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AERMOD Modeling Analysis of CO And Nox Parameters From Diesel Generator Emission Sources in the Coal Mining Industry.

Pandu Sapta Nugraha [1*], Arum Setiawan[2], Indra Yustian[2]

[1] *Environmental Management Study Program, Sriwijaya University*
[2]*Biology Department, Mathematic and Science Faculty, Sriwijaya University*
[2]*Biology Department, Mathematic and Science Faculty, Sriwijaya University*

Abstract: Air pollution is a problem related to industrial activities. The use of fuel for a long enough duration will produce exhaust emissions in a relatively constant amount, which has the potential to damage the ecosystem around the activity area. One of the pieces of equipment used to support the activities of the coal mining industry is a diesel generator. Diesel generators are used for more than 1,000 hours per year, impacting air quality. In an effort to overcome the resulting impacts, an analysis is carried out in the form of a model to determine the distribution pattern of the resulting emissions so that mitigation activities can be carried out effectively. The model used is the AERMOD model, whose application can provide a distribution scheme that is close to the actual conditions. Modeling is carried out with a radius of 5,000 meters and data from emission measurements from the power generation unit. Based on the modeling results, the emission dispersion of CO parameters obtained the highest value in February with a value of 30.4 µq/m3 and the lowest value in March with 3.43 µq/m3. As for the NOx parameter, the highest dispersion value was in June at 6.21 µq/m3, and the lowest value was in January at 3.51 µq/m3.
Keywords: Minning Industry, Air pollution, Emissions, Air pollution dispersion, software AERMOD

1. Introduction

Air pollution occurs due to changes in the atmosphere due to excessive contamination, which results in a decrease in air quality. Air pollutant emissions from business or industrial activities are highly dependent on the type of activity, process, industrial equipment, and utilities used during the activity [16]. Based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 4 of 2021, all forms of business activities and/or activities that have an impact on the environment are required to carry out environmental management. Business activities that produce exhaust emissions as a result of the combustion process originate from the heating process, engine propulsion, and generators [5].

Emissions generated come from heavy equipment such as scraper-dump trucks, loaders, grader excavators and bulldozers. Apart from heavy equipment, other equipment such as generators, conveyors that use fossil fuels also contribute. gas emissions. This is due to the relatively long use of sustain. The use of a mining generator as a source of electricity, the generator used for more than 1000 hours/year, means that the emission will have an impact on the quality of the air around the region of business activity [8].

Dispersion of air pollution Influenced by the distribution of air pollution and meteorological conditions in the surrounding area. Pollutant distribution can describe the amount of air pollution that needs to be checked. One of the models is the dispersion of the Gaussian plume model. To identify the spread of pollutants, software that aids in the mapping of pollutants is required. The aermod model is one piece of software that is used to monitor and evaluate the toxicity of dangerous pollutants when the concentration and pattern of emission spread are known [16].

Modeling is done by processing meteorological data with AERMOD software. AERMOD is an air quality spatial dispersion model intended for compliance with regulations, and is able to predict the distribution of air quality for up to 50 different sources (point, area, or volume sources), besides that the distribution of air quality from mobile sources can also be predicted by software [9].

2. Material and Methods

2.1. Time and Place

This research was conducted from

February 2023 until its completion. The research location is at the Coal Mining Industrial Estate Project Site in Sungai Lilin District, Musi Banyuasin Regency, South Sumatra Province. The secondary data used is data from meteorology, such as wind direction. Solar radiation, humidity, pressure, precipitation, and wind speed were obtained from the European Center for Medium-Range Weather Forecasts (ECMWF).

2.2. Tools and Materials

In this study used stationery, gas analyzer, anemometer, and personal protective equipment. Gas analyzer is a tool used to measure the content of the exhaust gas mixture in generator emissions (Pamungkas, 2014) an anemometer is used to measure wind speed and is based on the speed of the wind through a propeller [15]. Figure A and pictures B show a measuring instrument.

A. Anemometer B. Gas Analyzer

2.3. Ways of working

2.3.1. Meteorological Data Collection

Secondary data uses ERA-5 meteorological data obtained from the European Center for Medium-Range Weather Forecasts (ECMWF) website. These data represent hourly data [17]. while the primary data is in the form of instantaneous measurements made using an anemometer with parameters such as temperature, air humidity, wind speed, and direction. to measure CO and NO2 levels in the generator using a gas analyzer [15].

2.3.2. AERMET Data Processing

Meteorological data that has been obtained from the ERA5 European Center for Medium-Range Weather Forecasts (ECMWF) website will be processed using the AERMET software. There are several steps that must be taken in processing meteorological data.

2.3.3. Windrose Data Processing

Depiction of wind direction and speed from all areas within a predetermined range. Wind direction and speed can be visualized by converting meteorological data into a windrose map. This map can provide information about the distribution of wind direction and speed which is more important in carrying particulate emissions originating from generators. This data is converted into the SAMSON (sam) format, then processed using the WRPLOT View software [4].

2.3.4. DEM Data Processing

AERMAP is software that is used to measure the height of the observation field and receptors before being inserted into AERMOD to analyze the topography of an area. The AERMAP application requires terrain data to process DEM data which is available on the official website https://tanahair.indonesia.go.id. With the scope of the study, the processed terrain data will become a base map or topographical comparison [7].

2.3.4. AERMOD Data Processing

After processing data from AERMET and Windrose, the data will then be run through the AERMOD software. The first step is to create a new project and define a reference point for the area to be studied. In this study, the coordinate system used is the Universal Transverse Mercator (UTM) with the 1984 World Geodetic System (WGS) datum, and the position of the reference point used is the southern angle with a radius of 5,000 m. At that time, enter the coordinate values (X and Y) and the dimensions of the area to be analyzed [9].

The next step is to determine the control pathway where some information is entered, such as choosing a dispersion option with an output in the form of a pollutant concentration value, determining the type of pollutant in the form of a parameter, and determining the selected deployment time according to the required time period, such as 1 hour and the period. Terrain data that has been connected to AERMOD will produce a basemap that has elevation data. Each study area coordinate has an elevation contour grouped by color. The contour type used in this analysis is elevated terrain. The Profile File data that had previously been processed in AERMET was then filled in with station information: Station ID 96221, Sultan Mahmud Badaruddin II, and coordinate points E: 104° 42' 3" and S: 02° 54' 52". Then, the receptor that will be used will be determined by the location of the spread of pollutants originating from emission sources. The receptor used is a receptor with a uniform cartesian grid type [6].

The AERMOD program can be run by running the software, and a status window will appear showing the results of the data entered before the program is run. If the window has a project-complete status, then the AERMOD program can be run. The end result of this software is a simulation of the spread of air emissions originating from the generator, which is depicted on the base map with iso concentration lines and has a color classification for each range of emission concentrations [1].

2.4. AERMOD Data Processing

Data validation is carried out through direct pollutant distribution and measurement data; validation is used to analyze the work system and see the level of accuracy of AERMOD software. The data used in the measurement of pollutant dispersion validation which was measured directly at PT. X from the difference in data validation can be observed in the concentration comparison data from direct pollutant dispersion measurements using aeromod. Limited use of mean square root difference % error (rmspe) is used to determine the error and how it occurred so that the work and its accuracy can be assessed [10].

3. RESULTS AND DISCUSSION

Based on the research that has been done, the results of measuring generator emissions with code UE1 at coordinates (E = 104°08'41.0" and S = 02°32'53.0") with CO = 27 ug/m3 And NOx = 244 ug/m3. UE2 at coordinates (E = 104°09'04.8" and S =02°33'21.5") with CO = 51 ug/m3 and NOx = 4 ug/m3. The measurement results will then be processed using the AERMOD application to obtain output in the form of a map of the dispersion pattern of CO and NOx emission parameters over a period of 1 year.

3.1. Windrose Results

Winrose is obtained from the analysis results using the AERMET application with meteorological data processing. Meteorological data that has been processed is then applied to the AERMET application and the following results are obtained:

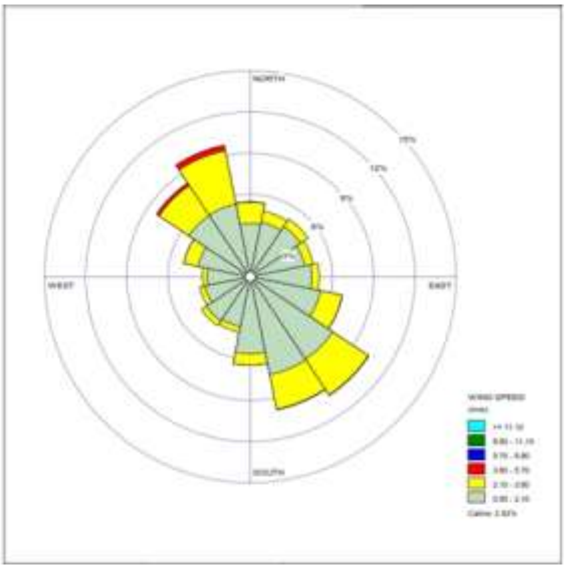

Figure 1. One Year Period Windrose

Based on the results of the analysis on the AERMET application in Figure 1, the dominant wind direction is towards the northwest and southeast. This is due to the monsoon direction, which carries particles in the air. In December–March 2022, the dominant wind direction is to the northwest, while the dominant wind direction is to the southeast in May–September 2022. This difference is influenced by monsoons in the region around the equator, as in Indonesia, especially in Sungai Lilin Village, Musi Banyuasin Regency, and South Sumatra Province. According to [3] the concentration of a pollutant gas in the air is influenced by the meteorological conditions of the area. The meteorological factors consist of wind speed, air humidity, and temperature.

3.2. AERMOD Modeling Result

Emission dispersion modeling was carried out using AERMOD software by processing the measurement results of emission values at the exhaust generator. Modeling is done using a radius of 5,000 meters, which includes data from the measurement results of emission values from two generator units with different capacities. Emission dispersion patterns are projected using color images, which respectively show the concentration levels of

CO and NOx in the air. A darker or contrasting color indicates that the concentration of CO and NOx is quite high; color degradation will decrease as the concentration of CO and NOx in the air decreases. The red color indicates areas exposed to fairly high concentrations of CO and NOx, and the green color indicates areas exposed to fairly low concentrations of CO and NOx. The resulting maximum concentration value can be seen in Table 1 as follows:

Table 1. AERMOD Result Data

No.	MONTH	Year	PARAMETERS	
			CO (ug/m^3)	NOx (ug/m^3)
1	December	2021	2.80	3.60
2	January	2022	19.0	3.51
3	February	2022	30.4	4.53
4	March	2022	3.43	4.14
5	April	2022	3.16	4.20
6	May	2022	5.70	3.94
7	June	2022	7.11	6.21
8	July	2022	9.27	5.72
9	August	2022	6.40	3.82
10	September	2022	7.07	4.27
11	October	2022	5.90	3.97
12	November	2022	4.71	3.55

Based on the results of the analysis using the AERMOD application presented in Table 1, it was found that the CO parameter emission dispersion was at its highest value in February with a value of 30.4 µq/m^3, and the lowest value was in March at 3.43 µq/m^3. As for the NOx parameter, the highest dispersion value was in June at 6.21 µq/m^3, and the lowest value was in January at 3.51 µq/m^3. The results of the AERMOD modeling for the emission distribution of CO and NOx parameters can be seen in Figures 2–5 as follows:

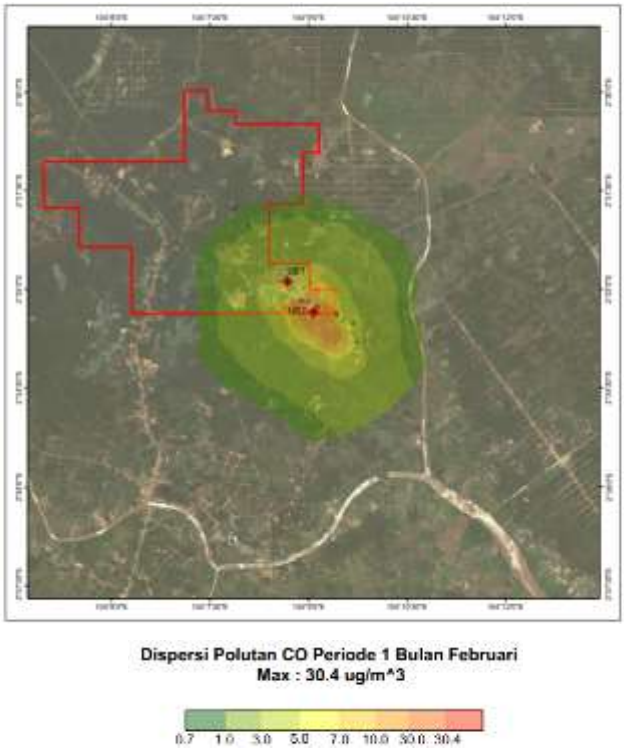

Figure 2. Highest CO Pollutant Dispersion

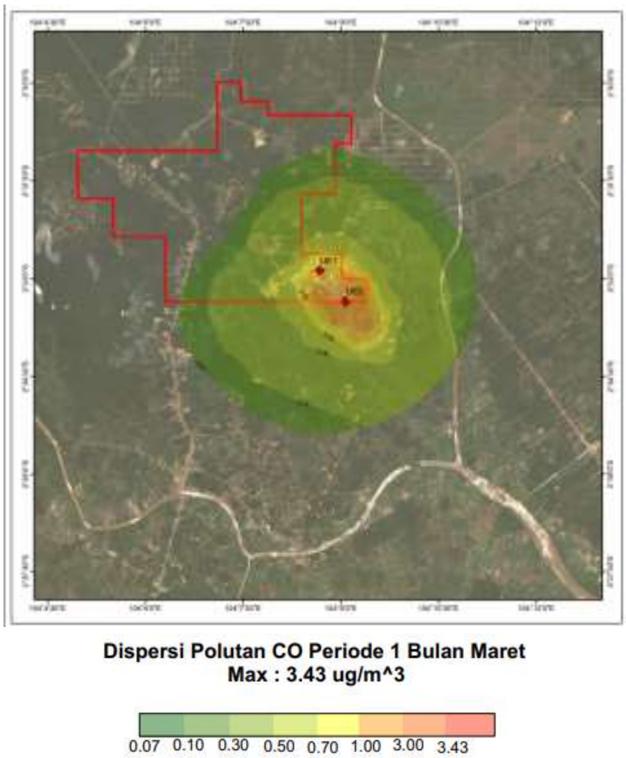

Figure 3. Lowest CO Pollutant Dispersion

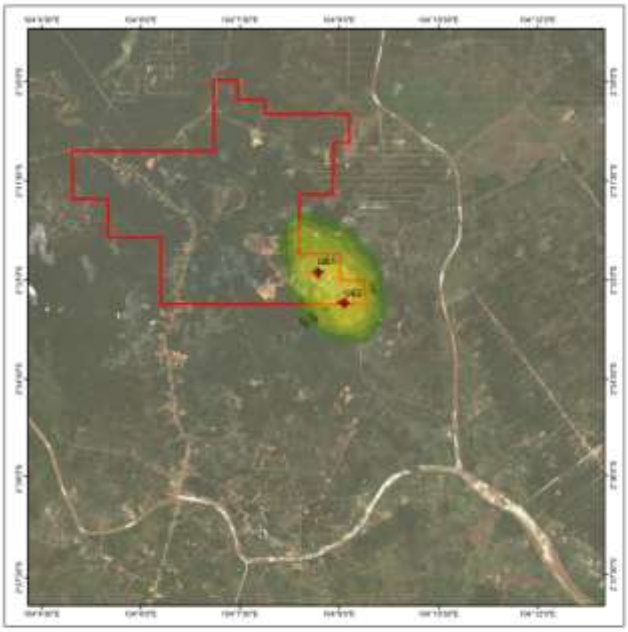

Figure 4. Highest CO Pollutant Dispersion

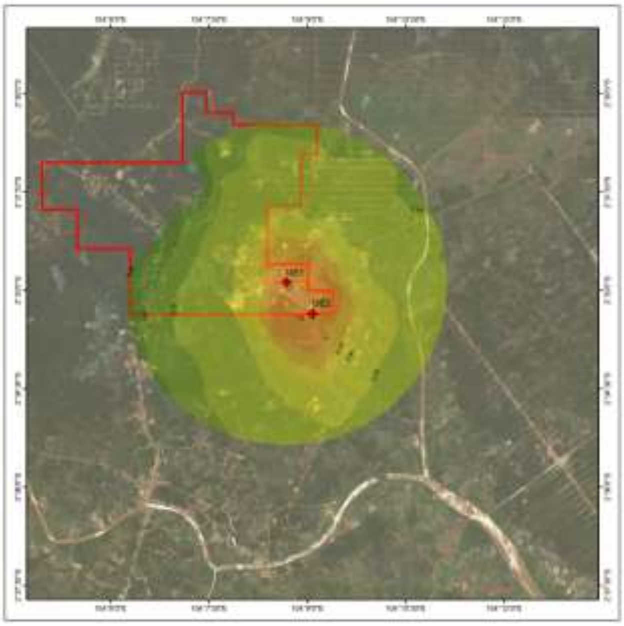

Figure 5. Lowest NOx Pollutant Dispersion

4. Conclusion

Based on the research that has been carried out, several conclusions are obtained as follows:

1. The emission distribution pattern based on AERMOD simulation shows the dominant direction to the Northwest and Southeast.
2. The results of AERMOD modeling with a radius of 5,000 m have a CO parameter emission value with the highest value of 30.4 µq/m3 and a NOx parameter of 62.1 µq/m3.
3. While the value of pollutant emissions for the CO parameter with the lowest value is 3.43 µq/m3 and the NOx parameter is 3.51 µq.

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