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Function Of Rubber Plant As Dust Absorbentfrom Coal Transportation

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ABSTRACT

Coal transportation is needed because there is a distance between the mine site and the port to ship minerals. The volume of coal transportation traffic reaches 3,338-5,000 trucks per day. The density of coal transportation disperses dustfall of 580.45 tons/km/month. Rubber trees that grow along coal haul roads have different growth than rubber plants that are not affected by dust due to the accumulation of dust particles on the leaves that disturb the photosynthesis process. This study aims to determine the absorption of dust by rubber plants on special roads for coal transportation in several road conditions and the position of rubber trees from pollutant sources. The results showed that the dust absorption by rubber trees on the side of the incline/bend road was always lower than the straight and bend conditions. Dust absorption by rubber trees located at zero meters from the highest coal haul road was 1,563.1 g/g leaf; leaf adsorption was reduced at a tree distance of 25 meters and reduced again at 50 meters. There is a difference in giraffe dust by rubber trees, by variableroad conditions, and the variable distance of the rubber tree from the coal haul road. There are also differences in dust absorption by the interaction of the two variables. The highest PM? dust content in residential areas around coal haul roads is 44 g/m, while the highest PMI? dust levels in houses in residential areas around coal haul roads, in the living room the highest is 65 g/m3 and the highest sleeping room is 53 g/m3.

Keywords: coal, transportation, dust, absorbent, rubber

Introduction

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The potential for coal mining in South Kalimantan is still quite enormous, with coal reserves of 10,659 billion tons (South Kalimantan Province, 2012). Coal production in South Kalimantan was recorded at 149,845,244 Tons in 2015 (DistambenProvKalsel, 2016). The production consists of the Coal Mining Concession Work Agreement and Mining Business Permit that coal production requires transportation.

Coal mining produces dust and disperses it into the surrounding environment, especially coal transportation activities from the mine site to the stockpile. Coal transportation is carried out using dump trucks with capacities between 20 -100 tons. Trucks with large carrying capacity are usually used by large national-scale companies, while dump trucks with small capacities are used mainly by small-scale coal mining companies. The volume of coal transportation traffic on special coal haul roads in Ta pin Regency, South Kalimantan Province reaches 3,338 trucks per day with a truck capacity of 20 tons (Junaidi, 2016), even reaching 5,000 trucks per day (As, 2010).

The results of field observations show that the coal haul road cuts rubber plantations for more than 10 km on certain sections, so that along the road the rubber plantations are directly adjacent to the coal haul road. This rubber plant indirectly functions as a barrier to the spread of dust to the surrounding environment and absorbs dust. Rubber tree is an annual plantation plant in the form of a straight trunk tree with the Latin name Heveabrasiliensis. The first rubber tree only grows in Brazil, South America. Still, after repeated experiments by Henry Wickham, this tree has been successfully developed in Southeast Asia. Currently, this plant is widely developed. Until now, Asia has been a source of natural rubber (PS Tim Penulis, 2008).

Junaidi (2016) stated that rubber trees that grow along coal haul roads have different growth than rubber plants that are not affected by dust. The growth disturbance is caused by the accumulation of dust particles in the leaves. The dust that has been attached to the leaves of the rubber plant cannot even be washed with water because it is firmly attached and changes the physical appearance of the leaves to brown so that they cover the penetration of sunlight that enters the leaves and disturb the photosynthesis process. The results of this study indicate that the leaves of the rubber tree function as absorbent dust.

Hermawan, Rachmad, et al. (2011) stated that acacia plants (Acaciamangium) growing on the green line of the Jakarta-Begor Jagorawi Toll Road could absorb dust is 1,102.5 ppm, and the lowest is 747.0 ppm. Zahriyani's research, Pramudipta (2014), showed that the ability of plants in the Begor Botanical Gardens to reduce CO2, NO2 and dustfall emissions, namely 28.7% CO2 reduction, 2.2% NO2 reduction and 11.4% dustfall reduction, specifically for dustfall absorption. ranged from 0.02 to 0.7 mg/cm2. The biggest dustfall absorption is by the Fukien Tea tree (Philippine tea) or with the Latin name Carmona retusa. The effect of exposure to fine particles (PM2.5) on school-age children who live on the edge of the coal haul road, Binuang District, South Kalimantan Province, was studied in 2010. As a result, 68% of school-age children are at risk of experiencing respiratory problems due to the inhalation of small-sized coal dust. (As, 2010),

This study aims to determine absorption of dust by the leaves of rubber plants, to determine the level of dust in the residential environment, in the bedroom and living room, and determine the number of cases of respiratory tract and TB in people living on the side of the road used for coal transportation.

Research methodology

This research is an observational type because it observes changes in the field without intervening on the variables studied to conclude (Suparyanto, 2010). The research was conducted on a coal haul road located in Tapin Regency, South Kalimantan Province, used by several coal mining companies. Coal road sampling plots where dust absorption is measured are divided into several categories, representing 3 road conditions: straight/flat roads, uphill/downhill roads, and bend roads. Each rubber tree sampling plot is 50 meters long parallel to the road in each row. In the first row, namely the first row of rubber trees encountered after the coal road, 5 rubber trees were sampled 10 meters apart between trees parallel to the road. In the second and third rows, namely the rows of rubber trees which are 25 meters and 50 meters from the first row, in this row also 5 rubber trees were sampled 10 meters apart between trees parallel to the road. So that each sampling plot; A sample of 15 rubber trees was taken.

Leaf samples were taken on selected rubber trees. Leaves were taken from each tree in the front canopy (the part in front, in the direction of the road) and the back canopy (the canopy behind, in the direction of the road). The leaves were taken simultaneously on the same day. The leaves taken are fully opened, are green, occupy the second or third position from the tip and base of the tree branch (Sukarsono, 1998). The leaves taken were also not damaged by pests and diseases. The number of leaves taken for each replication was 15 strands, while the leaf collection day was carried out 3 times. So the number of leaf samples is 270 samples. The leaves of the samples taken were washed with 100 ml of distilled water 4-5 times (until the washing water was clear/with no dust). The washing water is collected in a breaker glass, then centrifuged until the dust is separated from the solvent water. The dust was rinsed into a petri dish of known weight and evaporated at a temperature of 105 degrees Celsius for 2 hours, cooled and weighed. The sample leaves were dried in an oven at a temperature of 105 degrees Celsius, then cooled and the weight was calculated. The amount of dust adsorption is calculated by the formula Dust weight (µg)/dry leaf weight (grams).

Air temperature and humidity were measured on the same day as the day of leaf collection. Air temperature is measured by thermometer. Air and humidity were measured with a psychrometer. These two tools spliced and suspended at a height of + 1.5 meters from the surface, readings after 15-20 minutes at each location. So the number of physical air samples is 9 samples. Observation of the source of particulate pollutants, aims to describe the conditions during the study (when taking leaf samples).Observation this is against traffic volume, i.e. the number of coal trucks passing in both directions per hour.Vehicle speed is the estimated speed of coal transport trucks measured by the average travel time of coal trucks at a distance of 200 meters. The vehicle speed is calculated in kilometres per hour (km/hour). 3 coal trucks are randomly selected at each hour to measure their speed (each loaded truck and an empty truck).

Respiratory disease in question is a disease that is closely related to air quality, in this case, is respiratory tract and pulmonary TB. Respiratory diseases were recorded according to reports from residents who were used as respondents, namely residents living around coal haul roads with a maximum access distance of 100 meters from the haul road. The incidence of respiratory tract and pulmonary TB is only calculated if the disease occurs during the respondent's stay in the country settlement and explore its fluctuations according to season, weather and environmental conditions. Instrument used is questionnaire and observation sheets. Dust samples in the ambient air and dust in the house were measured using a Digital Dust Monitor, with an instantaneous measurement time. This dust measurement was carried out at the 2 largest residential spots on the edge of the coal hauling road, with a proportional number of samples in each spot, as much as 50%. or a maximum of 40 house samples. This measurement of dust levels is compared with ambient air quality standards referring to PP RI No. 41 of 1999.

After being collected in the field, research data entered into the table to be analyzed using Two Way Anova to see differences in dust absorption based on road conditions and the position of rubber trees from pollutant sources. The subsequent analysis is carried out by considering condition of dust source, distance of access from the house to the road, barrier, building condition, and condition and quality of the air (dust). The respiratory tract and pulmonary TB incidence are associated with dust levels in ambient air, bedrooms, and living rooms. The statistical test used to analyze this relationship was chi-square with a significance level of 95%.

Results and Discussion

The traffic volume of coal-hauling trucks ranges from 228 to 324 trucks/hour or 5,472 to 7,776 trucks/day. Meanwhile, the truck speed ranges from 31.0 to 64.8 km/hour. Truck speed on uphill/downhill road conditions is higher (50.4 to 64.8 km/hour) than on straight roads (43.0 to 39.4 km/hour) and bends (31.0 to 41.4 km/hour). The weather factor is relatively the same in every road condition: temperature between 31 to 33C, humidity between 49 to 57%, wind direction from east and northeast, and speed between 2.1 to 3.5 m/second.

Absorption of coal dust by rubber plant leaves Dust absorption by rubber plants on coal haul roads can be seen in the following tables.

Table 1. Dust Adsorption on Leaves of Rubber Plants 1st Repetition

No	Location	Tree to-	1st row		2nd line		3rd row	
			TD	TB	TD	TB	TD	TB
		1	1107.5	723.2	771.0	394.8	915.1	526.2
		2	1252.9	818.9	1563.1	800.3	809.6	486.6
		3	2892.8	1880.3	1332.3	1292.3	1020.6	602.2
1	Straight	4	1965.6	1906.6	1222.1	994.9	911.1	553.2
		5	1751.1	1332.3	1372.5	892.1	899.2	598.0
	Average		1563.1		1063.5		732.2	
		1	1332.3	996.5	921.5	573.0	720.6	503.9
		2	1032.4	874.9	713.6	553.2	557.9	345.0
	Incline/	3	1060.9	842.0	799.4	623.5	583.2	389.6
2	Descent	4	935.1	654.6	617.9	482.0	269.7	186.0
		5	1090.2	861.2	813.2	633.4	784.8	524.2
	Average		968.0		673.1		486.5	
		1	3309.3	1107.5	1304.1	409.3	1149.2	818.9
		2	2042.1	818.8	1198.4	400.1	1149.2	818.9
		3	2524.3	1203.7	1042.4	829.2	1343.0	886.4
3	Bend	4	3455.4	1075.9	2815.8	129.6	1276.0	1021.7
		5	3669.8	1331.5	624.9	3643.8	828.6	548.6

	Average		2053.8		1239.8		984.0	

There is a pattern of decreasing dust absorption by groups of rubber trees located in the 1st row, 2nd row and 3rd row. This means that the farther the position of the tree from the dust source, the smaller the dust absorption will be. The effect of this distance is because the movement of particulates by gravity depends on the particle size, density and wind speed (Caramagna, et al., 2015), so that only particles with a lighter gravity will fly farther and this at the same time on tree positions that are farther from the ground. the dust source will have a smaller adsorption than the dust absorption at the position of the tree which is close to the dust source.

Table 2. Dust Adsorption on Leaves of Rubber Plants 2nd Repetition

No	Location	Tree to-	1st row		2nd line		3rd row	
			TD	TB	TD	TB	TD	TB
		1	171.3	67.2	65.9	56.8	60.6	56.0
		2	245.1	85.9	86.8	42.8	56.8	51.1
		3	196.6	48.6	110.0	71.8	66.9	65.3
1	Straight	4	367.4	358.5	54.2	36.2	72.0	65.4
		5	245.1	239.2	56.6	37.7	46.7	42.1
	Average				61.9		58.3	
		1	94.4	72.1	99.1	94.2	226.6	76.9
		2	46.5	35.5	182.1	52.3	146.6	118.1
	Incline/	3	132.8	101.5	189.2	112.1	140.0	134.4
2	Descent	4	414.8	172.2	119.9	71.0	145.0	172.1
		5	349.9	57.0	151.1	89.5	92.3	155.9
	Average				116.1		140.8	
		1	132.1	149.0	82.7	31.6	26.4	21.6
		2	106.3	85.2	32.4	18.3	22.2	17.4
		3	87.9	94.9	70.0	25.7	83.0	20.9
3	Bend	4	149.7	120.0	33.3	21.9	72.3	21.6
		5	98.9	150.9	57.3	21.1	77.0	35.3
	Average				39.4		39.8	

The physical properties of dust that determine particle weight and potential transport distance from the source are particle density and particle size. Gravitational sedimentation is the main depositional process, for particles > 1 m in diameter, while for particles < 0.001 m i.e. suspended particles, inertia is more important in determining its impact on the surface (Chamberlain, 1986; Wesely and Hicks, 2000).

Table 3. Dust Adsorption on Leaves of Rubber Plants 3rd Repetition

No	Location	Tree to-	1st row	2nd line	3rd row

			TD	TB	TD	TB	TD	TB
		1	100.1	80.8	105.3	29.1	24.0	15.7
		2	77.3	62.4	55.0	31.5	44.7	19.8
		3	50.8	42.3	35.5	20.3	62.3	44.6
1	Straight	4	111.5	56.0	40.8	32.9	50.2	24.3
		5	96.1	70.5	63.4	31.7	53.3	33.8
	Average				44.6		37.3	
		1	34.1	23.3	7.7	20.4	4.6	9.0
		2	75.5	24.0	12.3	11.8	3.4	12.9
	Incline/	3	65.7	27.8	10.2	15.0	8.4	1.5
2	Descent	4	36.4	30.3	11.7	7.2	4.0	3.6
		5	58.2	49.8	5.3	9.1	2.5	3.1
	Average				11.1		5.3	
		1	168.1	26.3	8.6	2.5	4.7	2.5
		2	162.9	69.2	7.6	3.9	5.8	1.3
		3	77.8	35.5	5.2	1.9	6.6	0.8
3	Bend	4	44.7	27.6	1.6	6.0	6.0	2.5
		5	123.1	178.2	4.5	1.5	5.6	5.4
	Average				4.3		4.1	

Plants can reduce pollutant dust particles. Solid particles suspended in the earth's biosphere can be cleaned by tree canopy through adsorption and absorption processes (Alerich and Drake, 1995 in Syamsoedin, 2010). Dense vegetation can increase the deposition of air pollutants near the canopy surface and inhibit the transport of pollutants to the surface (Liu et al., 2004; Litschke and Kuttler, 2008; Lin, Katul and Khlystov, 2012; Maher et al., 2013). However, this study was conducted on rubber plants with the same cropping pattern between locations. The effect of vegetation density was not a variable that contributed to differences in dust absorption on rubber trees in this study.

The deposition of dust particles on the leaf surface occurs through four processes: sedimentation caused by gravity; diffusion with Brownian motion; impaction due to turbulent airflow, and interception resulting from flow airturbulent (Sternberg et al., 2010). Sedimentation mainly affects the deposition of large particles (10-100 m), impaction and interception affect the deposition of particles larger than 0.5 m (Hinds, 1999), and Brownian motion leads to deposition of ultrafine particles (<0.1 m) .. This also corresponds to more dust absorption in trees that are close to the source, because the size of dust particles close to the main source is larger, so that it has a greater gravitational force and quickly settles on the leaf surface.

Differences in road conditions (straight, uphill/downhill, and bends) cause differences in coal trucks' speed. This speed difference affects the turbulencewind that disperses dust. The movement of air masses significantly affects the fate and behaviour of air pollutants. Therefore every weather pattern localis important to observe, when there is a strong wind and turbulent wind blows, the pollutants will be dispersed quickly (Taseiko et al., 2009). The highest amount of dust absorption on the day of the first repetition is on the bend road conditions with an average adsorption of 1,425.9 g/m3, the second repetition on the road climb/down by 134.9 g/m3, and the third repetition on a straight road of 52.2 g/m3, Sampling was carried out on 3 variations of tree positions in each haul road condition. However, the comparison of dust absorption in each road condition based on the tree's position is only done at a distance of O meters from the road. This is because the distribution of dust to the surroundings is also influenced by other environmental factors such as wind direction and speed, concentration and distance from the source, and the length of exposure of leaves to pollutants (Hermawan et al., 2011).

The high sorption is at a position of O meters from the road because, at this distance, the trees will be directly exposed to dust from the coal haul road. The further the tree is from the haul road coal, the lower the dust trapped on the rubber plant's leaves. This is because the direction and speed of the wind will be lower at a distance of 25 and 50 meters. After all, it is blocked by trees in front of it (O meters distance from the road). Trees at a distance of O meters from the road have the greatest exposure because they are closest to the pollutant source. The movement of dust particles from one tree to another is carried by the wind (Hermawan et al., 2011). Dust that is not absorbed by a tree at a distance of O meters will be carried away by the wind and absorbed by the tree behind it (25 and 50 meters). Test results statistics the tree position factor using Two Way ANOVA showed a significant value of 0.000 in the first, second, and third repetitions. There is a big difference in dust absorption by rubber plant leaves based on the tree position factor.

The statistical test results of differences in dust absorption by rubber plant leave based on the interaction of road conditions and tree positions in the first repetition showed a significant value of 0.562 {HO was accepted). This means that there is no interaction between the model of road conditions and the tree's position in influencing the amount of difference in dust absorption on the first iteration day. Different conditions were shown in the second and third repetitions with significant 0.015 and 0.001, respectively {HO was rejected). This means that there is an interaction between the road condition model and the tree's position in influencing the difference in dust absorption on the third iteration day. The significant interaction in the test was continued to the Post Hoc test to find out the significant differences variables. The results of the Post Hoc test show that there is a considerable difference in dust absorption between a straight road with an inclined road and a straight road with a bending road, but it is not significant between an uphill road and a bending road. There is a significant difference in dust absorption between a distance of O meters and a distance of 25 meters and a distance of O meters and a distance of 50 meters, but not significant between a distance of 25 meters and a distance of 50 meters.

Dust absorption on all repetition days showed a downward trend in the back canopy. The dust absorption on the front canopy is higher than the rear canopy because the front canopy is the part that is first exposed to dust from the coal haul road. The leaves on the back canopy only receive the remaining exposure that is not absorbed in the front canopy and dust carried by the wind from the top of the canopy.

The difference in dust absorption between canopy on the day of the first repetition at a distance of O meters from the haul road was 866.2 g/m3, at a distance of 25 meters was 297.4 g/m3, and a distance of 50 meters was 293.9 g/m3. The difference in dust absorption between the canopy on the second repetition day at a distance of O meters from the haul road was 66.8 g/m3, at a distance of 25 meters was 40.5 g/m3, and a distance of 50 meters was 18.7 g/m3. Meanwhile, the difference in dust absorption between crowns on the third repetition day at a distance of O meters from the haul road was 31.9 g/m3, at a distance of 25 meters was 10.0 g/m3, and a distance of 50 meters was 7.1 g/m3.

Dust Levels in Residential Settlements

The dust concentration was measured in PantaiWalang Village which is directly intersected with the coal haul road. Measurements were made on both sides of the haul road {left and right) and then compared with PP RI No. 41 of 1999 concerning ambient air quality standards. Dust concentrations ranged from 22 to 44 gr/m3 with an average of 28.85 gr/m3(± 4.8 gr/m3). This value is entirely still below the air quality standard or still meets the requirements. The low concentration of dust is due to the relatively humid air and road conditions due to the weather and the activity of watering the road by coal companies.

When compared, the pattern of dust concentration at the two measurement points looks different. This is because the weather conditions when measuring in the settlements on the left are shortly after light rain, while the settlements on the right of the road are measured when the weather conditions are normal. When the environment is wet, the dust concentration appears random or does not correlate with the distance from the coal haul road. On the other hand, when the climate is dry, the dust concentration negatively correlates with the increase in length from the coal haul road. This shows that the drier the environmental conditions, the more visible the impact of haul roads on increasing dust levels in settlements. On the other hand, when wet, dust settlement is more influenced by the surrounding conditions, including from inside the house.

Even in dry conditions, the concentration of dust in the settlementpopulation still meets ambient air quality standards. This is because the road conditions, which are the primary source of dust, do not potentially produce dust. The condition of the road in PantaiWalang village is well paved.ActivityThere are very few vehicles on village roads, so dust resuspension from village roads is relatively small. Another factor is that the coal haul road that cuts the village road is wet because it is routinely flushed using a water truck. Environmental management efforts are indeed prioritized on coal transportation roads that intersect with public infrastructure, compared to other locations. To minimize the impact of coal transportation on air quality, the company's management conducts intensive watering so that the road surface is always in a wet condition and dust from the road is not dispersed into settlements.

The concentration of dust in the living room (living room} of the people who live on the side of the road specifically for coal transportation ranges from 23 to 65 gr/m3with an average of 34.65 gr/m3 (± 12.66 gr/m3) .

The results of measuring the dust concentration in the living room of the residents' houses increasingly show the relevance of the dust concentration to the distance from the coal haul road, especially under normal conditions. In polluted areas, the indoor dust concentration is strongly influenced by the dust in the ambient air. Dust particles in the ambient air can enter through doors, windows, vents, or other building crevices. Penetration of particulates from the outside into the building is influenced by the state of the windows, wind direction and speed, temperature inversion, building wall density and season (Stern, 1977}. On the other hand, in areas that are not polluted or naturally leached, the concentration of particulates may be higher in buildings resulting from various sources such as floors, bedding, kitchens, clothing, construction parts of buildings, and human activities in it. (Phalen, 2003).

In this case, dust particles from the coal haul road that enter the house can accumulate as a source of dust and can continuously pollute the indoor air. The washing of ambient air due to rain only reduces the penetration of dust into the house but does not affect the dust level accumulated in the house. The closer a settlement is to a dust source, the more dust is likely to gather in the place.

In addition to the family room, dust measurements were also carried out in the bedrooms of the people who live on the side of the road, specifically for coal transportation. one-thirdThe measured dust concentration in the bedroom ranges from 24 to 53 gr/m3 with an average of 33.6 gr/m3 (± 9.14 gr/m3). This concentration describes the level of dust exposure to the community because approximately one third of the human day is in the bedroom. The trend of dust concentration is almost the same as the concentration of dust in the living room. This explains that the dust in the house comes from the same source.

Incidence of respiratory tract and TB in the Community

The population's morbidity rate, specifically in the form of respiratory tract diseases, in the form of respiratory tract and pulmonary TB, was obtained from the morbidity rate recorded at the local health centre. Infectious respiratory tract diseases were recorded as the 2nd highest in 2016 and the 1st in 2017 and 2018.

Respiratory tract disease is closely related to air quality conditions in general, including air with relatively high dust levels. When related to the results of measuring the level of dust in the house when the study was carried out, the levels were still below the quality standard, the highest was only 65.0 gr/m3(quality standard 150 gr/ m3), the low dust content is due to rain and wet coal roads during the measurement, so there is no dust dispersion into the environment. However, on dry road conditions and a rainy day, at the exact location as this study, the PMlO dust content was above the quality standard. Outside the house it reached 190.4 gr/m3 and inside the house the highest was 185.4 gr/m3 (unaidi, 2010). 2016). This indicates that dust exposure in the community has been beyond established quality standards, thereby causing respiratory problems for the community.

Conclusion

The absorption of dust by rubber trees in several road conditions (straight, uphill/downhill and bends) does not show a certain pattern. Only the absorption on uphill/bend road conditions is always lower than the other 2 road conditions. Dust absorption by rubber trees located at zero meters from the highest coal haul road was 1,563.1 g/g leaf. Leaf adsorption was reduced at a tree distance of 25 meters and decreased again at 50 meters from the coal haul road. Further research is expected to increase the types and quality of variables, considering seasonal factors and the uniformity of the measurement object. Assessing the causative relationship of the impact of coal dust on public health, it is also necessary to measure the lung function of the people who live on the side of the haul road.

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