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Present State Analysis and Future Prediction of Atmospheric Pollution in Jakarta City.
ジャカルタ都市大気汚染の現状解析と将来の予測

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Abstract: Indonesia as with many Southeast Asia nations, is in rapid development in many sectors. Broadly speaking about air pollution in Indonesia, it is important to consider that the development of industry like in Jakarta city, are the cause of the worsening of the air quality. This study is an attempt to analyze and to suggest some idea to improve air quality in Jakarta City. The monitoring result of ambient air was analysis and could be made conclusion that the air pollutant problem are mainly of Nitrogen Dioxide (NO_2), Total Hydrocarbon (THC) and Suspended Particulate Matter (SPM). The simulation was done to simulate present and future concentration of Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Suspended Particulate Matter(SPM). The result indicated that the Sulfur Dioxide(SO_2) and Nitrogen Dioxide(NO_2) agreed with observed result, but simulation concentration of Suspended Particulate Matter (SPM) was less than observed concentration in Jakarta City. Emission load from each emission sources was evaluated. The evaluation result indicate that the mobile source is a main contribution to Nitrogen Dioxide (NO_2) and Suspended Particulate Matter(SPM). Factory source main contribute to the major part of Sulfur Dioxide (SO_2) in Jakarta City.

Key words: ambient air, emission load, simulation model
大気、排出量、シミューレションモデル

Introduction

The analysis of atmospheric pollutant concentration is very important for the management of air pollution problem. In Indonesia there is a tendency that air pollution increases year to year due to the increasing industrial activities on several sectors. Another reason of increasing air pollution is the lack of expert persons in air pollution problem. Jakarta, the national capital, is the center of the most highly urbanized and industrial area in Indonesia, with area 662 Km^2, 106º, 48’ – 107º, 02’ east latitude and 6º, 05’ – 6º, 23’ south latitude and 0 – 7 m altitude above sea level. In 1990 the population of DKI-Jakarta (the Jakarta Provincial Government area, see fig 1.) was close to 8.2 million and by 2005 it is expected to be 10.5

millions. Motor vehicles registrations are also increasing rapidly, and for the period of 1989 to 1992, number of vehicles (in hundred thousand) increased as follows: cars 4.4 to 5.7, motor cycles 7.4 to 9.2, buses 1.5 to 2.5 and trucks 1.6 to 2.2. Increasing rate of industrial activity is expected to 8% to 10% annually, and it will reach by 13 times of the 1990 level by 2020.

1. Area of Study

Jakarta City area comprises five districts, that is: North Jakarta, East Jakarta, West Jakarta, South Jakarta and Central Jakarta. East, North and West Jakarta are industrial, residential and commercial area. Central Jakarta is a commercial area with heavy traffic volume and South Jakarta is a residential and commercial area. Northern part faces to Jakarta bay (Java Sea), western part borders on Tangerang City, southern part borders on Bogor City and eastern part borders on Bekasi City.

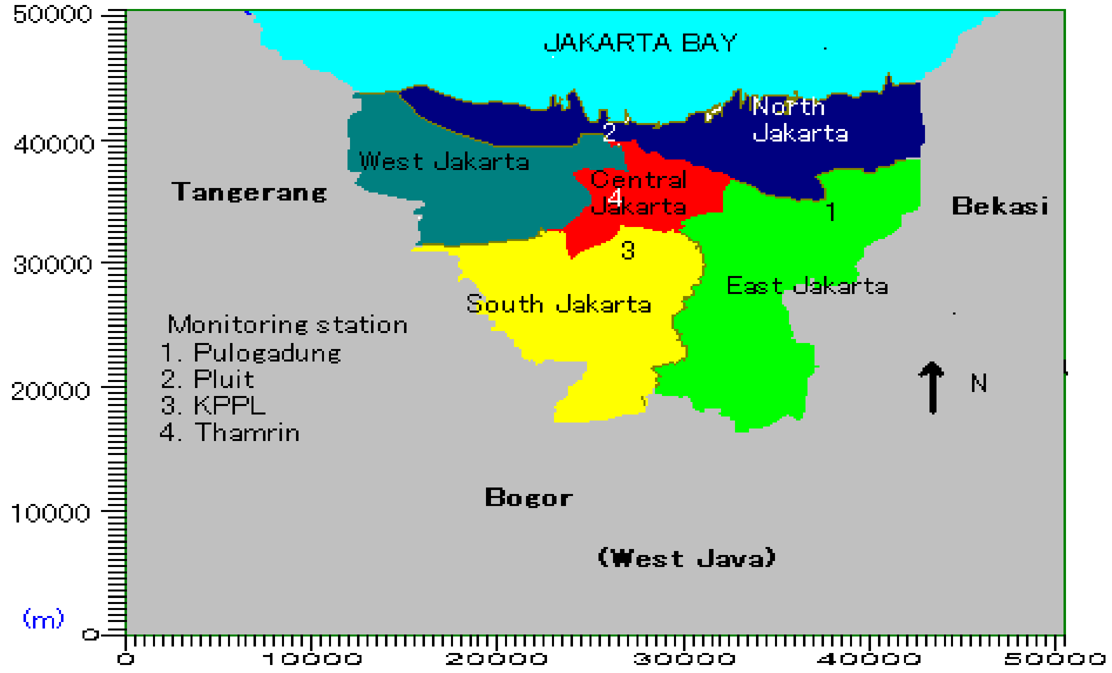


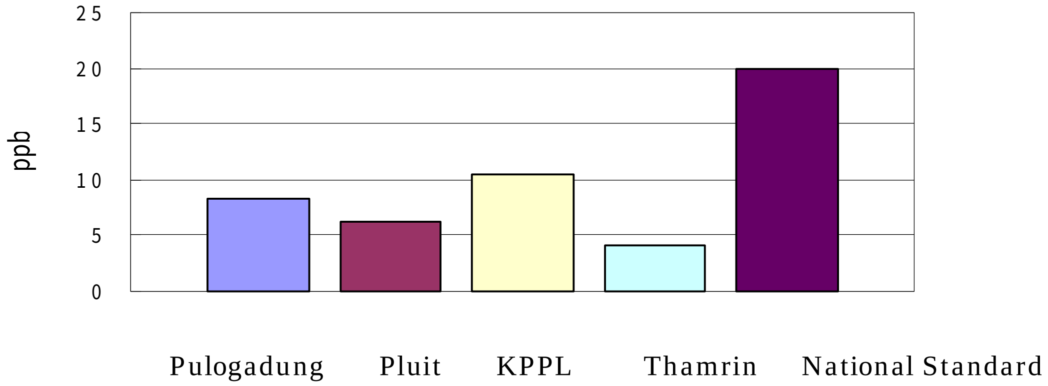
Fig 1. Map of Jakarta (m)

2 Atmospheric Pollutants Concentration in Jakarta city

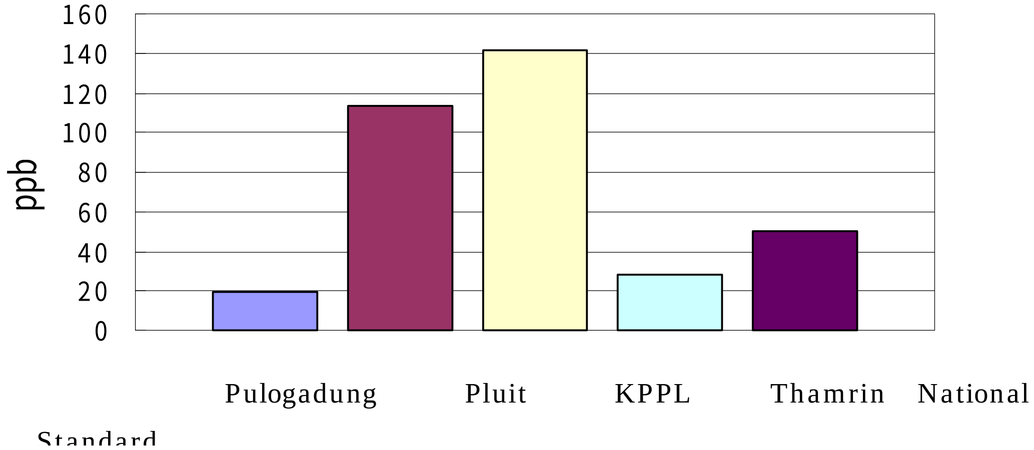
Hourly monitoring data was collected by automatic ambient air monitoring instruments, during the period from January to December 1997. Yearly average concentration in each monitoring station was analyzed. Monitoring result of ambient air quality at Jakarta city indicated that Suspended Particulate Matter (SPM), Nitrogen Dioxide (NO_2) and Total Hydrocarbon (THC), exceeded National Ambient Air Quality Standard (NAAQS).

3. Meteorology

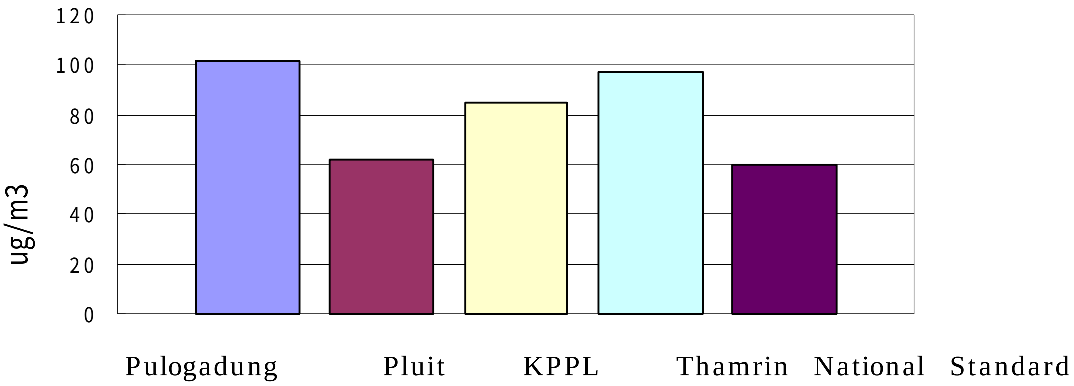
SO_2 Observation result at Jakarta city



NO_2 Observation result at Jakarta city



SPM Observation result at Jakarta city



Annual average of wind speed at Jakarta city is very weak (0.8 – 1.8 m/s) and calm condition (wind speed < 0.5 m/s) prevails at night. Lowest temperature is 24-26^{o} C and highest temperature is 32-33°C in a day, and annual humidity is 60-80 %. The figure below shows wind rose and yearly average wind speed at Pulogadung

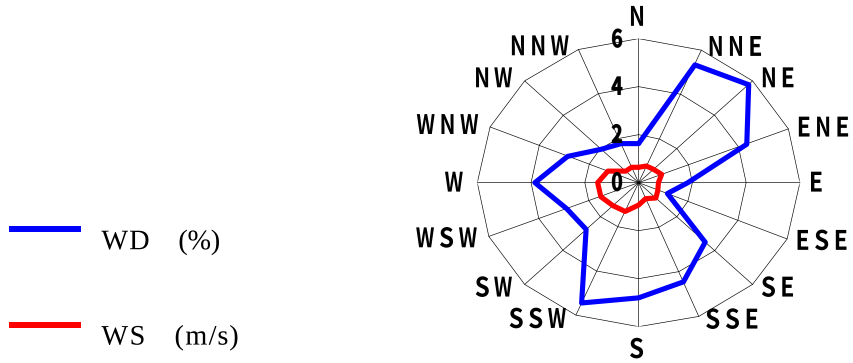


Fig.2 Wind Rose and Speed at Pulogadung station

station.

4. Emission Estimation

Japan International Cooperation Agency (JICA) and Environmental Management Center (EMC) conducted emission measurement, for stack facilities of factories, buildings and hotels. Base on this data and statistical industry data of Jakarta city, emission load from all factories was estimated. Sources from household and traffic were estimated by using fuel consumption and emission factor borrowed from Japan. New estimation method was introduced to estimate emission load from motor vehicles. Total emission load in Jakarta city in 1997 was estimated for each source as shown in table 1

Table.1 Total Emission Load in Jakarta City

Emission Load (ton/year) 1997						
	SO_2	NO_2	PM	% (SO_2)	% (NO_2)	% (PM)
Factory	19,820	20,720	1,649	37.1	11.3	9.6
U.Factory	17,873	18,684	848	33.5	10.2	4.9
Household	2,456	3,020	377	4.6	1.6	2.2
Vehicles	13,226	140,946	14,291	24.8	76.9	83.3
Total	53,375	183,370	17,165			

5. Dispersion Model

Plume and Puff model was used for the calculation of concentration.

CONCAWE and Briggs equation were used to calculate effective stack height for point source, and other sources except for factories were set as area sources.

6. Simulation Result

Simulation was done to predict present state concentration of SO_2, NO_2, and SPM. Simulation result were compared with observed results and the correlation coefficient for SO_2 was 0.72 and NO_2 was 0.94, but observed concentration for SPM could not be reappeared by simulation results.

7. Future Prediction

Air Pollutant emission in Jakarta City is closely related to fuel consumption, population growth and socio-economic condition. Future trend of fuel consumption, population and number of motor vehicles growth was predicted to simulate atmospheric pollutants concentration in the future. Three control strategies was suggested to improve air quality in Jakarta city

(1) Japanese K - value to control Sulfur Dioxide (SO_2) from industry.

(2) Combustion Modification(CM) to control Nitrogen Dioxide (NO_2) from industry.

(3). UN-ECE regulation to control Suspended Particulate Matter (SPM) and Nitrogen Dioxide (NO_2)

8. Conclusion

Based on the study conducted in this research, main conclusions are highlighted as follows:

1. Air pollution problems in Jakarta city are Suspended Particulate Matter (SPM), Nitrogen Dioxide (NO_2), and Total Hydrocarbon (THC).
2. The main source of NO_2 and SPM is mobile and SO_2 is industry.
3. Simulation results of SO_2 and NO_2 agreed with observation result, but simulation concentration of SPM was less than observed concentration.
4. Future emission load of SO_2, NO_2 and SPM

- from factory source, will be 2.3 in 2007 and 4.3 in 2015 of present (1997)
- from household will be 1.1 in 2007 and 1.9 in 2015 of present (1997)
- from motor vehicles will be 1.12 and 1.5 for SO_2, 1.11 and 2.16 for NO_2 and 1.03 and 2.08 for SPM.

5. Emission load of SOx is reduce until 29% if sources are controlled by Japanese K-Value, and NOx is reduced to 33% if sources are controlled by Combustion Modification and UN-ECE regulation, and SPM is reduce to 11% by UN-ECE regulation.