

A Study on Carbon Monoxide Emissions in Some Resource-Limited Settings in Southern Nigeria: Outdoor/Indoor Diurnal and Spatial Trends

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ABSTRACT

This study was carried out in some selected homes in Edo State, Southern Nigeria to access the level of carbon monoxide (CO) emissions where kerosene and firewood are used as cooking fuels. In-situ CO emissions were monitored diurnally in three sampling sites; kitchen (point source), living room, and outdoor in the selected homes during cooking and non-cooking hours with a docimeter sampler. The meteorological parameters in the respective homes were also recorded during each visit. The spatial trends of atmospheric CO emissions at point source indicated high risk of exposure on the occupants. CO values recorded were within the range of 5.75ppm – 11.12ppm was recorded in homes using kerosene while 14.79ppm and 16.43ppm in the homes using firewood. These values exceeded the permissible limits for indoor air quality and daily emissions in these environments increase the adverse health effects of CO exposure.

Keywords: carbon monoxide, kerosene, firewood, spatial, diurnal.

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INTRODUCTION

- The worldwide cumulative incidence and mortality of CO poisoning are currently estimated at 137 cases and 4.6 deaths per million, respectively (Mattiuzzi and Lippi, 2020).
- CO toxicity is not due simply to the reduced oxygen-carrying capacity of the blood (Nelson, 1998).
- Carbon monoxide (CO) intoxication is one of the most frequent causes of accidental poisoning, mechanistically related to the inhibition of oxygen transport following blockage of the oxygen binding site of hemoglobin (Stucki and Stahl, 2020).
- However, the Emissions of CO in Residential buildings have long been recognized as a source of ambient air pollution with negative health effects.

This paper shows a study carried out at Ikpoba Okha LGA is a semi-urban area of Edo State, Nigeria assessing indoor and outdoor air quality in some selected homes in the Evboriaria axis of the local government, by measuring the diurnal and spatial trends of CO in relation to the meteorological parameters.

Materials and Methods

Data sources

- A questionnaire on household characteristics indication the type of cooking fuel was distributed to 6 houses.

Scope of study

- This study was carried out in six homes located in a rural-urban area of Ikpoba Okha LGA in Benin City, Edo State, in the southern part of Nigeria. See Fig 1 and 2.

Sampling method

- Insitu CO and Meteorological Measurements were taken for 1 week in the selected homes. A Dosimeter sampler an electrochemical sensor was used to measure ambient levels of CO in triplicates at the three sampling sites at the designated homes.

Statistical analysis

The tables, graphs, and statistical indices were employed to describe the obtained data. The data were also analyzed using SPSS.

RESULTS AND DISCUSSIONS

Table 1: Diurnal CO Concentrations in the Selected Homes during Cooking and Non-Cooking Hours

(Mean CO Value in ppm)

House Sample Code	Sampling Location	Cooking Hour					
		Morning	Afternoon	Evening	Morning	Afternoon	Evening
K1	Outdoor	1.50±0.50	-	0.00 ± 0.00	1.85 ± 0.36	-	1.80 ± 0.39
	Kitchen	1.50 ± 0.50	-	1.00 ± 0.00	11.40 ± 5.60	-	10.80 ± 5.02
	Living Room	1.50 ± 0.50	-	1.00 ± 0.00	2.00 ± 0.74	-	4.40 ± 1.80
K2	Outdoor	1.50 ± 0.45	2.00 ± 0.00	2.00 ± 0.00	2.30 ± 4.22	-	1.20 ± 0.53
	Kitchen	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	7.20 ± 3.20	-	4.30 ± 1.89
	Living Room	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	5.50 ± 1.92	-	2.50 ± 1.03
K3	Outdoor	1.50 ± 0.50	2.00 ± 0.00	2.00 ± 0.00	1.30 ± 0.47	-	1.04 ± 0.69
	Kitchen	1.00 ± 0.00	1.80 ± 0.48	2.00 ± 0.00	11.00 ± 5.62	-	11.40 ± 5.46
	Living Room	0.00 ± 0.00	1.90 ± 0.38	1.70 ± 0.50	2.80 ± 1.50	-	3.00 ± 0.75
K4	Outdoor	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	1.60 ± 0.49	-	1.10 ± 0.43
	Kitchen	0.00 ± 0.00	-	0.00 ± 0.00	5.60 ± 3.90	-	5.40 ± 2.30
	Living Room	0.00 ± 0.00	-	0.00 ± 0.00	1.70 ± 0.56	-	2.90 ± 0.87
F1	Outdoor	2.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	1.60 ± 0.49	2.00 ± 0.00	2.00 ± 2.00
	Kitchen	1.50 ± 0.50	0.00 ± 0.00	1.00 ± 0.00	17.81 ± 7.88	16.49 ± 35.23	15.00 ± 7.61
	Living Room	1.75 ± 0.45	0.00 ± 0.00	1.00 ± 0.00	2.48 ± 0.66	2.29 ± 0.45	2.60 ± 0.49
F2	Outdoor	1.00 ± 0.00	0.00 ± 0.00	2.00 ± 0.00	1.50 ± 0.50	1.82±0.39	2.00 ± 0.00

K1-K4 = Homes using kerosene

F1 & F2 = Homes using firewood

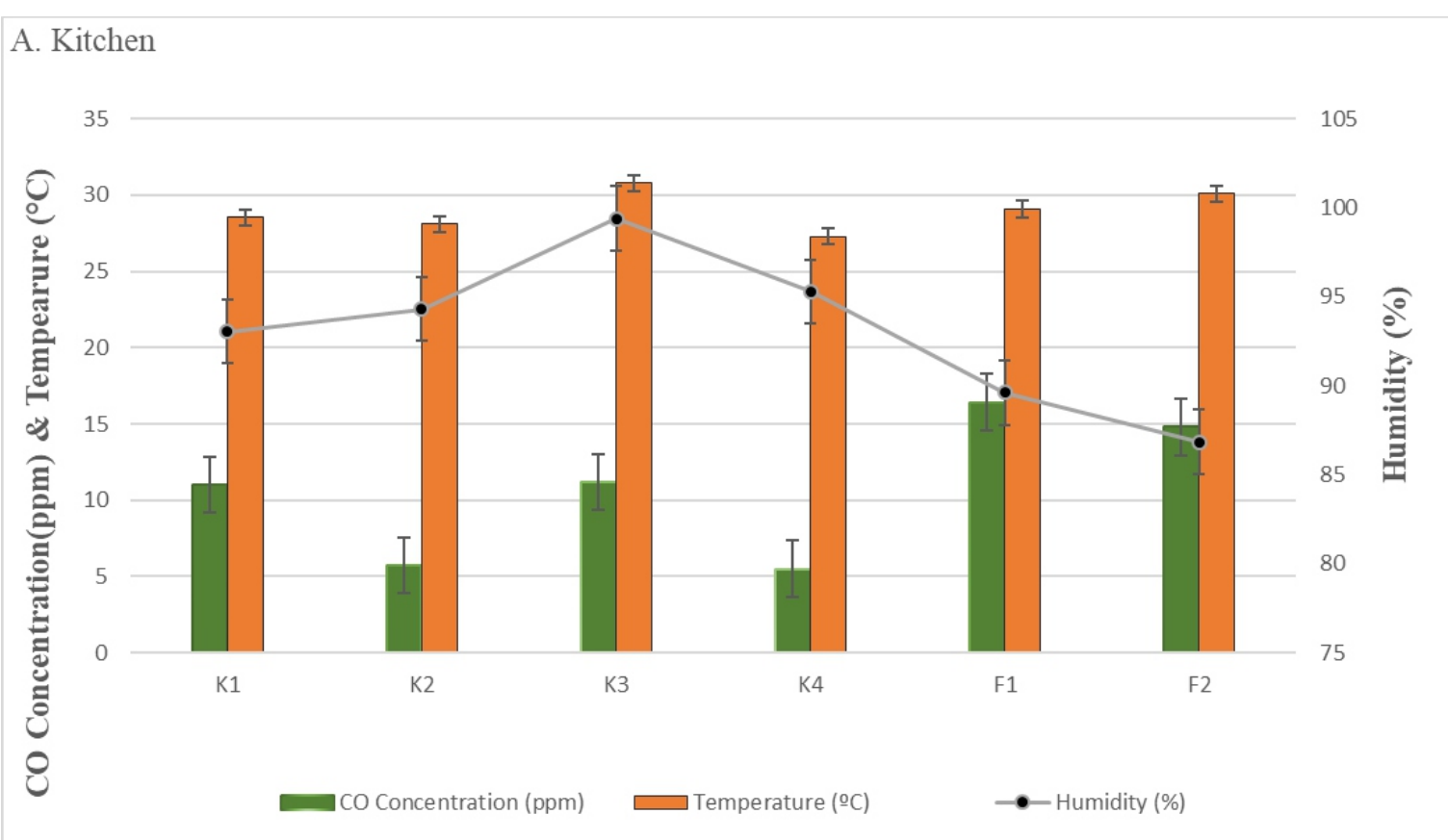


Fig 3a: Indoor CO Spatial Trends and Meteorological Data during Cooking Hours in the Kitchen.

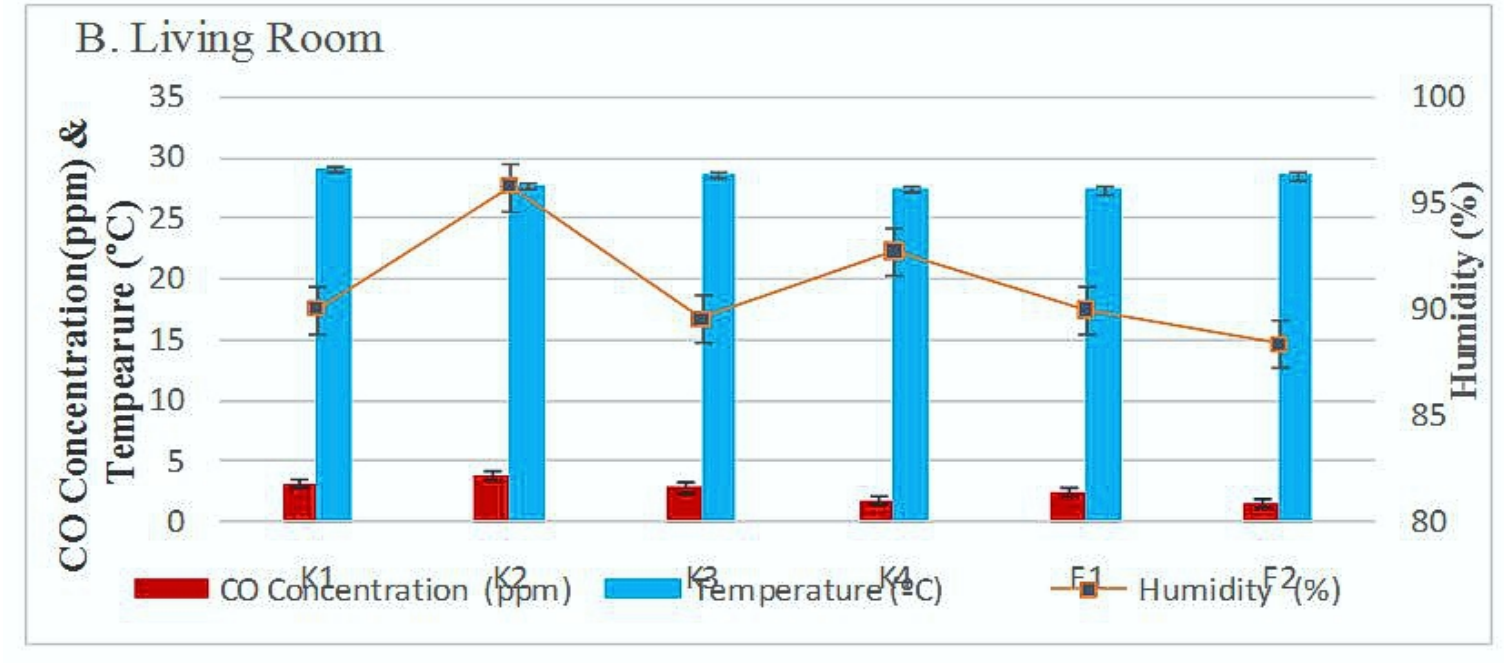


Fig 3b: Indoor CO Spatial Trends and Meteorological Data during Cooking Hours in the Living Room.

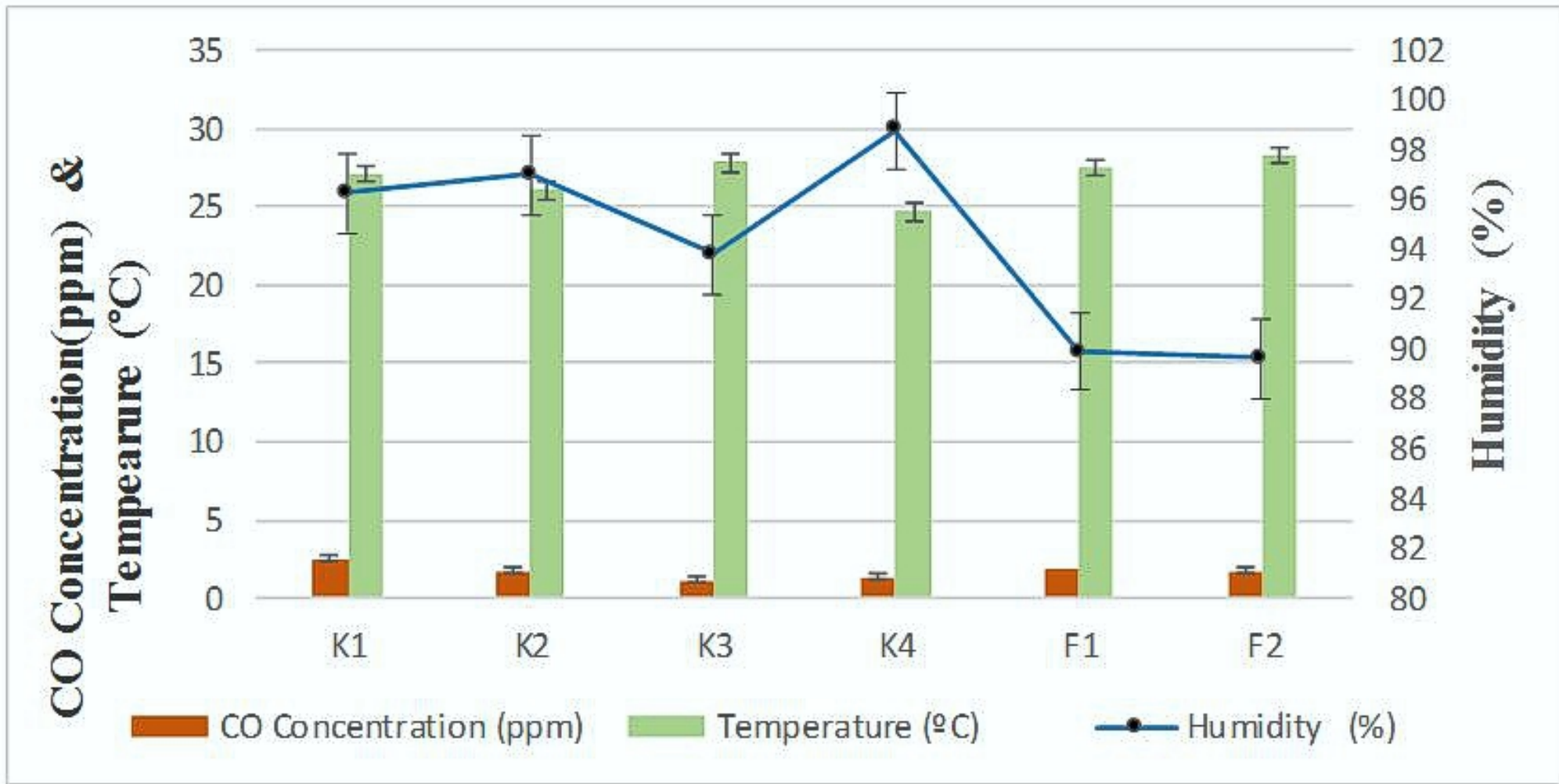


Fig 4: Outdoor CO Spatial Trends during and Meteorological Data Cooking Hours

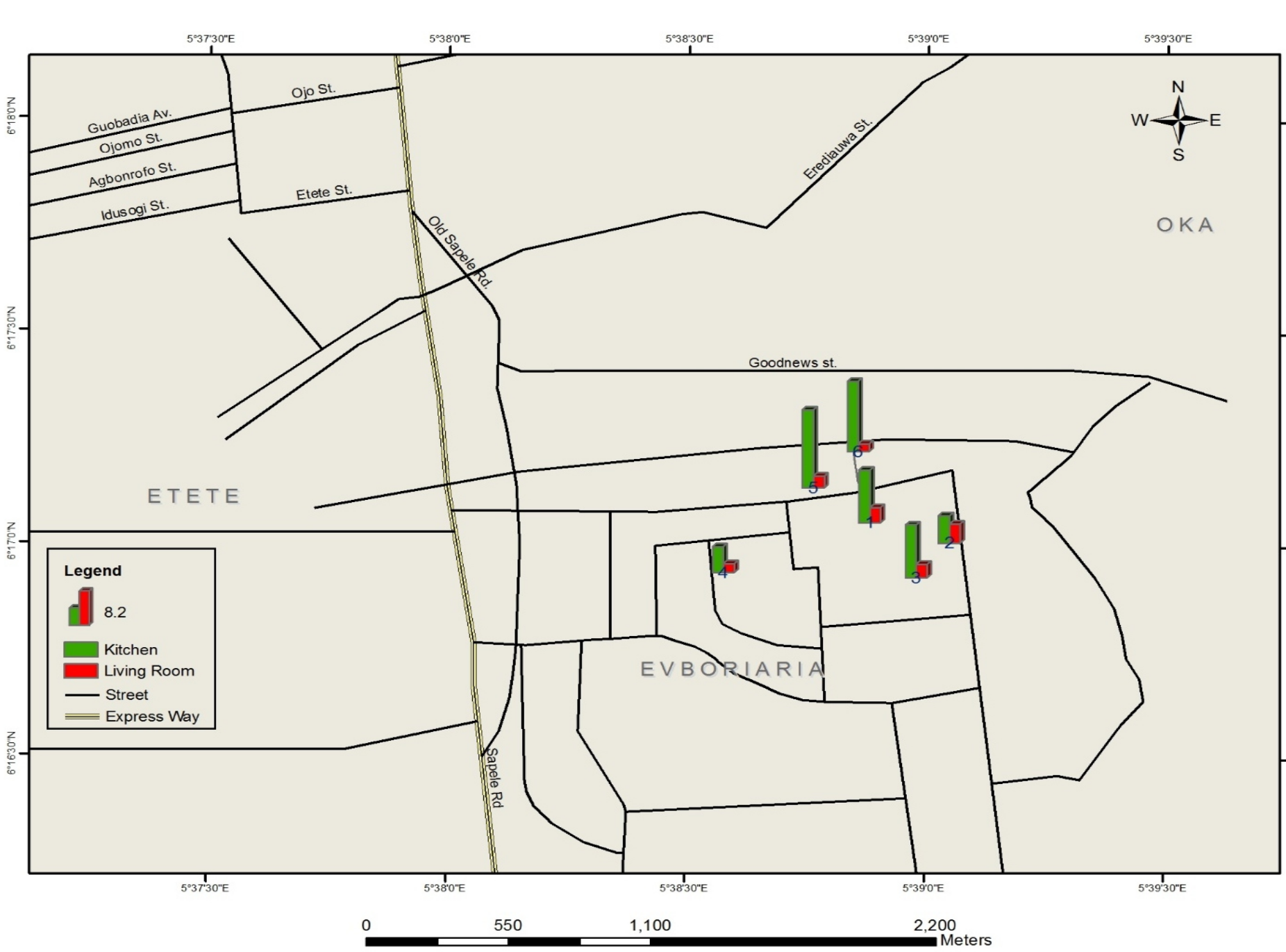


Fig 5: Map showing the Spatial Trends of CO Concentration in the selected homes at Ikpoba Okha Local Government, Benin City, Nigeria.

Fig 1: Coordinate Map showing the selected homes using kerosene as cooking fuel

Fig 2: Coordinate Map showing the selected homes using firewood as cooking fuel

- High CO emissions were recorded at K1, K3, F1, and F2, in the morning with the CO values respectively 11.40 ± 5.60, 11.00 ± 5.62, 17.81 ± 7.88, and 15.36 ± 6.42 at the point source.
- The low CO values were all found to slightly increase in the living rooms as well as the outdoor CO levels and difference in CO values during and after cooking when juxtaposed revealed the cooking fuels as the source of the emission.
- Also revealed in fig 3a was high CO levels at 16.43 and 14.79 in F1 and F2 respectively at point source.
- The outdoor spatial trends are seen in Fig 4. Low CO levels were recorded outdoor as seen in Fig 4. The data obtained also revealed that the CO emitted was localized at the point source (kitchen). This was also observed in the living room where reading was also taken (Fig 3b).
- The spatial trend data in fig 3a shows with the highest mean CO load of 16.43 ppm was measured at F1, the lowest CO value was at 5.75ppm at house K2. (see appendix table 2a).

- In accordance to the United States Environmental Protection Agency, indoor air quality, average levels of CO in homes without gas stoves vary from 0.5 to 5 parts per million (ppm), Levels near properly adjusted stoves are often to 5 to 15ppm and those near poorly adjusted stoves may be 30ppm or higher (Tran *et al.*, 2020).
- This study revealed that the occupants were samples were taken have of high risk of developing the suggestive symptoms of CO exposures which will result in adverse health effects due to the use of the cooking fuels (kerosene and firewood).
- Thus, it's important to advocate for a better air quality especially in low income areas in Africa should be gain more importance politically and socially.
- Active policy response, legislation and commitments at the global and local levels of government can in no small measure improve on the level of air quality in both urban and rural communities.

References

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