



## **Spatial Analysis Of Pm10 Concentration In Villages In The Area Of Lime Stone Mining, Bandung Barat Regency**

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### **Abstract**

Air pollution can occur one of which is due to the activities of limestone mining, especially the combustion process which has a high potential to cause lime dust. This study examines PM<sub>10</sub> pollutant levels in villages that are close to limestone mining areas in West Bandung Regency. PM<sub>10</sub> is airborne

particles smaller than 10 micrometers. The research was conducted in Citatah Village, Gunungmasigit Village, Jayamekar Village, Ciburuy Village and Padalarang Village. This study aims to compare the results of PM<sub>10</sub> pollutant measurements in the five villages with the PM<sub>10</sub> pollutant quality standard in Indonesia. Air sampling was carried out for three days. These results were then analyzed spatially using Arcmap 10.3. Sampling using a particle counter measuring instrument HT-9600. The result showed that there were two villages, Citatah Village (98.78 µg/m<sup>3</sup>) and Gunungmasigit Village (111.67 g/m<sup>3</sup>) with an average PM10 measurement above the standard value of air pollution quality in Indonesia (75 µg/m<sup>3</sup>).

**Keywords:** Air pollution, PM10, Limestone, West Bandung Regency

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## **Introduction**

Air pollution that occurs in the environment and in households is estimated to cause seven million deaths every year (Greenstone, M dan Fan, Q, 2019). Air pollution is the biggest cause of disease burden and Indonesia is ranked fourth in the world for premature deaths due to air pollution, which is 123.753 people/year (Fuller, R, et. Al, 2019). Pollution that occurs in the environment occurs due to industrial activities, transportation emissions, burning of waste that causes smoke, dust and gas pollutants. One of the industrial activities in Indonesia is limestone mining. Limestone is usually processed to become limestone and lime powder by going through a combustion process.

One of Indonesia's limestone mining areas is located in West Bandung Regency. This mining has been established since 1960. Air pollution can occur due to activities from limestone mining, especially the combustion process which has a high potential to cause lime dust (Budiyono, A, 2001). Limestone dust contains calcium carbonate and silica which can cause respiratory tract irritation if inhaled (Armaeni, E. D dan Widajati, N, 2016). Factories in limestone mining produce exhaust gases in the form of CO, NO<sub>2</sub> and dust (Iqbal, M, 2016). The final report on Dinas Lingkungan Hidup Kabupaten Bandung Barat shows the results of ISPU dust content of 87.18 µg/m<sup>3</sup> (medium pollution category).

The smoke generated from the limestone burning process can cause respiratory problems in humans because it is discharged directly into the air. Anggun, D in his research stated that dust exposure is associated with the incidence of Acute Upper Respiratory Infection (Anggun, D, 2013). PM<sub>10</sub> is an inhaled particle that is generally 10 micrometers in size. Air pollution caused by PM<sub>10</sub> can have an impact on the respiratory health of residents living in limestone mining areas. In 2019 in West Bandung Regency, Acute Upper Respiratory Infection was ranked first out of the top ten diseases, with 13,109 cases.



The purpose of this study was to compare the PM<sub>10</sub> pollutant content in five villages located close to the limestone mining area of West Bandung Regency with Indonesian air pollution quality standards.

### Methods

This research using quantitative descriptive research through a spatial approach to indentify and mapping the distribution of PM<sub>10</sub> levels around limestone mining areas in West Bandung Regency. Air sampling using a particle counter measuring instrument HT-9600.

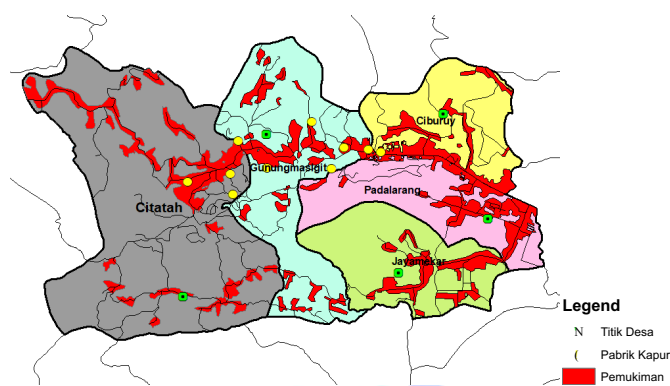


Figure 1. Air sampling map

The sampling locations are in five village points which are located adjacent to the limestone mining area. This point was taken with the consideration that there are settlements.

Table 1. Coordinate point of sampling

| Village       | Coordinate  |            |
|---------------|-------------|------------|
|               | X           | Y          |
| Citatah       | 107.4229029 | -6.8351986 |
| Gunungmasigit | 107.4378833 | -6.831201  |
| Ciburuy       | 107.4659767 | -6.824919  |
| Jayamekar     | 107.4578473 | -6.8536318 |
| Padalarang    | 107.4740553 | -6.8438045 |

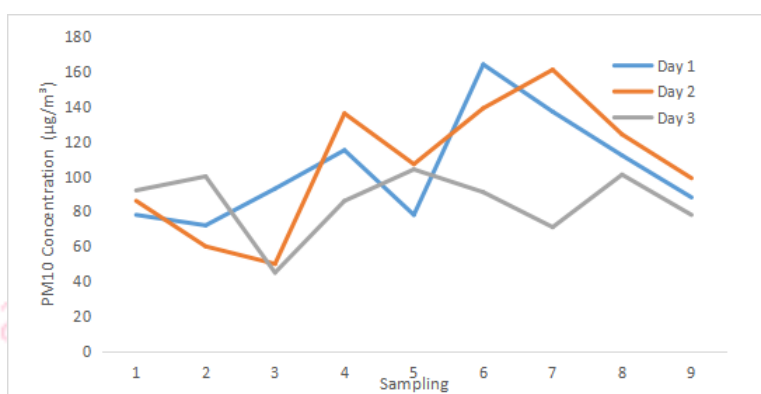
Measurements were carried out every hour for three working days with a total of nine hours per day, starting at 07:00 WIB until 15:00 WIB. Data analysis using SPSS to determine the minimum, maximum, average PM<sub>10</sub> concentration in each village and the results will be presented in graphical form using microsoft excel. Spatial analysis using Arcmap 10.3



application with the Inverse Distance Weighted method. Inverse Distance Weighted is the conventional interpolation method that takes distance as a weight into account. The distance in question is the distance (flat) from the data point (sample) to the estimated block. This method assumes that the interpolated values will be more similar to the sample data that is close to it than farther away. The weights will change linearly according to their distance from the sample data. This weight is not affected by the location of the sample data (Hadi, B.S, 2013).

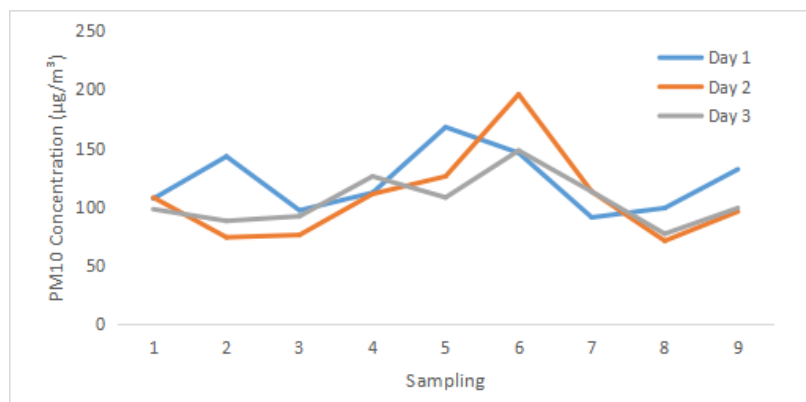
### Results and Discussion

The measurement results for three days, 5-7 June 2021 at 07.00 WIB to 15.00 WIB show PM<sub>10</sub> data as follows:



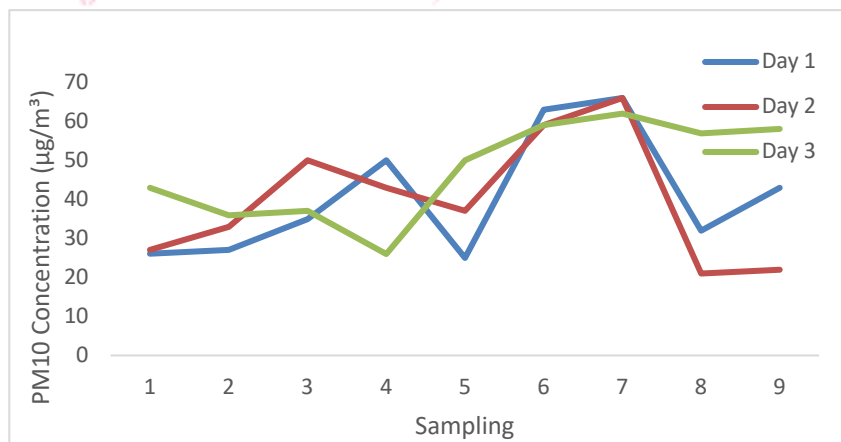
Graph 1. Graph of PM<sub>10</sub> concentration in Citatah Village

Graph 1 shows PM<sub>10</sub> concentrations for three days taken in Citatah Village with nine measurement data per day. The 1st measurement starts at 07.00 WIB until the 9th measurement at 15.00 WIB. The maximum PM<sub>10</sub> concentration occurred on the 1st day at the 6th measurement at 12.00 WIB, which was 164 µg/m<sup>3</sup> and the minimum PM<sub>10</sub> concentration occurred on the 3rd day on the 3rd measurement at 09.00 WIB, which was 45 µg/m<sup>3</sup>. Maximum measurement can occur because at that time there was limestone burning activity carried out by factories. The minimum measurement occurs on the 3rd day where that day is a Sunday where limestone burning activities are not carried out by several factories.



Graph 2. Graph of PM<sub>10</sub> concentration in Gunungmasigit Village

Graph 2 shows PM<sub>10</sub> concentrations for three days taken in Gunungmasigit Village. The maximum PM<sub>10</sub> concentration occurred on the 2nd day of the 6th measurement at 12.00 WIB, which was 196 µg/m<sup>3</sup> and the minimum PM<sub>10</sub> concentration occurred on the 2nd day of the 8th measurement at 14.00 WIB, which was 71 µg/m<sup>3</sup>. The maximum measurement occurs on Saturday where there are still many limestone factories that carry out limestone burning activities and the minimum measurement occurs on Friday at 14.00 WIB which can occur because PM<sub>10</sub> has started to move.

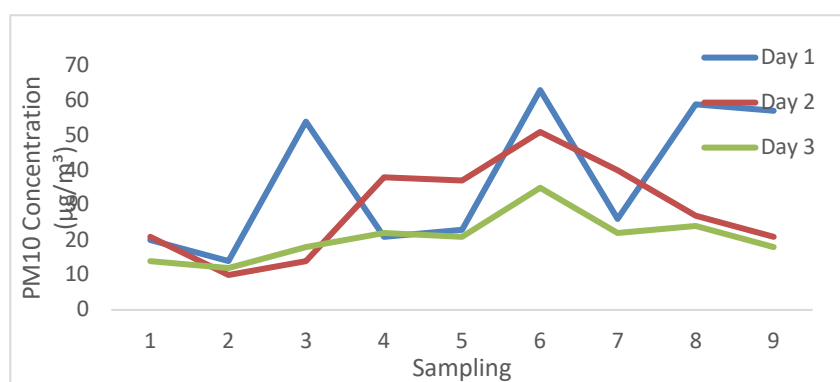


Graph 3. Graph of PM<sub>10</sub> concentration in Ciburuy Village

Graph 3 shows the concentration of PM<sub>10</sub> for three days taken in Ciburuy Village. The maximum PM<sub>10</sub> concentration occurred on the 1st and 2nd day at the 7th measurement at 13.00

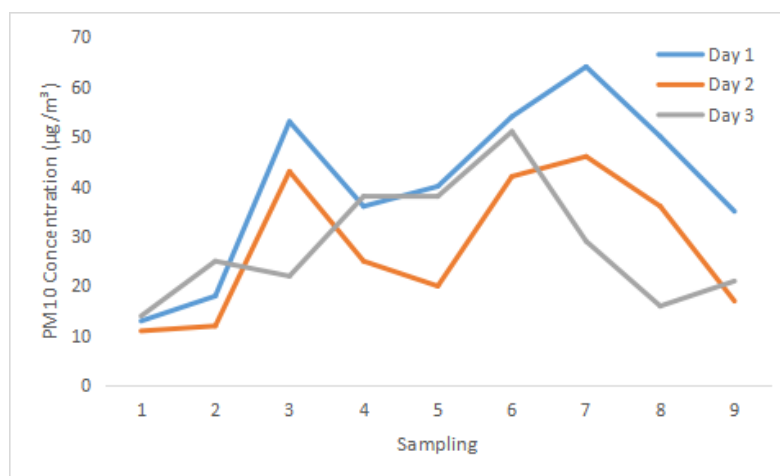


WIB, which was  $66 \mu\text{g}/\text{m}^3$  and the minimum  $\text{PM}_{10}$  concentration occurred on the 2nd day of the 8th measurement at 14.00 WIB, which was  $21 \mu\text{g}/\text{m}^3$ . The maximum measurement occurs on Friday and Saturday afternoon, this can occur due to the influence of industrial activity and the activity of large vehicles that pass through the main road in Ciburuy Village. The minimum measurement occurs on Saturday at 14.00 WIB where  $\text{PM}_{10}$  has started to move.



Graph 4. Graph of  $\text{PM}_{10}$  concentration in Jayamekar Village

Graph 4 shows  $\text{PM}_{10}$  concentrations for three days taken in Jayamekar Village. The maximum  $\text{PM}_{10}$  concentration occurred on the 1st day at the 6th measurement at 12.00 WIB, which was  $63 \mu\text{g}/\text{m}^3$  and the minimum  $\text{PM}_{10}$  concentration occurred on the 2nd day of the 2nd measurement at 08.00 WIB, which was  $10 \mu\text{g}/\text{m}^3$ . Maximum measurements also occur during the day, this can happen because at that time because vehicle mobility is high and the minimum measurements occur on Friday mornings, this happens because not many people have started activities.



Graph 5. Graph of PM<sub>10</sub> concentration in Padalarang Village

Graph 5 shows the concentration of PM<sub>10</sub> for three days taken in Padalarang Village. The maximum PM<sub>10</sub> concentration occurred on the 1st day of the 7th measurement at 13.00 WIB, which was 64 µg/m<sup>3</sup> and the minimum PM<sub>10</sub> concentration occurred on the 2nd day of the 1st measurement at 07.00 WIB, which was 11 µg/m<sup>3</sup>. The maximum measurement occurred on Friday afternoon, it could occur due to community activities and vehicle mobility being high. The minimum measurement is on Friday morning, it can happen because not many people are active at that hour.

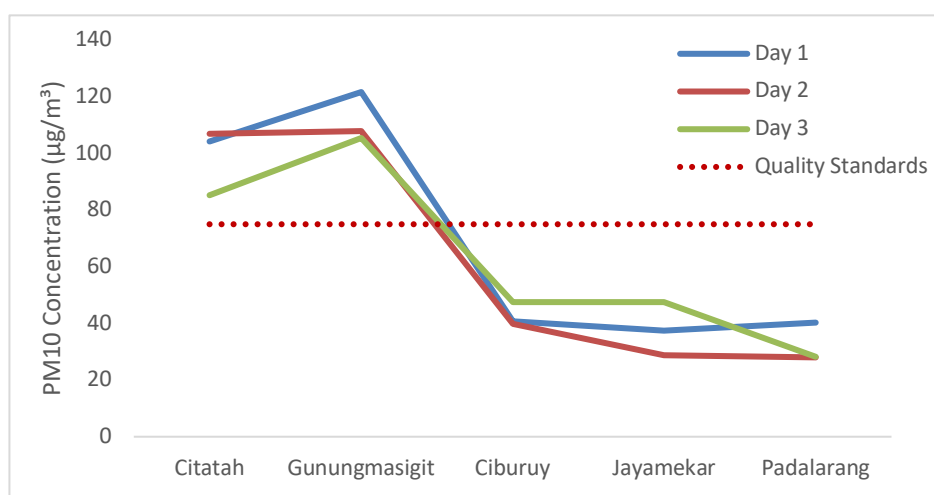
Table 1. PM<sub>10</sub> concentration for 3 days

|               | Maximum Value<br>Concentration<br>(µg/m <sup>3</sup> ) | Minimum Value<br>Concentration<br>(µg/m <sup>3</sup> ) | Average<br>Concentration<br>(µg/m <sup>3</sup> ) |
|---------------|--------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------|
| Citatah       | 164                                                    | 45                                                     | 98.78                                            |
| Gunungmasigit | 196                                                    | 71                                                     | 111.67                                           |
| Ciburuy       | 66                                                     | 21                                                     | 42.7                                             |
| Jayamekar     | 63                                                     | 10                                                     | 37.93                                            |
| Padalarang    | 64                                                     | 11                                                     | 32.19                                            |

The maximum value in the five villages on average is obtained from the results of the 6th (12.00 WIB) and 7th (13.00 WIB) measurement, these times are the time when the limestone burning plant is operating. Based on table 1, it can be seen that the average concentration of



PM<sub>10</sub> is in Gunungmasigit Village. Gunungmasigit village is a village in which there are many limestone factories. Based on data from the Mining Business Permit of the Ministry of Energy and Mineral Resources as of February 2021, there are only two registered limestone factories, but in fact there are 4 large factories and 7 small factories located in Gunungmasigit Village.



Graph 6. Graph of the average concentration of PM<sub>10</sub> compared to the quality standard

Graph 6 shows the average PM<sub>10</sub> concentration data taken in five villages over a period of 3 days. Citatah Village (98.78 µg/m<sup>3</sup>) and Gunungmasigit Village (111.67 µg/m<sup>3</sup>) is a village that has an average concentration of PM<sub>10</sub> above the PM<sub>10</sub> quality standard in Indonesia. PM<sub>10</sub> quality standard in Indonesia is 75µg/m<sup>3</sup>[7]. The average PM<sub>10</sub> of the two villages can be affected because Citatah Village and Gunungmasigit Village are the villages closest to the limestone mining area and there are many limestone factories around the village. The concentration of PM<sub>10</sub> can sit and float in the air for a long time before finally settling, this is what causes local pollution in villages close to limestone mining areas (Novianti, SF, 2020).

PM<sub>10</sub> levels above the quality standard cause air pollution. Air pollution can cause irritation of mucous membranes and cause changes in various lung functions for example in respiratory mechanics, clearance of mucociliary and alveolar particles, lung gas exchange and



airway permeability (Setiani, O, 1996). These possibilities can cause Acute Upper Respiratory Infection in people living in villages with PM<sub>10</sub> levels above the quality standard.

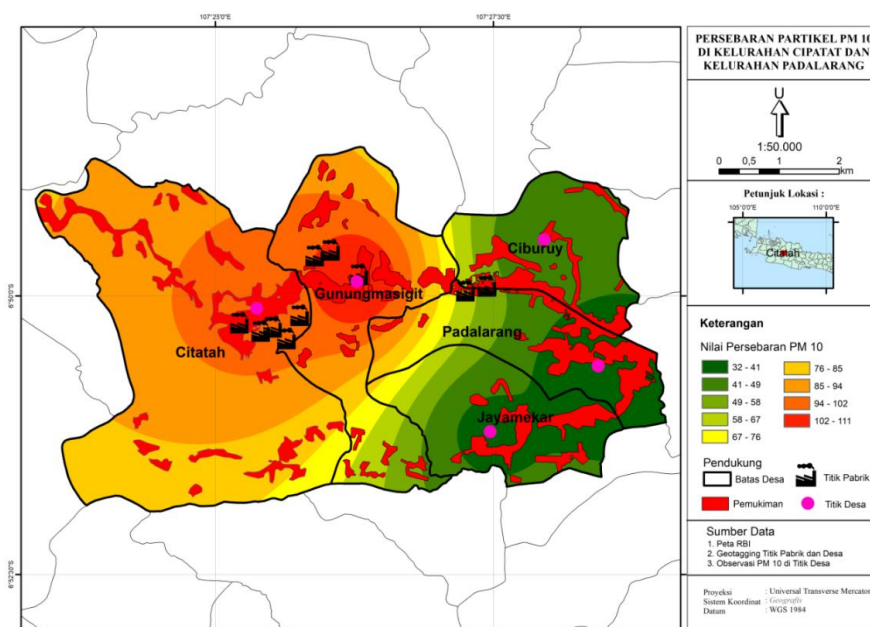


Figure 2. Spatial analysis of PM<sub>10</sub> concentration

On the spatial analysis map using the Inverse Distance Weighted (IDW) method, which is an interpolation method that takes distance as a weight, it can be seen that there are two villages, namely Citatah Village and Gunungmasigit Village which have high PM<sub>10</sub> concentrations. This is because there are many limestone factories in the two villages. With this map, it can be seen that Citatah Village and Gunungmasigit Village are the villages most affected by limestone activity in the area.

## Conclusion and Recommendation

### Conclusion

Based on the research, the following conclusions can be drawn:

1. The average measurement of the maximum concentration of PM<sub>10</sub> is at the 6th measurement (12.00 WIB) and the 7th (13.00 WIB) which is the time when the limestone kiln is operating.



2. Citatah Village and Gunungmasigit Village are villages that have an average  $PM_{10}$  concentration above the  $PM_{10}$  quality standard in Indonesia.

### **Recommendation**

The local government needs to tackle air pollution that occurs in villages close to limestone mining areas so that the presence of  $PM_{10}$  concentrations can be reduced to a minimum so as not to cause respiratory health problems for the community. Local residents are also trying to be able to use masks when doing activities outside the home so that  $PM_{10}$  is not inhaled.

### **References**

- Anggun, D.(2013).*The Effect of Urea Dust Exposure on Acute Respiratory Infections (ARI) in Workers at the Urea Fertilizer Packing Unit (PPU) PT. Pupuk Sriwidjaja Palembang*. Sriwijaya University Palembang
- Armaeni, E. D and Widajati, N.(2016).*The Relationship of Lime Dust Exposure with Lung Physiology Status in Gamping Workers*. The Indonesian Journal of Occupational Safety and Health
- Budiyono, A.(2001).*Air Pollution: The Impact of Air Pollution on the Environment*. Dirgantara News. Vol. 2 No.1
- Deputy for Legislation and Legal Administration.(2021).Attachment VII Government Regulation of the Republic of Indonesia Number 22 Year 2021. Jakarta
- Fuller, R, et. al.(2019).*Pollution and Health Metric*.Switzerland: Global Alliance on Health and Pollution
- Greenstone, M dan Fan, Q.(2019).*Indonesia's Worsening Air Quality and its Impact on Life Expectancy*.Air Quality Life Index
- Hadi, B.S.(2013).*Metode Interpolasi Spasial dalam Studi Geografi*.Geomedia.Vol. 11 No. 2



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Iqbal, M.(2016).*Air Pollution Due to Limestone Burning in the Citatah Karst Area, West Bandung Regency associated with West Java Regional Regulation Number 11 of 2006 concerning Air Pollution Control*. Thesis. Bandung Islamic University

Novianti, SF., Sumeru, K.(2020).*Measurement of PM<sub>10</sub> Concentration in Industrial, Semi-Industrial, and Non-Industrial Areas in Bandung Regency*. Proceedings. The 11th Industrial Research Workshop and National Seminar

Setiani, O.(1996).*Trend of Air Pollution and its Effect on Human Health in Hiroshima Prefecture*.Hiroshima J.Med.Sci



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