International Journal of Innovative Environmental Studies Research 12(4):71-79, Oct-Dec., 2024

 www.seahipublications.org ISSN: 2354-2918

DOI:10.5281/zenodo.14016903

Specific Criteria Pollutants Determination in Some Selected Wards of Sokoto Metropolis

[1*]Umaru Bello Sifawa, [2]Abdullahi Usman Budah & [3]Abubakar Abbas Sa'idu

[1, 2&3]Department of Geography, Shehu Shagari College of Education, Sokoto, Nigeria
***Corresponding Author email: sifawabello@gmail.com**
Mobile No: 08066028299

ABSTRACT
Ambient air pollution is a major environmental challenge confronting urban areas and is currently the problem faced by developed and developing countries. The aim of this study is to examine air pollution in Sokoto urban area, with the objectives to determine the concentration level of four criteria air pollutants (SO2, NO2, CO & PM10) and compare the pollutants concentration level with documented standards (NEAREA and WHO). The emission concentration level was determine using a hand held BH-4S portable multi gas detector air sampler and a portable air quality meter. Average measurements were done in ppm and µg/m^3. Statistical Package for Social Science (SPSS) and Microsoft excel software where used for data analysis. The level of emission recorded at the sample sites in Sokoto showed PM10 with highest concentration (52.96±36.22µg/m^3), followed by CO (10.80±12.19ppm), NO2 (0.12±0.18ppm) and SO2 (0.01±0.03ppm) in all the sampled sites. The results established that the emission levels in metropolis especially in the evening were higher than the NESREA and WHO standard accepted safe limits of 10 ppm for atmospheric CO, 0.05 - 9.00ppm, NO2 0.12- 0.04ppm, SO2 0.12- 0.02ppm and PM10 150-50 µg/m^3, respectively. This will have adverse health effects if unmitigated. Environmental laws should be enforce to reduce the emission of this pollutants.
Keywords: Pollutants**,** urban air pollution, dumpsites

1.0 INTRODUCTION

Clean air is one of the basic requirements for human existence. However, in and around the urban areas natural and clean air is far from normal because it contains a lot of hazardous impurities release from various human activities. Air pollution is the contamination of the indoor or outdoor air by a range of gasses and solids that modify its natural characteristics. Air pollution is often not visible to the naked eye as the size of the pollutants are smaller than the human eye can detect. The fact that you cannot see the air pollution does not mean that it does not exist (WHO, 2018). Globally, air pollution is a matter of concern at all levels and has become a global challenge which ranged from local/regional/national in scope, owing to the rapid population growth, urbanization and industrialization. The Transportation is the major source of air pollution accounting for over 80% of total air pollutants. In addition disposal of waste in open dump sites or burning of collected waste (Faize and Sturm, 2000; Abam and Unachukwu, 2009). Globally, the hazardous impact of air pollution on human health and the environment has been on the rise, particularly in developing countries where most people still generate their own electricity by means of fossil fuel (diesel and petrol) powered electricity generator sets for both commercial and domestic use.

Among the major air pollutants of concern are carbon monoxide, carbon dioxide, oxides of nitrogen, oxides of sulfur, particulate matter, noise and volatile organic compounds such as benzene, polycyclic hydrocarbons and formaldehyde (WHO, 2018). The effects of the above on human lives are enormous as it causes disease and can result in chronic illness. Exposure to air pollutants has been associated with increased risk of upper respiratory tract diseases such as asthma, inflammation, fibrosis and chronic obstructive pulmonary disease, exacerbation of heart disease due to hypertension and

degeneration of the cells which line blood vessels, irreparable damage to the central nervous system, as well as cancers.

Njoku, (2015) examined the effects of waste dumpsites on the water and air qualities in Abakaliki, and reported that air and water nearer to dumpsites recorded higher concentration of pollutants than control. There was a significant ($p<0.05$) difference in the concentration of CO, H_2S and NO_2 and a non-significant ($p<0.05$) change in NH3 in the dumpsites studied. The air nearer to dumpsites recorded higher values for pollutants than the control points. Weli *et al,* (2014) worked on air quality in the vicinity of a landfill site in Port Harcourt, result showed that temperature and relative humidity influenced the concentration of NO2, NH3 and H2S. Wind speed influences the level of concentrations of SO2 and Volatile Organic Compounds (VOC). The research attributed the calmness to the dry season when the data was collected. Poor planning and management of pollutant sources in most cities of developing countries leads to problems that impair human and animal health and ultimately result in economic, environmental and biological losses (Sharholy *et al*, 2008).

The focus of this research work is Sokoto city which is the capital of Sokoto State as well as a regional centre in the North West geo - political zone. The problem of urban air pollution is ominous as it is pervasive. Sokoto urban area is being characterized by the emission of gases, emanating from commercial and vehicular exhaust. The nuisance of harmful air affects both human health and environment. Itchy discomfort emanating pollutants concentration in some localities decreases the economic and social values in the locality. The study assesses pollutant concentration in Sokoto Metropolis, Nigeria, within the wet and dry seasons. Few air pollutants studies were conducted in Sokoto urban area. This study is crucial due to unavailability of air pollution monitoring stations and no emissions inventory in the study area. In addition independent and research-based measurement data are not readily available.

Objectives

This research work intend to achieve the following objectives:

(a) To determine concentration for the four selected criteria pollutants in the study area

(b) To determine if there are any pollutants above WHO and NASREA regulatory limits.

MATERIALS AND METHODS

1.1 Study Area

Sokoto Metropolis is located between latitudes $13^0 1^1 0^{11}$N to $13^0 5^1 0^{11}$N and longitudes $5^0 13^1 0^{11}$E to $5^0 17^1 0^{11}$E. It covers 16km radius from Shehu Kangiwa Square and is bounded by Kware Local Government to the North, Wamakko to the West, and Bodinga to the south, situated in the Sudan savanna (Olayinka, 2003). Sokoto Metropolis constitutes the whole of Sokoto North and Sokoto South Local Government Areas and parts of Dange/Shuni and Wamakko local government areas respectively. The area experiences two distinct seasons: the dry season (October–April) and wet season (May–September) (SOSG, 2011).

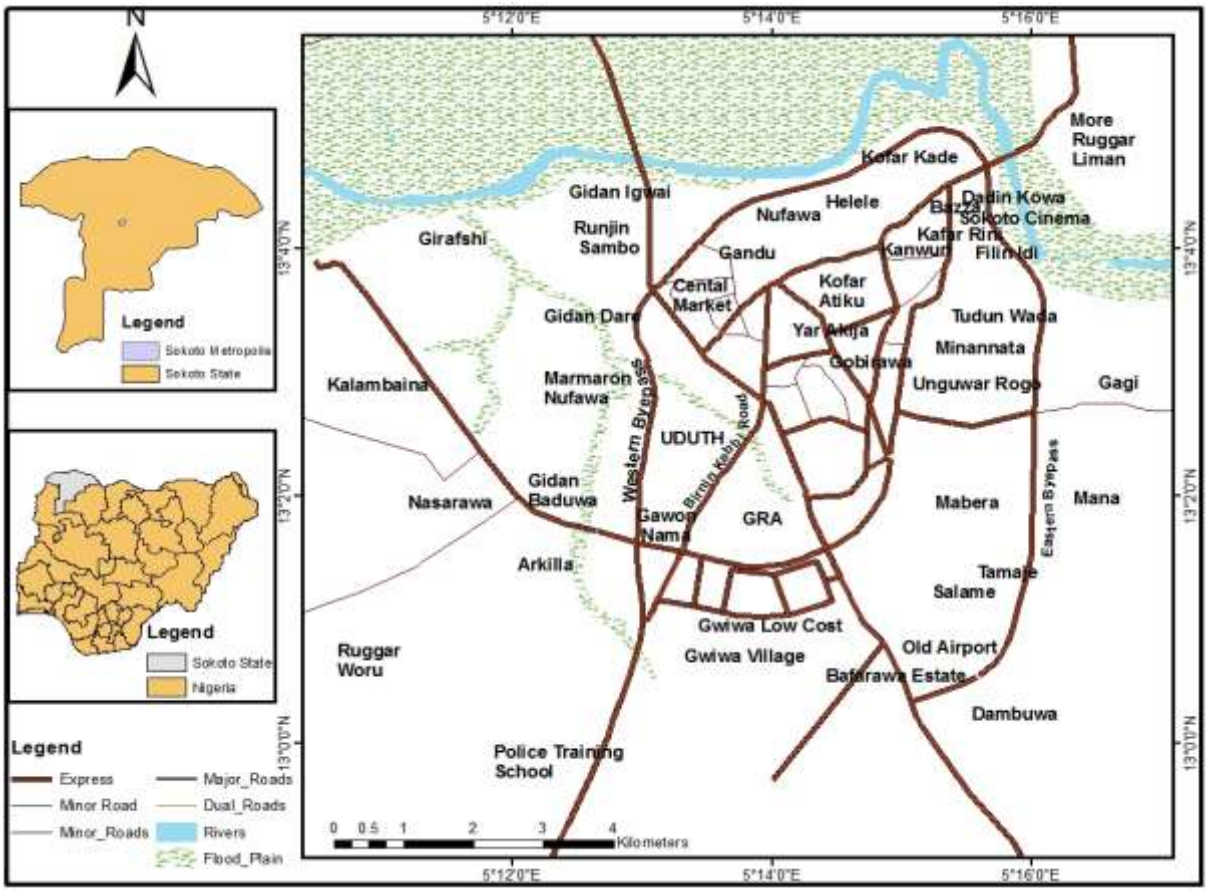

Plate 1: Map of Sokoto Metropolitan area
Source: GIS Lab. Department of Geography UDUS, 2020.

Data collection and analyses

Sokoto metropolis was divided into twenty seven township wards under the jurisdictions of five local government areas, this is further sub divided into a number of smaller local areas by Sokoto State Primary Health Care Development Agency (SSPHCDA), and this was used to identify sampling points within the city. Five sampling points were selected purposively from commercial areas and another five points from residential areas. The commercial areas included Gidan Man Ada, CBN Bridge, Old Market, Illela Garage and FGC Roundabout while the residential areas are Giginya Barracks, Unguwar Rogo, Kofar Taramniya, Dandima and Arkilla Housing. The primary data was collected using Bosean BH-4S Portable multi gas detector air sampler for detection of the gasses (SO_2, NO_2 and CO), and an air quality meter for the Particulate matter (PM_{10}), and a hand held GPS (Global Positioning System Garmin GPS map 78s receiver) was used to obtain the coordinates of the sample locations. The data collection was carried out in four months, two months for each season (dry season and wet season) in two different periods of the day (morning 7:30am to 9:00am and evening 4:00 5:30pm). SPSS software was used to find the mean, average and variation of the pollutant gasses. Tables were used to show the average and mean concentration and variation between periods of recorded emission levels and comparison with NESREA/WHO safe limits.

RESULT AND DISCUSSION

This section discusses the result of the study which was divided into two parts based on seasonality.

Dry Season Pollutants Concentration in the Study Area

The average concentration of Nitrogen Dioxide (NO_2) recorded on Monday was 0.4ppm at FGC, Sokoto and Illela Garage 0.4ppm, but low 0.07ppm at Arkiilla Housing, while on Wednesday the emission concentration was 0.23ppm at Unguwar Rogo and 0.04ppm at Arkilla housing, 0.17-0.17ppm was recorded at FGC roundabout and Kofar Taramniya respectively and lower reading (0.05ppm) was obtained at CBN Bridge on Saturday. However, the mean concentration shows that old

market has the highest 0.18ppm emission concentration across the sampling points and Arkilla housing recorded the lowest 0.05ppm emission concentration (Table 1). The mean concentration of NO_2 across the sampling points ranged between 0.05- 0.18ppm, this was found to be lower than the daytime average of 5.07 - 32.5ppm recorded at Sabon Gari in Kano, Nigeria (Okunola, Uzairu, Gimba & Ndukwe, 2012)**.**

The Sulphur Dioxide (SO_2) concentration recorded on Monday ranged between 0.00ppm - 0.07ppm across the sampling points, with 60% of the sites recording zero emission level which is also similar Wednesday readings (0.00ppm - 0.02ppm). However, the emission level was different on Saturday where majority of the sampling points recorded almost uniform values 0.01ppm-0.03ppm of emission concentration. Old market area recorded the highest level of emission on Monday with 0.07ppm while CBN Bridge recorded the lowest emission level of 0.02ppm.Wednesday revealed that Dandima roundabout, CBN Bridge and Gidan-man Ada recorded the highest level of emission of 0.02ppm, 0.02ppm and 0.02ppm respectively, but all were within safe limits. The zero emission level (0.00ppm) were obtained on Saturday around Arkilla housing and Illela garage area this is also similar on Monday and Wednesday. Giginya barracks and FGC roundabout had low emission level of 0.00ppm-0.00ppm compared to CBN Bridge and Gidan man Ada with high concentration of 0-03ppm-0.03ppm which is above safe limits (WHO, 2005; NESREA, 2014). The mean concentration shows Gidan man Ada with 0.03ppm emission above safe limits while Unguwar Rogo, Kofar Taramniya and Arkilla housing had 0.01ppm, 0.01ppm and 0.01ppm mean concentration across the sampling points (Table 1). The mean concentration of SO_2 recorded across the sampling points range between 0.01- 0.03ppm, was found to be lower than ranges of 3.21 - 5.18ppm and 7.4 - 15.5ppm, although higher than 0.270 - 0.051µm/^{3} the daily average reported for Sokoto Metropolis (Tsafe *et al*, 2010).

Regarding mean Carbon Monoxide (CO) emission concentration on Monday, Wednesday and Saturday it revealed 29ppm, 43.05ppm and 27.55ppm with the mean of 34.38ppm concentration across all the sampling points. FGC roundabout recorded 3ppm emission concentration on Monday while Giginya barracks records 4.1ppm level emission on Wednesday and Saturday with also low mean concentration across the sites 5.38ppm and 6.42ppm (Table 1). The old market area has the highest concentration of 43.05ppm on Wednesday, this was associated to the high vehicular and traffic congestion within the area throughout the daytime due to high transport and commercial activities. The result is similar to a study conducted around Kano central business district in North-Western Nigeria (Oji and Adamu, 2020). This is coupled with poorly serviced vehicles used for transportation and fuel inefficient cars that exacerbate the concentration of the CO in the area. The mean concentration of CO in the study area range between 4.62 and 34.38ppm, this was found to be higher compared to 1.58 – 8.50ppm obtained in the dry season. This is in tandem with a study conducted in Abeokuta metropolis on average atmospheric concentration of urban air pollutants (Olayinka, Adedeji, and Ajibola, 2015).

The average concentration of Particulate Matter (PM_{10}) recorded on Monday was high 76.2µm/m^3 at Gidan man Ada whereas old market recorded 92.67µm/m^3 which was hihg concentration level on Wednesday. Dandima roundabout has the highest 85.98µm/m^3 concentration on Saturday. The mean concentration shows that Old market area recorded (979.58µm/m^3) the highest emission concentration across the sampling points while the lowest emission concentration of 22.19µm/m^3 was recorded at Giginya barracks on Monday and Wednesday (29.22µm/m^3). The mean concentration shows Giginya barracks with the lowest 31.43µm/m^3 concentration level across the sampling points while the highest concentration level of 92.67µm/m^3 was recorded at Old market area on Wednesday. This was attributed to higher traffic congestion of trucks and trailers conveying goods, motorcycles, tricycles and generators. The mean concentration for PM_{10} recorded across the sampling points range between 31.43 and 79.58µm/m^3. This was found to be lower than daytime weighted average concentration level of 451.96µm/m^3 recorded for Zaria, Nigeria (Aliyu & Botai, 2018).

Table 1: Mean Criteria Pollutants Concentration in Dry Season

Sample point	Monday	Wednesday	Saturday	Mean	SD	%CV
Mean concentration of Nitrogen dioxide NO_2 emission						
Giginya Barracks	0.26	0.17	0.1	0.13	0.17	128
FGC Roundabout	0.4	0.15	0.17	0.17	0.22	130.3
Unguwar Rogo	0.13	0.23	0.15	0.15	0.24	162.09
Kofar Taramniya	0.18	0.07	0.17	0.11	0.16	154.32
Illela Garage	0.4	0.13	0.08	0.14	0.20	149.26
Old Market	0.39	0.22	0.14	0.18	0.23	125.77
Dandima	0.13	0.08	0.12	0.09	0.13	147.66
CBN Bridge	0.1	0.09	0.05	0.06	0.10	149.99
Arkilla Housing	0.07	0.04	0.08	0.05	0.09	171.61
Gidan Man Ada	0.3	0.07	0.13	0.12	0.17	144.78
Mean concentration of sulphur dioxide SO_2 emission						
Giginya Barracks	0.0	0.00	0.01	0	0.01	424.26
FGC Roundabout	0..0	0.00	0.01	0	0.01	424.26
Unguwar Rogo	0.0	0.00	0.02	0.01	0.02	424.26
Kofar Taramniya	0.0	0.00	0.02	0.01	0.02	424.26
Illela Garage	0.00	0.00	0.0	0.09	0.00	0.00
Old Market	0.07	0.00	0.02	0.02	0.04	230.09
Dandima R/About	0.03	0.02	0.02	0.02	0.03	174.15
CBN Bridge	0.02	0.02	0.03	0.02	0.03	174.15
Arkilla Housing	0	0.01	0.02	0.01	0.03	301.1
Gidan Man Ada	0.06	0.02	0.03	0.03	0.04	147.22
Mean concentration of carbon monoxide CO emission						
Giginya Barracks	4.1	4.32	4.1	4.62	2.57	55.69
FGC Roundabout	3	5.38	6.42	5.87	3.13	53.26
Unguwar Rogo	4.1	11.72	6.87	8.17	7.11	86.95
Kofar Taramniya	3.77	7.27	7.77	7.38	4.07	55.18
Illela Garage	3.33	8.15	4.88	6.08	3.79	62.37
Old Market	29	43.05	27.55	34.38	21.2	61.67
Dandima Area	9.67	14.98	17.97	14.78	11.63	78.68
CBN Bridge	12.2	10.93	10.98	10.61	6.26	58.96
Arkilla Housing	4.63	5.32	5.05	5.19	5.32	102.5
Gidan Man Ada	13.43	10.93	11.1	10.95	8.08	73.76
Mean concentration of PM10 emission						
Giginya Barracks	22.1	29.22	43.27	31.43	21.9	69.67
FGC Roundabout	42.33	43.15	40.43	40.47	19.92	49.22
Unguwar Rogo	50.43	54.75	54.6	51.71	26.59	51.42
Kofar Taramniya	29	54.77	53.15	47.43	21.51	45.35
Illela Garage	57.87	54.77	37.65	48.15	36.81	76.44
Old Market	66.43	92.67	72.32	79.58	38.01	47.76
Dandima area	63.77	73.17	85.98	77.47	32.36	41.76
CBN Bridge	34.33	52.7	60.42	48.48	51.50	106.23
Arkilla Housing	45.43	37.32	50.72	41.75	33.59	80.45
Gidan Man Ada	76.2	64.77	65.55	63.14	42.17	66.79

Source: Authors field survey, 2021.

Wet Season Criteria Pollutants Emission Concentration

During the wet season no emission of NO_2 were recorded due to the dilution effect of rainfall that dilute and washed away some of criteria pollutants in the study area. The measurement period coincided with the Month of September, during the peak wet season. As a result no data were obtained for emission of NO_2 throughout the study locations. It was also observed that metrological parameters has an influence on the seasonal variability, concentration and environmental fate of pollutants (Oji and Adamu, 2020). This is because lower pollutants concentration were observed during the high-intensity fall of precipitation during wet season compared to the levels recorded for dry season. The concentration of Sulphur Dioxide (SO_2) on Monday and Wednesday recorded 0.00ppm emission level across the sampling points, but was low on Saturday 0.03ppm with 90% of the sites recording zero emission level. Gidan man Ada recorded 0.03ppm the only emission concentration on Saturday which was high above safe limits of WHO (2006). The emission concentration at Gidan man Ada is due to high traffic in the evening periods which can be attributed to the fact that most wedding events taking place on Saturday, (Table 6). The mean concentration of SO_2 across the sampling points range between 0.00- 0.01ppm in the study is found to be lower than ranges of 3.21- 5.18ppm, and 7.4- 15.5ppm, daytime average reported by Ayodele and Abubakar (2010).

Old market recorded high level concentration of Carbon Monoxide (CO) on Monday 36.1ppm, Wednesday 50.1ppm and Saturday 38.777ppm, with also high mean concentration across the sampling points 41.66ppm. While Giginya barracks recorded the lowest level of concentration on Monday with 6.77ppm, Wednesday 6.3ppm and Saturday 6.1ppm, with also low mean concentration of 6.39ppm across the sites (Table 2). The highest emission concentration of 50.1ppm level recorded at old market (commercial area) is attributed to high vehicular and traffic congestion as traders/customers trip to the market from far distance to trade their goods and services. In addition, the need to close and return home may also be a cause to high vehicular and tricycle movement. This phenomenon coupled with poorly serviced vehicles used for good and service conveyances, as well as fuel inefficient cars exacerbate the concentration of the CO at the site. The mean concentration of CO range between 6.39- 41.66ppm across the sampling points was higher than the range of daily average of 1.22 – 25.75ppm for wet season in Abeokuta Metropolis (Olayinka, Adedeji, & Ajibola 2015).

Dandima roundabout recorded high concentration level of Particulate Matter (PM_{10}) on Monday 82.77µm/m^3, Wednesday 65.67µm/m^3 and Saturday 96.53µm/m^3, with also higher mean concentration of 81.66µm/m^3 across the sampling points. Low emission concentration were recorded at Giginya barracks on Monday 21.53µm/m^3 and Wednesday 24.1µm/m^3, while Illela garage records low concentration on Saturday 37.2µm/m^3. The mean concentration indicate Giginya barracks with low level of emission concentration of 34.17µm/m^3 across the sites (Table 2). The mean concentration of PM_{10} recorded across the sites range between 34.17- 81.66µm/m^3 was found to be lower than 170 - 260µm/m^3 (Abam & Unachukwu 2010).

Table 2: Mean criteria pollutants concentration in wet season

Sample Location	Mon	Wed	Sat	Mean	SD	%CV
Mean concentration of NO_2 emission						
Giginya Barracks	0.00	0.00	0.00	0.00	0.00	0.00
FGC Roundabout	0.00	0.00	0.00	0.00	0.00	0.00
Unguwar Rogo	0.00	0.00	0.00	0.00	0.00	0.00
Kofar Taramniya	0.00	0.00	0.00	0.00	0.00	0.00
Illela Garage	0.00	0.00	0.00	0.00	0.00	0.00
Old Market	0.00	0.00	0.00	0.00	0.00	0.00
Dandima Area	0.00	0.00	0.00	0.00	0.00	0.00
CBN Bridge	0.00	0.00	0.00	0.00	0.00	0.00
Arkilla Housing	0.00	0.00	0.00	0.00	0.00	0.00
Gidan Man Ada	0.00	0.00	0.00	0.00	0.00	0.00
Mean concentration of SO_2 emission						
Sample Location	Mon	Wed	Sat	Mean	SD	%CV
Giginya Barracks	0.00	0.00	0.00	0.00	0.00	0.00
FGC Roundabout	0.00	0.00	0.00	0.00	0.00	0.00
Unguwar Rogo	0.00	0.00	0.00	0.00	0.00	0.00
Kofar Taramniya	0.00	0.00	0.00	0.00	0.00	0.00
Illela Garage	0.00	0.00	0.00	0.00	0.00	0.00
Old Market	0.00	0.00	0.00	0.00	0.00	0.00
Dandima Area	0.00	0.00	0.00	0.00	0.00	0.00
CBN Bridge	0.00	0.00	0.00	0.00	0.00	0.00
Arkilla Housing	0.00	0.00	0.00	0.00	0.00	0.00
Gidan Man Ada	0.00	0.00	0.03	0.01	0.03	300.
Mean concentration of the study Co emission						
Giginya Barracks	6.77	6.3	6.1	6.39	2.27	35.55
FGC Roundabout	8.63	7.77	9.2	8.53	1.66	19.42
Unguwar Rogo	7.77	18.43	8.97	11.72	8.37	71.41
Kofar Taramniya	10.43	9.67	10.2	10.1	3.46	34.22
Illela Garage	7.1	6.1	7.77	6.99	1.08	15.4
Old Market	36.1	50.1	38.77	41.66	15.74	37.79
Dandima Area	13.1	14.87	25.63	17.87	13.47	75.37
CBN Bridge	7.63	12.2	14.53	11.46	5.17	45.1
Arkilla Housing	5.77	8.1	10.1	7.99	6.03	75.5
Gidan Man Ada	8.2	11.1	14.43	11.24	5.96	52.97
Mean concentration of PM10 emission						
Giginya Barracks	21.53	24.1	56.87	34.17	26.3	76.97
FGC Roundabout	33.33	45.1	41	39.81	23.02	57.82
Unguwar Rogo	41.1	45.97	53.67	46.91	22.39	47.73
Kofar Taramniya	39.77	46.1	50.77	45.54	20.7	45.44
Illela Garage	46.2	28.1	37.2	37.17	23.5	63.22
Old Market	81.1	74	89.43	81.51	30.34	37.23
Dandima Area	82.77	65.67	96.53	81.66	38.12	46.68
CBN Bridge	30.33	28.87	86.97	48.72	61.75	126.73
Arkilla Housing	29.0	34.53	69.77	44.43	46.53	104.72
Gidan Man Ada	42.0	60.77	97.43	66.73	46.57	69.78

Source: Authors field survey, 2021.

Study Comparison with NESREA and WHO Standards Values

The NESREA air quality standard for SO_2, NO_2, CO and PM_{10} are stated 0.12ppm, 0.12ppm, 0.05ppm, 0.25ppm and 0.15ppm respectively while the WHO air quality guideline for the above parameters are: 0.02ppm, 0.04ppm, 9ppm, 0.025ppm and 0.05ppm respectively. The mean value of NO_2 for the period of study ranged from 0.00 - 0.8ppm with the highest value recorded at high traffic areas while the lowest values were recorded at residential areas. The emission concentration level for NO_2 is below the recommended standard set by NESREA (2014), and above the WHO (2006) standard which were 0.12ppm and 0.04ppm (Table 3). The average value of SO_2 for the period of

study ranges from 0.00 - 0.10ppm with the highest value recorded at high traffic areas while the lowest values were recorded at Residential areas. Petroleum contain Sulphur compound and the combustions generate sulphur dioxide (SO_2). The high level of SO_2 in the traffic areas can be attributed to vehicular emissions in the study area. Comparing the values with the WHO and NEASREA standard level of 0.02ppm and 0.12ppm respectively, it was found to be above the limit of WHO (Table 3).

The average value of CO for the period under study ranges from 0.00- 81.00ppm with the highest value recorded at old market while the lowest value was recorded at Arkilla housing area, while old market have the highest level of CO. This might be due to the high vehicular emission during the day, with relatively low wind speed and high traffic congestion. (Okunola *et al*., 2012). The values have exceeded limits set by WHO and NESREA standards (Table 3). The average value of PM_{10} recorded for the period of study range from 12.00- 210.60µm/m^3 with the highest value recorded at old market and Dandima roundabout while the lowest value recorded at Giginya Barracks. The highest value recorded at old market and Dandima can be attributed to higher traffic congestion, commercial activities and refuse dump at old market, and the movements of trucks carrying sand, laterite and also the burning of refuse dumps around the Dandima Roundabout. The values of PM_{10} obtained from the study were found to be lower than 170 - 260µm/m^3 and above the WHO and NESREA 50µm/m^3 permissible limit (Table 3).

Table 3: Criteria Air Pollutants Concentrations and Recommended Standards

			Standards	
Parameters	Range	Mean±SD	NESREA	WHO
PM_{10} (µg/m^3)	12.00 - 210.6	52.96±36.22	150µm/m^3	50µm/m^3
NO_2 (ppm)	0.00 - 0.80	0.12±0.18	0.12ppm	0.04ppm
SO_2 (ppm)	0.00 - 0.10	0.01±0.03	0.12ppm	0.02ppm
CO (ppm)	0.00 - 81.0	10.80±12.19	0.05ppm	9.00ppm

NO_2 – Nitrogen (IV) oxide; SO_2 – Sulphur (IV) oxide; CO– carbon (II) oxide; PM – particulate - matter; NESREA - WHO SD – Standard Deviation. Recommended standards are source from NESREA (2014) and WHO (2006).

CONCLUSION

This study has shown that many areas in Sokoto metropolis were characterized with high concentration of air pollutants gases and particulate matter emission above health and safety limits sets by regulatory bodies (NASREA and WHO). This pose a serious threat to the resident population as well as those who engage various activities in the most vulnerable parts of the Metropolis. This is significant particularly for the vulnerable groups such as children and the aged population. This calls for certain safety measures, to protect the increasing population in the study area especially the vulnerable group against the adverse effect of these pollutants. Based on the findings of this study, there is the urgent need for the authorities to strengthen and enforce the existing environmental regulations in Sokoto metropolis for $PM_{10,}$ SO_2 and CO that were found above safe limits. The State Government through its agencies; Ministry for environment, Sokoto Urban and Regional Planning Board (SURPB) and State environmental protection agency (SEPA), must protect the existing urban green spaces as well as creating additional ones. Tree planting should be encouraged to serve carbon sink and dust basins and Trucks conveying dusty products such as laterite, sand and municipal wastes should be well covered.

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