REDUCTION EFFORT OF PM_{10} AND CO WITH PHYTOREMEDIATION METHOD USING TREES AND DECORATIVE PLANTS IN SURABAYA, INDONESIA

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Abstract- This study scrutinizes The Reduction Efforts of PM_{10} and CO with The Phytoremediation Method which Using Trees and Decorative Plants in Surabaya. This study uses literature study from the previous research and other relevant textbooks which has been adjusted to Indonesia's situation and policy. Surabaya as one of the biggest cities has less quality of air which caused by high air pollution from several pollutants, for example SO_2, NO_2, CO, CO_2, O_2, and PM_{10} dioxide. From the five parameters, PM_{10} and CO marked as the highest pollutants in Surabaya. Surabaya is an area of tropical climate, moderate rainfall, 23,6 ^oC until 33,8 °C which needs right solution for its topographic condition. One of the solutions to reduce PM_{10} and CO is phytoremediation. Phytoremediation is a method of pollution lowering using green plants, fungi, algae, bacteria and microbial mats which one of three vital plant processes is involved in waste management. Phytoremediation which will be applied in Surabaya uses trees and decorative plants. To reduce $PM_{10,}$ decorative plants type Cassia fistula is used, it can reduce pollutant as many as 48 g/m^3 and tree typed Dialium indum can reduce pollutant to the tune of 76,3 g/m^3. Furthermore, CO pollutant can be lowered using decorative plant typed Codiaeum interuptum which able to reduce as many as 109 ppm/day. Based on the studies, the four plants above have high and effective phytoremediation. As the effort to control pollution using phytoremediation, there are three targeted interventions; they are domestic area, industry and public places which the planting can be adjusted with the level of pollution and the possible planting area.

Keywords- Phytoremediation, Reduction of PM_{10}, Reduction of CO, Surabaya

I. INTRODUCTION

Indonesia is one of the largest countries in South East Asia[13] located between two continents, Asia and Australia, also between two oceans, Hindia and Pacific[14]. According to Badan Informasi Geospasial, Indonesia is the biggest archipelago with 13.466 islands[14] consists of five big islands which are Sumatera, Java, Kalimantan, Sulawesi, and Papua. From the five islands, Java is the most populated island. Data Center and Information of Indonesia Health Ministry said that the total population in Indonesia at 2014 reaches 252.124.458 inhabitants[14]. More than half lived in Java with the percentage of 56,8 % or approximately 143.173.265 people.

The number of people who live in Java caused the centralization of economy, industry, health, education, and transportation activity. Those kinds of activity is centralized in big cities, include Surabaya as the biggest city after Jakarta. The development of industry and transportation is not only gives positive impact, but also negative. For example indoor and outdoor air pollution which may jeopardize human's health. Based on Health Department in Surabaya, people who affected upper respiratory tract infection have reached 235.725 sufferers. This infection ranks first in incidence of disease[2].

The growth number of vehicles in urban cities in Indonesia has reached 15% per year. Transportation in city becomes the biggest pollution approximately 70% air pollution is caused by motor vehicle activities. The air pollution parameter can stimulate global warming[6]. The most frequented air pollutants in city, includes Surabaya is sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), carbon dioxide (CO_2), ozone (O_3), and PM_{10} (Suspended Particulate Matter)[2]. From the five parameters, PM_{10} and CO are the high risked pollution[3.]

According to international journal of Weyens, N., at all, particulate matter (PM) is a mixture of liquid and solid substances which has different origin, shapes, and chemical composition. PM is one of the dangerous pollutant for human, specifically $PM_{2,5}$ (fine and ultrafine particulate matter) which caused more than 2 million deaths around the world[15]. Based on the measurement data of ambient air quality in East Java, it can be concluded that parameter particulates still becomes the main problem, specifically in roadside location and industry. There are many industries that the dust emissions do not fulfill the standard from Regulation Governor Number 10 in 2009. It indicates that there are some industries which have not controlled their dust pollution or particulates properly[9].

From the problem explicated above, the control of air pollution in Surabaya is urgently needed; one of the ways is through phytoremediation which effective in air cleaning. Plants are able to decrease air pollutant. Other than that, plants also have a big role to degrade and detox the pollutants through increasing plants growth[15].2.

II. DETAIL OBSERVATIONAL

This study uses literature from previous studies and textbook which have been adjusted in real condition and policy in Surabaya.

Surabaya is a capital of East Java Province. It is located in 7°9'–7°21 South Latitude and 112°36'–112°57' East Longitude. The majority area is lowland with altitude 3-6 meters above sea level. Other areas in south are hills with altitude 25-50 meters above sea levels[4].

The area of Surabaya is 52.087 Ha, with the area of land is 33.048 Ha or 63,45% and 19.039 Ha or 36.55% is sea area which managed by Surabaya Government. It is not only because of Surabaya as the capital of province, but also Surabaya is one of the five biggest cities which has impressive growth in Indonesia. Surabaya is the center of business, trade, industry, and education in West Indonesia. Surabaya has one big harbor, Tanjung Perak[4].

Surabaya is a tropical climate alike other big cities in Indonesia where there are only two seasons in year, wet and dry seasons. The average of rainfall in Surabaya is 165,3 mm. The highest rainfall above 345 mm happens in January until March. The average air temperature in Surabaya is between 23,6 °C until 33,8 °C. Climate condition, temperature, and rain fall are relatable with the growth and development of fauna and flora[1].

Here the data of ambient air in Surabaya, include PM_{10} and CO as the two parameter which has the highest number of ISPU in 2015.

Table 1: Concentrate of PM_{10} after Converted to ISPU Number

No	Max	ISPU	Category
1	139	94.5	Moderate
2	149	99.5	Moderate
3	197	123.5	Bad
4	198	124	Bad
5	199	124.5	Bad
6	199	124.5	Bad
7	197	123.5	Bad
8	197	123.5	Bad
9	196	123	Bad
10	199	124.5	Bad
11	191	120.5	Bad
12	191	120.5	Bad

Source: Badan Lingkungan Hidup, 2015

Table 2: Concentrate of CO after Converted to ISPU Number

No.	Max	ISPU	Category
1	7.47	79.70	Moderate
2	9.77	97.70	Moderate
3	7.23	72.30	Moderate
4	8.33	83.30	Moderate
5	6.93	69.30	Moderate
6	7.48	74.80	Moderate
7	4.28	42.80	Good
8	4.46	49.60	Good
9	4.14	41.40	Good
10	3.80	38.00	Good
11	5.61	56.10	Moderate
12	10.49	107.00	Bad

Source: Badan Lingkungan Hidup, 2015

II. RESULT AND DISCUSSION

Phytoremediation is defined to encompass the use of green plants, fungi, algae, bacteria and microbial mats when one of three vital plant processes is involved in waste management. It is possible, feasible and proven for organic and some inorganic pollutants in water, soil and air[7].

Table 3: Process of Phytoremediation PM_{10} and CO Using Plants

Pollutant	Process of Phytoremediation
PM_{10}	- Adsorption foliage and stem (leaf size, structure and surface roughness) - Stabilization in waxes (Wax thickness and composition)
Inorganic Pollutants	- Adsorbtion and uptake (stomata vs cuticle) - Detoxification - Biofertilization (SO_2 and NO_x) - Carbon sequestration

Source: Weyens, et al, 2015

Table 4. Plants for Phytoremediation PM_{10} and CO

Type of Pollutant	Plants			
	Tree	Reduction Levels	Decorative plant	Reduction Levels
PM_{10}	*Asam kranji (Dialium indum)*	76,3 g/m^3	*Trengguli (Cassia fistula)*	48 g/m^3

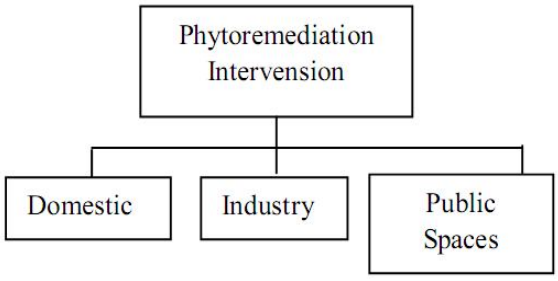
Type of Pollutant	Plants			
	Tree	Reduction Levels	Decorative plant	Reduction Levels
CO	*Angsana (Pterocarpus indicus)*	109 ppm/day	*Puring (Codiaeum interuptum)*	125 ppm/day

Sources: Nugrahani, et al, 2006 and Santoso, n.d

Plant	Image
Dialium indum	 Source: Rusyana, 2013

Pterocarpus indicus	 Source : Plantpono, 2011
Cassia fistula	 Source : Kinanti, 2015
Codiaeum interuptum	 Source: Wikipedia, 2013

Phytoremediation is done in the following concept:



There are three targeted intervention of Phytoremediation; domestic area, industry, and public spaces. Generally, intervention is done through plant the trees and decorative plants on those three locations. In domestic area, suggested plants is decorative plants, it is due to the limit of residents housing area. In the industry, according to Indonesia policy, the minimum area for green open area is 10% from total area. Industry is recommended to plant trees. The public spaces for example, main roads, bus station, and parks, need to adjust its own plant based on potential air pollution, so that the planting could support outdoor air pollution reduction.

CONCLUSIONS

Based on data from Badan Lingkungan Hidup (2016), In Surabaya, from the five parameters SO_2, NO_2, CO, CO_2 and O_3, PM_{10} and CO are the highest pollution risk. Phytoremediation is possible, feasible, and proven way to reduce organic and some inorganic pollutants in water, soil, and air. Plants for phytoremediation PM_{10} is Dialium indum as the tree and Cassia fistula for decorative plants. Furthermore, to reduce CO, Pterocarpus indicus can be used for trees plant type while Codiaeum interuptum for decorative plant type. Those four plants have high and effective phytoremediation based several research in Indonesia. As the effort to control pollution using phytoremediation, there are three targeted intervention include domestic area, industry, and public spaces where the planting can be adjusted with the pollution levels and possible area that can be used.

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Phytoremediation is defined to encompass the use of green plants, fungi, algae, bacteria and microbial mats when one of three vital plant processes is involved in waste management. Reduction effort of PM_{10} and CO in the air used phytoremediation method with trees and decorative plants. There are three targeted intervention of phytoremediation; domestic area, industry, and public spaces. Based on the studies, the plants which use for phytoremediation have effectiveness capability to reduce air pollutant especially PM_{10} and CO.

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