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ASSESSMENT OF METEOROLOGICAL VARIABLES IN LAGOS STATE, NIGERIA

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ABSTRACT

This study assessed key meteorological variables in Lagos State, Nigeria, between 2020 and 2024, focusing on temperature, humidity, wind speed, and rainfall. Secondary data obtained from the Nigerian Meteorological Agency (NiMet) were analyzed using descriptive statistics, correlation and regression to evaluate trends and interrelationships among variables. Descriptive statistics showed that the average temperature was 27.68°C, humidity averaged 81.65%, wind speed averaged 213.01 units, and rainfall occurred on approximately 52% of days. Correlation analysis revealed a moderate negative relationship between temperature and humidity ($r = –0.45$) and temperature and rainfall ($r = –0.40$), while humidity correlated positively with wind ($r = 0.44$) and rainfall ($r = 0.45$). Regression results showed the distinct seasonal patterns, with higher temperatures and lower humidity during the dry season, and cooler temperatures, higher humidity, and stronger winds during the wet season. Rainfall occurrence was positively associated with humidity and wind, while temperature exhibited an inverse relationship with both. Based on these findings, integration of meteorological monitoring into climate risk management strategies to strengthen early warning systems for extreme weather events, improve urban drainage infrastructure to manage seasonal rainfall, and provide climate-informed guidance for peri-urban agriculture is recommended. Additionally, public health interventions should consider temperature and humidity patterns to mitigate heat-related and vector-borne diseases.

KEYWORDS: Meteorological variables, Regression analysis, Lagos State, Standardized Anomaly index, Correlation.

1.0 INTRODUCTION

Meteorological variables such as temperature, humidity, rainfall, and wind are significant to environmental and socio-economic structures of any region. These variables influence agriculture, water resource management, urban planning, public health, and disaster risk reduction efforts (Ayoade, 1988). In particular, for a densely populated and economically vital region like Lagos State, understanding meteorological dynamics is critical for sustainable development. Lagos State, situated in the southwestern coastal belt of Nigeria, experiences tropical climate conditions characterized by distinct wet and dry seasons. These climatic patterns are largely governed by the Inter-Tropical Convergence Zone (ITCZ) and influenced by Atlantic Ocean currents (Odjugo, 2010). As climate change accelerates, there is a growing concern about shifts in rainfall patterns, temperature anomalies, and extreme weather events which can adversely affect livelihoods and critical infrastructure. Given the vulnerability of the state to flooding, sea-level rise, and heatwaves, systematic analysis of meteorological data is essential. Reliable climate data and robust statistical analysis enable informed decision-making in areas such as urban drainage design, agricultural planning, and climate risk mitigation (NIMET, 2020). This research therefore seeks to assess key meteorological variables across time to identify trends, seasonal variations, and anomalies in Lagos State between 2020 and 2024. Over the years, urban expansion and population growth in Lagos have triggered the exposure of the city to climate-induced risks. The disruption of natural drainage channels, loss of green cover, and poor waste management have intensified the effects of heavy rainfall and storm surges (Adelekan, 2015). Consequently, assessing historical meteorological patterns can support early warning systems and long-term adaptation planning. In addition, fluctuations in temperature and humidity have direct implications on public health, particularly the prevalence of heat-related illnesses and the transmission of vector-borne diseases such as malaria (WHO, 2021) and waterborne diseases such as cholera. Monitoring these variables can help guide public health interventions and resource allocation in climate-sensitive communities. Rainfall variability also poses significant challenges to food security in Lagos. Although not an agrarian hub like other Nigerian states, Lagos relies on food imports and supply chains that are climate-sensitive. A better understanding of rainfall distribution helps reduce losses in post-harvest handling and ensures stable market supply (FAO, 2022). Wind dynamics, though less frequently analyzed in local climate studies, also play a critical role in ventilation, pollutant dispersion, and storm forecasting. Strong wind patterns can exacerbate coastal erosion and damage infrastructure, especially in informal settlements (NEMA, 2020). Thus, capturing wind trends over time is important for urban resilience. Furthermore, the increasing frequency of urban flooding events and prolonged dry spells in recent times call for a proactive approach to data-driven climate assessment. This study provides evidence-based insights that can assist policymakers, environmentalists, and urban planners in crafting resilient and adaptive strategies (Ajayi *et* al., 2019). In the agricultural sector, understanding meteorological fluctuations is critical for crop calendar optimization, pest control, and irrigation planning. Farmers and agricultural extension officers need accurate weather forecasts and historical patterns to minimize crop failure and enhance food security. Lagos, despite being heavily urbanized, relies on peri-urban agriculture, which is highly sensitive to climate dynamics (Olajide-Taiwo *et* al., 2012). Another pressing concern is the health implications of weather extremes. Heat stress, respiratory issues, and cardiovascular complications are also closely linked to extreme weather events, especially in densely populated neighborhoods with poor ventilation and limited access to healthcare (Ebi and Bowen, 2016). Bello *et al*. (2025) investigated the influence of temperature, rainfall, and humidity on mosquito distribution and found that increased temperature enhances mosquito abundance, while excessive rainfall reduces larval survival due to wash-off effects; Emekwuru and Ejohwomu (2023) examined the relationship between meteorological variables and air pollution and found that pollution levels were higher during the dry season and strongly influenced by temperature and humidity variations. In another study, Oduwole *et al*. (2025) assessed the role of meteorological variables in predicting air pollution using machine learning models and concluded that meteorological factors are essential components in environmental modeling and forecasting. Furthermore, Olawale and Adetunji (2024) assessed the impact of global climatic phenomena on temperature and rainfall and found significant variations in meteorological variables during El Niño and La Niña events, concluding that global climate systems have a strong influence on local weather patterns in Lagos. Interaction between rainfall and land surface temperature by Sulaiman *et al*. (2025) indicated an inverse relationship, where increased rainfall leads to a reduction in land surface temperature.

2.0 MATERIALS AND METHODS

The data used for this study was obtained from the Nigerian Meteorological Agency (NiMet). The dataset included monthly records of temperature (°C), rainfall (mm), relative humidity (%), and wind speed (m/s) between 2020 and 2024. These variables were selected based on their relevance in describing weather patterns and climate variability within the study area.

Descriptive statistical analysis was used to summarize the data and estimate the standard anomaly. Inferential statistical techniques are used to illustrate the trend behaviour and relationship of the meteorological variables.

3.0 RESULTS

The monthly and annual data series of the meteorological variables are examined using descriptive and inferential statistics.

Table 1: Descriptive Statistics of Meteorological Variables in Lagos State. (2020–2024)

	Temperature (°C)	Humidity (%)	Wind	Rain flag
count	1826	1826	1826	1826
mean	27.68	81.65	213.01	0.52
std	1.44	6.89	43.74	0.50
min	23.70	47.00	1.00	0.00
Q1	26.60	79.40	200.93	0.00
Median	27.80	82.50	219.70	1.00
Q3	28.90	85.50	234.30	1.00
max	31.10	98.30	359.40	1.00

Table1 provides the summary of key statistical characteristics of temperature, humidity, wind, and rainfall patterns over the study period. The average temperature recorded is 27.68°C, with a standard deviation of 1.44, indicating relatively stable temperature variations across the observed period. The minimum temperature observed is 23.7°C, while the maximum is 31.1°C, suggesting that the region experiences generally warm conditions with mild fluctuations typical of tropical climates. For humidity, the mean value is 81.65%, with a standard deviation of 6.89, reflecting moderately high and consistent moisture levels in the atmosphere. The minimum humidity of 47% indicates occasional dry conditions, while the maximum of 98.3% represents periods of high saturation, likely during the peak of the rainy season. The interquartile range of 6.1% showed a moderately spread humid climatic environment. The wind speed exhibits a mean value of 213.01 units, with a relatively higher standard deviation of 43.74, suggesting greater variability compared to temperature and humidity. The minimum recorded wind speed is 1.00, and the maximum is 359.4, highlighting instances of both calm and strong wind conditions. The rain flag variable, which indicates rainfall occurrence, has a mean value of 0.52, showing more days of rain than dry spell. throughout the observed period.

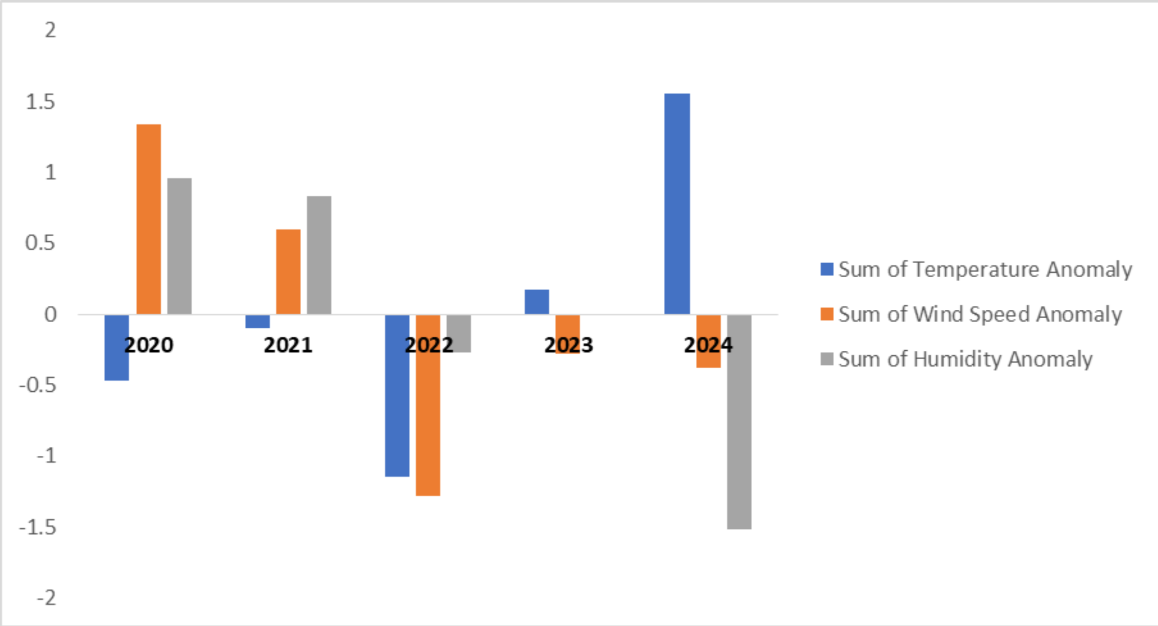

Figure 1: ***Yearly Standardized Anomalies of Temperature, Humidity and Wind Speed.***

The yearly standardized anomalies from 2020 to 2024 in figure 1 provides insight into the variations in temperature, humidity, and wind speed relative to their long-term averages. For temperature; 2020, 2021 and 2022 are years of below average with 2022 being the highest while 2023 and 2024 are years of above average with 2024 visibly higher. For humidity, 2020 and 2021 are years with above average while 2022 and 2024 are below average and 2023 being normal. For wind speed; 2020 and 2021 are notably above average while 2022, 2023 and 2024 are above average. All the variables are below average in 2022.

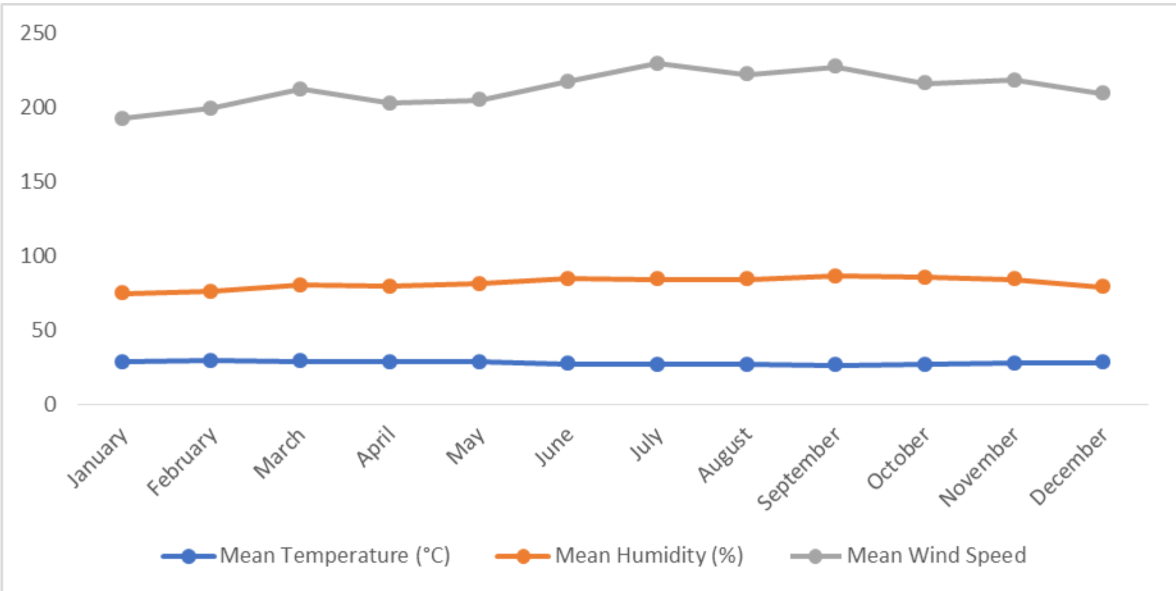

Figure 2: ***Monthly Climatology of Temperature, Humidity, and Wind Speed.***

The monthly mean values of temperature, humidity, and wind speed from January to December in figure 2 reveal distinct seasonal variations that reflect the climatic characteristics of the study area. Overall, temperature values show a gradual decline from the early months of the year toward mid-year, followed by a slight recovery toward the end of the year. This pattern indicates that the early months represent the warmer period, typically corresponding to the dry season, while the mid to late months mark the cooler and wetter period. Humidity displays an opposite trend to temperature, increasing steadily from January to a peak in September, after which it slightly decreases toward December. This inverse relationship between temperature and humidity suggests that cooler months are generally more humid, aligning with the onset of the rainy season when atmospheric moisture is higher. Wind speed follows a similar pattern to humidity, with lower values observed in the early months and higher values during the mid-year months.

Table 2: Correlation Analysis.

	Temperature (°C)	Humidity (%)	wind	Rain flag
temperature	1.00	-0.45	-0.09	-0.40
Humidity	-0.45	1.00	0.44	0.45
Wind	-0.09	0.44	1.00	0.16
Rain flag	-0.40	0.45	0.16	1.00

Table 2 shows the correlation matrix that reveals several key relationships among the weather variables. There is a moderate negative correlation between temperature and humidity, indicating that as temperature rises, humidity tends to decrease. This is typical in tropical or subtropical climates where dry, sunny conditions elevate temperature but lower atmospheric moisture content. Similarly, temperature and rain flag (rain occurrence) exhibit a moderate negative correlation, suggesting that days with rainfall tend to have slightly cooler temperatures. This cooling effect is often due to cloud cover and evaporative cooling during rainfall events. In contrast, humidity shows a moderate positive correlation with both wind and rain flag. This indicates that higher humidity is often associated with windier conditions and a greater likelihood of rainfall. This relationship is consistent with weather systems where moist air is transported by wind and results in precipitation when conditions are favourable. The positive correlation between wind and rain flag, although weaker, still supports the observation that rain events are generally accompanied by increased wind speeds. This may be due to convective storms or the presence of low-pressure systems that generate both rain and wind.

Table 3: Monthly Mean Values of Temperature, Humidity, and Wind Speed.

Month	Mean Temperature (°C)	Mean Humidity (%)	Mean Wind Speed
January	28.3	74.63	192.79
February	29.18	75.93	199.55
March	29.04	80.2	212.75
April	28.58	79.32	202.87
May	28.43	81.21	205
June	27.12	84.46	217.63
July	26.6	84.39	229.86
August	26.51	84.19	222.43
September	26.15	86.46	227.7
October	26.93	85.59	216.63
November	27.58	84.21	218.52
December	27.86	78.95	209.59

From table 3, the monthly mean values of temperature, humidity, and wind speed reveal a clear seasonal pattern across the year. The mean temperature is highest in February at 29.18°C, indicating the peak of the dry season, and gradually decreases towards July and August, where it reaches the lowest values of 26.60°C and 26.51°C respectively. This shows that the mid-year months experience cooler weather conditions, which aligns with the rainy season in the region. Humidity shows an opposite trend, increasing from 74.63% in January to a peak of 86.46% in September, reflecting higher moisture levels in the atmosphere during the rainy months. Wind speed follows a slightly different pattern, starting at 192.79 in January, peaking at 229.86 in July, and then gradually declining towards the end of the year. This indicates stronger wind movement during the middle of the year, which coincides with the period of intense rainfall and atmospheric instability.

Table 4: Multiple Linear Regression Output for the Relationship between Temperature, Humidity and Wind Speed.

Regression Statistics	
Multiple R	0.917762178
R Square	0.842287415
Adjusted R Square	0.807240174
Standard Error	4.991807038
Observations	12

Table 5: Analysis of Variance (ANOVA) for the Regression Model of Meteorological Variables in Lagos State.

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1197.71	598.856	24.0329	0.00025

Residual	9	224.263	24.9181		
Total	11	1421.97			

The regression results provide a comprehensive overview of the relationship between temperature, humidity, and the dependent variable (wind speed). The Multiple R value of 0.918 indicates a strong positive correlation between the independent variables (temperature and humidity) and the dependent variable. The R Square value of 0.842 reveals that approximately 84.2% of the variation in the dependent variable is explained by changes in temperature and humidity, while the remaining 15.8% can be attributed to other factors not included in the model. The Adjusted R Square of 0.807 further confirms that the model is robust and provides a good fit to the data, even after accounting for the number of predictors. The ANOVA results show an F-statistic of 24.03 with a significant p-value of 0.00025, showing further that there is significant association among the meteorological variables.

4.0 DISCUSSION

The analysis of meteorological variables in Lagos State between 2020 and 2024 revealed clear seasonal patterns and interrelationships among temperature, humidity, wind speed, and rainfall occurrence. Descriptive statistics and graphical analysis showed that the dry season (January–April) was characterized by higher temperatures and lower humidity, while the wet season (May–October) experienced cooler temperatures, elevated humidity, and stronger wind activity. Rainfall occurrence was closely associated with increased humidity and slightly lower temperatures, reflecting the tropical climatic dynamics of Lagos State. The standardized anomalies further highlighted years with significant deviations, such as 2024, which was notably warmer and drier, emphasizing the impact of interannual variability on local weather conditions. These findings align with prior studies showing that tropical coastal regions exhibit strong seasonal cycles where temperature, humidity, and rainfall are interdependent. Correlation and regression analyses provided insight into the strength and direction of relationships among variables. A moderate negative correlation between temperature and humidity (-0.45) and between temperature and rainfall (-0.40) indicated that higher temperatures are generally accompanied by lower moisture levels and reduced rainfall likelihood. Conversely, humidity positively influenced rainfall occurrence and wind intensity, suggesting that moisture-laden air and atmospheric circulation patterns drive precipitation and wind dynamics. Regression results confirmed that humidity is a significant predictor of the dependent variable, while temperature had a weaker individual effect. Independent sample t-tests showed no statistically significant differences between dry and wet season means for some variables, highlighting natural variability within the climate system. Collectively, these findings emphasize the interconnected nature of meteorological variables in Lagos State and underscore the importance of monitoring temperature, humidity, and wind dynamics for applications in urban planning, disaster risk management, agriculture and public health.

5.0 CONCLUSION

The assessment of meteorological variables in Lagos State from 2020 to 2024 demonstrates that temperature, humidity, wind speed, and rainfall are strongly interrelated and exhibit clear seasonal variations. The dry season is marked by higher temperatures and lower humidity, while the wet season shows cooler temperatures, elevated humidity, and stronger winds. Rainfall occurrence is closely linked to increased humidity and moderate wind activity, reflecting the tropical coastal climate of the region. Variations in these variables, including anomalous years like 2024, highlight the influence of both local and global climatic factors on Lagos State's weather patterns. The statistical analyses further reveal that humidity plays a significant role in predicting meteorological behaviour, whereas temperature alone has a weaker individual effect. The observed correlations and regression results underscore the interconnected nature of these variables, providing valuable insights for urban planning, agriculture, public health, and climate risk management.

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