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Research Article

Analysis of Nitrogen Dioxide as an Air Pollutan in Cold and Hot Areas in 4 Districts in Lampung

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ABSTRACT

Air pollution has become a significant environmental issue, particularly in urban and industrial areas. One of the major air pollutants is nitrogen dioxide (NO_2), which is mainly produced by transportation, industrial activities, and fossil fuel combustion. Therefore, this study aimed to analyze NO_2 levels in cold areas (Tanggamus and West Lampung) and hot areas (Bandar Lampung and Metro) in Lampung Province during 2019–2020 using two-way Analysis of Variance (ANOVA). The results showed that NO_2 concentrations in both hot and cold areas ranged from 0–50 µg/m^3, indicating that the measured concentrations were still within the "Good" category based on the Air Pollution Standard Index (ISPU) No. 107 of 1997. The ANOVA results for cold areas showed a P-value of <0.05 with an Anderson-Darling (AD) test value of 1.1715, while hot areas showed a P-value of 0.672 with an AD test value of 0.478. These findings indicate that NO_2 concentrations in both hot and cold areas of Lampung Province were still within acceptable air quality standards and may provide baseline information for future air quality monitoring and environmental management strategies.

Keywords: Air Quality Analysis, Nitrogen Dioxide (NO_2), Seasonal Variations, Lampung Province, Analysis of Variance (ANOVA).

1. INTRODUCTION

Air pollution has become a significant environmental issue in the 21st century, particularly since 2019 [1], particularly in urban and industrial areas. Nitrogen dioxide (NO_2) is one of the major air pollutants produced mainly from transportation, industrial activities, and fossil fuel combustion [1]. Excessive NO_2 exposure can negatively affect human health and contribute to environmental problems such as acid rain and tropospheric ozone formation [2,3]. In Indonesia, this phenomenon is also a serious concern, especially in large cities experiencing rapid economic growth and urbanization.

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One example is Lampung Province, which in the third quarter of 2024 recorded economic growth of 4.81% compared to the previous year. This rapid growth was driven by the transportation and warehousing sector, which increased by 10.97%, and the manufacturing sector, which grew by 10.22% [4]. This intensive transportation and industrial activity has the potential to increase NO_2 levels in the air, especially in densely populated areas such as Bandar Lampung City, Metro City, Tanggamus Regency, and West Lampung. Previous studies in Lampung Province generally evaluated NO_2 concentrations across multiple districts without specifically comparing areas based on climatic or geographical characteristics [5]. Based on regional geographical and climatological characteristics, Bandar Lampung City and Metro were classified as relatively hot urban areas with temperatures generally ranging from 23–32 °C, higher transportation density, and rapid urban development. In contrast, Tanggamus Regency and West Lampung were categorized as relatively colder highland areas with temperatures ranging from 20–29 °C and different environmental characteristics. Therefore, these four regions were selected to evaluate variations in NO_2 concentrations based on climatic and land-use characteristics in Lampung Province.

Air quality data in Lampung shows that current NO_2 levels are in the range of 7-8 ppb, which is still below the WHO guideline of 13.29 ppb [1]. However, this data requires further analysis to understand the distribution of NO_2 across various areas with different uses, such as office, industrial, residential, and transportation areas. Although air quality in Lampung is considered good based on existing data, in-depth research is lacking on variations in NO_2 concentrations across different areas.

Research on air quality in Indonesia is generally conducted in large cities such as Jakarta and Surabaya. For example, in Yogyakarta, NO_2 concentrations at several measurement points ranged from 0 to 25 μg/m³ [6,7]. On the other hand, data from the Ministry of Environment and Forestry shows that several major cities in Indonesia have exceeded the annual NO_2 standard of 100 μg/m³ [8]. However, research on NO_2 concentrations in Lampung Province, particularly in Bandar Lampung, is still very limited. Several studies in Lampung indicate that average NO_2 concentrations range from 12.20 to 15.00 ISPU [9], which is still within the good category. However, there are not many studies examining the differences in NO_2 levels based on land use categories (such as transportation, industry, offices, and residential), especially in areas with hot and cold climates. This creates a research opportunity that requires further

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investigation to better understand the distribution of air pollutants in these areas.

Nitrogen dioxide (NO_2) is a reactive gas belonging to the nitrogen oxides (NOx) group. Other nitrogen oxides include nitrous acid and nitric acid. NO_2 is used as an indicator for the larger group of nitrogen oxides. NO_2 primarily enters the air due to fuel combustion. This gas is formed from emissions produced by vehicles such as cars, trucks, and buses, power plants, and off-road equipment [8]. NO_2 pollution is influenced by weather conditions, particularly temperature. Winter and low temperatures can significantly increase the impact of NO_2 pollution on air quality because at low temperatures, NO_2 pollution is more concentrated near the surface. Conversely, high temperatures cause the air to release water vapor and become less dense, which allows the upward convection of various pollutant gases, including NO_2, resulting in lower NO_2 concentrations. Thus, NO_2 pollution tends to be more severe in winter with low temperatures than in high temperatures [9,10]. Based on our research, in 2019, NO_2 concentrations in the Lampung region were categorized as safe and remained within the permissible limits established by the ISPU Regulation Number 107 of 1997. This condition was observed both in cooler areas, such as Tanggamus Regency and West Lampung, as well as in hotter regions, including Bandar Lampung and Metro.

Various methods for sampling NO_2 in ambient air have been developed to monitor air pollution and its impacts on health and the environment. One popular approach is passive sampling, which offers ease of use, low cost, and reusability. For example, the use of a Willems badge diffusive sampler coupled with derivatization using Griess-Saltzmann solution has proven effective in measuring NO_2 concentrations in ambient air. The main advantage of this passive method is its simplicity, which allows for the determination of average NO_2 concentrations in ambient air without the need for sophisticated equipment. It also allows samples to be stored under appropriate conditions (e.g., at 4°C) for two weeks before analysis, providing flexibility in data collection. Therefore, this method was used in the present study to measure NO_2 pollution [11]. Therefore, this study aims to examine in more depth the analysis of NO_2 levels in the air based on cold areas (Tanggamus and West Lampung) and hot areas (Bandar Lampung and Metro) in Lampung in 2019 and 2020, which were statistically analyzed using two-way ANOVA. The results of this study are expected to provide a deeper understanding of the distribution of NO_2 pollution in different geographical areas of Lampung Province and can serve as baseline information for future air quality monitoring and the

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development of more effective environmental management policies.

2. EXPERIMENTAL SECTION

This research was conducted at several locations in cold regions (Tanggamus and West Lampung) and hot regions (Bandar Lampung and Metro). The methods used were as follows:

2.1. Materials

The materials used in this study included 1% (v/v) glacial acetic acid (≥99% purity, Merck), crystalline sulfanilic acid (≥99% purity, Sigma-Aldrich), 0.1% (w/v) sodium nitrite (≥97% purity, Sigma-Aldrich), 0.1% (w/v) N-(1-naphthyl)ethylenediamine dihydrochloride stock solution (≥98% purity, Sigma-Aldrich) and demineralized distilled water. Acetone (≥99% purity, Merck) was used for cleanup, while the Griess-Saltzman absorbent solution was prepared following standard protocols. Additionally, a 1,000 ppm nitrite stock solution was prepared using analytical-grade reagents to ensure precision.

2.2. Instrumentation

The equipment and instruments used in this study to collect standard NO_2 samples. Measurement of micro-particulate volumetric samples (volumetric flasks, microbursts, and cylinders and graduated beakers (Pyrex) were used for solution preparation and measurement. Absorbance measurements were performed using a Shimadzu UV-1800 UV spectrophotometer, calibrated before each measurement by verifying its wavelength accuracy. Weighting was performed with a high-precision analytical balance (Sartorius ENTRIS64-1S) with an accuracy of ±0.1 mg. In addition, an oven for drying glassware, a dark amber bottle for light-sensitive solutions, a barometer to help regulate atmospheric pressure to adjust NO_2 concentrations, and a thermometer to monitor temperature. A dryer was also used to store samples and dry materials, and a watch glass was used for handling and weighing samples and reagents.

2.3. Calibration and Maintenance

Prepare equipment for ambient air quality monitoring. 10 mL of Griess-Saltzman absorbent solution was added to a bottle protected from sunlight and rain. Using a calibrated flow meter, the air suction pump was adjusted to 0.4 L/min, and a UV spectrophotometer (Shimadzu UV-1800) was used for standard solution readings and baseline absorbance (540 nm) checks. Pump flow was checked every 15 minutes during sampling (over a 1-hour period), and the filter was cleaned regularly. The UV spectrophotometer was stored in a dust-free

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cabinet, and the optical holder and cuvette were cleaned after each use. Samples were collected by sealing the absorbent bottle, labeling it, and preparing it for analysis to ensure sample integrity.

2.4. Sampling Procedure

To avoid contamination, NO_2 samples were collected in a manner that minimized potential errors. A 10 mL Griess-Saltzman absorbent solution was then placed in a sealed vial, and the air suction pump was calibrated using a flow meter at a flow rate of 0.4 L/min. The standard solution was measured using a UV spectrophotometer (Shimadzu UV-1800) for calibration at 540 nm. The pump flow rate was measured every 15 minutes during the 1-hour collection period. After collection, the absorbent vial was sealed, labeled, and stored in a cool, dark environment. The samples were suspended in a temperature-controlled vessel, with every effort to minimize cross-contamination and maintain sample integrity. To perform sample testing with a UV spectrophotometer [12].

2.4.1. Reagent Preparation

Stock reagents were prepared for NO_2 measurement, including 0.1% (w/v) sodium nitrite solution and 0.1% (w/v) N-(1-naphthyl)ethylenediamine dihydrochloride solution. Next, Griess-Saltzman absorbent solutions were prepared according to standard procedures to maintain consistent reactivity. These reagents were stored in dark amber bottles to protect them from light exposure. De-mineralized distilled water was used to prepare all solutions to prevent contamination.

2.4.2. Measurement and Data Collection

Absorbance measurements were performed using a 0.5 mL sample collected after stirring using a Shimadzu UV-1800 UV spectrophotometer calibrated at 540 nm. Measurements were calibrated against standard solutions and absorbance blanks to normalize the data. The absorbance of each sample was recorded in a controlled environment, and the optical holder and cuvette were cleaned between samples to prevent cross-contamination. To maintain their integrity, samples were transported to the laboratory in temperature-controlled containers.

2.5. Data Analysis

This study uses the Air Quality Index (ISPU) variable calculated based on Particulate Matter 10 µm (PM10) data (measured within 24 hours) for sulfur dioxide (SO_2), carbon

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monoxide (CO), oxidants, including ozone (O_3), and nitrogen dioxide (NO_2) [13], according to KEP-45/MENLH/10/1997, and KEP-107/KABAPEDAL/11/1997. Air quality determination was carried out on pollution parameters based on national ambient air quality standards with Government Regulation No. 41 of 1999 as a reference. Using the ANOVA model for multivariate correlation tests, in addition to analyzing monitoring locations, NO_2 sampling. The correlation test used the ANOVA model to analyze monitoring locations and NO_2 sampling. Air analysis of NO_2 was carried out based on monitoring points such as industry, transportation, offices and housing in four districts of Lampung Province collected from the Lampung Province Environmental Monitoring Agency (BPLHD) in 2019–2020. Monitoring was carried out in the dry and rainy seasons, then the data obtained were classified according to air quality at each monitoring point. Air quality limits based on ISPU can be seen in Table 2. The concentration value of parameter (I) is calculated using the following equation:

$$I = \frac{I_a - I_b}{(X_a - X_b)}(X_x - X_b) + Ib$$

Description:

I : Calculated Air Quality Index (ISPU)

X_a : Upper limit of ambient concentration (μg/m^3)

I_a : Upper limit of ISPU

X_b : Lower limit of ambient concentration (μg/m^3)

I_b : Lower limit of ISPU

X_x : Actual ambient concentration resulting from the measurement (μg/m^3)

To analyze the influence of location points on seasons, ANOVA with multivariate correlation was used. NO_2 concentrations were collected using passive air sampling. The diffusion process involves a molecular permease membrane filter, allowing for spatial and temporal distribution evaluation. Passive air sampling involves the absorption of vapor-diffusing chemicals in a sorbent over time [14].

3. RESULTS AND DISCUSSION

3.1. Nitrogen Dioxide (NO_2) Levels in Cold Regions

Tanggamus Regency and West Lampung were selected as representative cold areas due to their highland topography and lower temperatures, whereas Metro City and Bandar Lampung City represented hot urban areas with relatively higher temperatures and transportation activity. These regional characteristics were used to evaluate variations in NO_2

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air pollution levels based on geographical and land-use differences including temperature, while acknowledging that other meteorological factors such as humidity and wind may also influence NO_2 dispersion. [15]. Data from the Central Statistics Agency (BPS) of Lampung Province shows that in 2024 [4], the average air temperature in colold regions ranged from 27.8°C to 29.6°C. Therefore, it is important to measure NO_2 levels in several locations. The locations chosen were Tanggamus Regency and West Lampung, as cold areas due to their topography, which is dominated by highlands. Metro City and Bandar Lampung City are considered hot areas due to their high location above sea level, which causes temperatures to tend to be higher. These four locations will be analyzed for NO_2 gas air pollution levels.

Transportation areas generally showed higher NO_2 concentrations compared to industrial, residential, and office areas, indicating the contribution of vehicle emissions to ambient air pollution levels, consistent with previous studies Wardhana (2007). Therefore, this study compared NO_2 concentration data between cold and hot areas to evaluate the influence of geographical and environmental characteristics on NO_2 distribution in Lampung Province.

Table 1. Air Quality Monitoring Locations in Tanggamus Regency and West Lampung

Regency	Location Point	Address	Coordinate Point	
			East longitude	**South latitude**
Tangamus	Industry	Karang Rejo Village, Ulubelu District	S: 05° 18' 28,84"	E: 104° 34' 27,84"
	Habitation	Kopera housing area	S: 05° 28' 53,6"	E: 104° 40' 34,7"
	Office	Tanggamus Regional Government Complex	S: 05° 28' 55,6"	E: 104° 40' 56,9"
	Transportation	Jl. Ir H. Juanda	S: 05° 29' 46,6"	E: 104° 37' 38,9"
West Lampung	Industry	Jl. Lintas Liwa-Krui Pekon Kubu Perahu Kec. Balik bukit	S: 05° 05' 26,3"	E: 104° 25' 48,4"
	Habitation	Gunung Sugih Kec. Balik Bukit	S: 05° 01' 39,5"	E: 104° 06' 01,5"
	Office	Jl. Tulip No.2 Way Mengaku	S: 05° 01' 09,4"	E: 104° 03' 33,5"
	Transportation	Terminal Pasar Liwa	S: 05° 02' 18,3"	E: 104° 05' 00,8"

Lower NO_2 concentrations observed in several hot areas may be associated with greater atmospheric dispersion at higher temperatures, consistent with previous findings reported by Mortimer (2008) [17].

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Figure 1. Hot and Cold Area Monitoring Points

The data obtained in this paper will be compared with the Air Pollution Standards Index (ISPU) No. 107 of 1997 (Table 2) to determine the ISPU category for each monitoring.

Table 2. Air Pollution Standards Index (ISPU) No. 107 of 1997

No.	ISPU Index	Category	Color
1.	0-50	Good	Green
2.	51-100	Medium	Blue
3.	101-199	Unhealthy	Yellow
4.	200-299	Very unhealthy	Red
5.	> 300	Dangerous	Black

NO_2 data obtained in cold areas, Tanggamus Regency and West Lampung, are shown in Table 3 and Table 4.

Table 3. NO_2 Pollutant Parameter Data for Cold Areas in Tanggamus and West Lampung Regencies (μg/m^3) in Rainy Season (Phase 1)

Years	City/Regency	NO_2 concentration (μg/m^3)			
		Transportation	Industry	Habitation	Office
2019	Tanggamus	18.40	0.50	1.80	2.50
	West Lampung	5.30	5.00	5.20	12.40
2020	Tanggamus	15.31	1.87	3.36	3.24
	West Lampung	4.37	4.11	4.79	10.36

Table 4. NO_2 Pollutant Parameter Data for Cold Areas in Tanggamus and West Lampung Regencies (μg/m3) in Rainy Season (Phase 2)

Years	City/Regency	NO_2 concentration (μg/m^3)			
		Transportation	Industry	Habitation	Office
2019	Tanggamus	19.80	2.30	3.10	3.50
	West Lampung	5.20	6.90	4.70	10.50
2020	Tanggamus	12.72	2.57	2.73	2.42
	West Lampung	4.43	4.92	5.76	9.60

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3.2. Comparison of NO_2 Levels in Cold Regions with ISPU Data

Based on ISPU data from stage 1 and stage 2 (rainy season and dry season), the results of the sample categories according to ISPU NO_2 Number 107 of 1997 are shown in Table 5.

Table 5. NO_2 data results according to ISPU Number 107 of 1997

Years	City/Regency	Location Point	NO_2 Results
2019	Tangamus	Industry	Good
		Habitation	Good
		Office	Good
		Transportation	Good
2020	West Lampung	Industry	Good
		Habitation	Good
		Office	Good
		Transportation	Good

Based on the data obtained, the NO_2 results are good because they still meet the ISPU NO_2 standard Number 107 of 1997 in the range of 0-50 µg/m^3. Therefore, our study has many strengths. First, we used a tool originally designed to ensure properly measured air levels for health benefits, and took samples from various locations in the Tanggamus and West Lampung areas, so the spectrum of air pollution exposure levels obtained has heterogeneous exposure. Research by Bubalo et al. (2024) [17], suggested a relationship between mask use while working and respiratory complaints. Based on statistical analysis, workers who regularly wear masks while working tend to have fewer respiratory complaints than those who rarely wear masks. This indicates that terminal sweepers who do not wear masks are at high risk of experiencing respiratory problems due to exposure to dust particles and NO_2 gas. Based on this research, hot areas such as Bandar Lampung and Metro generally experience higher transportation activity, denser urbanization, and greater fossil fuel combustion, which can contribute to relatively higher NO_2 concentrations. In contrast, cold areas such as Tanggamus Regency and West Lampung tend to have lower traffic intensity, less industrial activity, and more vegetation coverage, which may reduce NO_2 accumulation in ambient air.

3.3. Nitrogen Dioxide (NO_2) Levels in Hot Areas

The next data is the measurement of NO_2 levels in hot areas, namely Metro City and Bandar Lampung City. NO_2 measurements in hot areas were conducted in Bandar Lampung City and Metro City, which represent urban regions with relatively higher temperatures and transportation activity. Hot regions generally ranging from 23–32 °C, higher transportation density, and rapid urban development. In addition, research by Syafrianto (2011) [18] revealed

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that the increase in built-up areas in Bandar Lampung City contributed to the increase in surface temperature, which resulted in an increase in air temperature in the area. Although NO_2 concentrations in both cold and hot areas remained below the air quality standard established by ISPU No. 107 of 1997, differences in concentration levels were still observed due to variations in environmental and anthropogenic conditions. Hot areas such as Bandar Lampung and Metro experienced ambient temperatures of approximately 28–34 °C during sampling. In contrast, cold areas such as Tanggamus Regency and West Lampung had lower temperatures ranging from approximately 18–25 °C during sampling, along with lower transportation intensity, less industrial activity. NO_2 data obtained in hot areas, namely Bandar Lampung City and Metro City are shown in Tables 6 and 7.

Table 6. NO_2 Pollutant Parameter Data for Hot Areas in Bandar Lampung and Metro Cities ($\mu g/m^3$) in Summer (Phase 1)

Years	City/Regency	NO_2 concentration ($\mu g/m^3$)			
		Transportation	**Industry**	**Habitation**	**Office**
2019	Bandar Lampung	13.80	6.80	12.50	7.30
	Metro	8.90	7.10	5.80	15.70
2020	Bandar Lampung	15.91	6.85	12.21	8.08
	Metro	12.96	10.15	14.80	12.85

Table 7. NO_2 Pollutant Parameter Data for Hot Areas in Bandar Lampung and Metro Cities ($\mu g/m^3$) in Summer (Phase 2)

Years	City/Regency	NO_2 concentration ($\mu g/m^3$)			
		Transportation	**Industry**	**Habitation**	**Office**
2019	Bandar Lampung	9.80	8.75	10.60	9.90
	Metro	8.40	11.60	5.90	20.80
2020	Bandar Lampung	13.44	7.68	9.76	7.07
	Metro	11.08	12.83	12.29	13.45

Based on ISPU data from stage 1 and stage 2 (winter and dry season), the results of the sample categories according to ISPU NO_2 Number 107 of 1997 are shown in Table 8.

Based on Tables 6 and 7, NO_2 concentrations in the hot areas of Bandar Lampung City and Metro during 2019 and 2020 were still within the "Good" category according to ISPU No. 107 of 1997. Although the measured concentrations remained below the established threshold, transportation areas tended to show higher NO_2 concentrations compared to residential,

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office, and industrial areas, indicating the influence of vehicle emissions and urban activities on ambient air quality. This finding is consistent with previous studies reported [19], which showed that transportation activities and combustion sources significantly increase NO_2 concentrations in urban environments. Similarly, Rahim et al. (2021) [20] reported that increased NO_2 concentrations were associated with declining air quality in areas with intensive human activities.

Table 8. NO_2 data results according to ISPU Number 107 of 1997

Years	City/Regency	Location Point	NO_2 Data Results
2019	Bandar Lampung	Industry	Good
		Habitation	Good
		Office	Good
		Transportation	Good
2020	Metro	Industry	Good
		Habitation	Good
		Office	Good
		Transportation	Good

3.4. Analysis of Varians (ANOVA)

The ANOVA statistical test was conducted using Minitab software version 21.4.1 with the TWO WAY model based on the normality data of NO_2 levels between sampling points (Tanggamus and West Lampung) with sampling stages (conducted in 2 stages) can be seen in Figure 3. The significant value of the P-value is not less than 0.05, while the results of the winter probability plot between Tanggamus Regency and West Lampung show a P-value <0.005 meaning there is a significant difference between the sampling area point and the sampling. This is reinforced by the ANOVA results which have a P-value of the sampling point <0.05. Thus, it can be concluded that the smaller the ANOVA P-value at the sampling point, the greater the P-value of the probability plot.

The Anderson-Darling (AD) test was conducted to determine whether the correlation between 2 variables on NO_2 levels follows a normal distribution. Based on the results of the cold area AD of 1.1715. The P-value results are directly proportional to AD so it can be concluded that the winter AD results also have a significant difference to the sampling point.

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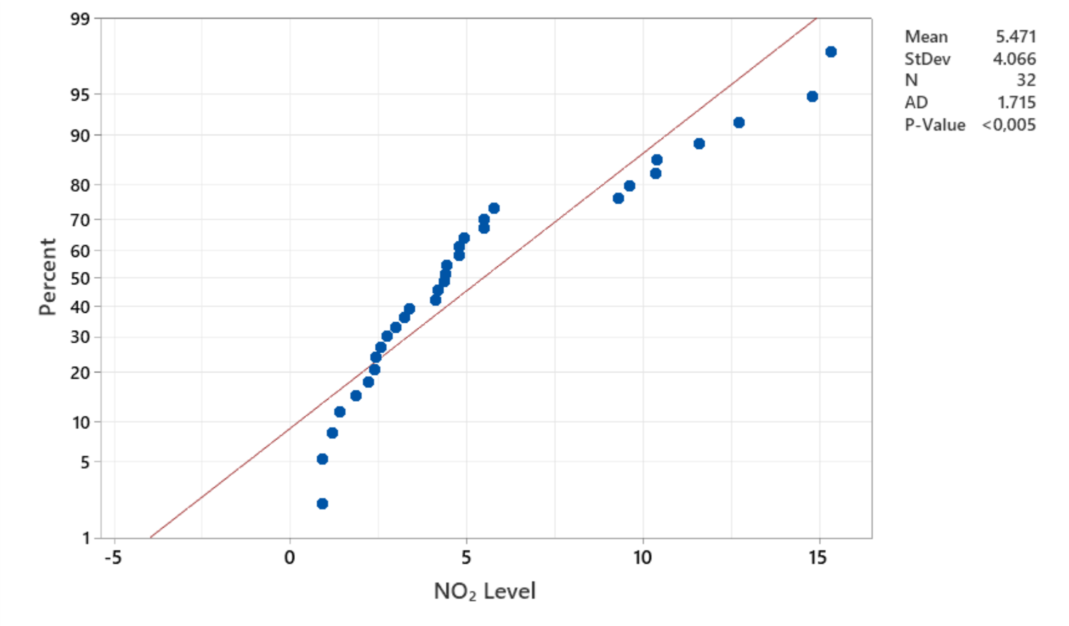

Figure 2. Probability Plot of Cold Areas

Table 9. ANOVA Result of Cold Areas

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Coordinate sampling	3	191.419	63.8062	4.86	0.009
Sampling collection	1	0.076	0.0761	0.01	0.940
Coordinate sampling * Sampling collection	3	6.010	2.0034	0.15	0.927
Error	24	315.042	13.1267		
Total	31	512.547			

Abbreviations: DF = Degrees of Freedom; Adj SS = Adjusted Sum of Squares; Adj MS = Adjusted Mean Square; F-Value = F-test statistic value; P-Value = Probability value indicating statistical significance.

The results of the summer ANOVA (Bandar Lampung and Metro) show the same relationship between the sampling point locations (Bandar Lampung and Metro) and the sampling stage on NO_2 levels. Based on Figure 3, a P-value greater than 0.05 means the data is normally distributed or in other words the data normality test is met. The result of the AD test on the probability plot is 0.478, meaning the AD test is also normally distributed. This is also reinforced by the P-value results in the ANOVA data. Where the value of the sampling point with the correlation between the sampling point and sampling both have a value >0.05, meaning the data is normally distributed [21].

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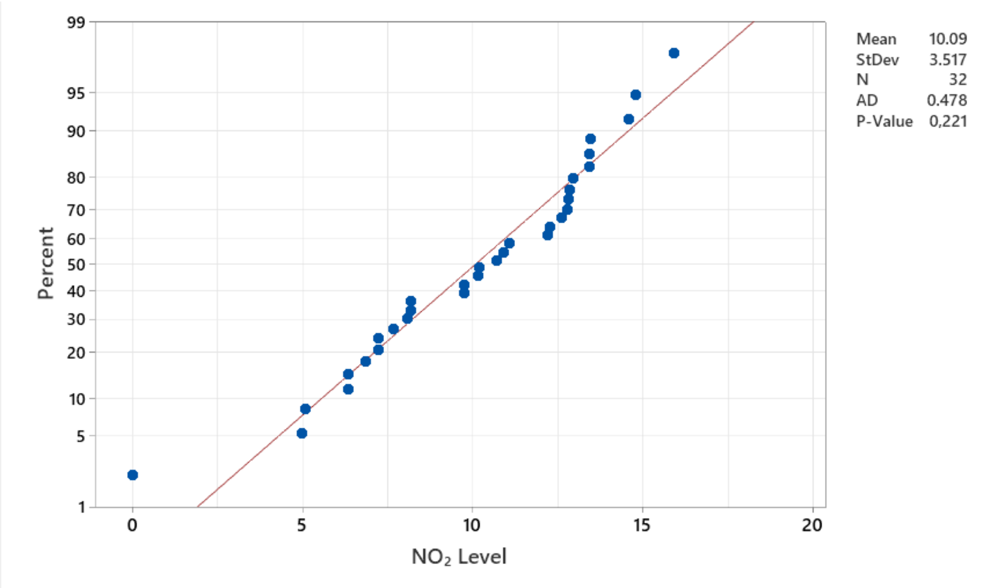

Figure 3. Probability Plot of Hot Areas

Table 10. ANOVA Result of Hot Areas

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Coordinate sampling	3	85.440	28,.480	2.50	0.084
Sampling collection	1	6.125	6.125	0.54	0.471
Coordinate sampling * Sampling collection	3	17.852	5,.951	0.52	0.672
Error	24	273.946	11.414		
Total	31	383.362			

Abbreviations: DF = Degrees of Freedom; Adj SS = Adjusted Sum of Squares; Adj MS = Adjusted Mean Square; F-Value = F-test statistic value; P-Value = Probability value indicating statistical significance.

4. CONCLUSION

This study was conducted to examine more deeply the NO_2 levels in the Lampung area, especially in cold areas, namely Tanggamus Regency and West Lampung and hot areas, namely Bandar Lampung City and Metro City in 2019, which were still declared safe and in accordance with the threshold according to ISPU Number 107 of 1997 because the results of air levels were in the range of 0-50 µg/m^3. This hypothesis was supported by the results showing that hot regions such as Bandar Lampung and Metro, with temperatures ranging from approximately 28–34 °C, generally showed relatively higher NO_2 levels compared with cold regions such as Tanggamus Regency and West Lampung, where temperatures ranged from approximately 18–25 °C. This difference indicates that warmer environmental conditions, combined with higher transportation may enhance NO_2 formation and accumulation in ambient air. In addition, the study also focused on statistical analysis using two-way Analysis of Variance (ANOVA). The results of NO_2 levels in cold and hot areas were

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carried out in 2 stages showing results in the range of 0-50 μg/m^3, this indicates that the results of NO_2 levels were in the good range of the threshold determined based on the Air Pollution Standard Index (ISPU) Number 107 of 1997. The results of the ANOVA P-value for cold areas were <0.05 with a probability plot of the Anderson-Darling (AD) test of 1.1715. Meanwhile, the P-value of the ANOVA for hot areas was 0.672 with an AD test probability plot of 0.478.

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AUTHOR CONTRIBUTIONS

Annur Valita Sindiani did the experimental research and wrote the manuscript, Dian Rifani Muthia did the data analysis and wrote the manuscript, Hanny Julya Putri did the experimental research and wrote the manuscript, Rinawati reviewed and revised the manuscript, Agung Abadi Kiswandono reviewed and revised the manuscript, Imelda Fajriati revised the manuscript.

CONFLICT OF INTEREST

The authors should clearly declare that they have no conflicts of interest related to the content of this work.

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