TEMPORAL AND SPATIAL AIR QUALITY IN BANDUNG CITY INDONESIA *)

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Abstrak

Dengan cepatnya pertumbuhan industrialisasi dan urbanisasi, khususnya di Kota Bandung dalam beberapa dekade kebelakang, membuat polusi udara perkotaan jadi mengkhawatirkan. Untuk menjawab permasalahan tersebut diatas, monitoring kualitas udara telah dilakukan oleh Badan Pengendalian Dampak Lingkungan Daearah (BPLHD), dan dikontrol melalui Pusat Management Kualitas Udara Regional (RAQMC).

Dalam makalah ini akan didiskusikan tentang kualitas uadara secara temporal dan spasial di Kota Bandung. Selama tiga tahun pengukuran kualitas udara, tingkat polusi udara di pusat kota dan beberapa bagian di Kota Bandung telah menunjukkan konsentrasi yang relatif tinggi dan menunjukkan peningkatan, khususnya O_3 dan NOx (NO_2 + NO) dan SO_2, namun masih dibawah indeks standar baku mutunya.

Abstract

With the rapidly growth of industrialization and urbanization, especially in Bandung city over the past several decade, the urban air pollution has grown to be worse. In order to solve this problem, the monitoring of air quality was conducted by Environment Impact Management Regional Agency of Bandung city (BPLHD) and was controlled by Regional Air Quality Management Center (RAQMC).

In this paper will be discusses about the temporal and spatial of air quality in Bandung city. During three years measurement of air quality, the level of air pollution in center and path of Bandung city are relatively higher and increase a specially in O_3 and NO_X (NO_2 + NO) and SO_2, but still in under standard index.

1. INTRODUCTION

Bandung city is the capital province of west java, where the location it's about 200 km southeast of Jakarta, with the altitude about 700 MSL (mean sea level) and the large area 16.729.650 hectare. The population density of Bandung city about 128 / hectare (great than of WHO standard), figure. 1. 1 shows the location of Bandung city.

Bandung city have especially characteristic of topography, the field area is valley such as of cup, the topography of Bandung is very different rather than Jakarta and Surabaya city, the both of Jakarta and Surabaya city are the free area and looks out on the sea (the coastal area), while the Bandung is valley of cup. The especially topography pattern of Bandung city is influence to the dynamical of air pollution due to the locally wind factor, such as upwind and downwind, turbulence of wind. On the long term, the possibility of accumulation air pollution will be occurred.

The local government give fully of authority to build of city used natural and man resources according to the government regulation no. 22, 1999 about "Local Government" call is " OTDA". The regulation of OTDA as base local to make use and built by used resources of the local ly potency.

Both of potency, natural and man resources are the vital potency which needed of good management to manage and conserved of environment.

The growth of economic and urbanization in Bandung city as high potency to the raising of energy consumes especially of fuel, which is affect to the raising of air pollution concentration in the atmosphere. Using of fossil fuel is source of air pollution, such as CO, NO_X, SO_X, SPM, TNMH, O_X and Pb.

Transportation sector have contributed dominant to the air pollution in Bandung and some big city in Indonesia respectively industries, household and natural. Some causes of the raising air pollution in Bandung city are unbalancing of the capability of road and increasing of vehicles transportations amount per year are 0.6 % : 12 %, the good less of transportation system and undisciplined of driver as the trigger to the raising of air pollution.

For anticipate and ward off the increasing air pollution, some project environment management of air quality have to be done, such as the continuously monitoring of air quality program.

Since the operation of air quality monitoring fixed station on the last of 2000 , as the joint agreement between the government of Swiss and the authority of Bandung city with the goal to monitoring air pollution condition, collecting of air pollution data and to give education and knowledge of public about air pollution, and to solved the problems of environment, a specially in air pollution.

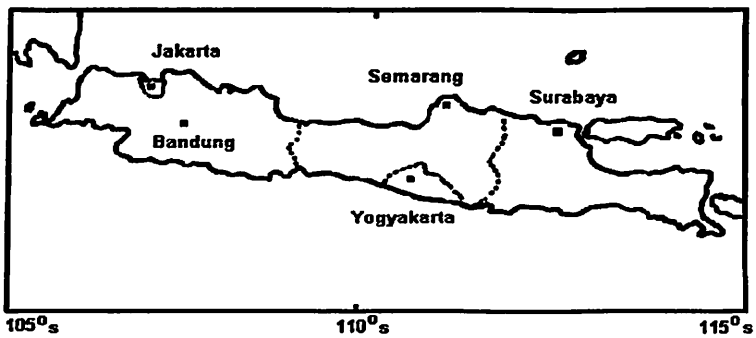


Fig. 1. 1. Bandung city location

2. INSTRUMENTATION AND MONITORING

To monitoring of air quality the horiba instrumentations have to be used, such as CO Monitor APMA-360, NO_X Monitor APNA-360, the all type's instrumentation and methodology of measurement show in table 2. 1.

Table. 2. 1. Parameters, instrumentation types and methodology of measurement

NO	Air Quality Parameter	Type of Instrumentation	Methodology
1	CO	CO Monitor APMA-360 Horiba	Non dispersion Cross Modulation Infra Red Method
2	NO_X , NO_2 , NO	NO_X Monitor APNA-360 Horiba	Cross-Low Modulated Semi decompression chemilimunecense Method
3	O_3	O_3 Monitor APOA-360 Horiba	UV Chemilimunation
4	SO2	SO_2 Monitor APSA-360 Horiba	UV Fluorescence.
5	PM-10	FH 62-1	Sampler
6	P, T, Rh, Wind	Meteorology Sensor	-

A start measurement of air quality parameters NO_X, O_3, SO_2, CO, Dust (PM10) and meteorology in Bandung City on the last 2000 to now, are the five fixed station surrounding of Bandung city included the center of city with some representation of locations such as industry , transportation, settlement and clean area.
Figure. 2. 1 and table 2. 2 show the five station location and public data board of air quality observation in Bandung city, figure 2. 2. Show the box fixed monitoring station and public data board.

The whole data from five fixed station were transferred by phone line to the Regional Center of Air quality Management (RAQMC) is located in the municipal of Bandung city.

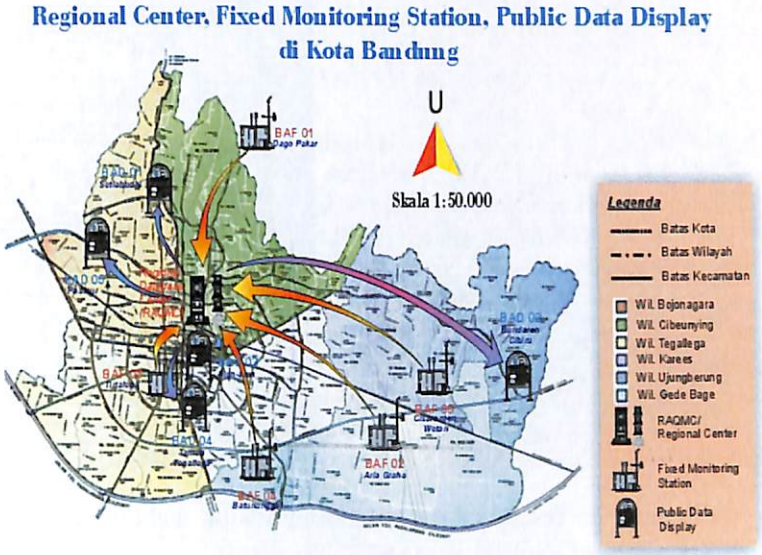


Figure. 2.1. Fixed Monitoring and Public Data Display Station in Bandung City

Table 2. 2. Station location of air quality observation in Bandung City

NO	Station codes	Location	Representatives
1	BAF.1	Dago, H = 3524.1 feet 6° 51,693'S -107°37,702' E	Clean Area
2	BAF.2	Ariagraha, H = 2307,1 feet 6° 56,537'S -107°40,348' E	Settlement Area
3	BAF.3	Tegallega, (Tirtalega) H = 2356,7 feet 6° 56.129'S - 107°36,309' E	Transportation Center Area and Business
4	BAF.4	Batununggal Indah, H= 2347,3 feet 6° 57,413'S -107°37,750' E	Settlement & transportation Area
5	BAF.5	Cisaranten Wetan, H = 2342,3 feet 6° 55,673'S -107°14,347' E	Industry Area

The whole air pollution parameter data are processes and analysis used the PSI system (Pollutants Standard Index) in the Regional Center of Air quality Management (RAQMC) and published to the public with the public data board.

Pollutants standard index base on five parameter such as CO, NO_2, O_3, PM_{10} and SO_2 with criteria 0 – 50 is good, 51 – 100 is fair, 101 – 199 is poor, 200 – 299 is bad and great than 300 is dangerous. Table 2. 3 show the value standard index of parameters air pollution

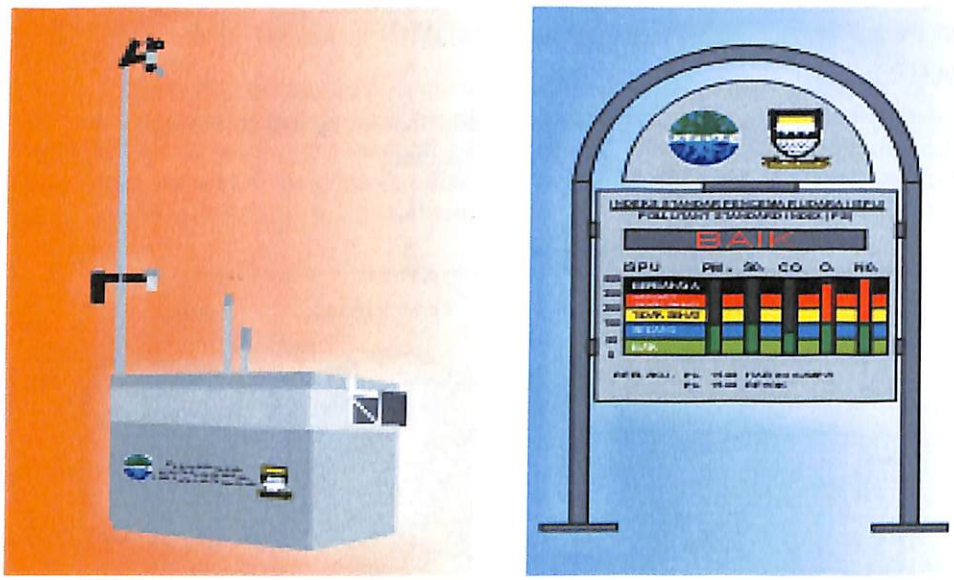


Figure 2. 2. The Box fixed monitoring station and Public data Board

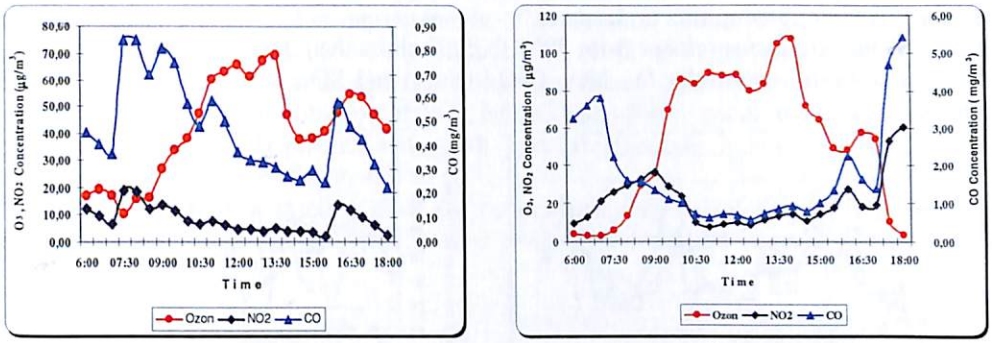
Table 2. 3. Standard Index of parameters air pollution
(Indonesian Government Regulation of air pollution index, Number 41, 1999)

No	Parameters	Index standard ($\mu g/m^3$)
1	CO (Carbon monoxide)	10
2	NO_2 (Nitrogen dioxide)	150
3	O_3 (Ozone)	235
4	SO_2 (Sulfur dioxide)	365
5	PM_{10}	150

PP. No. 41, Th. 1991

3. RESULT AND DISCUSSION

Figure 3.1 show the examples of diurnal variation of O_3 and precursor (NO_2 and CO) on April 14th, 2002 for two fixed station Dago (a) and Tirtalega (b), appears the characteristic of O_3 and their precursor (NO_2, CO), disagree characters between O_3 and precursor, where is the O_3 concentration raising just the opposite of NO_2 and CO. The rather smoothing of their character show in figure Tirtalega (b).



a b

Figure 3.1. Diurnal variation of O_3 and precursor (NO_2 and CO)

Figure 3. 2 show the examples of diurnal variation of PM_{10} (a) and SO_2 (b) on April 14th, 2002 for five fixed station Dago, Ariagraha, Tirtalega, Batununggal Indah and Cisaranten. The diurnal variation of PM_{10} and SO_2 have different character with the ozone and precursor of ozone, where is the PM_{10} and SO_2 as the characteristic of aerosol, while ozone and their precursor as the characteristic of gasses. The early of the morning PM_{10} and SO_2 concentration to became higher together with the raising activity of people and the heating and raising temperature of the atmosphere, and the relatively stable and lower concentration during noon time and afternoon.

The level and raising concentration of air pollution parameter (O_3, NO_X, CO, PM_{10} SO_2) are very depend on the sources, locations and very temporary depend on times.

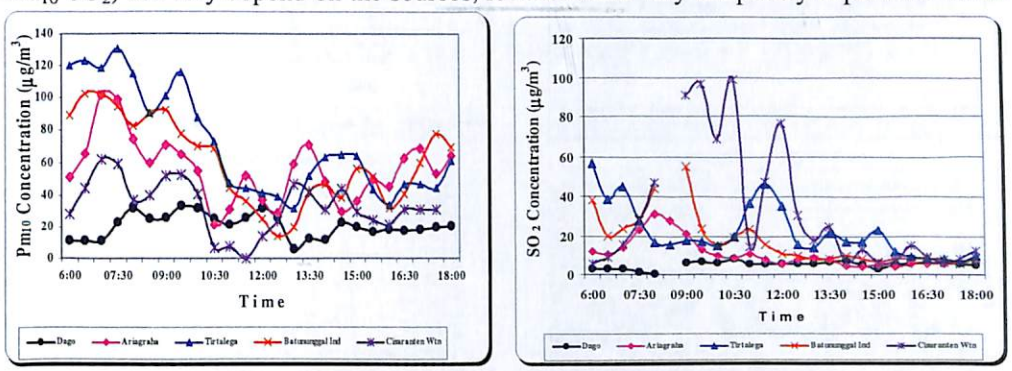


Figure 3. 2. Diurnal variation PM_{10} and SO_2

Figure 3. 3 show the monthly average of ozone, NO_2, NO, CO, PM_{10} and SO_2 during the period measurement of 2001 to 2003 on the five fixed station observation. The season variation of ozone is appear, the higher concentration of ozone was occur during dry season and lower concentration during wet season do to the photolysis processes, see fig. 3. 3. a. Higher and lower of concentration during the dry and wet season also was occur to the PM_{10} do to the locally factors, see fig. 3. 3.e. While the other concentration air pollution such as NO_2, NO, CO and SO_2 accompany with season and random.

The concentration of NO_2, NO, CO, SO_2, and PM_{10} are lower in Dago fixed station rather than four fixed station others, except ozone concentration.The relative higher of concentration CO was occur in Tirtalega station all along measurement of 2001 to

2003, the higher of concentration CO in Tirtalega do to the transportation activity. Tirtalega is the transportation high center.

The data measurement from 2001 to 2003 show the relatively increase was occur on concentration, especially O_3, NO_X (NO_2 + NO) and SO_2, but still in under standard index.

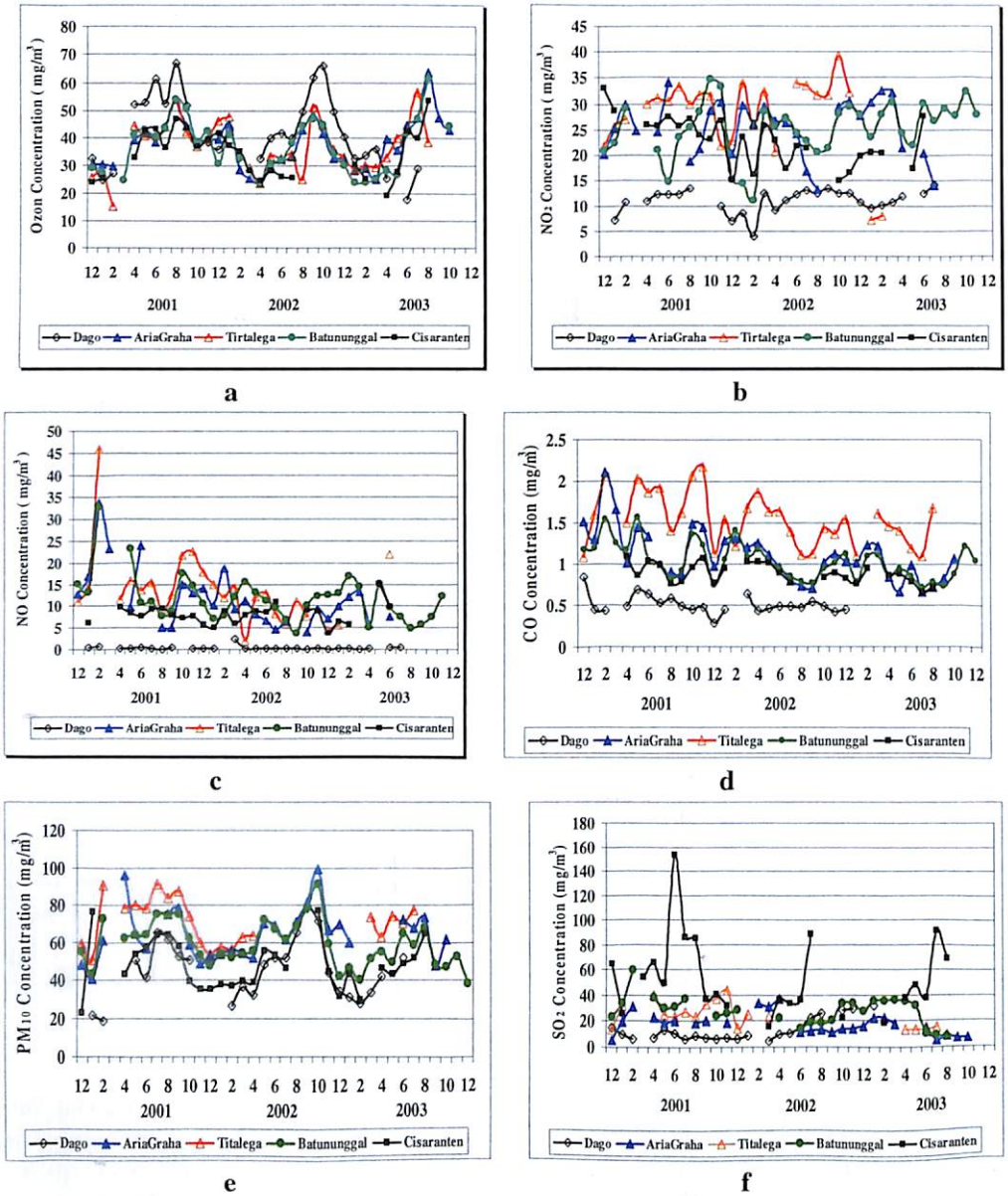
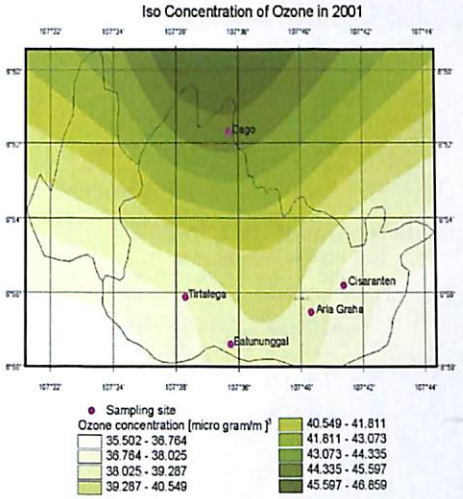


Figure. 3. 3. Monthly average of O_3, NO_2, NO, CO, PM_{10} and SO_2

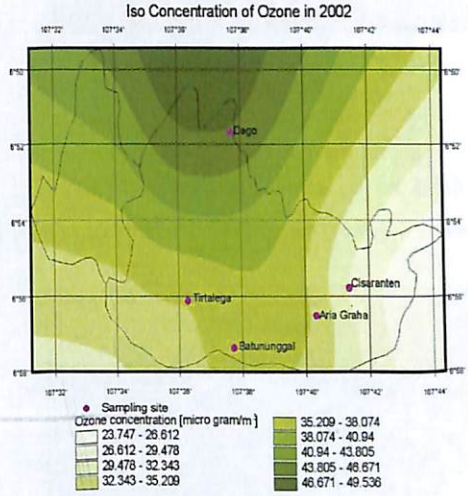
Figure 3. 4. show the iso concentration average of O_3, NO_2, NO, CO, PM_{10} and SO_2 for the years of 2001 and 2002, these figure explained the spatial of concentration of the parameter air pollution in Bandung city. The result of two years measurement of air pollution, show the high concentration of ozone was occur in Dago station (BAF1) on the years 2001 and 2002. Theoretically the higher of ozone concentration do to the lower of precursor ozone concentration NO_X (NO_2 + NO) and CO, the normal photolysis processes

occur without added of concentration precursor as the result of anthropogenic activity, where is Dago station as the representative of clean area. While in the center city and south part of Bandung the ozone concentration decrease as the influence of relatively higher NO_X and CO concentration result of transportation activity, see fig. 3. 4 a and b. The relatively higher concentration of NO_2, NO, CO and PM_{10} occur and be concentrated on Tirtalega station (Tegalega) and south part of Bandung as the center city and transportation activity, see fig. 3. 4. c to j.

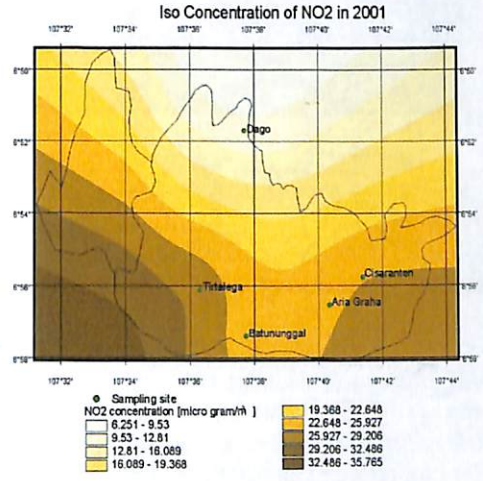
The figure 3. 4 k and l show the concentration spatial of SO_2 in Bandung, the relatively lower concentration occur in west part of Bandung and increase in east part of Bandung.



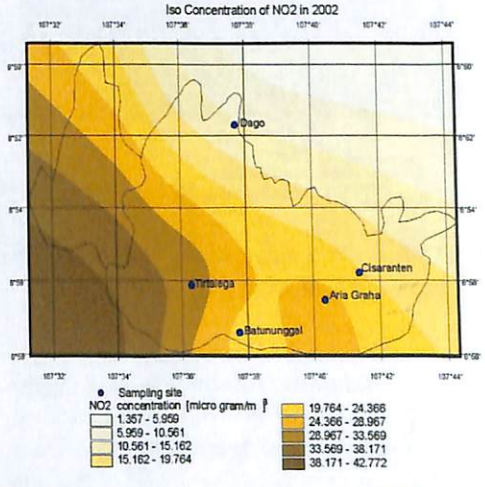
a. Isoconcentraion of Ozone in 2001



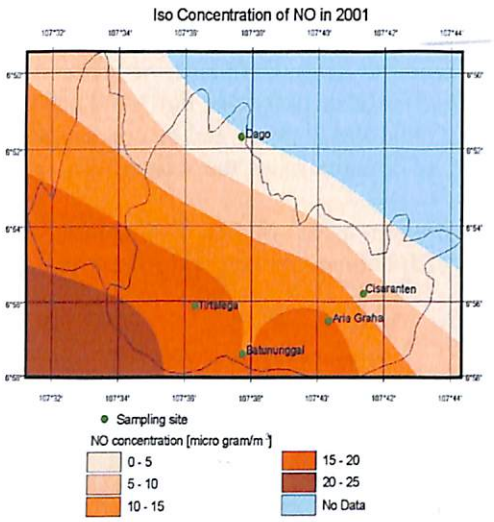
b. Isoconcentration of Ozone in 2002



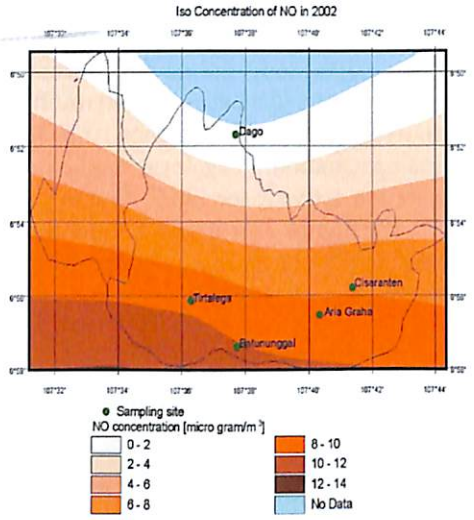
c. Isoconcentraion of NO_2 in 2001



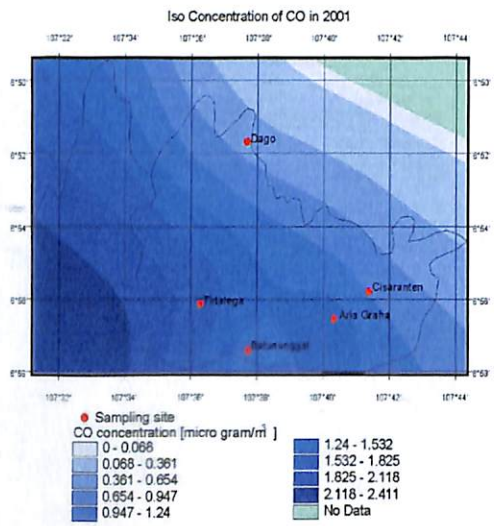
d. Isoconcentration of NO_2 in 2002



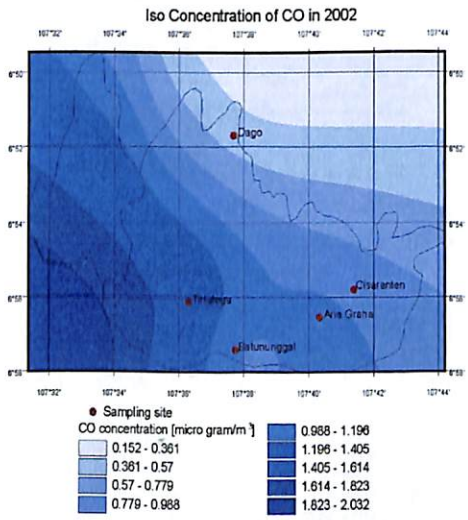
e. Isoconcentraion of NO in 2001



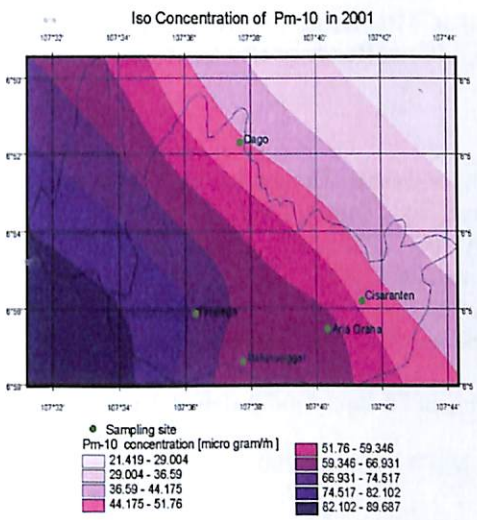
f. Isoconcentration of NO in 2002



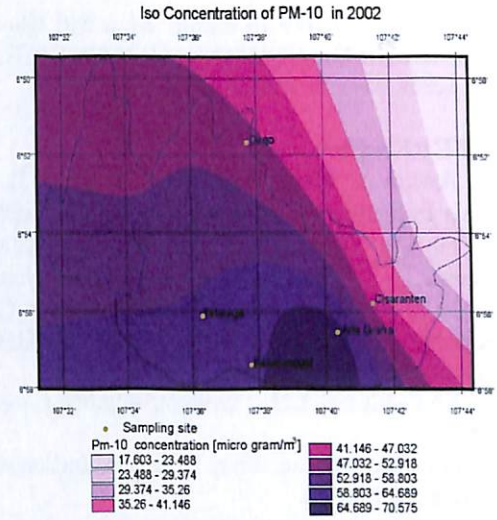
g. Isoconcentraion of CO in 2001



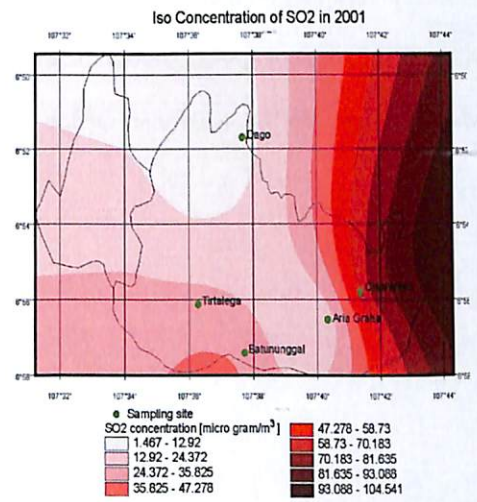
h. Isoconcentration of CO in 2002



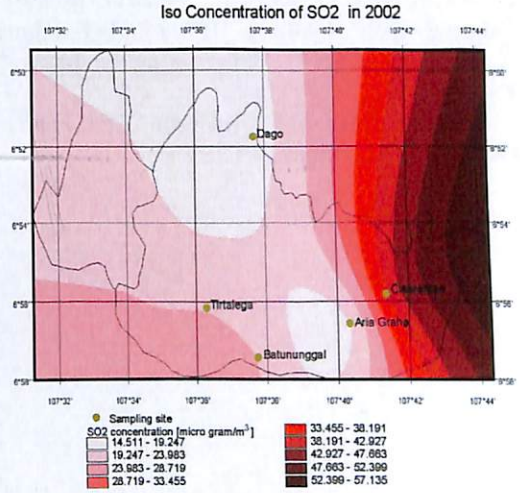
i. Isoconcentraion of Pm-10 in 2001



j. Isoconcentration of Pm-10 in 2002



k. Isoconcentraion of SO_2 in 2001



l. Isoconcentration of SO_2 in 2002

Figure 3. 4. Iso concentration of air pollution parameters for the years 2001 and 2002

4. CONCLUSION

From the result of two year measurement of air pollution in Bandung city show the center and south part of Bandung city as the area with relatively high of air pollution. The patterns and distributed of air pollution relatively unchanged on 2001 and 2002 be concentrated on center and south part of Bandung city

The high concentration of ozone was occurring in the north part of Bandung city, as the representative of clean area.

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