Analysis of the effect of CO and PM 2.5 parameters on vegetation conditions in red brick industrial area, Srimulyo Village, Sragen Regency

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Abstract. Red brick industrial activity which is developing in Srimulyo Village generates pros and cons related to CO gas emissions and the resulting particulates, which affect to the flora diversity. This study aims to identify flora biodiversity in the red brick industrial area of Srimulyo Village, then analyze the effect of the emission value of CO and Particulate Matter (PM) 2.5 on vegetation in the area. This study conducted at 4-point locations for sampling, using Shannon-Wiener formula to determine the biodiversity index. Result obtain low vegetation diversity index and low stability with the average index value was 1.91. The low vegetation diversity index has correlation with the measured value of CO and PM 2.5 gases which above the standard thresholds. The average range of CO gas levels is 353.3-844.7 ppm, and PM 2.5 levels is 1928.7-9517.7 µg/m³. In conclusion, this study shows that the CO gases and PM 2.5 resulted from Red Brick Industrial Area affect to the flora diversity index into a low cluster in the observed location.

1. Introduction

The environment is a unitary space with all objects, forces, conditions, and living things, including humans and their behavior, which affect nature itself, continuity of life, and the welfare of humans and other living creatures. Meanwhile, according to Rizal [1], a quality of living environment is a condition where the environment can provide a good and comfortable life and meet the health standards of humans and other living things such as flora and fauna. The quality of environment is also assessed from the interaction or interdependence between components of environment which includes ABC (Abiotic, Biotic, Culture) factors. In addition, the diversity of living things in an environment will also affect durability and resilience of environment.

Human activity is a process carried out by humans in order to manage, improve, and produce a product. Human activities have specificity in the variety of patterns and the resulting impacts, both on the environment and on humans themselves. One of these activities is industrial activity. Industrial activity is an economic activity that aims to process raw materials, semi-finished materials, or finished materials into other materials with a higher value, including industrial design and engineering activities. This industrial activity has the potential to cause various pollution impacts on environmental components, which generally include air, water, and soil pollution. This pollution then has negative impact on flora diversity at the genetic, species, and ecosystem levels. In addition to industrial activities,
agricultural and residential activities also have potential to cause pollution which can reduce the number and the distribution of plant species population.

Environmental protection and management are a systematic and integrated effort carried out to preserve environmental functions and prevent environmental pollution and/or damage. The protection and management which includes planning, utilization, control, maintenance, supervision, and law enforcement. The existence of differences in management and supervision of environment will have an impact to the reduction amount of land cover [2]. Changes land from productive vegetated landscapes to other landscapes without vegetation will result in a decrease in the ability to absorb carbon in environmental area [3]. Based on this, public awareness of the importance of flora diversity as a biological indicator of environmental pollution is still very low [4]. According to Nursia and Harudu [5], high consumption pattern and economic growth in the current era will have impact on the increasing concentration of CO\textsubscript{2} in the atmosphere by doubling within next 100 years. This increase in CO\textsubscript{2} gas concentration is causing global climate change. Human activities are one of the biggest contributors to CO\textsubscript{2} emissions on earth. The impact of global climate change will certainly endanger human health and cause a decrease in the quality of environment [6].

As the industrial centers located in Sragen Regency, Srimulyo Village, Gondang District, this place has red brick industrial center. The existence of red brick industry has become one of the main livelihoods for local community that commonly found in Srimulyo Village area. But on the other hand, red brick industrial activity resulting large amounts of air pollution. The red brick industry requires high temperature during combustion process so that the bricks can harden and not crumble when immersed in water. In Srimulyo Village, the brick-burning activity uses rice husks as fuel for combustion. As the result, thick smoke that pollutes air in the area around combustion site has been generated during the combustion process. In addition, there is a change in land use where the area that was previously designated as a residential area is then converted into a mixed land use area which is not only intended for housing but also used for industrial activities which is also considered unhealthy for plant biodiversity in the area. Therefore, industrial activities in the form of burning red brick products, passing vehicles transporting raw materials for making red bricks and other activities have the potential to cause air pollution and other environmental problems, such as reducing the number of flora diversity. This study aims to analysis the effect of CO emission and Particulate Matter (PM) on the biodiversity of flora and fauna in red brick industrial area in Srimulyo Village, Sragen.

2. Methods
The study was performed in Srimulyo Village which was selected purposively by considering the location as one of villages in Gondang Subdistrict, Sragen Regency. This village has population of 7,280 people based on the demographic data at year 2020. The study was conducted from March to June 2021. Tools and materials used in field data collection are CO meter to measure CO parameters (ppm), particulate counters to measure PM 2.5 (µg/m\textsuperscript{3}), environmental meters to measure environmental parameters such as wind direction, wind speed (mph), temperature (°C), and humidity or RH (%RH), meter rollers/raffia strings, and worksheets. In addition, to determine the types of plant species that exist, a reference book entitled "Flora" by C.G.G.J. van Steenis was used [7].

![Figure 1. Quadrat method.](image)
The research was conducted using survey method in Srimulyo Village. The data were analyzed using quantitative descriptive analysis method. Collected data were converted using criteria according to the established formula rules. In plant samples, the method used is single lined which is made by determining the research location by purposive sampling, then divided into 4 predetermined observation points (location). After making a compass line, the size of plot is made with the following criteria: Seedling (A): 2×2 m²; Sapling (B): 5×5 m²; Polishing (C): 10×10 m²; Dominant/tree (D): 20×20 m². All tree names in each plot were recorded according to the criteria, for poles and trees their circumference/diameter was recorded, while for seedling and sapling the diameter of the canopy was recorded. The shape of the plot using the checkered line method can be seen in Figure 1.

Vegetation analysis was carried out with the aim of obtaining quantitative data from the collected vegetation data. To determine the diversity index or diversity at each point, vegetation data were analyzed using the Shannon–Wiener formula as follows:

$$H^+ = - \sum_{i=1}^{n} \left( \frac{N_i}{N} \right) \ln \left( \frac{N_i}{N} \right)$$

Note:
- $H^+$: Shannon-Wiener diversity index
- $N_i$: Number of individuals of the A-th species
- $N$: Total number of individual species found

While the range of the Shannon–Wiener (1949) diversity index is:
- $H^+ < 2.3026$ = low diversity and low community stability
- $2.3026 < H^+ < 6.9078$ = medium diversity and medium community stability
- $H^+ > 6.9078$ = high diversity and high community stability

3. Results and discussion

3.1. Carbon Monoxide (CO) gas analysis

The physical parameter of 4 location observed in the current study was presented in Table 1, and the result of CO gas measurement in Table 2. Measurement of carbon monoxide gas levels was carried out using a CO meter. Measurements were carried out at four location points in the Srimulyo Village area. Measurement of carbon monoxide gas was carried out for six times at each location point. At location 1, the average CO gas content was 646 ppm. Location 2 the average CO gas content is 855.7 ppm. Location 3 the average CO gas content is 672.3 ppm. Location 4 the average CO gas content is 353.8 ppm. Based on the measurement data, it can be seen that the highest CO level is at location 2 of 844.7. This is because the burning of bricks that produces a lot of smoke is taking place at the site. The ongoing combustion produces a lot of smoke and tends to be quite thick. The smoke from burning the bricks can help increase CO gas levels in the air.

| Location | Time (WIB) | Coordinate          | Wind Direction | Wind Speed (mph) | Temperature (°C) | RH (%RH) |
|----------|------------|---------------------|----------------|------------------|-----------------|----------|
| Location 1 | 9.53       | (-7.449162; 111.082298) | South          | 3.2              | 35.6            | 64.7     |
| Location 2 | 12.07      | (-7.459402; 111.082649) | South          | 3.1              | 38.3            | 51.3     |
| Location 3 | 12.31      | (-7.459505; 111.084686) | South          | 2.6              | 36.3            | 62.5     |
| Location 4 | 13.24      | (-7.451578; 111.084236) | South          | 0.3              | 35.1            | 65.8     |
Burning bricks which causes high levels of CO is included in incomplete combustion. According to earlier report [8] complete combustion will produce carbon dioxide and water vapor while incomplete combustion will produce carbon monoxide. The lowest level of CO gas was found at location 4, which was 353.8 ppm. Location 4 is the central location point in the Srimulyo sub-district office. In location 4, no brick burning activity was found, so CO gas levels were low. In addition, road conditions that are not so crowded by motorized vehicles also affect CO gas levels. CO gas levels and the number of motorized vehicles is comparable and influence each other. This is in accordance with Anggarani et al. [9] which states that the number of motorized vehicles contributes to the amount of CO gas in the air.

| Location | CO (ppm) | CO (ppm) | CO (ppm) | CO (ppm) | CO (ppm) | CO (ppm) | Average |
|----------|----------|----------|----------|----------|----------|----------|---------|
| Location 1 | 763      | 824      | 826      | 555      | 443      | 465      | 646     |
| Location 2 | 1,027    | 537      | 596      | 1,391    | 748      | 769      | 844.7   |
| Location 3 | 618      | 957      | 903      | 410      | 464      | 682      | 672.3   |
| Location 4 | 339      | 452      | 371      | 316      | 317      | 328      | 353.8   |

There are several regulations regarding value of CO gas quality standards. Based on the Regulation of the Minister of Manpower and Transmigration the threshold value of CO gas in the workplace is 25 ppm. Based on the Peraturan Pemerintah Republik Indonesia Nomor 41 Tahun 1999, the standard value for ambient air CO is 30,000 µg/Nm3 (24 ppm). The average value of CO gas in Srimulyo Village is 353.3-844.7 ppm. This shows that the value of CO gas in Srimulyo Village has exceeded the threshold value. The measurement results of all location points indicate that the CO gas content has exceeded the quality standard. CO gas levels that exceed the threshold can pollute the air. Besides being able to reduce air quality, excessive CO levels can harm living things that are plants, animals, and humans. Based on Budiyono's research [10] air polluted by pollutant gases can affect leaf organs, causing damage. CO gas levels also affect the biodiversity of flora in Srimulyo Village. CO levels that exceed standard threshold cause the flora biodiversity in Srimulyo Village to be in the low-medium category. This indicates that the types of plants found in Srimulyo are still lacking. Types of plants that are usually often encountered are teak and mahogany. The low flora biodiversity index can be caused by the inability of plants to live in conditions that have high CO levels, and many plants die then the types of plants that can live are less varied.

CO gas level has a correlation with several other parameters such as temperature and humidity (RH). Based on the data obtained, locations that have the highest CO gas content tend to have high temperatures and relatively low humidity. Location 1 has a CO gas level of 646 ppm, with a temperature of 35.6 °C and a humidity of 64.7% RH. At location 2, which has the highest CO gas content, the highest temperature is 38.3°C and the lowest humidity is 51.3% RH. At location 3, the CO gas level is 672.3 ppm, has a temperature of 36.3°C and a humidity of 62.5% RH. Location 4, which has the lowest CO level, also has the lowest temperature among other locations, which is 35.1°C, and the highest humidity which is 65.8% RH. This is in accordance with research conducted by Aprilina et al. [11] which states that CO gas levels and air temperature have a mutually reinforcing effect, when the CO levels increase, the air temperature will also increase, and vice versa.

3.2. PM 2.5 analysis
Measurement of PM 2.5 levels was carried out using a tool called a particulate counter and summarized in Table 3. This tool can measure particulates ranging in size from 0.3-10 microns. Measurements were carried out at 4 location points in the Srimulyo area. PM 2.5 measurements were carried out six times at each location point. At location 1, the average level of PM 2.5 was 9517.7 µg/m3. Location 2 the average level of PM 2.5 is 3,325.75 µg/m3. Location 3 the average level of PM 2.5 is 2,339.5 µg/m3. Location 4 the average level of PM 2.5 is 1,928.7 µg/m3. Based on the measurement data, the highest PM 2.5 level is at location 1, which is 9,517.7 µg/m3. This is because the burning of bricks using rice husks is mostly done in that location. The activity of burning bricks will turn rice husks into ashes. The ash can freely fly in the air and can cause air pollution. Ash from burning rice husks contains PM 2.5 pollutants.
Rice husk which is one of the biomasses when burned will produce smoke. This smoke will also contain dust particles such as PM 2.5 [12]. The result of burning rice husks is causes PM 2.5 levels in location 1 to be very high. The lowest PM 2.5 level was found at location 4, which was 1,928.7 µg/m³. Location 4, which is the central location point, is at the Srimulyo sub-district office. In location 4, no brick burning activity was found so that the PM 2.5 content was low. In addition, there were no other combustion activities that could trigger the generation of dust particles. The flow of traffic that is not so crowded also causes not too many dust particles to be produced even though the road conditions are classified as very dry and quite bumpy. The more rice husks that are burned, the more dust particles will be produced [13].

| Location | Level 1 (µg/m³) | Level 2 (µg/m³) | Level 3 (µg/m³) | Level 4 (µg/m³) | Level 5 (µg/m³) | Level 6 (µg/m³) |
|---------|----------------|----------------|----------------|----------------|----------------|----------------|
| Location 1 | 2,435 | 6,233 | 11,406 | 11,176 | 14,608 | 11,248 | 9,517.7 |
| Location 2 | 6,468 | 1,972 | 2,939 | 38.5 | 3,980 | 4,557 | 3,325.75 |
| Location 3 | 2,159 | 3,316 | 2,369 | 2,189 | 1,776 | 2,228 | 2,339.5 |
| Location 4 | 2,228 | 1,779 | 552 | 980 | 3,000 | 3,033 | 1,928.7 |

The standard threshold value for PM 2.5 dust particles has been contained in several regulations. Based on the Peraturan Menteri Tenaga Kerja dan Transmigrasi Republik Indonesia, the threshold value of PM 2.5 in the workplace is 3 mg/m³. Based on the Peraturan Badan Meteorologi Klimatologi dan Geofisika (BMKG) Republik Indonesia Tahun 2016 and Peraturan Pemerintah Republik Indonesia No. 41 Tahun 1999, the permissible limit of PM 2.5 concentration in ambient air is 65 µg/m³, while the average level of PM 2.5 in Srimulyo Village is 1,928.7–9,517.7 µg/m³. This shows that the value of PM 2.5 dust particle content in Srimulyo Village has far exceeded the specified threshold value. The measurement results of all location points showed that the PM 2.5 level had exceeded the quality standard. PM 2.5 dust particles that exceed the standard quality standards can cause air pollution, thereby reducing air quality. The dust particles themselves actually have several sizes, where the smaller the size of the dust particles, the more dangerous it is, especially for humans [14]. In addition to affecting the human condition, dust particles also affect the condition of the vegetation in Srimulyo Village. Based on the results of the research conducted, PM 2.5 levels that exceed the quality standard can cause the flora biodiversity in Srimulyo to be classified as low-medium. The number of PM 2.5 with the results of the analysis of flora biodiversity tends to be negatively correlated. This means that if the PM 2.5 level is high, the flora biodiversity index is low and vice versa. Dust particulates will be accommodated by the leaf surface. Dust particulates that accumulate on the leaf surface can interfere with stomata function so that it can cause plant death [15]. On the one hand, plants can indeed absorb dust particles through the adsorption process, but when dust particles are found in large quantities, they can actually harm plants. Plants that are not tolerant of dust tend not to survive long because of the difficulty in adapting.

PM 2.5 levels have a correlation with wind speed. Based on the data obtained, locations that have the highest PM 2.5 levels tend to have high wind speeds. At location 1 with the highest PM 2.5 content, the highest wind speed is 3.2 mph. At location 2, the wind speed is not much different from location 1, which is 3.1 mph. At location 3 the wind speed is 2.6 mph. At location 4 which has the lowest PM 2.5 levels, it also has a low wind speed of 0.3 mph. Research by Cavanagh et al. [16] also states that there is a mutually reinforcing correlation between wind speed and the number of dust particles, where the higher the wind speed, the higher the concentration of particulates in the air.

3.3. Vegetation analysis
At location 1 we found 5 species of flora with an index value (H') of 1.37 Table 4. It is in the range of $H' < 2.3026$, so it includes low diversity and low community stability. The seedling category was dominated by the species *Urena lobata* L., the pole category was dominated by the species *Tectona grandis sp*, the sapling category was dominated by the species *Leucaena leucocephala*, and the tree
category was dominated by the species *Senna siamea*. Of the 29 individuals, the species *Urena lobata L* became the dominant flora species in the vegetation at this location with a total of 12 individuals.

Table 4. Vegetation diversity index at location 1.

| No | Species                  | Tree Growth Rate | Local Name | Amount | phi      | Ln     | Index  |
|----|-------------------------|------------------|------------|--------|----------|--------|--------|
| 1  | *Urena lobata L*         | Seedling         | Pulutan    | 12     | 0.4138   | -0.8824| 0.3651 |
| 2  | *Senna siamea*           | Tree             | Johar      | 2      | 0.0690   | -2.6741| 0.1844 |
| 3  | *Tectona grandis sp*     | Pole             | Jati       | 9      | 0.3103   | -1.1701| 0.3631 |
| 4  | *Leucaena leucocephala*  | Sapling          | Lamtoro    | 2      | 0.0690   | -2.6741| 0.1844 |
| 5  | *Psidium guajava*        | Pole             | Jambu      | 4      | 0.1379   | -1.9810| 0.2732 |
|    | **Total**                |                  |            | 29     |          |        | 1.3703 |

Table 5. Vegetation diversity index at location 2.

| No | Species                  | Tree Growth Rate | Local Name | Amount | Phi      | Ln     | Index  |
|----|-------------------------|------------------|------------|--------|----------|--------|--------|
| 1  | *Leucaena leucocephala*  | Sapling          | Lamtoro    | 3      | 0.0380   | -3.2708| 0.1242 |
| 2  | *Carmona retusa*         | Seedling         | Serut Pagar| 4      | 0.0506   | -2.9832| 0.1510 |
| 3  | *Urena lobata L*          | Seedling         | Pulutan    | 18     | 0.2278   | -1.4791| 0.3370 |
| 4  | *Vernonia amygdalina*     | Sapling          | Daun Africa| 3      | 0.0380   | -3.2708| 0.1242 |
| 5  | *Tectona grandis sp*      | Tree             | Jati       | 26     | 0.3291   | -1.1114| 0.3658 |
| 6  | *Psidium guajava*         | Pole             | Jambu      | 3      | 0.0380   | -3.2708| 0.1242 |
| 7  | *Thevetia peruviana*      | Tree             | Ginje      | 1      | 0.0127   | -4.3694| 0.0553 |
| 8  | *Colocasia esculenta*     | Sapling          | Talas      | 5      | 0.0633   | -2.7600| 0.1747 |
| 9  | *Senna siamea*            | Tree             | Johar      | 16     | 0.2025   | -1.5969| 0.3234 |
|    | **Total**                |                  |            | 79     |          |        | 1.7798 |

Then at location 2 (Table 5) found 9 species of flora and 79 individuals with an index value ($H^+$) reaching 1.78 or $H^+ < 2.3026$ so that it includes low diversity and low community stability. The seedling category was dominated by the species *Urena lobata L*, the pole category was dominated by the species *Psidium guajava*, the sapling category was dominated by the species *Colocasia esculenta*, and the tree category was dominated by the species *Tectona grandis sp*. The *Tectona grandis sp* became the dominant flora species in the vegetation in this location with a total of 26 individuals.

Table 6. Vegetation diversity index at location 3.

| No | Species                  | Tree Growth Rate | Local Name | Amount | Phi      | Ln     | Index  |
|----|-------------------------|------------------|------------|--------|----------|--------|--------|
| 1  | *Leucaena leucocephala*  | Sapling          | Lamtoro    | 6      | 0.0674   | -2.6969| 0.1818 |
| 2  | *Carmona retusa*         | Seedling         | Serut Pagar| 7      | 0.0787   | -2.5427| 0.2000 |
| 3  | *Curcuma longa*          | Seedling         | Kunyit     | 8      | 0.0899   | -2.4092| 0.2166 |
| 4  | *Mangifera indica L.*    | Tree             | Mangga     | 5      | 0.0562   | -2.8792| 0.1618 |
| 5  | *Tectona grandis sp*      | Tree             | Jati       | 17     | 0.1910   | -1.6554| 0.3162 |
| 6  | *Artocarpus heterophyllus*| Tree             | Nangka     | 2      | 0.0225   | -3.7955| 0.0853 |
| 7  | *Manihot esculenta*       | Sapling          | Singkong   | 6      | 0.0674   | -2.6969| 0.1818 |
| 8  | *Musa paradisiaca*        | Pole             | Pisang    | 11     | 0.1236   | -2.0907| 0.2584 |
| 9  | *Swietenia macrophylla*   | Tree             | Mahoni     | 12     | 0.1348   | -2.0037| 0.2702 |
| 10 | *Urena lobata L*          | Seedling         | Pulutan    | 15     | 0.1685   | -1.7806| 0.3001 |
|    | **Total**                |                  |            | 89     |          |        | 2.1721 |

At location 3 (Table 6), 10 species of flora and 89 individuals were found with an index value ($H^+$) of 2.17, which was included in the range of $H^+ < 2.3026$, thus including low diversity and low community stability. The seedling category was dominated by the species *Urena lobata L*, the pole category was dominated by the species *Musa paradisiaca*, the sapling category was dominated by the species *Manihot esculenta* and *Leucaena leucocephala*, and the tree category was dominated by the...
species *Tectona grandis* sp. The *Tectona grandis* sp is the dominant flora species in the vegetation at this location with a total of 17 individuals.

| No | Species                  | Tree Growth Rate | Local Name  | Amount | Phi     | ln      | Index  |
|----|--------------------------|------------------|-------------|--------|---------|---------|--------|
| 1  | *Swietenia macrophylla*  | Tree             | Mahoni      | 10     | 0.0885  | -2.4248 | 0.2146 |
| 2  | *Urena lobata* L         | Seedling         | Pulutan     | 12     | 0.1062  | -2.2425 | 0.2381 |
| 3  | *Tectona grandis* sp     | Tree             | Jati        | 24     | 0.2124  | -1.5493 | 0.3291 |
| 4  | *Sansevieria*            | Seedling         | Lidah mertua| 3      | 0.0265  | -3.6288 | 0.0963 |
| 5  | *Leucaena leucocephala*  | Pole             | Lamtoro     | 9      | 0.0796  | -2.5302 | 0.2015 |
| 6  | *Carmona retusa*         | Sapling          | Pugar serut | 7      | 0.0619  | -2.7815 | 0.1723 |
| 7  | *Torenia Fournieri* sp.  | Sapling          | Toenia ungu | 6      | 0.0531  | -2.9356 | 0.1559 |
| 8  | *Thevetia peruviana*     | Seedling         | Ginje       | 5      | 0.0442  | -3.1179 | 0.1380 |
| 9  | *Psidium guajava*        | Pole             | Jambu       | 6      | 0.0531  | -2.9356 | 0.1559 |
| 10 | *Pithecellobium dulce*   | Sapling          | Asam belanda| 3      | 0.0265  | -3.6288 | 0.0963 |
| 11 | *Terminalia catappa*     | Pole             | Ketapang    | 2      | 0.0177  | -4.0342 | 0.0714 |
| 12 | *Ipomoea batatas*        | Seedling         | Ubi jalar   | 21     | 0.1858  | -1.6829 | 0.3127 |
| 13 | *Artocarpus heterophyllus*| Tree             | Nangka      | 5      | 0.0442  | -3.1179 | 0.1380 |
|    | **Total**                |                  |             | **113**|         |         | **2.3201** |

At location 4 found 13 species of flora and 113 individuals with an index value (H') reaching 2.32 (Table 7) which is still included in the range 2.3026 < H' < 6.9078 so that it includes moderate diversity and moderate community stability. The seedling category was dominated by the species *Ipomoea batatas*, the pole category was dominated by the species *Leucaena leucocephala*, the sapling category was dominated by the species *Carmona retusa*, and the tree category was dominated by the species *Tectona grandis* sp. The *Tectona grandis* sp is the dominant flora species in the vegetation in this location with a total of 24 individuals.

From the four research locations, it is known that the level of vegetation diversity is categorized as low and the community stability also low. This is because the characteristics of the soil in Sragen Regency on average have a rather hard, dry, and lack of humus soil texture so that the soil is not very fertile [17]. However, some of the species found can grow on the land. These species do not need a lot of nutrients to live so they can survive there. The flora species that live there are planted intentionally, and some are not planted intentionally but live by themselves. Species that are deliberately planted such as teak (*Tectona grandis* sp) which has a regular distribution pattern. Meanwhile, unintentionally planted species such as pulutan (*Urena lobata* L) which has an irregular distribution pattern.

Location 4 is the location with the highest vegetation diversity index value in all these research locations. Because at the time of this research, this location still has many types of flora and land functions that have not been converted. So that location 4 is also the shadiest location from other locations. The number of tall plants can prevent sunlight from reaching directly to the ground. In addition, trees can store water both in the trunk and in the roots so that the temperature around the tree becomes cooler [18]. While location 1 is the lowest vegetation diversity index value because a lot of flora and land have been used to fulfill the life of the people there. Vegetation plays a role in species diversity, surface temperature, water availability, air quality and soil fertility [19]. This proves that vegetation has an important role for the environment.

In all the research sites, the three locations namely location 2, location 3, and location 4 were dominated by teak species (*Tectona grandis* sp). According to Pamungkas’s report [20] teak was deliberately planted to be used for its wood. Teak wood can be used as furniture such as tables, chairs, cabinets, and other wooden equipment, so it has a high selling price. While location 1 is dominated by pulutan (*Urena lobata* L). This is because the teak species there have been widely used. Although pulutan is considered a plant that does not have a selling price, pulutan has great benefits for health and treatment, such as treating diuretics, antipyretics, toothaches, gonorrhea, vaginal discharge, and antibacterial [21]. The average value of the vegetation diversity index (H') of the four research locations
reached 1.91 which included the category of low diversity and low stability. This is in line with the conversion of land used for the brick industry.

4. Conclusion
Based on the analysis of the existing vegetation in the Srimulyo Village area, Sragen Regency, it was found that from the 4 sampling locations the highest biodiversity index was in the 4th location with a total index value of 2.3201. Meanwhile, the lowest biodiversity index is in location 1 with a total index of 1.3703. The average diversity index at all points only reached 1.91. Then it can be said that the diversity index value in the area is in low category. This refers to Shannon Wiener's theory with specific ranges for clusters of high and low flora diversity indices. In addition, the highest CO level was at location 2 with an average of 844.7 ppm. This is considered to have a potential hazard to health and affect the flora around the area. Meanwhile, the lowest particulate was in the 4th location with a value of 9,517.7 g/m³. Therefore, in this study, it is shown that the influence of CO gas and particulates makes the flora diversity index into a low cluster in the red brick industrial area of Srimulyo Village, Sragen Regency.

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