usually in the mornings and early evenings. The frequency distribution pattern for the gas in the medium population density area of Sabongari/Brigade is as shown in Figure 3c, with a mean indoor sulphur dioxide concentration and standard of deviation 39.22 ± 13.65 $\mu g/m^3$. The distribution is skewed toward high frequency of low concentrations. The observed pattern may be due to the burning of solid and fossil fuels, and increased automobile emissions, through poor combustion. It was also observed that coal, firewood, and kerosene were the main sources of energy for cooking in this zone.

The low population density area Nassarawa was the least in sulphur dioxide with a mean and standard deviation of 17.01 ± 20.08 $\mu g/m^3$. The frequency distribution pattern for the gas in this location is as shown in Figure 3d. The distribution is bimodal with higher frequency of low concentrations. This distribution pattern may be due to the persistent burning of fossil fuels and the incomplete combustion from stationary sources and car engines. The mean and standard deviation of sulphur dioxide in all these areas are as shown in Table 1.

CONCLUSION

Everyone agrees that the basic objective in the area of environmental health and safety in our homes is to ensure minimal/acceptable levels of risk. The definition of "minimal/acceptable" risk and the implementation of practices and policies to meet the objective form the crux of the policy issue [19].

When the phrase "acceptable risk" is applied to the atmospheres in our rooms, there is the implication that a range of gas concentrations must be identified with some health problems that may develop for some people if concentrations are tolerated above this level for a period of time. Relating health effects to concentrations of gases requires field information, experiences of people, a foundation in scientific theory, some laboratory animal test data, and a process for reading a decision as to what constitutes an acceptable level—Permissible Exposure Level

Table 1. Mean Sulphur Dioxide Concentrations in Kano Metropolis, Nigeria

Location	Mean ($\mu g/m^3$)	*SD*	Number of samples
Metropolis	34.61	22.9	275
Old City	43.81	27.33	130
Sabongari/Brigade	39.22	13.65	95
Nassarawa	17.01	20.08	50

(PEL), or "Threshold Limit Value" (TLV), or a similar term that may be revised as more information becomes available [20]. While this study does not address such broader issues, the results suggest that even on local and neighborhood scales, there is significant variety in the practical factors (human behavior and activities, population density) that may have to be weighed.

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