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Determining the Concentration Level of Air Pollutants Related to Road Traffic in Kano Metropolis

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ABSTRACT
The problem of road traffic-related air pollutants is universal. Traffic air pollution usually occurs on roads and mainly at intersections which significantly affects the air quality of such areas. The research aims to provide empirical evidence on the relationship between road transport air pollutants and temperature conditions on climate modification in the study area, which might perfect environmental sustainability. The study was best designed on field Experimentation to assess the spatiotemporal emission levels and analyses the implications of road Vehicular traffic-related air pollutants Concentration (such as, Carbon monoxide, Nitrogen dioxide, Sulphur dioxide, Hydrogen Sulphide and Methane gas) on Kano weather conditions (precisely Temperature) in 15 selected sample sites or locations, the measurements of pollutants Concentration, temperature level were carried out using the instruments called a Crowcorn gas detector, field thermometer were used together with the help of 5 research assistants. presents the periodic concentration levels of CH4 (methane) in relation to road traffic in different time periods: afternoon, evening, and morning, categorized into three concentration levels: high, medium, and low. The table provides various statistical measures to describe the distribution of methane concentrations within each category. High Concentrations in the afternoon reveal an average mean methane concentration is 0.20. The coefficient of variability, which measures the dispersion of the data points around the mean, is 46.06%. The skewness of 1.19 implies a moderately positively skewed distribution. The kurtosis of 1.38 indicates a distribution with a peak slightly higher than a normal distribution and a moderate presence of outliers. These findings could inform air quality management and monitoring efforts in Kano Metropolis. If temperature is consistently correlated with higher CO and CH4 levels, authorities may need to consider seasonal variations and temperature-related interventions when addressing air quality issues.

Keywords: pollutants; air; noise; traffic; concentration

INTRODUCTION
Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, as well as damages to the natural and built environment (Abam et. al., 2009). The atmosphere is a complex dynamic natural gaseous system that is essential to support life on Planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems. Thus, Air pollution is the contamination of the air by harmful substances which can cause health problems including burning eyes and nose, itchy irritated throat and breathing problems (USEPA, 2020; Dangambo, 2014). Also, the World Health Organization (WHO, 2001) defines air pollution as the disequilibrium of air due to the introduction of foreign elements to human's natural and manmade sources in the air, so that it becomes injurious to biological communities. Transportation as a necessity of contemporary life is vital in all aspects of human development. The need to move people, goods and services from one place to another opens the new horizons for local, national and international development and allow better contact and understanding between people (Koku et. al., (2007). The socio-economic development of any region depends on the easy access to people and goods ensured by modern transport technology (Faize et. al., 2011).

A multitude of air contaminants of varying toxicity comes from road transport. These contaminants originate from the tailpipes of vehicles with internal combustion engines, from other vehicle components (such as brake and clutch linings and pads, tires and fuel tanks), and from road-surface wear and treatment materials. Road traffic can be labeled the most important source of some pollutants of great concern, such as nitrogen oxides, benzene and carbon monoxide. Until recently, petrol was an important contributor to exposing the population to environmental and health dangers and how such variables as fuel quality and additives, engine and after treatment technologies and transport patterns affect the environment (Faize et. al., 2011).

It is against this background and based on accumulated evidence that this study sorts to identify the key facts emerging from the available evidence, on the effects of road vehicular traffic related air pollution on the environments in order to suggest actions necessary to reduce the climatic and health risks created by road traffic. Basically, air pollution can result from both natural and man-made (anthropogenic) sources.

NESREA, (2007) reported that some chemicals found in polluted air could cause cancer, birth defects, brain and nerve damage, acid rain, eutrophication, and long-term injury to the lungs and breathing passages in certain circumstances (Avol et. al., (2001). The concentrations of such chemicals beyond a limit, and an exposure over a certain period are extremely dangerous and can cause severe injury, environmental damages or even death. In support of this, it was stated that transportation accounts for an important fraction of greenhouse gases (especially carbon monoxide) emission (Cline, 2000; Ibrahim, et. al., 2017; Ibrahim and Abdullahi, 2019).

Micro-climate is characterized as any area where the climate differs from the surrounding area, which occurs naturally and can be quite small or quite large. For instance, a city creates its own climatic patterns, and the larger the urban area, the more significant these will be (Ibrahim, 2020a; Ibrahim, 2020b).

Urban microclimate plays an important role in building energy consumption and thermal comfort in outdoor spaces. Nowadays, cities need to increase energy efficiency, reduce pollutant emissions and mitigate the evident lack of sustainability. In light of this, attention has focused on the bioclimatic concepts use in the urban development (Ibrahim and Abdullahi, 2016; USEPA, 2012; Ibrahim, et. al., 2022a).

However, the speculative unsustainability of the growth model highlights the need to redirect the construction sector towards urban renovation using a bioclimatic approach. The public space plays a key role in improving the quality of today's cities, especially in terms of providing places for citizens to meet and socialize in adequate thermal conditions (Fung et. al., 2012; Ibrahim, et. al., 2022b). Thermal comfort affects perception of the environment, so microclimate conditions can be decisive for the success or failure of outdoor urban spaces and the activities held in them. The knowledge on perceptions of microclimate in outdoor space can serve as a basis for urban spatial design (Ibrahim, 2019; Ibrahim and Abdulkadir, 2019; USEPA, 2020; Ibrahim and Adamu, 2020).

STUDY AREA

The study was conducted in Kano Metropolis which is shown in Figure below: Most of the locations on the map were selected owing to the fact that they host/represent some major roads supporting heavy transport users, The Kano metropolitan city has the advantage of being in the center of commerce where most commercial activities take place. According to the 2006 census figures from Nigeria, Kano State had a population totaling 9,383,682 (Ibrahim, 2017; Ibrahim, et. al., 2022c). This culminates to the influx of road transport users thereby paving the way for increase in traffics that results to air pollution in the areas. Kano metropolitan is the second largest in Nigeria after Lagos. Kano is a city in Nigeria and the capital of Kano State in Northern Nigeria, in the Sahelian geographic region south of the Sahara. Its metropolitan population makes it the second largest city in Nigeria. The Kano urban area covers 137 km2 and comprises six local government areas (LGAs) of Kano Municipal, Fagge, Dala, Gwale, Tarauni and Nassarawa. The metropolitan area covers 499 km2 and comprises eight LGAs, the six mentioned above plus Ungogo and Kumbotso.

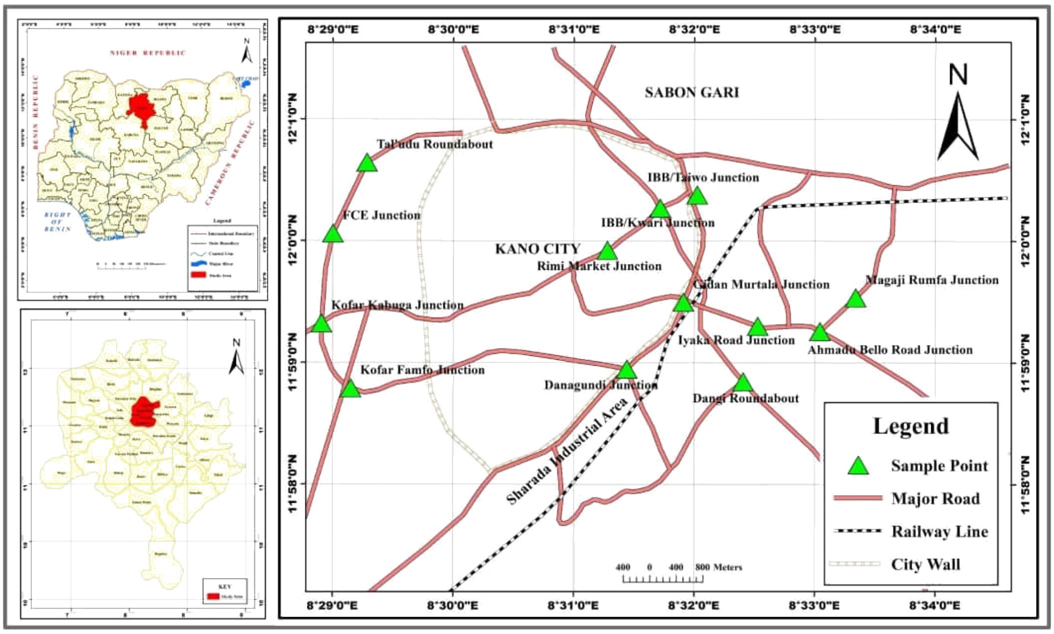

FIGURE 1: Map of Nigeria, Kano State and Kano Metropolis.
Source: Ibrahim, et. al., (2022).

Kano city, the state capital, is a manufacturing centre producing processed foods, textiles, furniture, cement, rolled steel and light trucks. Most of the state's inhabitants are Hausa or Fulani, but there are also other Nigerians from other parts of the country, Arab traders, and Europeans. Kano city, Rano, and Wudil are its chief market centres (Ibrahim and Falola, 2021).

Materials and Methods

The Research Design that is best for field Experimentation to assess the spatio-temporal emission levels and analyses the implications of road Vehicular traffic related air pollutants Concentration (such as, Carbon monoxide, Nitrogen dioxide, Sulphur dioxide, Hydrogen Sulphide and Methane gas) on Kano weather conditions (precisely Temperature) in 15 selected sample sites or locations, the measurements of pollutants Concentration, temperature level was carried out using the instruments called a Crowcorn gas detector, field thermometer was used together with the help of five (5) research assistance. Owing the fact that, most of these selected locations were having high Vehicular traffic flow leading to such kind of emissions of the pollutants and implications on the temperature of the study area.

The total or mean emission levels of gases, and temperature records for each day was calculated and presented in a table using the Gaussian dispersion model of the following modified formula below;

$$TE_{Li} = \frac{ME_L = EL_S\,(M + A + E)}{3}\ i \ldots\ldots(1)$$

Where;

TE_{Li}	=	Total Emission Levels...i
ELsi	=	Emission Levels...i
ME_{Li}	=	Mean Emission Level...i
M	=	Morning
A	=	Afternoon
E	=	Evening
i	=	Temperature condition

Source: Model adopted and modified by the author, 2023

The concentration levels of the gaseous emissions and temperature in the selected land uses were recorded at the sampling locations, which was compared using the ANOVA (analysis of variance) to test for significant relationship or difference between the pollutants and temperature on air quality of the study area. The test was carried out at 0.05 level of significance. Analysis of variance (ANOVA) was used to test for variation in the concentration of pollutants and temperature at various land uses in the four seasons.

RESULTS AND DISCUSSIONS

Concentration Levels of Air Pollutants

Air quality is a vital aspect of urban planning, public health, and environmental management. With increasing road traffic, pollutants like carbon monoxide (CO), Sulfur dioxide (SO2), nitrogen dioxide (NO2), and others are emitted, affecting the air we breathe.

By utilizing statistical metrics, we can gain insights into the nature of pollutant concentrations. The average mean concentration provides a central tendency of pollutant levels. It helps us understand the typical concentration levels during specific time periods. In Kano Metropolis, this metric would allow us to grasp the baseline air quality situation under the influence of road traffic. The coefficient of variability indicates the extent of variability around the mean concentration. In the context of air pollutants related to road traffic, a low CV implies relatively stable pollutant levels, while a high CV suggests fluctuating concentrations. This metric offers insights into the consistency of pollutant emissions over time. Skewness measures the asymmetry of the distribution of pollutant concentrations. A positive skewness indicates that higher concentrations are less common but more extreme when they occur, while negative skewness suggests the opposite. In Kano Metropolis, skewness values would help us understand whether pollutant concentrations tend to be skewed towards higher or lower levels during specific time periods. Kurtosis characterizes the shape of the distribution. A distribution with high kurtosis has more extreme values in the tails, either higher or lower than the mean, compared to a normal distribution. A distribution with low kurtosis has thinner tails. Analyzing kurtosis helps us comprehend the presence of outliers or extreme values in the pollutant concentration data.

Periodic Concentration of Air Pollutant Related to Road Traffic

Table 1 presents a comprehensive overview of the periodic concentration levels of carbon monoxide (CO) in relation to road traffic, categorized by different times of the day and under varying concentration levels (high, medium, and low). The table provides statistical measures that help us understand the characteristics of these concentration levels.

TABLE 1: Periodic Concentration of CO (PPM).

Variable	TIME	Mean	SE Mean	STD	CV	Minimum	Maximum	Skewness	Kurtosis
HIGH	Afternoon	17.591	0.434	1.942	11.04	13.21	22.12	0.08	1.33
	Evening	13.217	0.511	2.286	17.3	7.3	17.87	-0.11	2.22
	Morning	21.614	0.477	2.132	9.86	18	26.05	0.58	0.49
MEDIUM	Afternoon	16.801	0.476	2.13	12.68	11.47	19.33	-0.58	0.24
	Evening	11.838	0.334	1.495	12.62	6.303	14.217	-2.82	10.71
	Morning	20.054	0.423	1.893	9.44	14.217	22.903	-1.52	4.22
LOW	Afternoon	17.819	0.442	1.978	11.1	13.16	23.91	0.95	5.36
	Evening	13.06	0.649	2.901	22.21	7.69	19.03	0.33	-0.15
	Morning	21.814	0.826	3.695	16.94	16.183	29.533	0.4	0.53

Note: CV-Coefficient of Variation, STD- Standard Deviation.
Source: Author's Compilation (2023).

High Concentration in the afternoon reveal average Mean Value of 17.591, Coefficient of Variability of 11.04, Skewness 0.08 and Kurtosis: 1.33. Medium Concentration has an average Mean Value of 16.8 Coefficient of Variability 12.68, Skewness -0.58, Kurtosis 0.24 while the low concentration is with average Mean Value of 17.819, Coefficient of Variability 11.1, Skewness 0.95, Kurtosis 5.36 Evening Period show a High Concentration with an average Mean Value of 13.217, Coefficient of Variability 17.3, Skewness -0.11 and Kurtosis 2.22. Medium Concentration has average Mean Value of 11.8, Coefficient of Variability 12.62, Skewness -2.82 and Kurtosis 10.71 while the low concentration presents an average mean value of 13.06, Coefficient of Variability 22.21, Skewness 0.33 and Kurtosis -0.15 Morning Period is presented with average mean value of 21.614, Coefficient of Variability 9.86, Skewness 0.59 and Kurtosis 0.49 under high concentration.

Medium Concentration show average mean value of 20.054, Coefficient of Variability 9.44, Skewness -1.52 and Kurtosis 4.22. Low Concentration has an Average Mean Value of 21.814, Coefficient of Variability 16.94, Skewness 0.4 and Kurtosis 0.53.

This indicates the average mean i.e., central tendency of the CO concentration levels reveals that, the values seem to be higher in the morning and lower in the evening and afternoon for each concentration level. Coefficient of Variability express the measures of the variability of the data. A higher coefficient suggests greater variability. The highest variability is observed in the evening hours under medium concentration, which indicates fluctuating CO levels. Skewness measures the asymmetry of the data distribution. Positive skewness indicates a longer tail on the right side of the distribution, while negative skewness indicates a longer tail on the left.

Most of the skewness values are close to zero, suggesting relatively symmetric distributions. Kurtosis measures the tails' thickness of the distribution compared to a normal distribution. Higher kurtosis values indicate heavier tails. Some values, particularly in the evening and morning periods under medium concentration, deviate significantly from a normal distribution.

Table 2 provides insight into the variability, symmetry, and shape of the CO concentration distributions across different times of the day and concentration levels. These statistics can be crucial for understanding the patterns and characteristics of CO levels in relation to road traffic and for making informed decisions about air quality management and traffic control.

TABLE 2: Periodic Concentration of CH_4 (PPM).

Variable	TIME	Mean	SE Mean	STD	CV	Minimum	Maximum	Skewness	Kurtosis
HIGH	Afternoon	0.20	0.02	0.09	46.06	0.11	0.44	1.34	1.05
	Evening	0.08	0.01	0.05	69.67	0.01	0.19	0.62	-0.87
	Morning	0.25	0.01	0.04	17.78	0.20	0.35	1.19	1.38
MEDIUM	Afternoon	0.17	0.02	0.11	60.68	0.06	0.36	0.77	-0.73
	Evening	0.07	0.01	0.06	74.95	0.01	0.19	0.67	0.29
	Morning	0.23	0.02	0.07	31.80	0.11	0.40	1.41	1.93
LOW	Afternoon	0.16	0.03	0.12	74.31	0.03	0.54	1.78	3.82
	Evening	0.08	0.01	0.06	72.91	0.00	0.20	0.90	0.28
	Morning	0.23	0.01	0.06	26.35	0.02	0.29	-2.39	7.90

Note: CV-Coefficient of Variation, STD- Standard Deviation.
Source: Author's Compilation (2023).

Table 2 presents the periodic concentration levels of CH4 (methane) in relation to road traffic in different time periods: afternoon, evening, and morning, categorized into three concentration levels: high, medium, and low. The table provides various statistical measures to describe the distribution of methane concentrations within each category. High Concentration in the afternoon reveal, an average mean methane concentration is 0.20. The coefficient of variability, which measures the dispersion of the data points around the mean, is 46.06%. This suggests that the data points have a moderate level of spread. The skewness of 1.34 indicates that the distribution of methane concentrations is positively skewed, meaning there is a longer tail on the right side of the distribution. The kurtosis of 1.05 indicates a distribution that is slightly more peaked than a normal distribution but with fewer extreme outliers. The evening, the average mean methane concentration is 0.08. The coefficient of variability is 69.67%, which suggests a higher degree of variability compared to the afternoon readings. The skewness of 0.62 indicates a less pronounced positive skewness compared to the afternoon readings. The negative kurtosis of -0.87 suggests a distribution that is less peaked than a normal distribution and has a wider spread of data points. In the morning, the average mean methane concentration is 0.25. The coefficient of variability is 17.78%, indicating a relatively low variability in comparison to the other time periods. The skewness of 1.19 implies a moderately positively skewed distribution. The kurtosis of 1.38 indicates a distribution with a peak slightly higher than a normal distribution and moderate presence of outliers.

Result from Medium Concentration show that in the afternoon, the average mean methane concentration is 0.17. The coefficient of variability is 60.68%, suggesting a higher variability similar to the high-concentration afternoon readings. The skewness of 0.77 indicates a distribution that is moderately positively skewed. The negative kurtosis of -0.73 suggests a distribution with a flatter peak and potentially fewer outliers. The evening, the average mean methane concentration is 0.07. The coefficient of variability is 74.95%, indicating a high degree of variability in the evening medium-concentration readings. The skewness of 0.67 suggests a distribution that is less skewed compared to the afternoon medium-concentration readings. The kurtosis of 0.29 indicates a distribution with a lower peak and a more dispersed pattern while in the morning, the average mean methane concentration is 0.23. The coefficient of variability is 31.80%, suggesting a moderate level of variability in comparison to the other medium-concentration time periods. The skewness of 1.41 indicates a moderately positively skewed distribution. The kurtosis of 1.93 suggests a distribution with a higher peak and a more pronounced presence of outliers.

Low Concentration presents that in the afternoon, the average mean methane concentration is 0.16. The coefficient of variability is 74.31%, indicating a high variability similar to the medium-concentration afternoon readings. The skewness of 1.78 suggests a moderately positively skewed distribution. The kurtosis of 3.82 indicates a distribution with a higher peak and a potentially significant number of outliers. In the evening, the average mean methane concentration is 0.08. The coefficient of variability is 72.91%, indicating a high degree of variability similar to the other low-concentration evening readings. The skewness of 0.90 suggests a distribution that is moderately positively skewed.

The kurtosis of 0.28 indicates a distribution with a lower peak and a flatter pattern while in the morning, the average mean methane concentration is 0.23. The coefficient of variability is 26.35%, indicating a relatively low variability compared to the other low-concentration time periods. The skewness of -2.39 indicates a highly negatively skewed distribution, suggesting a long tail on the left side of the distribution. The kurtosis of 7.90 indicates a distribution with a very high peak and potentially significant presence of outliers.

The provided statistics give insight into the distribution, variability, skewness, and kurtosis of methane concentrations in relation to road traffic during different times of the day and under various concentration levels. These measures help characterize the nature of the data distribution and provide information about the trends and patterns of methane levels in the given contexts.

Periodic Concentration of NO_2 (PPM)

Table 3 presents the results of a study focusing on the periodic concentration levels of methane (CH4) in relation to road traffic. The data is divided into three different concentration categories: high, medium, and low. Each concentration category is further categorized by the time of day: afternoon, evening, and morning. The table provides statistical values for each combination of concentration level and time of day, including the mean value, coefficient of variability, skewness, and kurtosis. High Concentration in the Afternoon reveal the average mean concentration of CH4 during the afternoon under high concentration is 0.17.

The coefficient of variability, which measures the spread of the data, is 26.65, indicating moderate variability. The skewness is positive at 0.58, suggesting a slightly right-skewed distribution. The kurtosis is negative at -0.60, indicating a distribution that is less heavy-tailed than a normal distribution.

Table 3: Periodic Concentration of NO_2 (PPM).

Variable	TIME	Mean	SE Mean	STD	CV	Minimum	Maximum	Skewness	Kurtosis
HIGH	Afternoon	0.17	0.01	0.05	26.65	0.11	0.26	0.58	-0.60
	Evening	0.12	0.01	0.05	39.23	0.05	0.16	-0.58	-1.32
	Morning	0.19	0.01	0.06	32.97	0.12	0.30	0.33	-1.56
MEDIUM	Afternoon	0.16	0.01	0.06	36.32	0.08	0.24	0.31	-1.36
	Evening	0.12	0.01	0.03	21.67	0.07	0.16	-0.12	-0.41
	Morning	0.23	0.04	0.19	84.18	0.08	0.68	1.77	2.11
LOW	Afternoon	0.21	0.01	0.06	26.90	0.12	0.30	0.22	-0.72
	Evening	0.15	0.02	0.10	69.90	0.01	0.33	0.56	-1.07
	Morning	0.18	0.01	0.06	35.59	0.11	0.30	0.47	-1.14

Note: CV-Coefficient of Variation, STD- Standard Deviation.
Source: Author's Compilation (2023).

The average mean concentration during the evening under high concentration is 0.12. The coefficient of variability is higher at 39.23, indicating a wider spread of data. The skewness is negative at -0.58, indicating a slightly left-skewed distribution. The kurtosis is more negative at -1.32, suggesting a distribution with thinner tails than a normal distribution. The average mean concentration during the morning under high concentration is 0.19. The coefficient of variability is 32.97, similar to the afternoon's value. The skewness is positive at 0.33, indicating a slightly right-skewed distribution. The kurtosis is even more negative at -1.56, suggesting a distribution with very thin tails. These results suggest that during periods of high CH4 concentration related to road traffic, the distribution of CH4 concentrations tends to be slightly skewed, with varying degrees of kurtosis.

Medium Concentration show that the average mean concentration of CH4 during the afternoon under medium concentration is 0.16. The coefficient of variability is 36.32, indicating a higher variability compared to the high-concentration afternoon data. The skewness is positive at 0.31, indicating a slight right-skewed distribution. The kurtosis is negative at -1.36, suggesting a distribution with thinner tails. The average mean concentration during the evening under medium concentration is 0.12, similar to the high-concentration evening data. The coefficient of variability is lower at 21.67. The skewness is negative at -0.12. The kurtosis is also negative at -0.41. The average mean concentration during the morning under medium concentration is 0.23. The coefficient of variability is much higher at 84.18, indicating a wide spread of data.

The skewness is positive at 1.77, indicating a significantly right-skewed distribution. The kurtosis is positive at 2.11, suggesting a distribution with heavy tails. In periods of medium CH4 concentration related to road traffic, the distribution characteristics vary. Afternoon and evening data tend to have relatively thinner tails, while morning data exhibit heavier tails with significant right skewness.
Low Concentration show that the average mean concentration of CH4 during the afternoon under low concentration is 0.21. The coefficient of variability is 26.90, similar to the high-concentration afternoon data. The skewness is positive at 0.22. The kurtosis is negative at -0.72. The average mean concentration during the evening under low concentration is 0.15. The coefficient of variability is 69.90, indicating high variability. The skewness is positive at 0.56. The kurtosis is more negative at -1.07. The average mean concentration during the morning under low concentration is 0.18. The coefficient of variability is 35.59. The skewness is positive at 0.47. The kurtosis is negative at -1.14. In periods of low CH4 concentration related to road traffic, the distribution characteristics are similar to those during high concentration periods, with varying skewness and kurtosis values.

Seasonal Concentration of Air Pollutant Related to Road Traffic

Seasonal concentrations of air pollutants related to road traffic can vary based on a variety of factors including weather patterns, vehicle emissions, and human activities. It's important to note that the specific seasonal patterns can vary by location, as different regions experience different weather conditions and traffic patterns.

Table 4 presents the results of a study that investigates the seasonal concentration levels of carbon monoxide (CO) in relation to road traffic. The table provides data for different seasons and their corresponding concentrations and variability coefficients. Cold/Dry Season has an average Mean Concentration of 17.066, Coefficient of Variability 20.05; Hot/Dry Season reveal an average Mean Concentration of 17.96, Coefficient of Variability 26.38; Warm/Dry Season Average Mean Concentration 17.5, Coefficient of Variability 27.7; Warm/Wet Season Average Mean Concentration 17.37, Coefficient of Variability 18.81.

These values represent the CO concentration levels and their variability in different seasons under high concentration conditions. CO concentration levels and their variability in Cold/Dry, Hot/Dry, Warm/Dry and Warm/Wet seasons, a medium concentration reveal Average Mean Concentration of 16.268, 16.694, 16.19 and 15.772 and Coefficient of Variability of 22.53, 23.15, 27.67 and 23.78 respectively. Cold/Dry, Hot/Dry, Warm/Dry and Warm/Wet seasons shows Average Mean Concentration of 16.17, 18.4, 17.81 and 17.882 and Coefficient of Variability of 25.06, 30.11, 31.5 and 16.35 under low concentration respectively.

TABLE 4: Seasonal Concentration of CO (PPM).

Variable	SEASONS	Mean	SE Mean	STD	CV	Minimum	Maximum	Skewness	Kurtosis
HIGH	COLD/DRY	17.066	0.883	3.421	20.05	11.367	22.14	-0.36	-1.04
	HOT/DRY	17.96	1.22	4.74	26.38	11.81	26.05	0.26	-1.37
	WARM/DRY	17.5	1.25	4.85	27.7	7.3	26.05	-0.32	0.09
	Warm/Wet	17.37	0.843	3.267	18.81	11.99	22.21	-0.4	-0.9
MEDIUM	COLD/DRY	16.268	0.946	3.665	22.53	9.977	21.09	-0.29	-1.36
	HOT/DRY	16.694	0.998	3.864	23.15	11.89	22.903	-0.07	-1.58
	WARM/DRY	16.19	1.16	4.48	27.67	6.3	22.9	-0.63	-0.02
	Warm/Wet	15.772	0.968	3.75	23.78	11.47	21	0.4	-1.58
LOW	COLD/DRY	16.17	1.05	4.05	25.06	9.31	22.14	-0.22	-0.82
	HOT/DRY	18.4	1.43	5.54	30.11	11.01	29.53	0.41	-0.62
	WARM/DRY	17.81	1.45	5.61	31.5	7.69	29.53	0.15	0.28
	Warm/Wet	17.882	0.755	2.923	16.35	13.16	22.08	0	-0.93

Note: CV-Coefficient of Variation, STD- Standard Deviation.
Source: Author's Compilation (2023).

The results from the table 4 provides a comprehensive view of how carbon monoxide (CO) concentration levels vary across different seasons (cold/dry, hot/dry, warm/dry, warm/wet) and under different conditions (high concentration). The "Average Mean Concentration" represents the average CO levels for each specific season and condition, while the "Coefficient of Variability" gives an indication of how much the concentration values vary around the mean. The data suggest that there are variations in CO levels across seasons and conditions, with the highest variability observed in some warm and hot seasons under high concentration conditions.

CONCLUSION AND RECOMMENDATION

The research established the relationship between road transport related air pollutants and the temperature of the study area. It also analyzed the concentration level of the pollutants on different land use areas. The study also looked at relationship between the pollutants within each land use and also tested the level of concentration of the pollutants with temperature variation based on seasons of the year.

These findings could inform air quality management and monitoring efforts in Kano Metropolis. If temperature is consistently correlated with higher CO and CH4 levels, authorities may need to consider seasonal variations and temperature-related interventions when addressing air quality issues.

The correlation analysis shows the correlation coefficients between temperature levels (high, medium, and low) and various air pollutants (CO, CH4, NO2, H2S, SO2) under low high and medium emission in Kano Metropolis. Correlation coefficients measure the strength and direction of the linear relationship between two variables.

A positive correlation (closer to 1) indicates that as one variable increases, the other tends to increase as well. Negative correlation (closer to -1) indicates that as one variable increases, the other tends to decrease and a correlation close to 0 suggests little to no linear relationship between the variables. Blank cells indicate that correlations between those specific variables were not calculated or not applicable.

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