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Monitoring Air Quality Parameters (NO2 AND SO2) at Kalianak region of surabaya

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Abstrak. Perkembangan infrastruktur kota dan pusat industri, serta peningkatan dalam sektor transportasi, menunjukkan pertumbuhan yang pesat. Adanya perubahan dalam kualitas udara disebabkan oleh peningkatan pencemaran udara, yang diakibatkan oleh parameter konsentrasi udara yang melampaui standar baku mutu. Salah satu parameter yang perlu diperhatikan adalah O3. Ozon berfungsi sebagai perlindungan alam terhadap radiasi sinar ultraviolet yang berlebihan. Jika lapisan ozon mengalami kerusakan, hal ini dapat menyebabkan dampak serius seperti kanker kulit pada manusia dan peningkatan suhu global. NOx, yang merupakan salah satu polutan udara, terdiri dari NO dan NO2. NOx banyak berasal dari proses pembakaran, baik dari kendaraan maupun kegiatan industri. Pembentukan NOx juga dapat terjadi pada suhu dan tekanan tinggi, seperti pada mesin kendaraan bermotor atau boiler. NOx memberikan kontribusi pada berbagai masalah lingkungan dan kesehatan. Oleh karena itu, pengelolaan kualitas udara menjadi penting dengan pemasangan sistem pemantauan udara. Studi ini melibatkan penggunaan sistem pemantauan untuk mendapatkan data yang akurat.

Katakunci: NO, NOx, NO2, SO2, stasiun pemantau udara

Abstract. The development of urban infrastructure and industrial centers, coupled with the expansion of transportation, is on the rise. Changes in air quality are attributed to increasing air pollution, driven by air concentration parameters exceeding quality standards. One crucial parameter to be noted is O3. Ozone serves as a natural shield against excessive ultraviolet

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radiation. If the ozone layer is damaged, it can lead to severe consequences such as skin cancer in humans and global temperature rise. NOx, a major air pollutant, comprises NO and NO2. NOx mainly originates from combustion processes, both from vehicles and industrial activities. NOx formation can also occur at high temperatures and pressures, such as in motor vehicle engines or boilers. NOx contributes to various environmental and health issues. Therefore, air quality management is essential, involving the installation of air monitoring systems. This study employs a monitoring system to gather accurate data.

Keywords: NO, NOx, NO2, SO2, Air monitoring stations.

1. Introduction

The air plays a crucial role in life and existence. However, in this modern era, parallel to the development of urban infrastructure, industrial centers, and the expansion of transportation, the air quality undergoes changes due to air pollution (Badan Pengelolaan Lingkungan Hidup Daerah Jakarta, 2013). This involves the alteration of one of the air components from its normal state, introducing pollutants (in the form of gases and small particles/aerosols) into the air in certain amounts for a considerable period, disrupting human, animal, and plant life (Budiyono, 2001).

This research will focus on analyzing the results of air quality monitoring data in the kalianak area in Surabaya. air quality data collection is expected to be strong evidence that the air in an area is suitable for living or not. and able to become a reference for further actions that the population needs to take in following up on existing air problems.

2. Literature Review

The rapid growth of economic activities and urbanization, both in urban and suburban areas, has significant potential to increase energy consumption, especially in fuel needs for electricity generation, industrial furnaces, and transportation. The combustion of these fuels is a major source of pollutants released into the air, such as COx, NOx, SOx, SPM (suspended particulate matter), Ox, and various heavy metals (Majid et al., 2013). The transportation sector, as a backbone of human activities, contributes significantly to air pollution, accounting for 44% of TSP (total suspended particulate), 89% of hydrocarbons, 100% of PB, and 73% of NOx (Peraturan Gubernur Jawa Timur Nomor 10 Tahun 2009).

Nitrogen dioxide is one of the components that influence air quality and is also considered a toxic gas. NO2 pollution sources include motor vehicle activities, industrial processes, and household activities. Nitrogen oxide (NOx) emissions contribute to various environmental issues such as acid rain and acidification in aquatic systems, ozone layer depletion, and reduced visibility (Rani et al., 2011). Therefore, NOx emissions are regulated at different levels by governments

worldwide. NOx is the most challenging gas pollutant to control from combustion processes (Supiyadi, Asri, & Nugraha, 2023). Two gases from nitrogen oxides, Nitric oxide (NO) and Nitrogen dioxide (NO2), collectively known as NOx pollution, are emitted from combustion processes as a trace type (Intyanto et al., 2023). Nitrogen Oxide consists of 97 to 98 percent Nitric oxide (NO) and approximately 2 to 3 percent Nitrogen dioxide (NO2) (Nugraha et al., 2023a). In the combustion process, NOx is formed when the temperature is high enough for nitrogen in the air to react with oxygen (Prasad & Prasad, 2018).

NOx has adverse effects on both humans and the environment when its concentration is too high (Prasad & Prasad, 2017). Therefore, monitoring of NOX concentration in the air is necessary (Prasad, 2019). NOX monitoring can be done using a detection tool, such as some tools from previous research like the one developed by Wicaksono and Suismono, which detects CO, CO2, and NOX gases (Prasad, 2018a).

O3 is also a crucial parameter in air quality that needs attention. This is because ozone (O3) is highly reactive (Prasad, 2018b). Ozone is present in the stratospheric layer, acting as a filter for UV rays entering the Earth. If there is damage to the ozone layer, UV rays cannot be filtered effectively, leading to various issues such as skin cancer in humans and an increase in global temperatures accompanied by polar ice melting (Prasad, 2018c).

3. Method

This qualitative research employs an observational and descriptive method, aiming to objectively depict a state or object under examination. The research design is cross-sectional, where exposure and outcomes are collected simultaneously or within a specific timeframe (Prasad, 2018d). The research population includes all residents living along the roads around Jl. Kalianak, Surabaya. The sample respondents are selected using non-probability purposive sampling within a 300-meter radius from the air sampling point, as this distance is considered the most impacted and in need of monitoring.

Other criteria include respondents aged between 20 and 55 years, residing along the roadside for a minimum of one year, with the main door facing the road, indicating a higher potential for respiratory disturbances due to air pollution. Respondents should engage in daily activities within the research area for a minimum of 8 hours per day, between 08:00 and 18:00 during peak traffic hours, not have a prior lung disease, and be willing to participate as respondents. Based on these criteria, a total of 19 research respondents were identified. Environmental parameters, such as NO2 and SO2 gas samples, were collected using an impinger device at a single point during peak traffic hours, measured three times (morning, afternoon, and evening) by officials from the Environmental Health and Disease Control Technical Center (BBTKLPP) in Surabaya.

The dependent variable in this study is respiratory disturbances in the community around the Kalianak area in Surabaya, including a decline in lung function measured using the MIR Spirobank II new S/N Y03545 spirometer and a questionnaire to assess respiratory complaints perceived by respondents. Independent variables include age, duration of residence, smoking habits, and Body Mass Index (BMI) (Nugraha et al., 2022). The obtained data is then descriptively presented to illustrate the magnitude of the respiratory disturbance risk in the surrounding community due to NO2 and SO2 pollutants using the Environmental Health Risk Analysis (EHRA) method (Apriani et al., 2023).

The analysis methods used in the study are as follows:

-Calibrating the microcontroller-based air monitoring device using the co-location method. Through co-location, a mathematical equation expressing the relationship between the sensor's output voltage and the detected gas concentration can be derived from the characteristic sensor graph when detecting pollutant gases(Nugraha et al., 2023b).

- Performing an analysis by creating a graph with the X-axis representing time (minutes) and the Y-axis representing the concentrations of NO, NO2, and O3 (µg/m3). This graph reveals the diurnal pattern and concentration peaks of NO, NO2, and O3.

- Conducting an analysis by creating a graph with the X-axis representing time (minutes) and the Y-axis representing the concentrations of NO, NO2, and O3 (ppm). This graph illustrates the concentration patterns of NO, NO2, and O3, and reference lines corresponding to air quality standards are added parallel to the X-axis.

- Analyzing the correlation between NO, NO2, NOx, and O3 concentrations with meteorological factors (temperature, humidity, wind direction and speed, and solar radiation), car-free days, weekends, and extended holidays.

3. Result

The Kalianak region is a lowland area with an elevation of 15 meters above sea level. This condition causes the wind to tend to carry airborne pollutants and spread them, potentially contaminating surrounding areas. Air temperature measurements in this area were conducted during the research, with an average temperature ranging from 33°C to 36°C. According to Sari et al. (2013), higher air temperatures lead to air expansion and lower concentrations of pollutant substances. The lower pollutant concentrations have a higher potential to cause respiratory disturbances as they are closer to the human respiratory system (Nugraha et al., 2023c). Ambient air quality measurements (NO2 and SO2) in the Kalianak region of Surabaya were taken during peak traffic hours at locations near the roadside and close to residential areas. These measurements were taken for one hour with three air sampling sessions during peak

traffic hours: in the morning, afternoon, and evening, to better represent field conditions.

The measured concentrations of both parameters are then compared with the ambient air quality standards set by East Java Governor Regulation Number 10 of 2009 regarding Ambient Air Quality Standards and Emissions from Non-Mobile Sources in East Java. The results of the average ambient air concentrations, for both NO2 and SO2, remain within the safe range as they are below the standard values. Although the NO2 level in the initial measurement (P1) approached the standard value, it is still considered acceptable (Nugraha et al., 2023d). The environmental parameters in this study were measured at a single point, with an estimated distance of 300 meters, representing the most affected area from the sampling point.

The highest concentrations of NO2 and SO2 parameters were obtained during the first measurement, amounting to 71.91 μg/Nm3 and 61.42 μg/Nm3, respectively. The elevated concentrations in this measurement compared to the second and third measurements were attributed to the significant number of motor vehicles and heavy-duty vehicles, such as trucks and trailers, traversing this road section. The traffic density conditions resulted in increased combustion emissions from motor vehicles entering the NO2 and SO2 absorbent solutions in the impinger. This aligns with observations indicating a weekly traffic density trend in the research area, showing a higher number of vehicles in the morning from 09:00 to 10:00 AM, averaging 4,316 vehicles per hour. In the afternoon from 15:00 to 16:00 PM, there was an average of 3,955 vehicles per hour. These calculations were made during these hours to illustrate the presence of heavy-duty vehicles passing through the Kalianak area, as heavy-duty vehicle operations typically occur from 09:00 to 15:00 PM before being redirected to the Surabaya-Gresik toll road and reopening at 18:00 PM.

SO2 is a colorless and pungent-smelling chemical compound. Accumulation of this gas in the body can lead to respiratory disturbances, especially lung function impairment, irritation, and asthma [21]. Dose-response assessment is employed to determine the toxicity values of the risk agent and is a crucial step as Environmental Health Risk Analysis (EHRA) studies can only be conducted once the toxicity values are known.

Table 1. The Measurement Results of NO2 and SO2 in the Ambient Air of Surabaya City

Time	NO_2 Level Standard: 92.5	SO_2 Level Standart:262	Description
P1 (09.00-10.00)	71,91	61,42	Meets the standard
P2 (12.00-13.00)	39,58	48,53	Meets the standard
P3 (15.00-16.00)	39,57	46,57	Meets the standard

Max	71,91	61,42	Meets the standard
Min	39,57	46,57	Meets the standard
Average	50,35	52,17	Meets the standard

Table 2. Dosis Respon (RfC, mg/ kg/ hari) agen risiko NO2 dan SO2 untuk karakteristik risiko non karsinogenik

Risk Agent	RfC Value (mg/kg/day)	Crisis Effect and Reference.
Nitroger Dioksida (NO2)	2E-2(0,02)	Respiratory Tract Disorders (EPA/NAAQS 1990)
Sulfur dioksida (SO2)	2,6E-2 (0,026)	Respiratory Tract Disorders (EPA/NAAQS 1990)

Toxicity is expressed as the RfC (Reference Concentration) for non-carcinogenic effects through the inhalation exposure pathway based on literature from the Integrated Risk Information System (IRIS) database. Assessment via this inhalation pathway involves entering the body in milligrams per kilogram of body weight per day and understanding its crisis effects on the body. The RfC value can be obtained from the researcher's experiments, but if not feasible, referencing previous research is sufficient. Toxicity values for NO2 and SO2 risk agents in this study can be found in Table 2.

Exposure assessment is employed to determine the entry route of risk agents into the human body, enabling the calculation of intake rates. In this study, NO2 and SO2 risk agents enter the body through the inhalation pathway. Based on ambient air quality measurements from Measurement 1 (P1), Measurement 2 (P2), and Measurement 3 (P3), each conducted for 1 hour at a single ambient air sampling location, the maximum, minimum, and average concentrations of NO2 and SO2 risk agents can be determined. Exposure analysis in this study is based on these maximum, minimum, and average concentrations. Respondents in this study are residents living along the roadside and potentially exposed to ambient air pollutants, selected based on a distance range from 0 to 300 meters from the air sampling location. This distance consideration is the most impactful as measurements are taken at a single point. The time of exposure (tE) or the duration of exposure each day uses the default value of 24 hours (residential) since most respondents spend more than 8 hours a day in that area. Respondents' body weight is measured using a weight scale, and the average body weight is determined to be 55 kilograms.

The duration of daily exposure and body weight are used as references in calculating the community's risk agent intake. The calculated results will be used to

determine the level of health risk for the community while in the research location over a specific period (projected for the next 30 years in this case). The Risk Quotient (RQ) value indicates the health risk level due to pollutant parameters (risk agents). This risk level is employed to understand the toxicity nature of risk agents in the human body over a projected period, determining whether it is safe or not. Any unsafe values can be addressed through control measures.

4. Conclusion

Air monitoring results in the Kalianak area show that during busy hours, there is a lot of pollution, especially from NO2 and SO2, which almost reaches safe limits. Pollutants are most often found in heavy traffic, especially from heavy vehicles. This condition has the potential to cause people to be exposed to pollutants. As a result, people living near roads with distance range from 0 to 300 meters from the air sampling location particularly high health risks. Therefore, to maintain public health, assessing toxicity and control are important.

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