MAPPING AIR QUALITY AND ITS IMPLICATIONS FOR PUBLIC HEALTH IN PAREPARE CITY

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ABSTRACT

Parepare is one of the areas experiencing ambient air pollution by NO_2 and SO_2 concentrations. At certain concentrations, NO_2 and SO_2 can cause health implications that require efforts from the government and the community to minimize the impact of this pollution. This study used a descriptive qualitative method with a Geographic Information System (GIS) approach to determine the distribution of SO_2 and NO_2 concentrations. The results showed that in NO_2 monitoring, the average concentration obtained was 91.39 $\mu g/m^3$, which falls into the category of moderate pollution based on the Air Pollution Standards Index (ISPU). This category is still acceptable for humans and other living things. The highest distribution of NO_2 in Parepare is in Kampung Pisang, Ujung Sabbang, and Lakessi villages with a concentration value of 0.000054 mol/m^2 - 0.000055 mol/m^2 or equivalent to 109.13 $\mu g/m^3$ - 112.85 $\mu g/m^3$ .In SO_2 monitoring, the average concentration obtained is 228 $\mu g/m^3$, which is included in the unhealthy pollution category based on ISPU. This condition can cause negative impacts on human health, especially on vulnerable groups such as children, the elderly, and individuals with respiratory disorders. The highest distribution of SO_2 in Parepare is in Lumpue and Watang Bacukiki urban villages with concentration values between 0.00019 mol/m^2 - 0.00022 mol/m^2 or equivalent to 543 $\mu g/m^3$ - 572 $\mu g/m^3$ .Based on the results of the above research, it can be concluded that people in areas with the highest concentrations of NO_2 and SO_2 , such as Kampung Pisang, Ujung Sabbang, Lakessi (for NO_2) and Lumpue, Watang Bacukiki (for SO_2), need to pay more attention to the implications and prevention efforts to avoid diseases caused by these pollutants.

Keywords: NO_2 and SO_2 Air Quality, Implications of NO_2 and SO_2 Concentrations, Geographic Information System (GIS).

1. Introduction

Air pollution is a challenge in every part of the world. More than 99% of the world's population breathes polluted air. Human activities are responsible for 90% of air pollution, while natural activities account for 10%. [1]. According to WHO, the increasing use of fossil fuels in transportation and industrial activities is a major cause of air pollution in the environment. Air pollution is considered a major risk factor for health problems. An estimated 4.2 million premature deaths were caused by exposure to urban and rural air pollution in 2016. Nearly 91% of premature deaths occurred in Southeast Asia and the Western Pacific. Motor vehicle activities mainly produce pollutants harmful to human health, such as nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) [2].

There is a strong correlation between air quality and respiratory diseases in children under five and adults. According to the World Health Organization (WHO), air pollution causes 3.8 million premature deaths worldwide. These include pneumonia (27%), stroke (18%), chronic obstructive pulmonary disease (20%), ischemic heart disease (27%), and lung cancer (8%). [3]. Some studies show that air pollution has a major impact on developmental disorders and stunted growth in children under the age of five, after water quality, hygiene and sanitation. [4]. Atmospheric pollution is an environmental problem that affects humans, animals, plants, materials and buildings, and impacts rainwater quality. [2]. Air pollution has short-term and long-term impacts on health. Common diseases are respiratory diseases, heart disease, cancer of various organs, reproductive disorders, and high blood pressure. [6]. Other studies have also shown that air pollution that exceeds standards can cause death. Air pollution is closely linked to premature death and other long-term adverse health effects. [7]. Industrial activities, road transportation, open-air garbage burning, biogenic sources, dust, and domestic indoor sources have a considerable influence on the severity of air pollutants and emissions to the environment. [3].

Pollutants in ambient air that have a high potential to cause respiratory problems in humans are NO_2 , SO_2 , because they are irritants to the human respiratory tract. Nitrogen dioxide is one of the components of air pollutants that is toxic, has a sharp smell that stings the nose and is brownish red in color, which can affect human health. Exposure to SO gas_2 causes health effects such as the onset of throat irritation at concentrations of 8-12 ppm, causing eye irritation at concentrations of 20 ppm and swelling of the mucous membrane and mucus formation, aggravating a person with asthma, COPD and bronchitis. [11]. Parepare City is one of the areas that experience ambient air pollution by the concentration of SO_2 and NO_2 . Ambient air is free air on the earth's surface in the troposphere that affects human health, living things, and other environmental elements [11]. [11]. Air quality measurements usually still use *portable* devices such as *fan anemometers, air quality monitors* and *Global Positioning System* (GPS). Therefore, there is a technology regarding digital mapping through Geographic Information Systems (GIS) that can be used to determine the distribution of air quality, especially in urban areas in the form of graphs and distribution maps.

2. Methods

The type of research used is a descriptive qualitative method with a Geographic Information System (GIS) approach to determine the distribution of SO_2 and NO_2 concentrations in Parepare City in 2023 so that the implications for public health caused by concentrations of SO_2 and NO_2 can be understood and make preventive efforts to minimize disease due to pollution of SO_2 and NO concentrations.$_2$.

This research was conducted for two months, namely from February to March 2024. The place of this research was conducted in Parepare City.

Data processing was carried out statistically using a computerized system with the following steps:

a. *Editing* is the activity of checking the list of entries whether the data filling is complete, clear, relevant, and consistent with the desired list of entries.

b. *Processing* is the activity of entering data into a computer program.

c. *Cleaning* is the activity of cleaning data or checking the data that has been entered. This is done to avoid errors that may occur when entering data into the computer program.

The analysis used is descriptive analysis and spatial analysis. Descriptive analysis to determine the distribution of air pollution concentrations of SO_2 and NO_2 in Parepare City presented in the form of maps using the *Quantum GIS* application. Spatial analysis through the map overlay feature, namely by uniting different layers so as to display attribute information from both maps, this analysis is to determine the level

of air pollution in Parepare City. Then the data is calibrated from satellite image measurement units, namely mol/m^2 to µg/m^3 using the following formula;

Formula for Converting Units of mol/m2 to µg/m3 Nitrogen Dioxide (NO2)

Molecular mass of NO_2 : 46.0055 g/mol

The molar volume of gas at standard conditions (STP): 22.414 m^3/mol

Mass to microgram conversion: 1 g = 1000000 µg

Conversion Factor is the ratio between the molar mass of NO_2 and the molar volume of gas at standard conditions.

$$\text{Conversion Factor} = \frac{\text{Massa Molar NO2}}{\text{Volume Molar Gas pada STP}}$$

$$= \frac{46{,}0055 \text{ g/mol}}{22{,}414 \text{ m}^3\text{/mol}}$$

$$= 2{,}051 \text{ g/m}^3$$

Each mole/m^2 NO_2 can be converted to microgram/m^3 by using the calculated conversion factor.

Concentration (microgram/m^3) = Concentration (mol/m^2)× Conversion Factor

Concentration (microgram/m^3) = Concentration (mol/m^2)× 2,051 g/m^3

Formula for converting units of mol/m2 to µg/m3 Sulfur Dioxide (SO2)

SO molar $mass_2$: 64.066 g/mol

The molar volume of gas at standard conditions (STP): 22.414 m^3/mol

Mass to microgram conversion: 1 g = 1,000,000 µg

The conversion factor is the ratio between the molar mass of SO_2 and the molar volume of gas at standard conditions.

$$\text{Conversion Factor} = \frac{\text{Massa Molar SO2}}{\text{Volume Molar Gas pada STP}}$$

$$= \frac{64{,}066 \text{ g/mol}}{22{,}414 \text{ m3/mol}}$$

$$= 2{,}860 \text{ g/}^{3}$$

Each mole/m^2 SO_2 can be converted to micrograms/m^3 by using the calculated conversion factor.

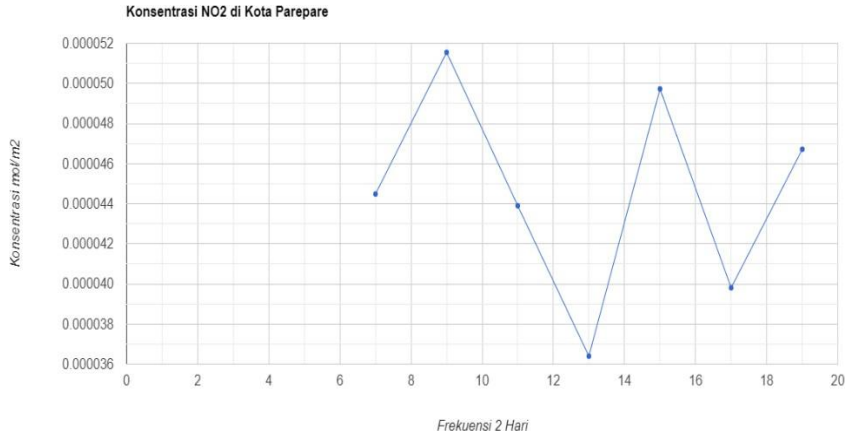
Concentration (microgram/m^3) = Concentration (mol/m^2)× Conversion Factor

Concentration (microgram/m^3) = Concentration (mol/m^2)× 2,860 g/m^3

3. Result and Discussion

Parameter Nitrogen Dioxide (NO)$_2$. Due to human activities, air quality often decreases and changes. This change in quality can be in the form of changes in physical properties and chemical properties. Chemical changes can be in the form of reduction or addition of one of the chemical components contained in the air, which is commonly known as air pollution, one of which is nitrogen dioxide gas (NO_2). Nitrogen gas is oxidized into NO gas$_2$, then if the oxidation continues, it will produce NO gas$_2$. When this gas reacts with water in the atmosphere, it will form nitric acid which plays a role in the occurrence of acid rain. [12].

NO concentration monitoring results$_2$ in (Figure 1) in the graph shows the results of Sentinel-5p satellite image monitoring with units of mol/m^2 .



Export of NO2 data from *Google Earth Engine* in units of mol/m^2

Google Earth Engine sentinel 5p reading results in the form of NO concentration^2 with units of mol / m^3 converted in units of µg / m^3 after averaging the results obtained as in (Figure 5).

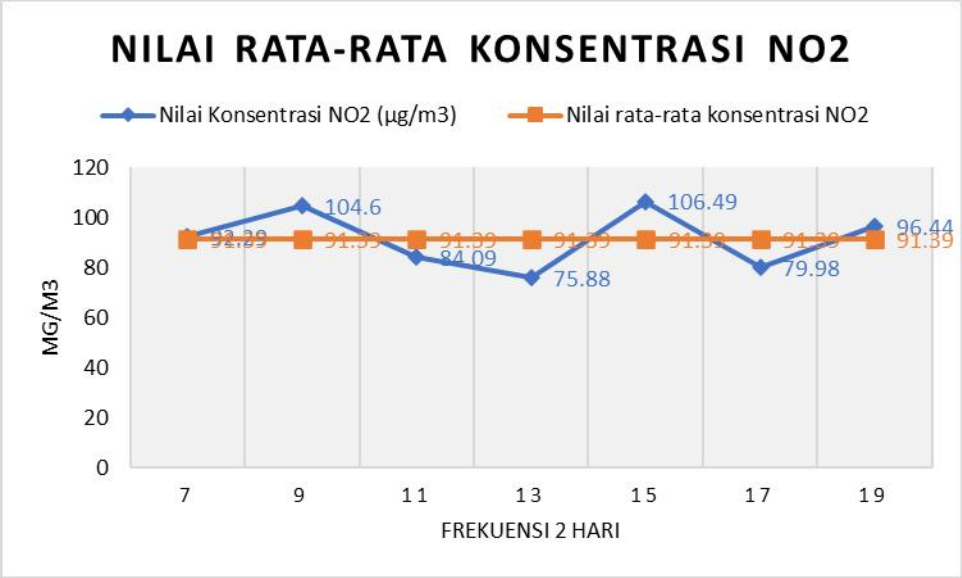


Figure 2. Graph of NO concentration values[2] in units of µg/m^3

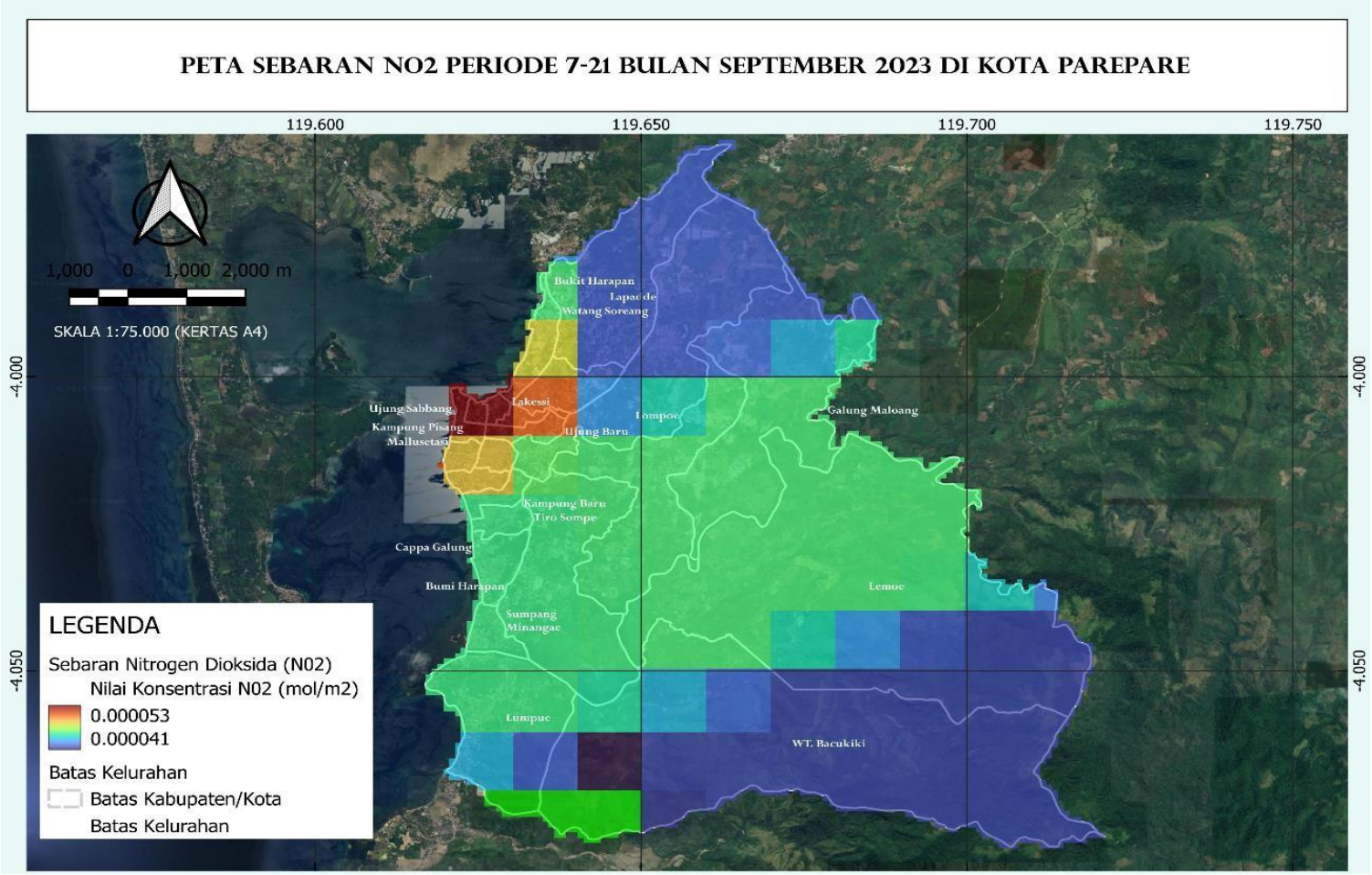
In measurements made by 5p sentinel image data recording for 2 weeks, starting on September 07, 2023, the average result of NO concentration$_2$ is 91.39 µg/m^3 or about 0.000044 mol/m^2 , the highest increase occurred on September 15, 2023 with a value of 106.49 µg/m^3 or about 0.000051 mol/m^2 , the first day of monitoring, namely September 7, 2023, the concentration value obtained was 92.29 µg/m^3 or about 0.000045 mol/m^2 while on September 9, 11, 17 and 19, 2023 there was fluctuating data recording and the lowest value decrease during the measurement period on September 15, 2023 with a concentration value of 75.88 µg/m^3 or about 0.000037 mol/m^2 .

The graph shows fluctuations in the concentration of NO_2 in the air in 2-day intervals. Although there is some variation in the NO_2 concentration values, the average value of NO_2 concentration remains relatively constant throughout the measurement period.

The highest concentration value recorded was 106.49 µg/m³ on day 15, while the lowest value was 75.88 µg/m³ on day 13.

Overall, although there were some fluctuations in NO_2 concentrations, the average values remained relatively stable over the analyzed period. This indicates that while environmental conditions or emission sources may change in the short term, NO_2 pollution levels tend to balance out over longer periods of time.

Distribution Map of Nitrogen Dioxide (NO_2) in Parepare City



Distribution Map of NO_2 in Parepare City

Table 1. Distribution of NO_2 in Parepare City

Color Spread	Concentration (mol/m)^2	Concentration (µg/m)^3	Category (ISPU)	Region
Blue	0,000041 - 0,000044	84,09 - 90,24	Medium	Lemoe urban village, Watang Bacukiki urban village, Lapadde urban village, Bukit Harapan urban village
Light Green	0,000045 - 0,000047	92,29 - 96,39	Medium	Lompoe Village, Bumi Harapan Village, Cappa Galung Village, Tiro Sompe Village, Galung Maloang Village,
Yellow	0,000048 - 0,000050	98,49 - 102,55	Medium	Mallusetasi urban village, Labukkang urban village, Ujung Bulu urban village, Watang Soreang urban village
Orange	0,000051 - 0,000053	104,60 - 106,65	Medium	Bukit Indah Urban Village, Lapadde Urban Village
Red	0,000054 - 0,000055	109,13 - 112,85	Medium	Kampung Pisang Village, Ujung Sabbang Village, Lakessi Village

Implications of NO Concentration Values$_2$ on Public Health . Nitrogen dioxide (NO_2) is a pollutant emitted from various sources in an area, especially the transportation sector. As an overview, the transportation sector contributes 69% of NO_2 pollutants in urban areas, followed by industry and households. The negative impact caused by air pollutant gases such as NO_2 can be estimated as a major health risk [13]. In monitoring NO_2 concentration, the average value obtained is 91.39 μg/m^3 which means it falls into the moderate pollution category, based on the Air Pollution Standards Index (ISPU) In the moderate category on the air pollution index, the level of NO_2 (dioxide nitrogen) The moderate condition category indicates a level of air quality that is still acceptable to humans and other living things but may not be at a level that is immediately dangerous to most people, but still has a negative impact on human health if exposed continuously**.**

Table 2. Impact of exposure to NO_2 in the moderate category

No.	Impact of NO Exposure$_2$	Description
1	Respiratory Irritation	Although not as bad as in the high category, NO_2 can still cause irritation to the respiratory tract, such as mild coughing, slight shortness of breath and throat irritation.
2	Increased Risk of Respiratory Disease	Long-term exposure to NO_2 at moderate levels may increase the risk of respiratory diseases such as asthma, bronchitis and pneumonia, especially in individuals who have pre-existing respiratory conditions.
3	Effects on Lung Function	Moderate concentrations of NO_2 can impair lung function and reduce lung capacity, especially in children, adults and the elderly who already have chronic lung diseases.
4	Increased Risk of Heart and Vascular Disease	NO_2 may also increase the risk of cardiovascular disease, such as heart attack and stroke, although at these moderate levels the risk may not be very significant
5	Increased Risk of Death	Moderate exposure to NO_2 has also been linked to an increased risk of death from cardiovascular and respiratory diseases, especially in already susceptible individuals

Preventive Efforts to Minimize Disease Due to the **Quality of** NO_2. In monitoring the air quality of NO_2 in the city of Parepare, the average NO_2 concentration value is 91.39 $\mu g/m^3$ which is included in the ISPU category as moderate pollution and can have implications for public health, The preventive efforts that can be made to minimize the diseases that can be caused by the quality of NO_2 are as follows;

1. Community Role

   Steps that people can take to contribute to minimizing NO air pollution$_2$ and protecting their health and the environment as a whole are described in (Table 3). [14].

Table 3. Community prevention efforts to minimize disease caused by NO_2

No.	Community Efforts	Description
1	Reducing the Use of Motorized Vehicles	People can reduce the use of private motor vehicles by switching to public transportation, cycling, or walking. This will reduce NO emissions$_2$ from motor vehicles
2	Using Protective Clothing	Wearing protective clothing to reduce exposure to NO_2 is one of the preventive measures that individuals can take to protect themselves from the adverse effects of such air pollution. Although the use of protective clothing does not directly reduce the concentration of NO_2 in the air, it can help reduce the risk of direct exposure to the body, especially when air conditions are very bad. The protective clothing in question can be in the form of face masks.
3	Reducing the Use of Combustion Devices	People can also reduce the use of combustion devices such as wood stoves, gas stoves, or other combustion devices that use fossil fuels. Choosing more efficient cooking equipment or using renewable energy can also help reduce NO emissions.$_2$
4	Encouraging the Use of Clean Energy	Communities can support the use of clean energy such as electricity from renewable sources. This can help reduce emissions from fossil fuel power plants.
5	Air Quality Monitoring	The public can monitor the air quality around them using air monitoring devices or access information from agencies responsible for air quality. This will help them take preventive action if the air quality is poor.

6	Maintain Respiratory Health	People who are vulnerable to the effects of NO_2 , such as children, the elderly, and individuals with respiratory illnesses, should pay close attention to their respiratory health. They should avoid strenuous outdoor activities and ensure they have access to medical care if needed.
7	Participation in Environmental Programs	Engage in environmental programs and volunteer activities aimed at reducing emissions and improving air quality.

2. Government Role

The government has a very important role in minimizing air pollution, including NO_2 air pollution. These measures, the government can play an active role in minimizing NO air pollution$_2$ and improving air quality for the overall welfare of society [15]The following are some preventive measures that can be taken by the government to address NO air pollution$_2$ in the moderate category (with a concentration of 91.39 μg/m³) described in (Table 4)

Table 4. Government prevention efforts to minimize diseases caused by NO_2

No.	The role of government	Description
1	Environmental Regulation and Policy	The government can implement stricter regulations on industries and motor vehicles to reduce NO_2 emissions. This includes stricter emission standards, incentives for the use of environmentally friendly vehicles, and operational restrictions on industries with high NO_2 emissions.
2	Promotion of Sustainable Transportation	The government can encourage people to use sustainable transportation such as walking, cycling, or using electric vehicles. This can be done through incentive programs, development of supporting infrastructure, and socialization campaigns.
3	Environmentally Friendly Infrastructure Development	The government can invest funds in the development of environmentally friendly infrastructure, such as bicycle lanes, sidewalks, and city parks. This infrastructure can encourage people to switch to more environmentally friendly modes of transportation and reduce the use of private vehicles.
4	Air Pollution Monitoring and Warning	The government should have an effective air pollution monitoring system and issue regular warnings to the public if air

		quality is poor. This information can help people take precautions to protect their health when air quality is poor.
5	Education and Public Awareness	The government should also conduct public education and awareness campaigns on the impact of air pollution on health and the environment. This can help raise public awareness about the importance of reducing NO emissions$_2$ and taking steps to protect their own health and the environment.

Effective prevention efforts to minimize nitrogen dioxide (NO_2) air pollution in the moderate category (with a concentration of 91.29 µg/m³) require cooperation between the government and the community. Cooperation between the government and the community in taking preventive measures will help minimize NO_2 air pollution and improve air quality for the common welfare.

Parameter Sulfur Dioxide (SO)$_2$. Sulfur dioxide is a colorless clear gas that is also part of air pollutants. The amount of SO_2 derived from the oxidation of H_2 S is 80%. The remaining 20% is man-made due to sulfur-containing fuels and non-ferrous metal melting, oil refineries, and mountain eruptions. SO_2 pollutants are irritants to the human respiratory tract. Even short-term exposure in low concentrations can have negative effects on health, especially the human respiratory tract.

SO concentration monitoring results$_2$ in (Figure 4) in the graph shows the results of Sentinel 5p satellite image monitoring with units of mol/m^2 .

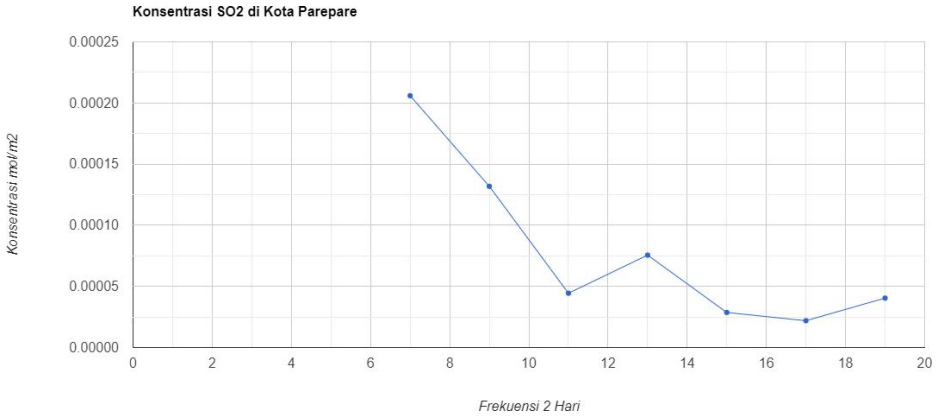


Figure 4. SO concentration graph$_2$ in units of mol/m^2

Then after the NO concentration value$_2$ with units of mol/m^3 is converted in units of µg/m^3 , the results are obtained as in (Figure 5).

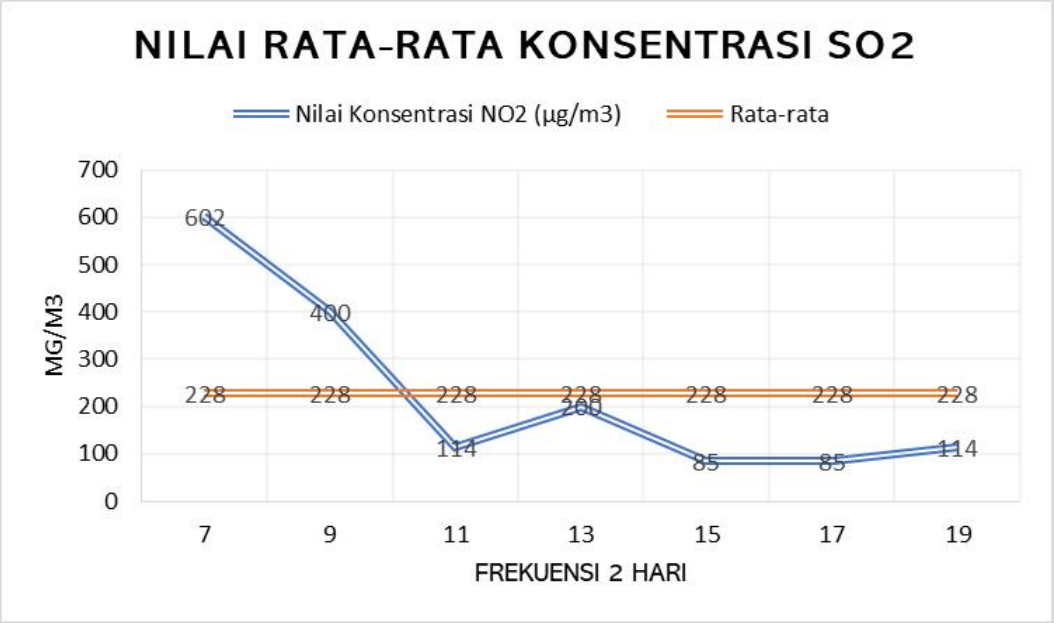


Figure 5. Average values of SO concentrations$_2$ in units of µg/m^3

In measurements carried out for 2 weeks, the average results of SO_2 concentrations in (Figure 8) were 228 µg/m^3 or equivalent to 0.00008 mol/m^2 , at the beginning of the measurement the highest concentration value was 602 µg/m^3 or equivalent to 0.00020 mol/m^2 , on the 9th and 11th there was a decrease of 400 µg/m^3 or 0.00014 mol/m^2 and 114 µg/m^3 or 0.00004 mol/m^2 . There was an increase on the 13th with a value of 200 µg/m^3 or equivalent to 0.00007 mol/m^2 , then on the 15th and 17th the value of SO concentration^2 decreased as well as being the lowest value of SO concentration^2 in the vulnerable 2 weeks of measurement with a value of 85 µg/m^3 or 0.00003 mol/m^2 . Then the last day of measurement, the SO_2 concentration value was 114 µg/m^3 or 0.00004 mol/m^2 . The chart shows considerable fluctuations in SO_2 concentrations in the air in 2-day intervals.

Although there is a large variation in SO concentration values$_2$, the mean value remains constant at 228 µg/m^3 , indicating the presence of extreme values that affect the measurement results.

$_2$Overall, although SO concentrations fluctuated significantly, the average concentration remained stable throughout the measurement period. These fluctuations may be caused by various environmental factors or emission sources that change in the short term.

Distribution Map of Sulfur Dioxide (SO_2) in Parepare City

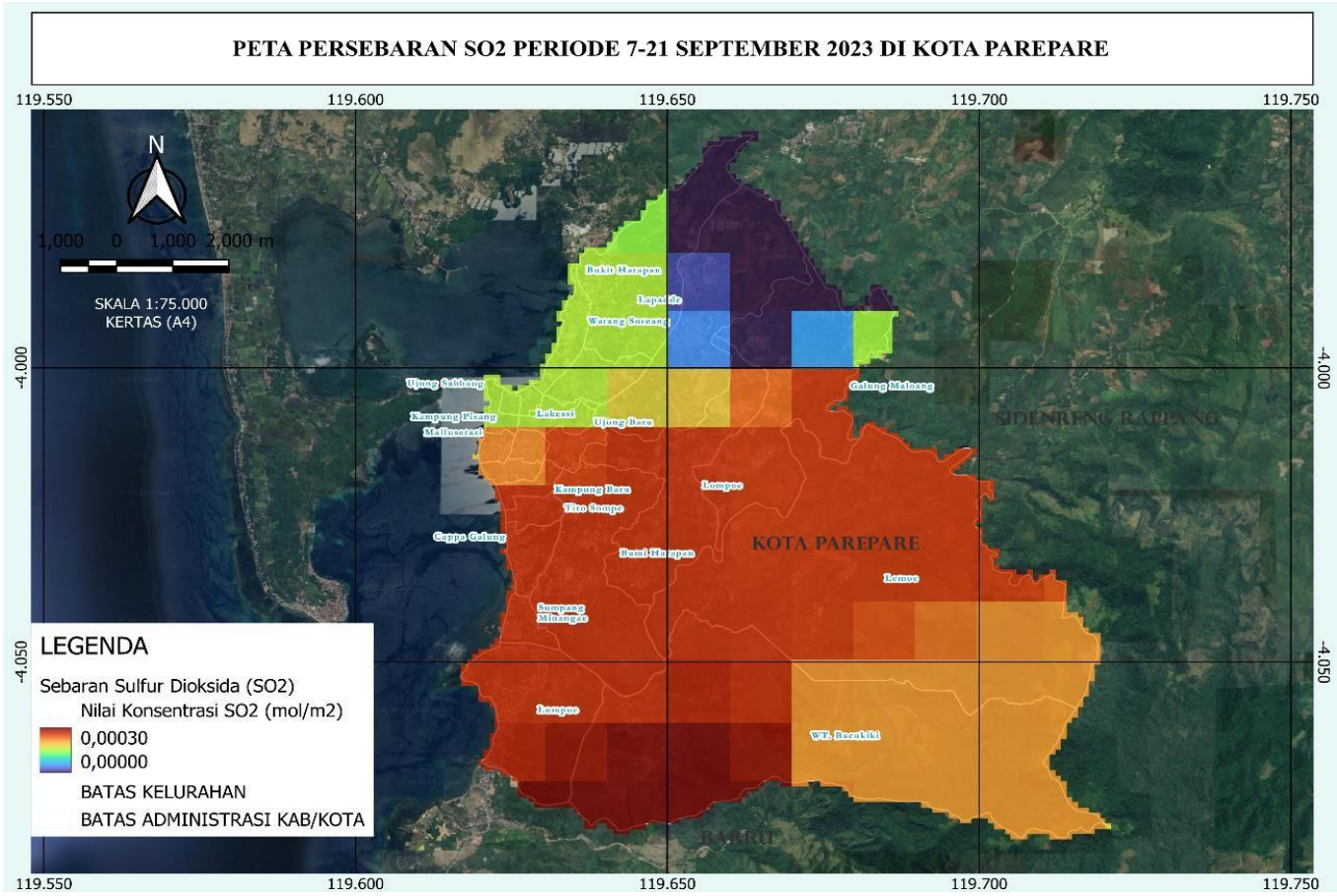


Figure 6. Map of SO Distribution$_2$ in Parepare City

Table 5. Distribution of SO_2 in Parepare City

Color Spread	Concentration (mol/m)^2	Concentration (µg/m)^3	Category (ISPU)	Region
Dark Blue/Blue	0,00000 - 0,00004	0 - 114	Medium	Lapadde Village, Bukit Harapan Village
Light Green	0,00005 - 0,00008	143 - 228	Unhealthy	Bukit Harapan Village, Watang Soreang Village, Lakessi Village, Ujung Lare Village, Kampung Pisang Village
Yellow-Brown	0,00009 - 0,00011	257 - 314	Unhealthy	Mallusetasi urban village, Ujung Bulu urban village, Labukkang urban village
Cream	0,00012 - 0,00015	343 - 429	Unhealthy	Watang Bacukiki Village
Orange	0,00016 - 0,00018	457 - 514	Very Unhealthy	Lemoe Village, Galung Maloang Village, Lompoe Village, Bumi Harapan Village, Lumpue Village, Sumpang Minangae Village, Cappa Galung Village, Tiro Sompe Village, Kampung Baru Village
Red/Maroon	0,00019 - 0,00022	543 - 572	Very Unhealthy	Lumpue Village,

Implications of SO Concentration Values$_2$ on Public Health

At certain concentrations, SO_2 can have a significant effect on human health, especially in susceptible individuals. Short-term respiratory tract irritation resulting in symptoms of cough, sore throat, and shortness of breath, eye irritation, sinus irritation, and pulmonary edema. In addition, it can increase the risk of long-term respiratory infections if the respiratory system is irritated by chronic exposure to SO_2 , which is more susceptible to respiratory infections such as bronchitis and pneumonia. [16]. In the monitoring of SO_2 concentration, the average value obtained is 228 $\mu g/m^3$ which means it falls into the unhealthy pollution category based on the Air Pollution Standards Index (ISPU). In the unhealthy category of the air pollution index, SO_2 concentrations are considered high enough to cause negative impacts on human health, especially on vulnerable groups such as children, the elderly, and individuals with respiratory disorders. The possible health impacts of unhealthy SO_2 concentrations can include (Table 6) [16].

Table 6. Impact of exposure to SO_2 in the unhealthy category

No.	Impact of SO exposure$_2$	Description
1	Irritation of the Respiratory Tract	SO_2 can make the respiratory tract inflamed and irritated, causing symptoms such as coughing, runny nose, sore throat and difficulty breathing.
2	Increases Risk of Respiratory Disease	Exposure to SO_2 can worsen symptoms of an existing respiratory illness, such as asthma or bronchitis. It can make a person find it harder to breathe or have a more serious attack of the disease.
3	Effects on the cardiovascular system	SO_2 can increase blood pressure, heart rate frequency, and the risk of heart attack.
4	Increases Risk of Heart Disease	Exposure to SO_2 may also increase the risk of heart disease, such as heart attack. This is because SO_2 can affect the cardiovascular system, which is the system associated with the heart and blood vessels.
5	Effects on the nervous system	SO_2 can cause irritation to the nerves, increasing the risk of nerve disorders, such as fatigue, headaches and sleep disturbances.
6	Influence on the skin system	SO_2 can cause skin irritation, increase the risk of dermatitis and other skin disorders.
7	Potentially Harmful for Vulnerable Groups	Children, the elderly, and individuals with pre-existing health conditions (such as heart or lung disease) are more susceptible to

		the negative impacts of SO exposure$_2$. They could potentially experience more severe symptoms or other health complications.
8	Lower Quality of Life	Long-term exposure to high levels of SO_2 can reduce overall quality of life, by making a person more susceptible to various health problems and lowering the ability to enjoy daily activities.

Preventive measures to minimize illness due to SO quality$_2$

In monitoring the air quality of SO_2 in the city of Parepare, the average SO_2 concentration value is 228 $\mu g/m^3$ which is included in the ISPU category as unhealthy pollution and can have implications for public health, The prevention efforts that can be done to minimize the diseases that can be caused by the quality of SO_2 are as follows;

1. Community Role

   Some efforts that can be done by the community to minimize diseases caused by SO_2 can be seen in (Table 7)

Table 7. Community prevention efforts to minimize disease due to SO_2

No.	The role of the community	Description
1	Community Awareness	People should have an awareness of the dangers posed by unbalanced SO_2 quality. They should understand how SO_2 can affect health and the environment, and how to reduce its impact.
2	Use of Masks	People can wear appropriate masks when in areas with high SO_2 levels. Masks can help reduce the inhalation of harmful SO_2 .
3	Use of Technology	The public can use technology that can detect air quality, such as smartphone apps, to monitor SO levels$_2$ in their area.
4	Lifestyle Changes	People can change their lifestyle to reduce their contribution to SO levels$_2$. For example, they can use more environmentally friendly transportation, such as bicycles or walking, and reduce their use of fossil fuels.

2. Government Role

   Some of the efforts that the government can make to minimize diseases caused by SO_2 can be seen in (Table 8).

Table 8. Government prevention efforts to minimize SO-related diseases$_2$

No.	The role of government	Description
1	Air Quality Monitoring	The government should monitor and supervise the air quality continuously to ensure that the SO_2 level does not exceed the allowable limit.
2	Technology Development	The government can develop more effective technologies to reduce SO emissions$_2$, such as more efficient air treatment systems.
3	Education and Campaigns	The government should conduct education and campaigns to raise public awareness about the dangers of SO_2 and how to reduce its impact
4	Policy and Regulation	The government can make stricter policies and regulations to reduce SO emissions$_2$, such as increasing fees for industries that do not meet emission standards.
5	Coordination with Institutions	The government should work with other agencies, such as environmental and health organizations, to improve the effectiveness of SO prevention and response efforts$_2$.

By making effective prevention efforts, both by the community and the government, we can minimize the risk of diseases caused by unbalanced SO_2 quality and improve air quality and public health.

4. *Conclusion*

Effects of SO_2 and NO_2 on Health, Exposure to NO_2 with an average of 91.39 µg/m^3 or about 0.000044 mol/m^2 is in the moderate category can cause respiratory tract irritation, increase the risk of respiratory and cardiovascular diseases, and potentially increase the risk of death. Exposure to SO2 with an average of 228 µg/m^3 or equivalent to 0.00008 mol/m^2 falls into the unhealthy category and is also dangerous, causing respiratory tract irritation, increasing the risk of respiratory and cardiovascular diseases.

Ambient Air Quality Distribution, The distribution map shows that the concentrations of NO_2 and SO_2 vary in different areas of Parepare City, with the highest concentrations found in several neighborhoods such as Kampung Pisang, Ujung Sabbang, Lakessi (for NO_2 with concentration values of 0.000054 mol/m^2 - 0.000055 mol/m^2 or equivalent to 109.13 µg/m^3 - 112.85 µg/m^3 .) and Lumpue, Watang Bacukiki (for SO_2 with concentration values between 0.00019 mol/m^2 - 0.00022 mol/m^2 or equivalent to 543 µg/m^3 - 572 µg/m^3).

Effective prevention efforts to minimize NO_2 air pollution in the moderate category (with an average concentration of 91.29 µg/m³ or about 0.000044 mol/m^2) and SO_2 air pollution in the unhealthy category (with an average concentration of 228 µg/m^3 or equivalent to 0.00008 mol/m^2) require cooperation between the government and the community. Efforts to minimize health impacts, the community can reduce the use of motorized vehicles, use masks, have a good lifestyle, use clean energy and maintain respiratory health. The government can make environmental regulations and policies, promote sustainable transportation, and conduct strict air quality monitoring and regulation.

Suggestion

Communities in the distribution areas that show concentrations of NO_2 and SO_2 found in several villages such as Kampung Pisang, Ujung Sabbang, Lakessi (for NO_2) and Lumpue, Watang Bacukiki (for SO_2) should pay more attention to the implications and prevention efforts to avoid diseases due to NO_2 and SO_2 pollution.

The results of this study can be used as input to the Parepare City Environmental Service Laboratory and the National Innovation Research Agency to collaborate as one of the government's efforts to use technology and

monitor air quality in *real time* in order to obtain data quickly and effectively so that people can quickly minimize diseases that can be caused by air pollution.

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