社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY FOR ENVIRONMENT AND REGIONAL POLICY
THE REPUBLIC OF HUNGARY

THE STUDY
ON
AN INTEGRATED AIR POLLUTION CONTROL PLAN
FOR
SAJÓ VALLEY AREA

FINAL REPORT

Summary

January 1995

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO

In association with

JAPAN ENVIRONMENT ASSESSMENT CENTER CO., LTD., TOKYO

In this report, project costs are estimated based on December 1993 prices with an exchange rate of 1 US$ = 100.19HUF (=¥109.35)

PREFACE

In response to a request from the Government of the Republic of Hungary, the Government of Japan decided to conduct a master plan study on An Integrated Air Pollution Control Plan for Sajó Valley Area and entrusted the study to the Japan International Cooperation Agency (JICA).

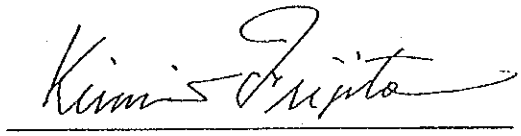
JICA sent to Hungary a study team headed by Dr. Akira Uchida, Pacific Consultants International and composed members from Pacific Consultants International and Japan Environment Assessment Center Co., Ltd. six times between September 1992 and October 1994.

The team held discussions with the officials concerned of the Government of Hungary, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Hungary for their close cooperation extended to the team.

January 1995



Kimio Fujita
President
Japan International Cooperation Agency

THE STUDY ON AN INTEGRATED AIR POLLUTION CONTROL PLAN FOR SAJÓ VALLEY AREA

January 1995

Mr. Kimio Fujita

President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit to you the final report entitled "THE STUDY ON AN INTEGRATED AIR POLLUTION CONTROL PLAN FOR SAJÓ VALLEY AREA". This report has been prepared by the Study Team in accordance with the contract signed on 4 September 1992, 12 March 1993, 18 January 1994 and 1 July 1994 between Japan International Cooperation Agency and Pacific Consultants International.

The report examines the existing conditions and projects the future conditions concerning air pollution in the Sajó Valley area, and presents an integrated air pollution control plan for the Sajó Valley area.

The report consists of the Summary, Main Report, and Supporting Report. The Summary summarizes the results of all studies. The Main Report presents the results of the whole study including analysis of background conditions, evaluation of the present air quality, development of an air quality simulation model, review of existing pollution control plans and study on additional control measures, prediction of future air quality, and formulation of the integrated air pollution control plan. The Supporting Report describes in detail the same contents of the Main Report, and includes a complete list of references. In addition, a Data Book has been prepared and is submitted herewith.

All members of the Study Team wish to express grateful acknowledgments to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Environment Agency, and Embassy of Japan in Hungary, and also to officials and individuals of the Government of Hungary for their assistance extended to the Study Team. The Study Team sincerely hopes that the results of the study will contribute to the improvement of the air quality and the social and economic development in the Sajó Valley area.

Yours faithfully,

内田顯

Akira UCHIDA
Team Leader

The Study on an Integrated Air Pollution Control Plan for Sajó Valley Area

Outline of the Proposed Air Pollution Control Plan

(1) Planning Area

The Sajó Valley area in Borsod-Abaúj-Zemplén County

(2) Target Year

The year 2005

(3) Air Quality Target

Pollutant	Target Concentration (Heating season average)
SO_2	50 μg/m^3 (19 ppb)
NO_2	70 μg/m^3 (37 ppb)

(4) Predicted Air Quality in 2005 Without Air Pollution Control

Pollutant	Maximum Concentration (Heating season average)	Remark
SO_2	173 μg/m^3 (65 ppb)	Not satisfying the target concentration
NO_2	53 μg/m^3 (28 ppb)	Satisfying the target concentration

(5) Proposed Pollution Control Measures

Proposed stationary source control measures and their initial costs are as follows:

Emission Source	Name or No.	Source Facility	Control Measure	Initial Cost (million HUF)
Thermal power plants	Borsod	Boilers	Introduction of a circulating fluidized bed combustion (CFBC) boiler (460 t/h x 1)	14,740
			Conversion of existing 4 boilers into hybrid fluidized bed combustion (HFBC) type (100 t/h x 4)	1,330
			Ash disposal site for HFBC	1,670
	Tisza I	Boilers	Drastic reduction of output	-
	Tisza II	Boilers	Use of low-sulfur fuel oil	-
Factories	02/1	Boilers	Increased use of natural gas	-
	03/0	Tunnel kiln	Fuel change from coal to natural gas	-
			Use of quality coal as raw material	-
	04/1	Incinerator	Two-stage combustion	2
	09/2	Incinerator	Two-stage combustion	2
	15/1	Forge furnaces	Remodeling of 8 forge furnaces to the Rath type	160
	15/2	Electric furnaces	Suction devices and dust collectors for 3 furnaces	62
		Heating furnace	Furnace retrofitting and recuperator	62
	17/1	Cement kiln	Low-NOx burner	32
	23/1	Nitric acid lines	Denitration equipment for 3 lines	31
Households		Home heating by coal	House connection of gas supply pipe and heating equipment for 52,400 households	9,170

Proposed institutional measures are as follows:

1) Implementation of the currently proposed government decree on air pollution abatement which includes new emission regulations for stationary and mobile sources
2) Establishment of a training center for air pollution control
3) Establishment of an air pollution monitoring and assessment center
4) Effective use of the Central Environmental Protection Fund (CEPF)

(6) Evaluation of Proposed Pollution Control Measures

1) Change in the Amount of Pollutant Emission

(Unit: ton/year)

Pollutant	Present (1992)	Target Year (2005)		
		(1) Without Measures	(2) With Measures	Reduction (1) - (2)
SO_2	97,798 (1.0)	72,413 (0.74)	23,930 (0.24)	48,483
NOx	16,492 (1.0)	14,691 (0.89)	9,186 (0.56)	5,505

Figures in parentheses indicate the ratio of the amount of pollutant emission to that in 1992.

2) Predicted Air Quality in 2005

Pollutant	Maximum Concentration (Heating season average)	Target Concentration (Heating season average)
SO_2	41 $\mu g/m^3$ (15 ppb)	50 $\mu g/m^3$ (19 ppb)
NO_2	34 $\mu g/m^3$ (18 ppb)	70 $\mu g/m^3$ (37 ppb)

3) Effect of the Proposed Measures

Through the implementation of the proposed air pollution control measures, the SO_2 concentration will satisfy the target value throughout the Sajó Valley area, and the NO_2 concentration will be improved further.

ACRONYMS

ÁNTSZ	:	National Public Health and Medical Officer's Service
ÁNTSZ-BAZ	:	Institute of ÁNTSZ in BAZ County
BAZ County	:	Borsod-Abaúj-Zemplén County
BAZKF	:	BAZ County Transport Management Office, KHVM
ÉKF	:	North Hungarian Environmental Protection Inspectorate, KTM
IKM	:	Ministry for Industry and Trade
JICA	:	Japan International Cooperation Agency
KHVM	:	Ministry for Transport, Communication and Water Management
KTM	:	Ministry for Environment and Regional Policy
MKI	:	Miskolc Road Management Office, KHVM
MVM Rt.	:	Hungarian Electricity Companies, Ltd.
NM	:	Ministry of Welfare
OKI	:	National Institute of Hygiene
OMSZ	:	National Meteorological Service

The Study on an Integrated Air Pollution Control Plan for Sajó Valley Area

FINAL REPORT

Summary

Contents

1. Introduction

The Sajo Valley is located in the Borsod-Abaúj-Zemplén County (hereinafter called "BAZ County") in the northeastern part of the Republic of Hungary. The principal city of the Sajo Valley area is Miskolc, the third largest city in Hungary with a population of about 200,000.

The greatest industrial development in Hungary was achieved in the Sajo Valley area. Iron and steel plants, chemical plants, power plants and related industries are located in the area. As a consequence, the area has been suffering air pollution due to exhaust gas emissions from various sources. The situation was said to be very severe until late 1980s when plants were fully operated to meet the demands from the Soviet block market. Although the air pollution level has been improved in some extent by today, many plants are still in operation, and the number of automobiles in the area, that are also sources of air pollutants, has been steadily increasing.

Under such circumstances, "The Study on an Integrated Air Pollution Control Plan for Sajo Valley Area" (hereinafter referred to as "the Study") was conducted by the Study Team of the Japan International Cooperation Agency (JICA) in cooperation with the Hungarian Authorities concerned under the general coordination of the Ministry for Environment and Regional Policy (KTM). The Study began in September 1992 with the first visit of the comprehensive study team of JICA (hereinafter called "the Study Team") to Hungary.

The objective of the Study is to formulate an integrated air pollution control plan based on the field investigation and analysis on the relation between socio-economic activities and air pollution in Sajó Valley Area.

Figure 1.1 shows the study area which covers approximately 1,900 km^2 of the area in BAZ County.

The study reports were prepared in English as follows :

1) Main Report
2) Supporting Report
3) Summary Report
4) Data Book

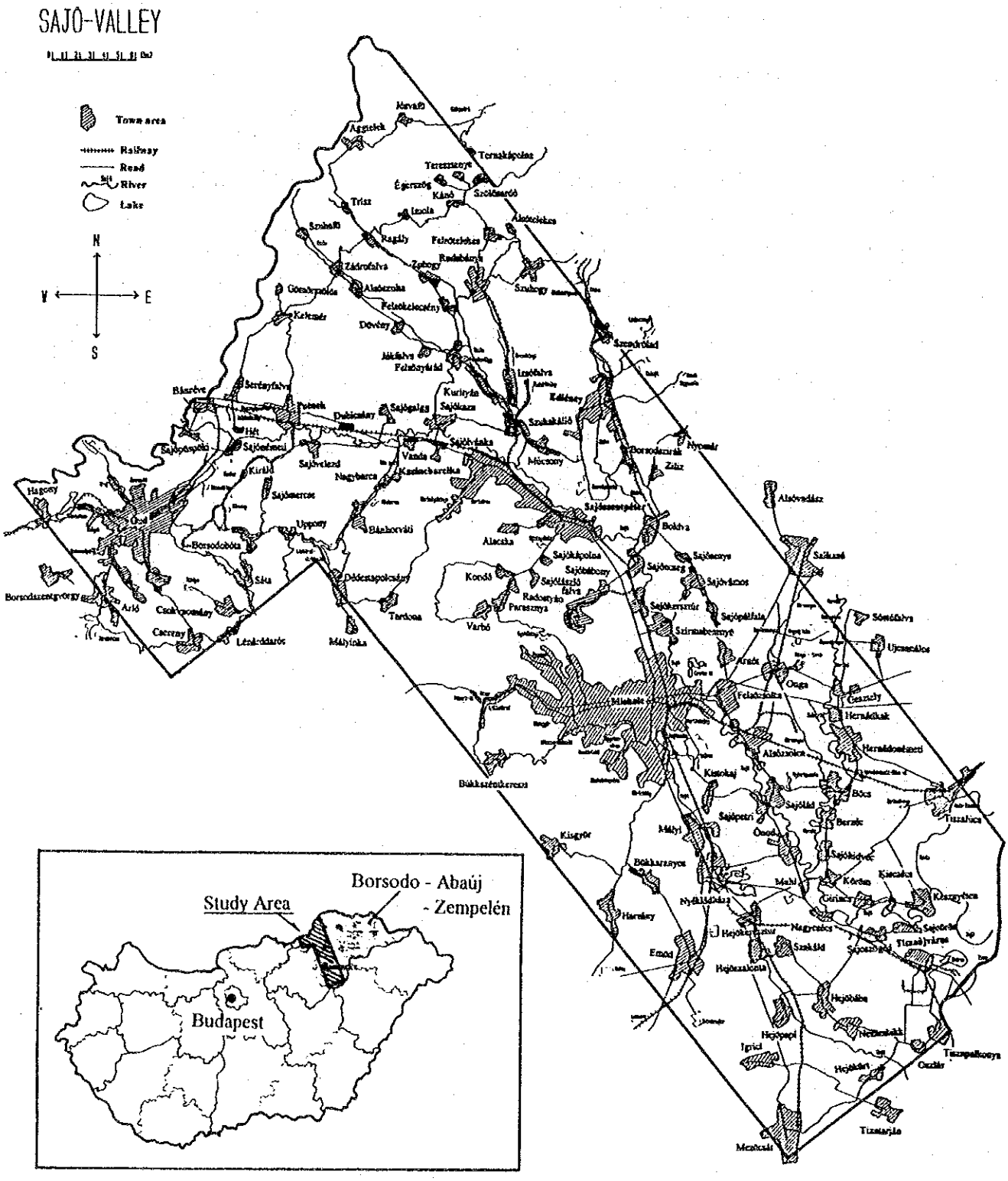


Figure 1.1 Study Area

2. Socio-economy and Energy

2.1 Social and Economic Conditions

(1) Administration

The Republic of Hungary consists of 19 counties and Budapest as its capital. In BAZ County, there were 15 towns and 333 villages in 1992. The Study Area consists of 9 towns and 113 villages, i.e. 34% of the villages and 60% of the towns within BAZ County.

(2) Population and Household

The population and the number of household in Hungary are 10,375,000 and 3,890,000, respectively, according to the 1990 census. Table 2.1 shows the population and a household number of the Study Area with their shares in BAZ County and the nation.

Table 2.1 Population and Household Number of the Study Area and Their Shares in BAZ County and the Nation

	Resident Population			Inter-census Pop. change 1980 - 1990		Number of Households
	1970	1980	1990	Natural	Migratory	1990
Towns Total	312,844	360,300	341,202	9,616	-28,714	124,054
Miskolc	181,398	208,103	196,442	1,487	-13,148	73,500
Other 8 Towns	131,446	152,197	144,760	8,129	-15,566	50,554
Villages Total	162,708	161,447	157,822	2,507	-6,132	54,126
Study Area Total	475,552	521,747	499,024	12,123	-34,846	178,180
Inter-census Change	-	9.7%	-4.4%			-
Share in BAZ County	61.0%	64.5%	65.5%			65.5%
Share in the Nation		4.9%	4.8%			4.6%

(3) Economy and Industry

The GDP in Hungary declined by 14.4% between 1988 and 1991, and further decrease of 4.5% was recorded in 1992. In the GDP, the relative contribution of industry fell from 38% in 1985 to 28% in 1992. Under such situation of the national economy, income and price conditions of the nation have been aggravated.

In the late 1980s, BAZ County produced more than 10% of the national industrial output, and its share in the national labour force was above 9%. But the fall of

production in the County's industry in the years 1990-92 was drastic even in its comparison to the national economy as shown in Table 2.2.

Table 2.2 County and National Level Decline in Industrial Production and Employment, 1990-1992 (1985 = 100.0)

	1985	1990	1991	1992
Production				
BAZ County	100.0	72.4	54.6	41.4
National economy*	100.0	94.6	81.3	67.3
Employees				
BAZ County	100.0	83.0	71.9	60.0
National economy	100.0	87.6	78.0	67.8
Production per employee				
BAZ County	100.0	87.2	75.9	69.6
National economy*	100.0	108.0	104.2	99.3

Note : * Based on Gross Output

However, the recent figures suggest that the economic recession in BAZ County may have reached its bottom-line by 1992. These county-level economic situations well approximate that of the Sajó Valley area since about 90% of the County's industry is located there.

(4) Energy Situation

1) National Trends

Figure 2.1 shows the trend of the national energy balance during the period of 1980 - 1992, which well corresponds to the trend in the economy. Table 2.3 shows import shares of basic energy carriers. From 1991 to 1992, import of electricity dropped considerably, but import of oil increased.

Table 2.3 Import Shares of Energy in Hungary (%)

	1991	1992
Coal-based sources	32	9
Crude oil	62	76
Natural gas	56	53
Electricity	20	10

Figure 2.2 shows the trend in the shares of the economic sectors in energy consumption. The energy consumption by the industrial sector has been markedly decreasing in its share even within the shrinking volume of total energy

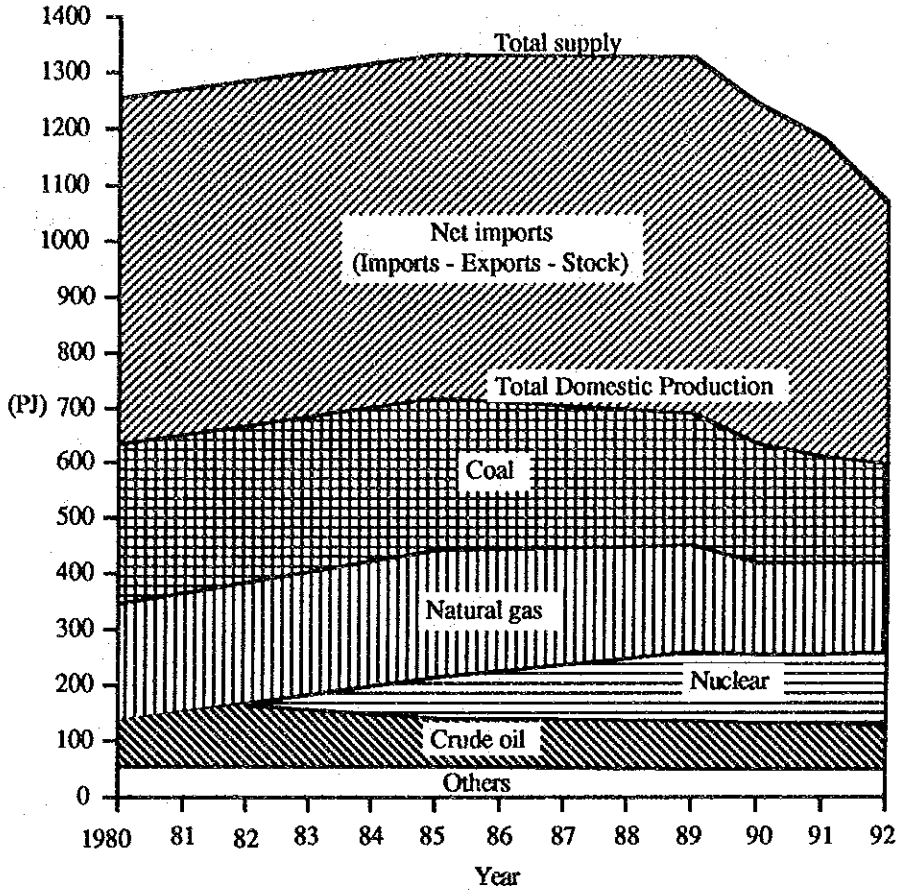


Figure 2.1 Trends of Energy Supply in Hungary

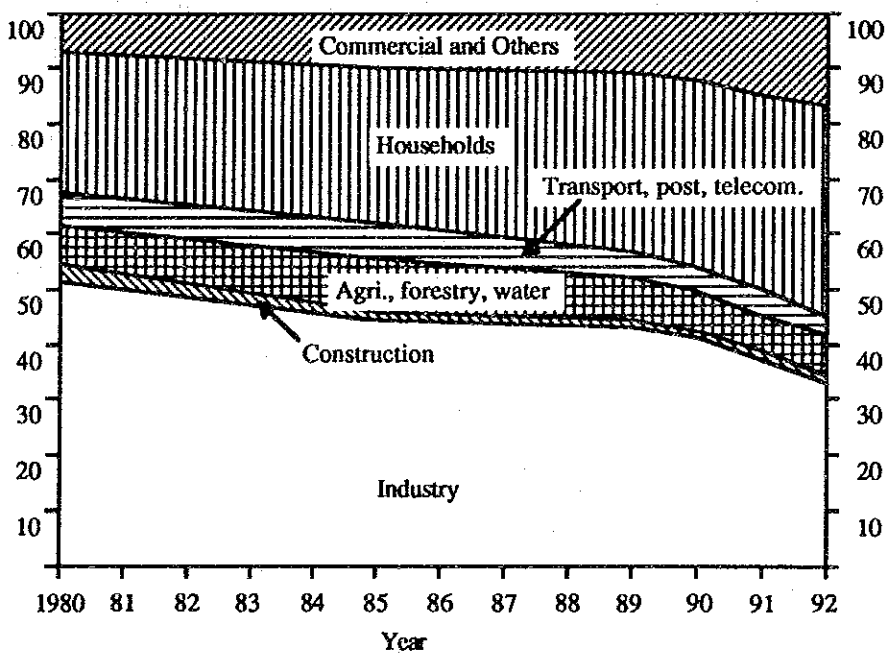


Figure 2.2 Trend in Shares of Sectoral Energy Consumption (%)

consumption. On the other hand, household energy consumption has increased dynamically. In 1992, its share surpassed that of industry.

2) Fuel Consumption in the Study Area

Result of investigation of the fuel consumption in the Study Area is summarized in Table 2.4. Business establishments account for 87% of the total fuel consumption in the Study Area. The shares for communal consumers and motor vehicles are 9.5% and 3.6%, respectively.

Table 2.4 Result of Investigation of Fuel Consumption in the Study Area

Sector	Fuel		One year total Apr. 92 - Mar. 93
Business Establishments	Solid	(TJ)	27,415
	Liquid	(TJ)	12,122
	Gas	(TJ)	44,716
	Sub-total	(TJ)	84,253
Communal Consumers	Solid	(TJ)	6,106
	Gas	(TJ)	3,104
	Sub-total	(TJ)	9,210
Motor Vehicles	Liquid	(TJ)	3,502
Grand Total (TJ)			96,965

The prominent primary energy consumers in the Study Area are three thermal power stations. In the total fuel consumption by business establishments, the three power stations account for 61%. These three power stations are largest emission sources of air pollutants in the area.

3. Present Air Quality

(1) Outline of Monitoring

Figure 3.1 shows locations of monitoring of air quality and meteorology. In addition to six existing stations (H1 ~ H3 and EC1 ~ EC3) for automatic monitoring of ambient air quality and surface meteorology in the Study Area, ten stations (JF1, JF2, J1 - J6, and JM1) were newly established in this Study to strengthen the monitoring network.

Other air quality related surveys conducted in the Study including the following :

1) upper-layer meteorological observation, 2) air quality measurement at road side, 3) measurement of ambient concentration of mercury, 4) measurement of falling dust, and 5) measurement of TSP and its composition.

(2) Result of Automatic Monitoring and Analysis

The Hungarian ambient air quality standards for SO_2, NOx and NO_2 are shown in Table 3.1. The summarized results of automatic monitoring of SO_2, NO_x and NO_2 for the one-year period from May 16, 1993 to May 15, 1994 are shown in Table 3.2. Stations J2 and J3 correspond to Protected Area II (industrial areas). All other stations correspond to Protected Area I (living area).

Concentrations of major pollutants (NOx, SO_2, CO, O_3, and SPM) increase during the heating season. Daily variations of SO_2 concentration during the heating season is shown in Figure 3.2. The high concentrations in the heating season are mainly caused by seasonally variable pollutant sources, such as house heating. It was observable that meteorological conditions also affected the concentrations.

Some monitoring stations are considered to be strongly affected by specific large pollution sources such as power plants under particular conditions of wind, and some stations are considered to be affected also by motor vehicles.

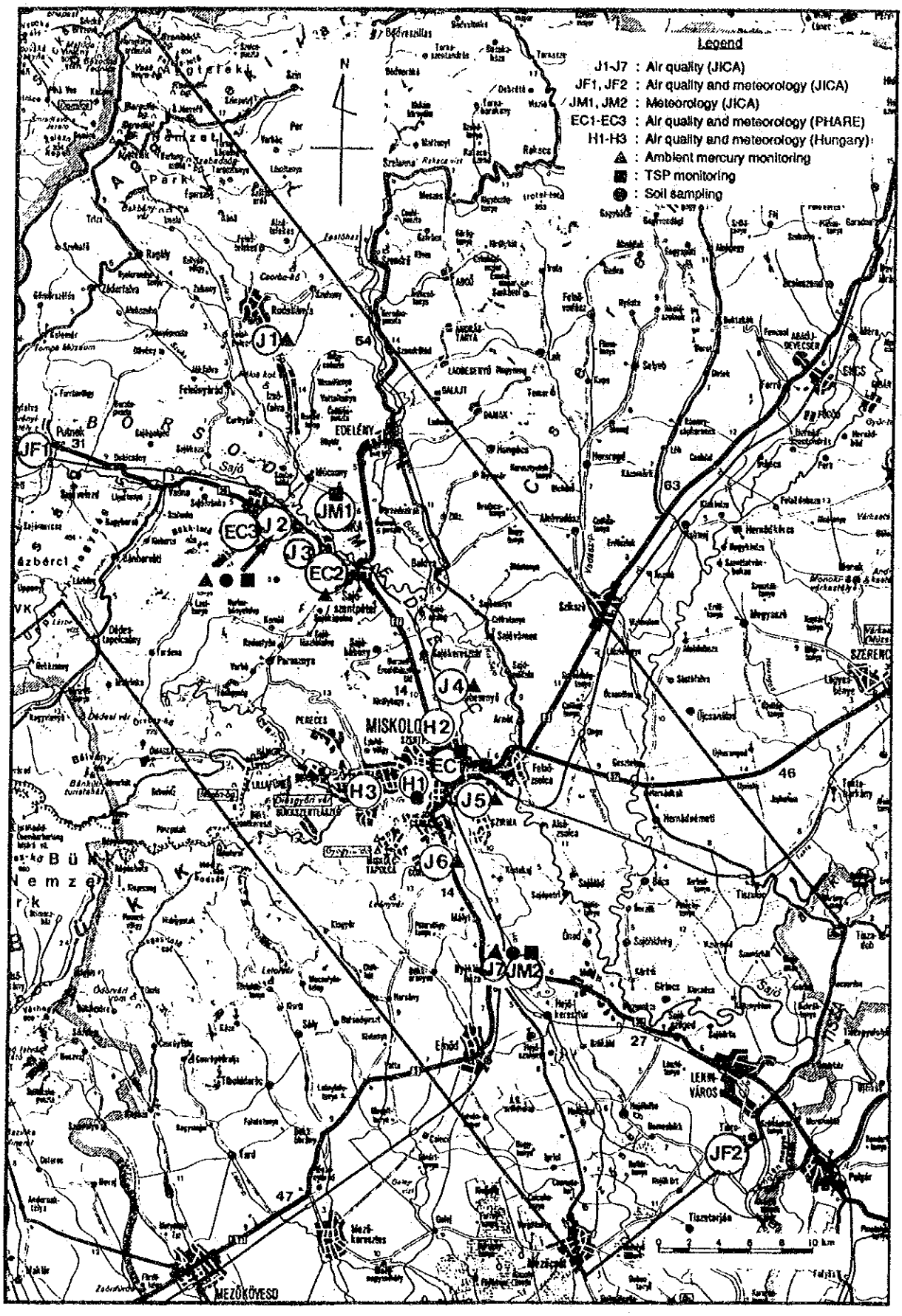


Figure 3.1 Location of Monitoring Stations of Ambient Air Quality and Meteorology

Table 3.1 Ambient Air Quality Standards for SO_2, NOx and NO_2

Pollutant	Averaging Time	Concentration (μg/m³) [(ppb 20°C)]		
		Specially Protected Area	Protected Area I	Protected Area II
SO_2	Annual average	30 [11]	70 [26]	100 [38]
	24-hours average	100 [38]	150 [56]	300 [113]
	30-minutes value	150 [56]	250 [94]	400 [150]
NOx	Annual average	30 [16]	100 [52]	150 [78]
	24-hours average	70 [37]	150 [78]	200 [105]
	30-minutes value	85 [44]	200 [105]	400 [209]
NO_2	Annual average	30 [16]	70 [37]	120 [63]
	24-hours average	70 [37]	85 [44]	150 [78]
	30-minutes value	85 [44]	100 [52]	200 [105]

Table 3.2 Summary of Measurements of SO_2, NOx and NO_2 (ppb)
(May 16, 1993 - May 15, 1994)

Protected Area			I			II		I			
Station			JF1	JF2	J1	J2	J3	J4	J5	J6	J7
SO_2	Annual Ave		28	9	6	16	16	09	14	09	09
	24 hours Ave	98%	96	30	26	71	60	44	55	38	36
		Max	197	164	56	213	200	148	107	102	50
	30 minutes Ave	98%	136	62	38	113	94	53	75	53	45
		Max	417	407	200	501	487	325	205	321	170
NOx	Annual Ave		11	6	11	33	17	16	27	23	29
	24 hours Ave	98%	27	16	22	77	44	43	78	66	79
		Max	34	30	32	115	70	53	152	95	103
	30 minutes Ave	98%	37	24	36	118	60	60	120	87	118
		Max	76	115	158	304	190	166	297	285	274
NO_2	Annual Ave		7	4	8	20	12	11	16	13	16
	24 hours Ave	98%	16	12	14	37	23	22	35	33	31
		Max	21	21	25	47	40	35	66	41	47
	30 minutes Ave	98%	22	16	20	47	32	29	42	40	40
		Max	52	56	39	164	79	70	117	85	99

: Over Ambient Air Quality Standard

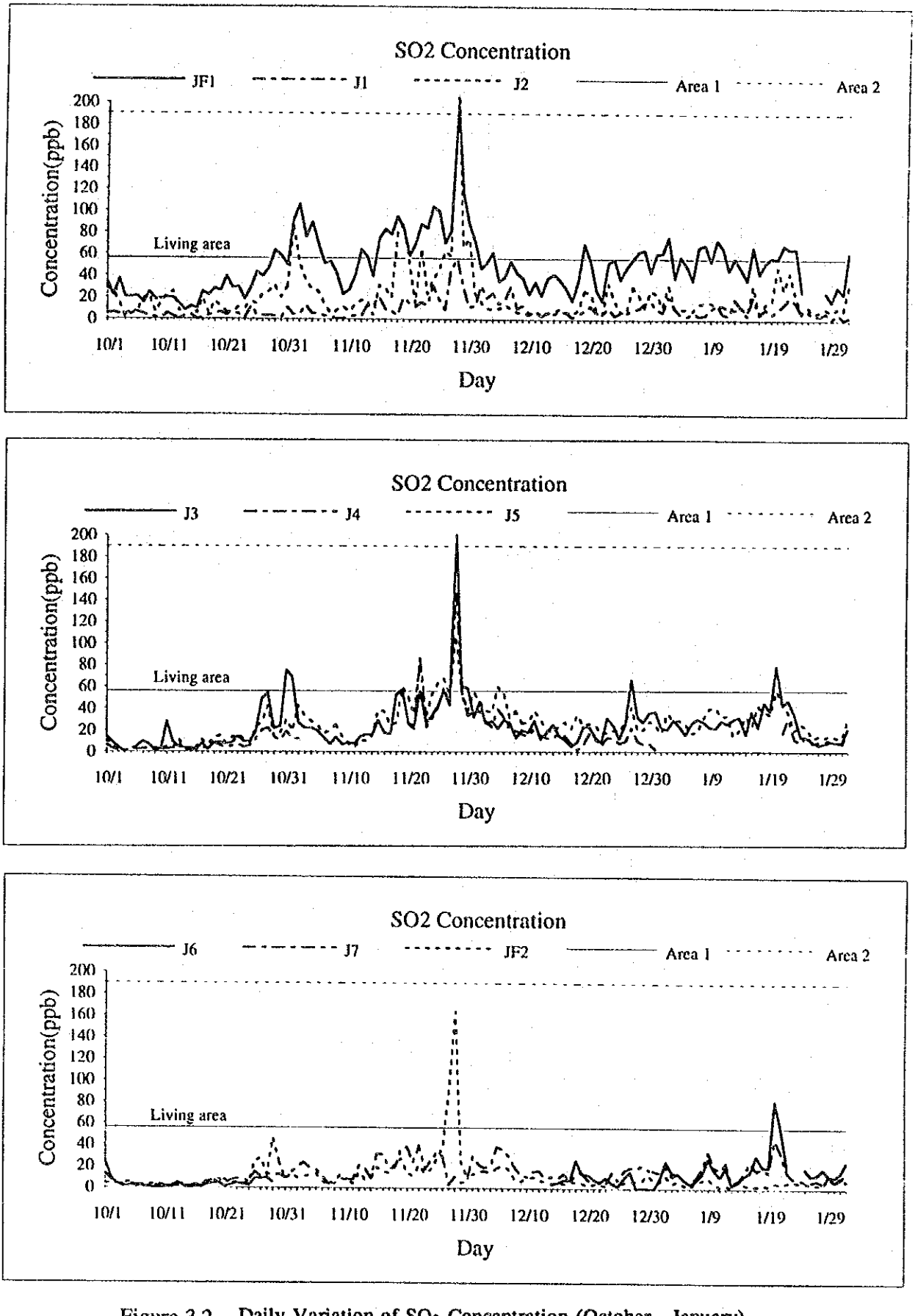


Figure 3.2 Daily Variation of SO_2 Concentration (October - January)

4. Pollutant Emission

Air pollution sources in the Study Area are largely classified as follows:

Stationary sources : Power plants (Borsod, Tisza I, Tisza II)
Factories
Communal sources (mainly household heating)

Mobile sources : Motor vehicles

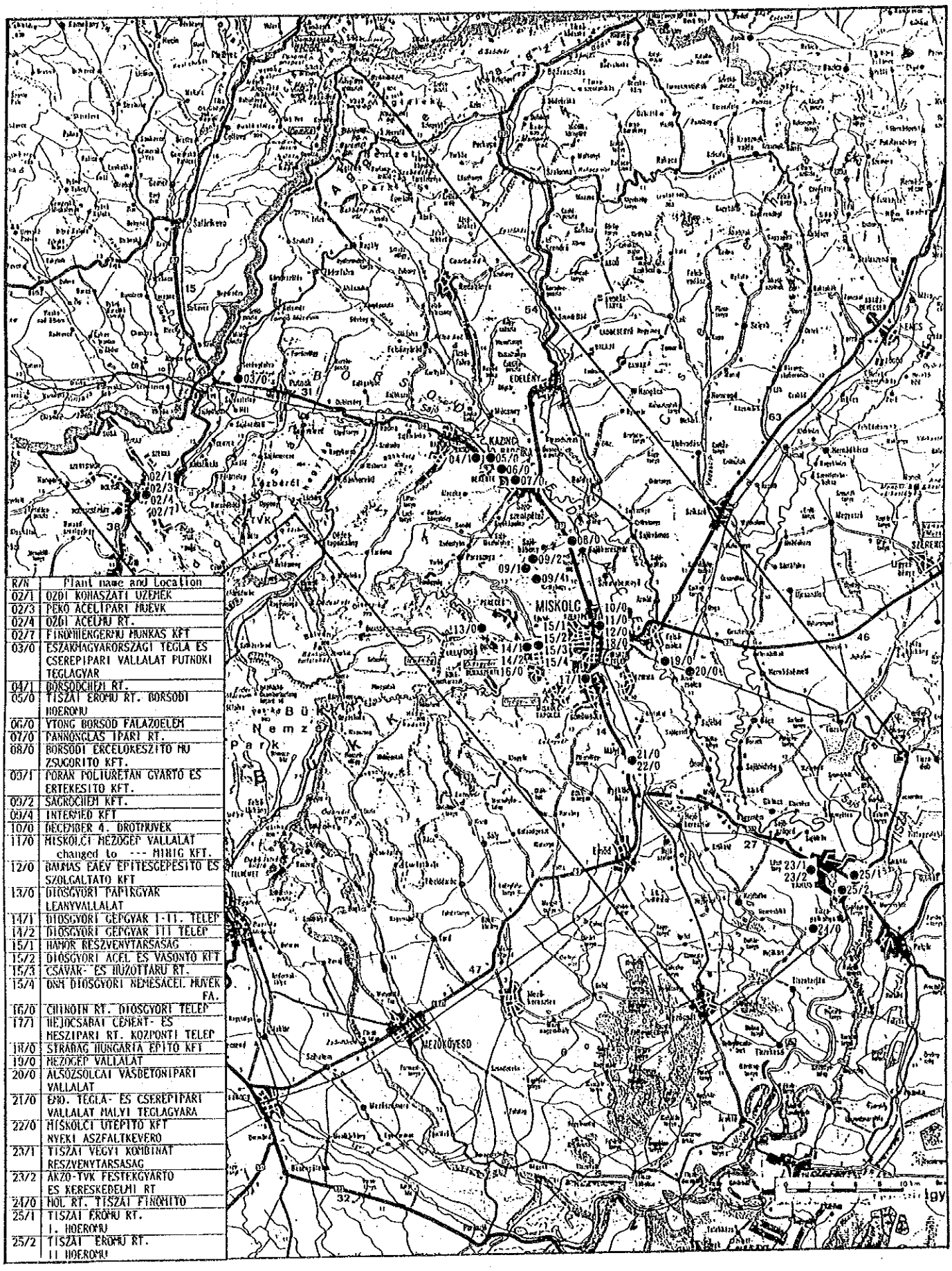
Locations of major stationary sources are shown in Figure 4.1. For the estimation of the amount of pollutant emissions, available data were provided by various Hungarian institutions including ÉKF. To supplement existing information, various pollution source surveys were conducted including : 1) questionnaire and visiting survey on factories, 2) flue gas measurement of combustion facilities, 3) questionnaire on home heating, 4) fuel analysis, 5) traffic volume survey, 6) driving speed and mode survey, and 7) emission factor test on automobiles.

Based on the provided data and the results of above surveys, the amounts of emissions of SO_2 and NOx were estimated.

The estimated amounts of air pollutant emissions at present in the Study Area are shown in Table 4.1. Shares of the source categories in the total emissions of SO_2 and NOx are shown in Figures 4.2 and 4.3, respectively. The stationary sources account for 99.7% of the annual total SO_2 emission and 82% of that of NOx.

Table 4.1 Total Emissions of SO_2 and NOx (Present)

Source Category		Heating Season				Non-heating Season				Whole Year			
		SO2		NOx		SO2		NOx		SO2		NOx	
		(t/y)	(%)	(t/y)	(%)	(t/y)	(%)	(t/y)	(%)	(t/y)	(%)	(t/y)	(%)
Stationary Sources	Borsod P.S.	20,570	38.1	1,481	15.4	10,689	24.4	654	9.5	31,259	32.0	2,135	12.9
	Tisza I. P.S.	17,698	32.8	1,662	17.3	17,110	39.1	1,220	17.8	34,808	35.6	2,882	17.5
	Tisza II. P.S.	3,000	5.6	1,742	18.1	12,036	27.5	1,406	20.5	15,036	15.4	3,148	19.1
	Major Factories	1,795	3.3	1,387	14.4	1,555	3.6	1,480	21.6	3,350	3.4	2,867	17.4
	Communal Facilities	10,851	20.1	2,021	21.0	2,233	5.1	463	6.7	13,084	13.4	2,484	15.1
	Sub total	53,914	99.8	8,293	86.1	43,623	99.7	5,223	76.1	97,537	99.7	13,516	82.0
Mobile Sources	Motor Vehicles	117	0.2	1,339	13.9	144	0.3	1,637	23.9	261	0.3	2,976	18.0
Total		54,031	100	9,632	100	43,767	100	6,860	100	97,798	100	16,492	100



R/N	Plant name and Location
02/1	OZDI KOHASZATI UZEMEK
02/3	PEKO ACELIPARI MUEVK
02/4	OZDI ACELÖNTÖ RT.
02/7	FINOMHENGERMÜ MUNKAS KFT
03/0	ESZAKMAGYARORSZAGI TEGLA ES CSEREPIPARI VALLALAT PUTNOKI TEGLAGYAR
04/1	BORSODCHEM RT.
05/0	TISZAI ERÖMÜ RT. BORSODI HOERÖMÜ
06/0	YTONG BORSOD FALAZOELEM
07/0	PANNONGLAS IPARI RT.
08/0	BORSODI ÉRCELÖKESZITÖ MÜ ZSUGORITÓ KFT.
09/1	PORAN POLIURETAN GYARTÓ ES ERTEKESITÖ KFT.
09/2	SAGROCHEM KFT.
09/4	INTERMED KFT
10/0	DECEMBER 4. DROTMUVEK
11/0	MISKOLCI MEZOGEP VALLALAT changed to --- MIMIG KFT.
12/0	BAUMAS ÉAEV ÉPITESGEPESITÖ ES SZOLGALTATÓ KFT
13/0	DIÓSGYÖRI PAPIRGYÁR LEÁNYVÁLLALAT
14/1	DIÓSGYÖRI GÉPGYÁR I-II. TELEP
14/2	DIÓSGYÖRI GÉPGYÁR III TELEP
15/1	HAMOR RÉSZVÉNYTÁRSASÁG
15/2	DIÓSGYÖRI ACÉL ÉS VASÖNTÖ KFT
15/3	CSAVAR- ÉS HÚZOTTÁRU RT.
15/4	DUNAFERR DIÓSGYÖRI NEMESACÉL MUVEK RÉSZVÉNYTÁRSASÁG
16/0	CHINOIN RT. DIÓSGYÖRI TELEP
17/1	HEJÖCSABAI CEMENT- ÉS MESZIPARI RT. KÖZPONTI TELEP
18/0	STRABAG HUNGÁRIA ÉPITÖ KFT
19/0	MEZOGEP VÁLLALAT
20/0	ÁLSÓZSOLCAI VASBETONIPARI VÁLLALAT
21/0	EHO. TEGLA- ÉS CSEREPIPARI VÁLLALAT MALYI TEGLAGYARA
22/0	MISKOLCI ÚTÉPITÖ KFT NYÉKI ASZFALTKEVERÖ
23/1	TISZAI VEGYI KOMBINÁT RÉSZVÉNYTÁRSASÁG
23/2	AKZO-TVK FESTÉKGYÁRTÓ ÉS KERESKEDELMI RT
24/0	HOL RT. TISZAI FINOMÍTÓ
25/1	TISZAI ERÖMÜ RT. I. HOERÖMÜ
25/2	TISZAI ERÖMÜ RT. II HOERÖMÜ

Figure 4.1 Location of Major Stationary Pollution Sources

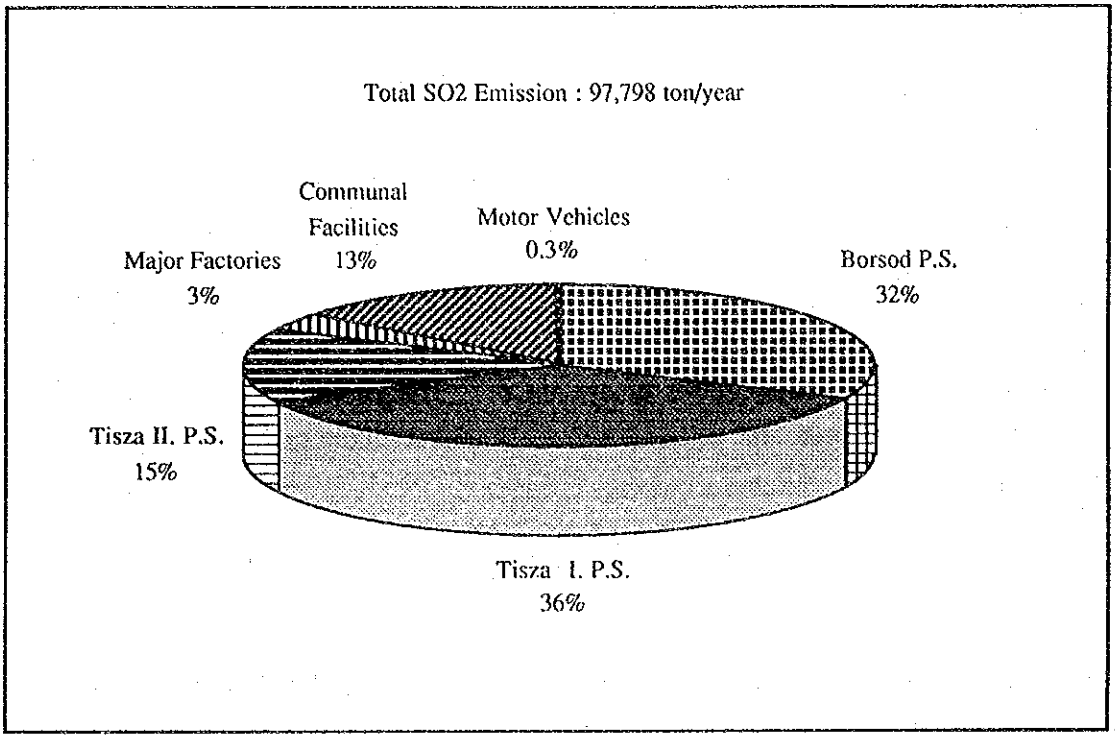


Figure 4.2 Shares of Source Categories in the SO2 Emission

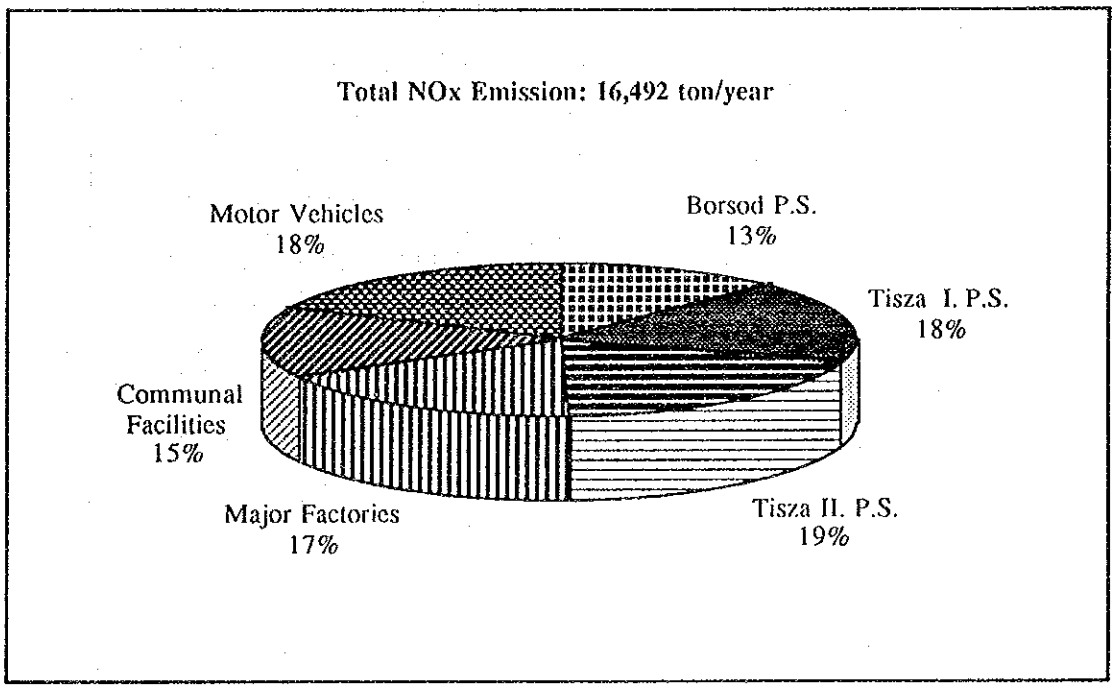


Figure 4.3 Shares of Source Categories in the NOx Emission

5. Air Quality Simulation Under the Present Conditions

Based on the data obtained through the air quality and meteorological monitoring and the pollution source surveys, an air quality simulation model was developed. Concentration distribution of SO_2 simulated and that of NO_2 converted from simulated values of NOx in the heating season are shown in Figures 5.3 and 5.4, respectively.

The annual average air quality standard of SO_2 for living area (70 $\mu g/m^3$) is exceeded in densely populated areas including whole or large part of Miskolc, Kazincbarcika, Sajoszentpeter and Ozd. Large parts of these towns even exceed the level of the quality standard for industrial area (100 $\mu g/m^3$). The concentration in the central part of Miskolc is more than 150 $\mu g/m^3$.

On the other hand, the NO_2 concentration satisfies the quality standard for living area (70 $\mu g/m^3$) in the whole area.

The result of analysis of source contribution to the ambient concentration at monitoring stations in the heating season is shown in Table 5.1.

Table 5.1 Source Contribution to Ambient Pollutant Concentration in the Heating Season (%)

Pollutant	Source	Monitoring Station								
		JF1	JF2	J1	J2	J3	J4	J5	J6	J7
SO_2	Power plants	4.9	50.0	30.6	18.7	25.6	23.8	16.7	16.8	20.3
	Industry	6.3	12.0	3.7	4.1	8.4	5.5	7.2	8.2	6.2
	Communal	86.7	35.0	64.8	70.2	62.3	68.0	72.1	70.7	59.3
	Automobiles	2.1	3.0	0.9	7.0	3.7	2.8	4.1	4.3	14.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NOx	Power plants	0.7	11.0	8.2	1.7	3.5	3.3	2.2	2.3	1.2
	Industry	2.2	8.8	4.1	2.9	6.1	4.4	2.5	2.6	1.7
	Communal	56.9	28.6	56.2	27.2	37.4	48.9	46.2	41.0	14.4
	Automobiles	40.1	51.6	31.5	68.2	53.0	43.4	49.1	54.1	82.7
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

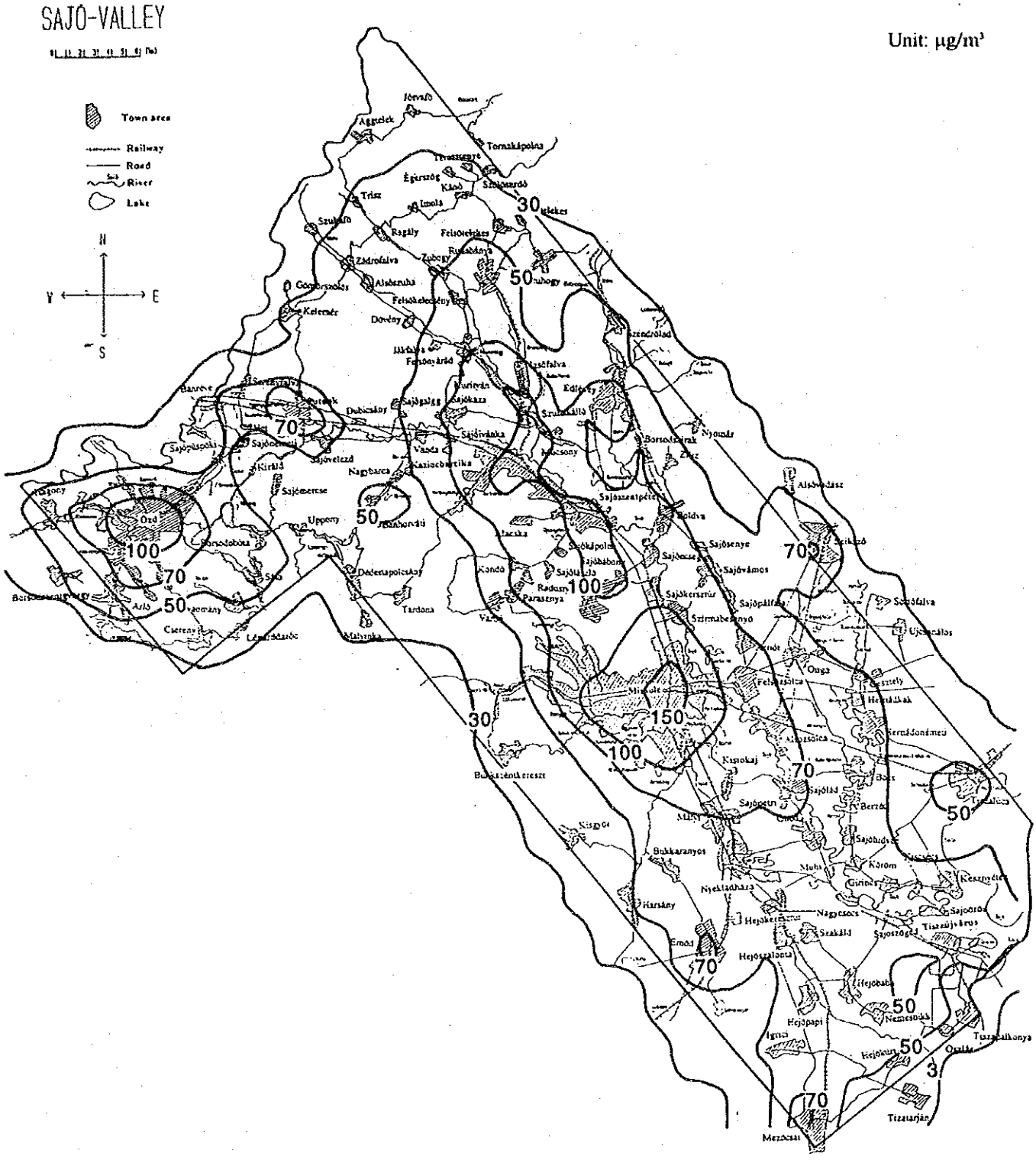


Figure 5.3 Concentration Isopleth for SO_2 in Heating Season (All Sources)

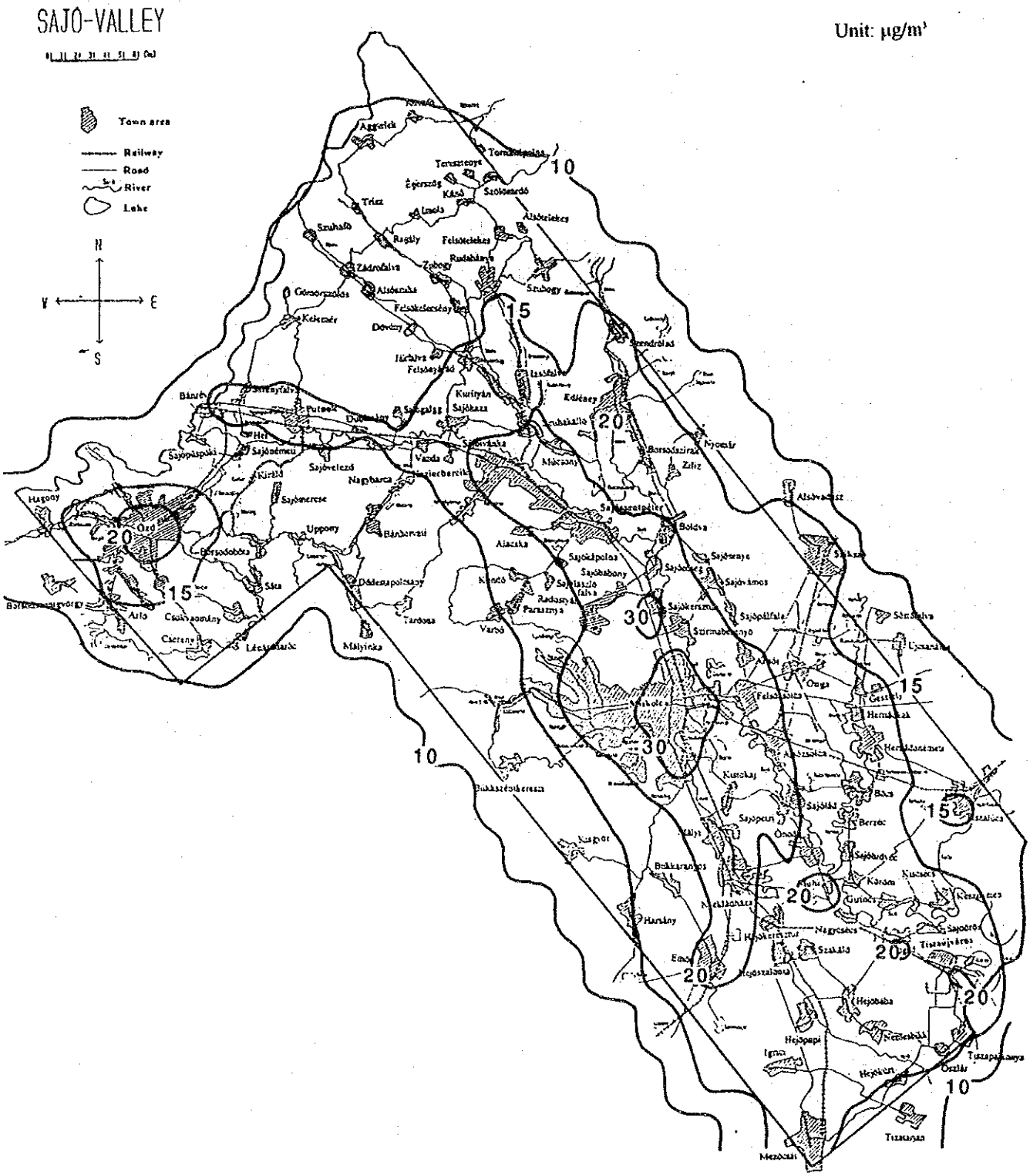


Figure 5.4 Concentration Isopleth for NO_2 in Heating Season (All Sources)

6. State of Air Pollution Control

6.1 Present State

(1) Institutional Framework

The present legal framework for air pollution abatement has been established on the basis of the Act on Environmental Protection (Second Act of 1976) being reinforced by other Acts. Legal regulations provided under this framework include the following:

1) Ambient air quality standards
2) Emission standards for stationary sources
3) Fining system for stationary sources
4) Emission standards for mobile sources
5) Fuel quality standards
6) Incentives for executing pollution control measures, e.g. grant and no or low interest loans from the Central Environmental Protection Fund (CEPF)

The Government has been continually reviewing the existing legal systems and proposed a new government decree. Under the draft of the new decree, items 1), 2), 3) and 4) above have been comprehensively revised and their new drafts have been also proposed.

In organizational aspect, KTM is performing central roles in air pollution control management. Other important organization include : ÁNTSZ, KHVM, IKM, NM, OKI and OMSZ at the national level, and ÉKF-KTM, ÁNTSZ-BAZ, BAZKF, BAZ County, and City Mayor Offices in the Sajó Valley area.

(2) Stationary Pollution Sources

Among the large and medium size plants in the Sajo Valley area having potentiality of emitting air pollutants, 54 plants are operating. They include those factories that are partially operating and 19 heating centers operating in the heating season. There are a total of 527 stacks emitting air pollutants in those 54 operating factories. Of these, 271 are emitting pollutants due to fuel combustion. Number of stacks emitting SO_2 due to combustion of coals and oils is 56 including 8 stacks of 3 power stations.

There is no flue gas desulfurization facility in the plants in the Study Area. Some combustion facilities emit SO_2 with its amount exceeding the emission standards.

As for NOx, there are some facilities that seem to need combustion control with an appropriate air ratio. A certain facility seems to need low-NOx burners.

For control of dust emission, electrostatic precipitators (EP) are installed in large-scale facilities. Sintering furnaces in an iron ore plant is equipped with multi-cyclones with efficiency of 80-85%.

Natural gas is supplied to household for home heating and other purposes covering about 57% of the all households in the Study Area. The rest use coal, firewood or light oil for heating.

(3) Mobile Pollution Sources

The major mobile sources of air pollution in the Sajó Valley area are motor vehicles. In BAZ County, about 129,000 vehicles were registered as of 1990. Of these, 45,000 vehicles were in Miskolc. Passenger cars account for 85% of the total in BAZ County followed by trucks at 13% and buses at 2%.

In Hungary, the share of the passenger cars produced by Lada, Travant and Wartburg is more than 60% of all passenger cars. About 40% of all motor vehicles in Hungary are 10 years of the age or older. In BAZ County, about 2,400 passenger cars are said to be equipped with a catalytic converter. These cars are considered to account for about 7% of passenger cars of the age 5 years or less.

6.2 Existing Plans for Air Pollution Control

There are various plans of the central government and enterprises in the Sajó Valley area for air pollution control as described below.

(1) Stationary Sources

1) Power Plants

In order to meet the requirements of newly proposed emission regulations, the power plant company (MVM Rt.) planned to improve the state of air pollutant emissions from three power stations in the Sajó Valley area. The plan consists of improvement of boiler facilities, reduction of production output, and fuel improvement as shown below.

Borsod plant :

a) Installation of a 460 t/h circulating fluidized bed combustion (CFBC) boiler with a sulfur removal efficiency of 90% or more

b) Reconstruction of 4 existing 100 t/h boilers into hybrid fluidized bed combustion (HFBC) boilers with a sulfur removal efficiency of 60%

With these boilers, production of electricity is to increase from the current level of 425 GWh (1993) to 970 GWh in 2005, while maintaining largely the present level of heat supply.

Tisza I plant :

Reduction of electricity production from the current level of 795 GWh (1993) to 35 GWh in 2005 by phasing out old boilers, while maintaining the heat supply at about 75% of the present level.

Tisza II plant :

a) Reduction of electricity production from the current level of 3,008 GWh (1993) to 1,581 GWh in 2005
b) Use of low-sulfur fuel oil (3.73% S at present, 1% S in 2005)

2) Factories

Some large-to-medium size plants are to be closed down. And some plants have their own plans to reduce emissions of SO_2, NOx or dust as shown below since the emission levels exceed or are close to the emission standard.

Plant No.	Type of industry	Source facility	Object pollutant	Fuel	Control measure
03/0	Brick production	Tunnel kiln	SO_2	Coal	Change the fuel to natural gas
15/1	Iron casting	8 Forge furnaces	NOx	Natural gas	Remodel the furnaces to the Rath type
15/2	Iron casting	3 Electric furnaces	Dust		Installation of suction devices and dust collectors
23/1	Chemicals production	3 Nitric acid lines	NOx		Installation of denitration equipment

3) Expansion of Natural Gas Supply for Household Heating

The gas supply company has a plan to expand the gas pipeline network to supply natural gas for households in the Sajó Valley area. The expanded pipe network will have a capacity to cover 86% of all households in the Sajó Valley area by the year 2005.

(2) Mobile Sources

The new government decree and action plans being proposed include the following measures to improve automobiles related air pollution:

- Domestic application of EC's emission standards
- Favorable import duties for environmentally desirable vehicles
- Financial support of population for owning catalyst equipped models
- Increase in spot-check of vehicles on the road
- Support to reduce pollutant emissions from public transport in cities

For fuels, the authorities plan to reduce sulfur content of diesel oil from the current level of 0.2% to 0.05%, and that of gasoline from current 0.05% to 0.04%.

7. Prediction of Future Air Quality

The target year of the Study was determined to be the year 2005. For prediction of future air quality, the following 3 cases were considered:

(1) No air pollution control measures are taken (Case F-0).

(2) Air pollution control measures already planned by the Hungarian authorities and individual enterprises are taken (Case F-1).

(3) Some air pollution control measures in addition to Case F-1 are taken (Case F-2).

Since the Hungarian authorities and individual enterprises are already planning various air pollution control measures, above Case F-0 is not realistic. However, it is included for analysis since the effects of air pollution control measures in other cases can be more clearly demonstrated in comparison to this case. Conditions of above 3 cases are explained below.

7.1 Case of No Air Pollution Control (Case F-0)

1) Borsod Power Station

It is assumed that the productions of electricity and heat energy in 2005 will be 970 GWh and 2,870 TJ, respectively, as planned by MVM Rt. But it is also asumed that the present facilities will be used.

2) Tisza I Power Station

As planned by MVM Rt., it is assumed that the productions of electricity and heat energy in 2005 will be 35 GWh and 1,700 TJ, respectively, by using the present facilities and the same fuels as the present.

3) Tisza II Power Station

It is assumed that the electricity production in 2005 is 1,581 GWh by using the present facilities as planned by MVM Rt. But it is also assumed that the quality of oil will be the same as the present and the gas/oil mixing ratio will be also the same as the present.

4) Major Factories

Future growth of fuel consumption by industries is assumed to be proportional to the growth of production. The growth rate was assumed to be 0 - 3% depending on the type of industry. Energy saving by about 10% for the future expected by the

government is excluded.

5) Communal Facilities

Population and the number of households in 2005 are assumed to be the same as the present. Fuel consumption in the heating centers (except power stations) is assumed to be the same as that of the present both in quantity and quality of fuels. Household consumption of natural gas and other fuels is also assumed to be the same as the present.

6) Motor Vehicles

The traffic volume would increase by 40% from the present, and the ratio of catalyst equipped motor vehicles is assumed be 6.8% of the all gasoline-powered motor vehicles. The sulfur contents of diesel and gasoline are assumed to be the same as the present.

7.2 Case of Existing Air Pollution Control Plan (Case F-1)

This case corresponds to the conditions described in Section 6.2. Air pollution control measures planned by the Hungarian authorities and enterprises are included. In addition, energy saving by about 10%, which is envisaged by IKM, is assumed for factories having such possibility. For Tisza II Power Plant, the fuel mix ratio of gas/oil is assumed to be the same as that of the present.

However, since the price of natural gas is scheduled to be doubled in the near future, it is assumed that only 55% of households having no access to the gas will have the gas supplied by the year 2005 as estimated by ÉKF. As a consequence, 78% of all households will have the natural gas rather than 86% which is the capacity planned by the gas supply company.

7.3 Case of Additional Pollution Control Measures (Case F-2)

This case corresponds to the situation where pollution control measures recommended by the Study Team are added to the case of existing air pollution control plan (Case F-1). The recommended measures are control of SO_2 and NOx in some factories and further expansion of natural gas supply.

(1) Factories

Certain control measures are recommended for control of SO_2 and NOx in 6 plants as shown below.

Plant No.	Type of industry	Source facility	Object pollutant	Fuel	Control measure
02/1	Iron and steel	2 Boilers* for heat supply	SO_2	Natural gas Brown coal	Increased use of natural gas
03/0	Brick production	Tunnel kiln	SO_2	Coal	Use of low-sulfur coal as raw material
04/1	Chemicals production	Incinerator	NOx	Waste solvent	2-stage combustion
09/2	Chemicals production	Incinerator	NOx	Waste solvent and solid	2-stage combustion
15/2	Iron casting	Heating furnace	NOx	Natural gas	Furnace retrofitting and recuperator
17/1	Cement production	Cement kiln	NOx	Natural gas	Low-NOx burner

* These boilers may be out of the service in the future requiring no control measure.

(2) Further Expansion of Natural Gas Supply

It is recommended that the use of coal be replaced by the natural gas as far as the planned supply network allows, i.e. 86% of the total number of households. However, since individual households have to bear the costs for the pipe connection and new equipment for heating, some measures to support the facility costs are seemed to be necessary. Therefore, application of existing support systems such as CEPF is recommended.

7.4 Amount of Pollutant Emission in the Future Cases

Based on the future conditions of pollutant sources described for above 3 cases, the emission quantities of SO_2 and NOx were estimated. The annual amounts of the SO_2 emission in the three cases are summarized in Table 7.1 and Figure 7.1, and the same for NOx are summarized in Table 7.2 and Figure 7.2.

7.5 Prediction of Future Air Quality

Ambient air quality of each case was predicted by the simulation model. The predicted NO_2 concentrations satisfy the new standard in all cases. The predicted SO_2 concentrations for the heating season are as follows.

- In Case F-0, the areas exceeding the new SO_2 standard (50 $\mu g/m^3$) occupy 70 - 80% of the Study Area as shown in Figure 7.3.
- In Case F-1, the new SO_2 standard is exceeded in the central part of Miskolc as shown in Figure 7.4.
- In Case F-2, the new standard is satisfied in the whole area as shown in Figure 7.5.

Table 7.1 Amount of SO_2 Emission by Sources and Cases (ton/y)

	Present	Case F-0	Case F-1	Case F-2
Borsod P.S.	31,259	40,636	9,690	9,690
Tisza I. P.S.	34,808	6,962	6,962	6,962
Tisza II. P.S.	15,036	9,172	2,406	2,406
Major Factories	3,350	2,192	1,996	1,804
Communal Facilities	13,084	13,084	4,564	2,963
Motor Vehicles	261	367	105	105
Total	97,798	72,413	25,723	23,930

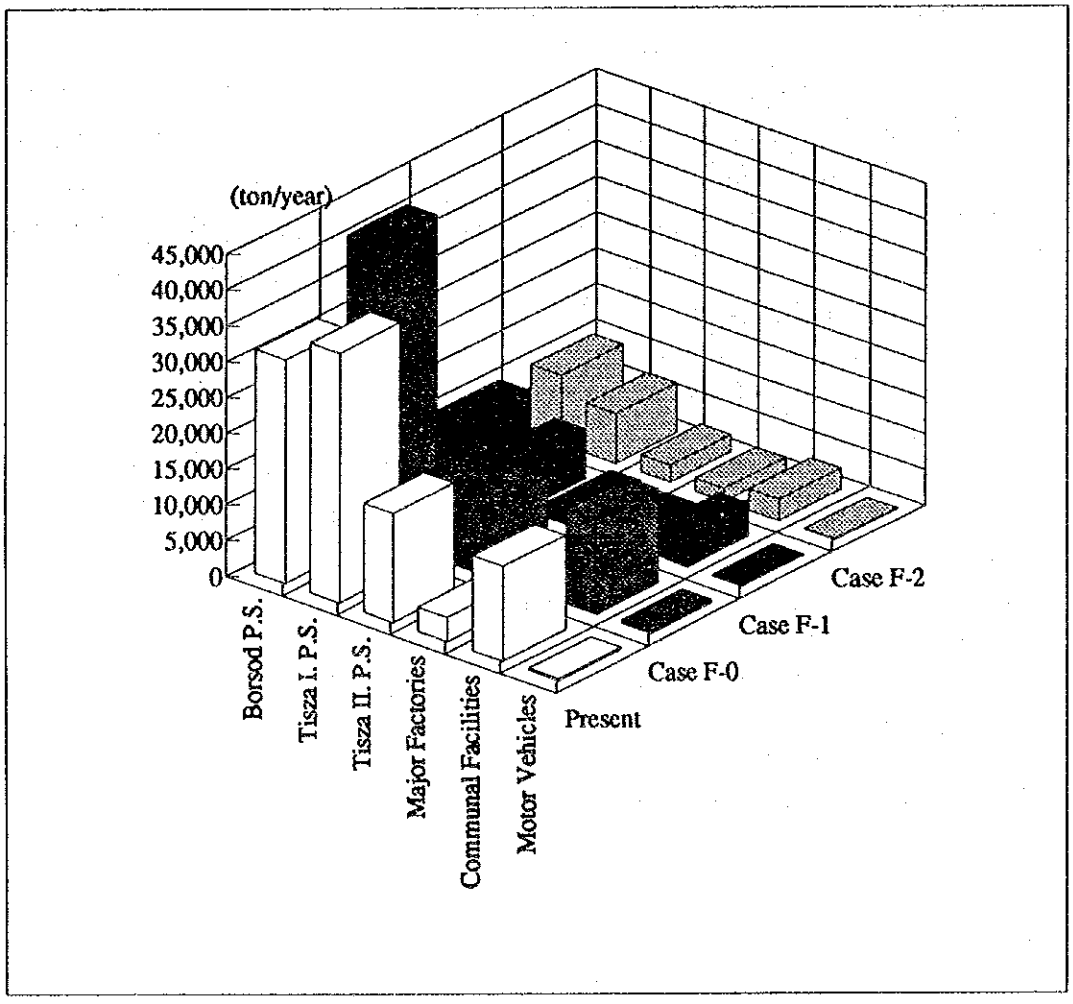


Figure 7.1 Amount of SO_2 Emission by Sources and Cases (ton/y)

Table 7.2 Amount of NOx Emission by Sources and Cases (ton/y)

	Present	Case F-0	Case F-1	Case F-2
Borsod P.S.	2,135	2,776	1,708	1,708
Tisza I. P.S.	2,882	576	576	576
Tisza II. P.S.	3,148	1,920	1,920	1,920
Major Factories	2,867	2,837	1,571	1,499
Communal Facilities	2,484	2,484	1,435	1,240
Motor Vehicles	2,976	4,098	2,243	2,243
Total	16,492	14,691	9,453	9,186

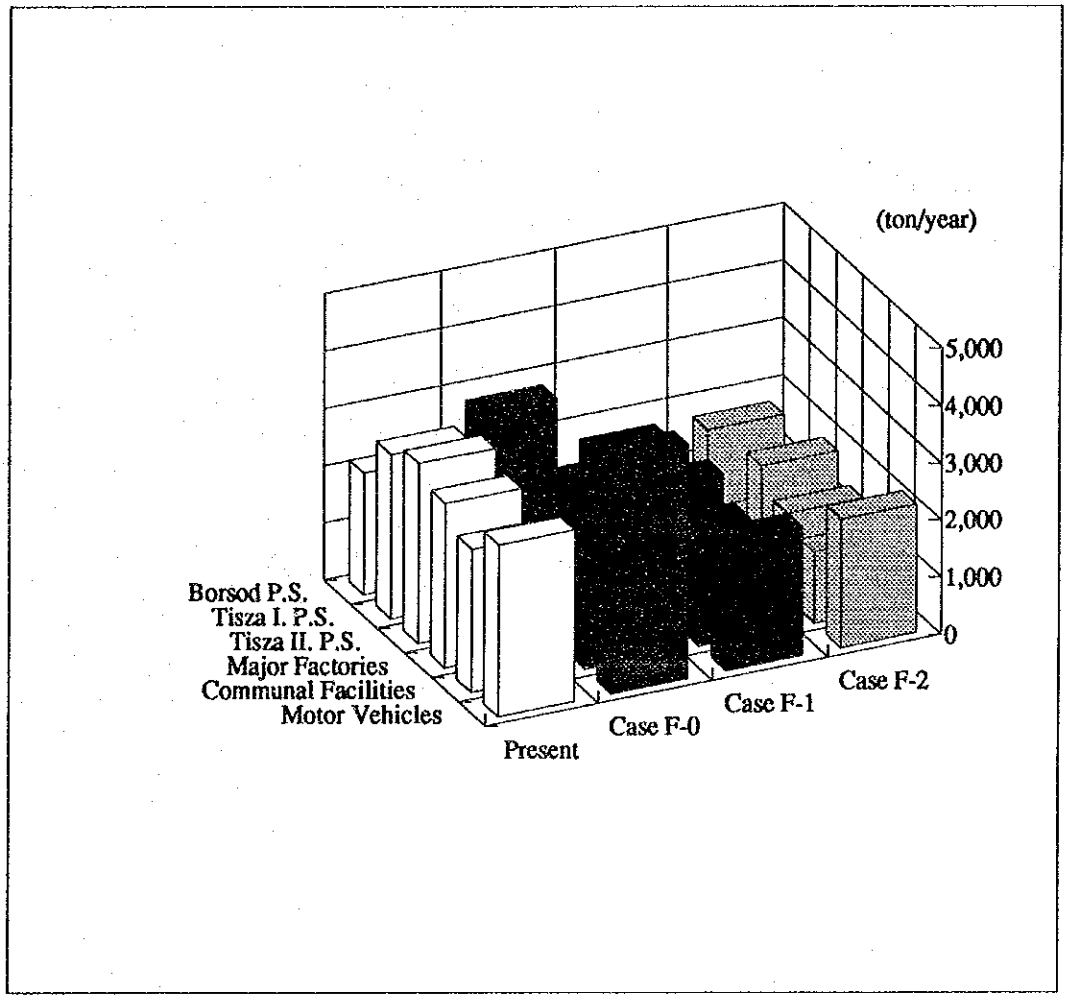


Figure 7.2 Amount of NOx Emission by Sources and Cases (ton/y)

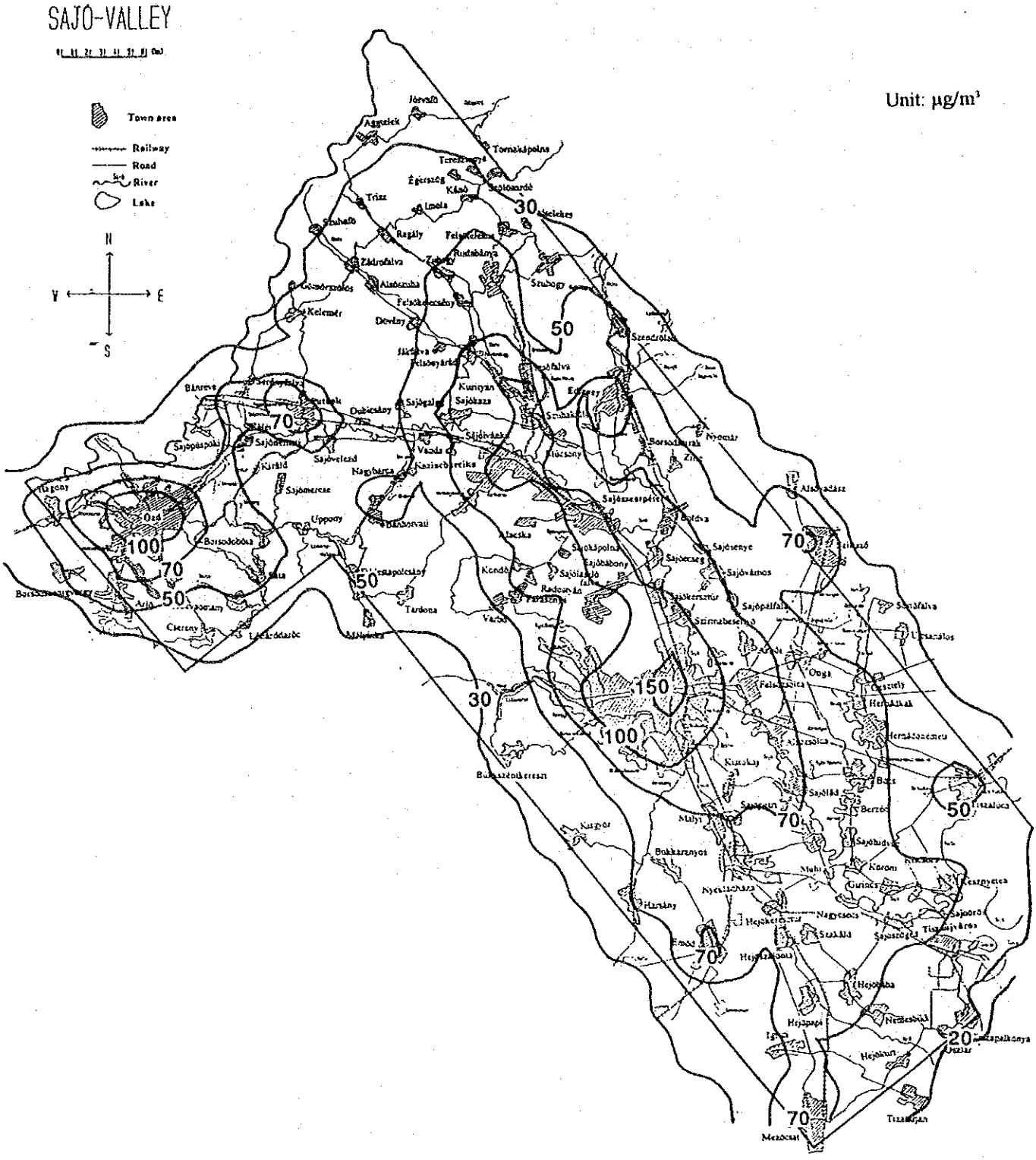


Figure 7.3 Average Concentration Isopleth for SO2 in Heating Season (Case F-0, All Sources)

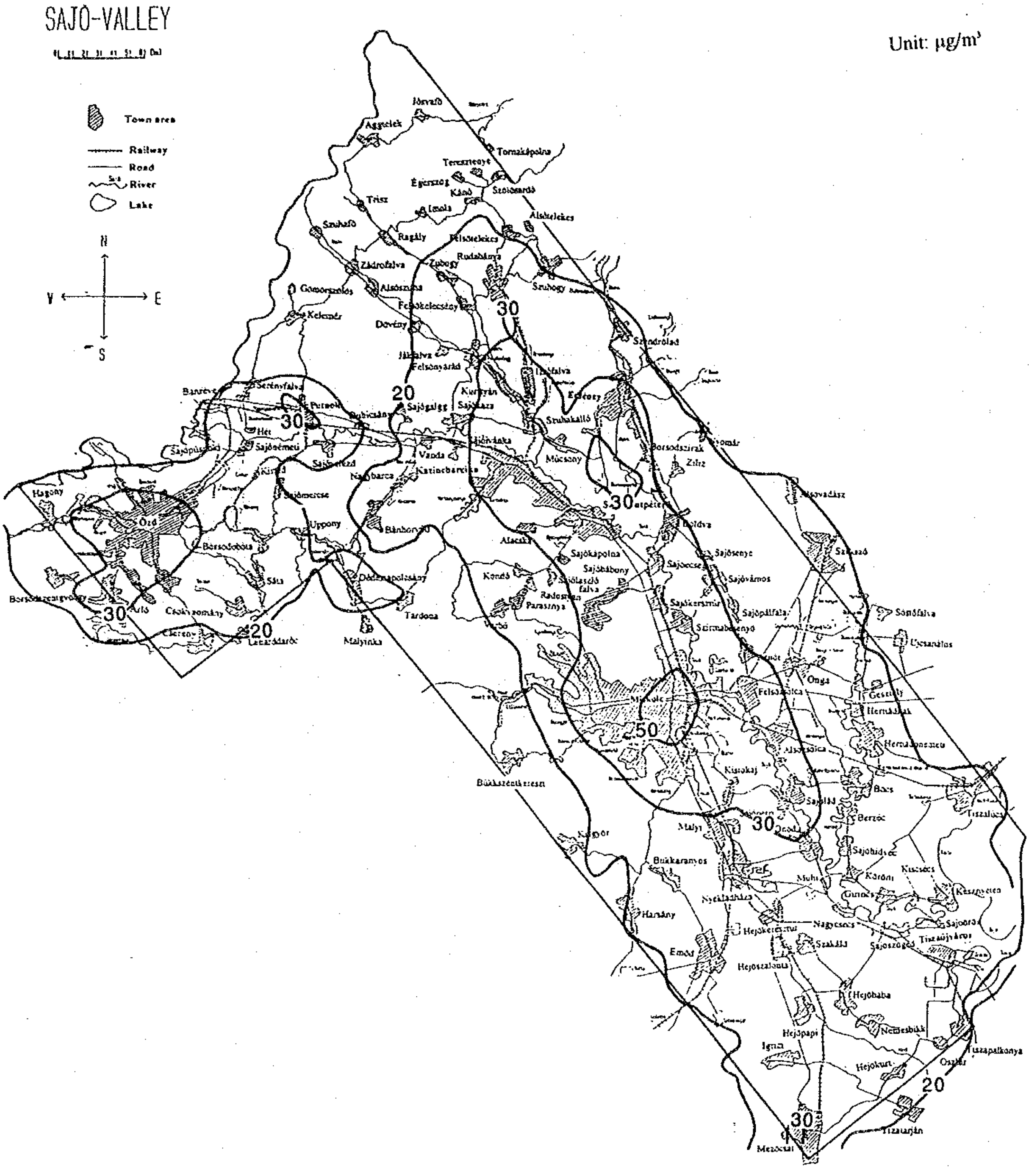


Figure 7.4 Average Concentration Isopleth for SO2 in Heating Season (Case F-1, All Sources)

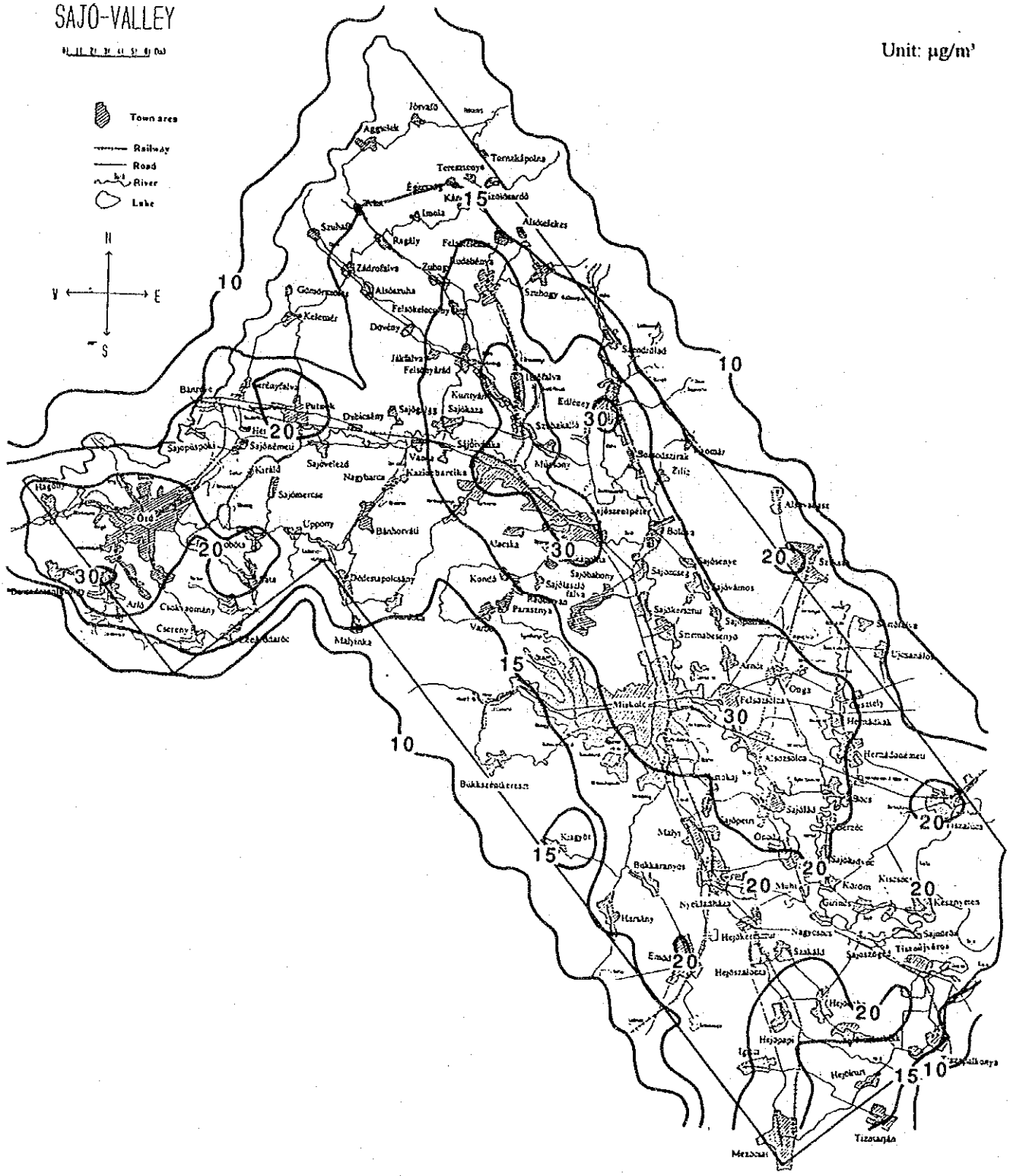


Figure 7.5 Average Concentration Isopleth for SO2 in Heating Season (Case F-2, All Sources)

8. Integrated Air Pollution Control Plan

8.1 Proposal of Air Pollution Control Plan

Conditions of pollution sources, control measures, and predicted air quality (SO_2 and NO_2) are summarized in Table 8.1 for the present and the three cases of the year 2005.

In Case F-0, the no pollution control case, the predicted concentration of SO_2 seriously exceeds the new ambient air quality standard.

In Case F-1, the amount of SO_2 emission will be reduced to about a quarter of the present level, and that of NO_x will be reduced to about 60% of the present level. However, the heating-season average concentration of SO_2 does not satisfy the new standards at the central part of Miskolc.

In Case F-2, the SO_2 emission is further reduced by 1,700 ton/y, as well as the NOx emission by 300 t/y from the levels of Case F-1. As a result, the heating-season average concentration of SO_2 satisfies the new standard in the whole area.

In view of air quality improvement in the Sajó Valley area, Case F-2 is proposed as the air pollution control plan for the Sajó Valley area.

8.2 Cost of the Source Control Measures

Initial costs of the proposed stationary source control measures are shown in Table 8.2.

8.3 Institutional Measures

To support implementation of the proposed air pollution control plan, the following measures are recommended:

1) Implementation of the currently proposed government decree on air pollution abatement
2) Establishment of training a center for air pollution control
3) Establishment of an air pollution monitoring and assessment center
4) Effective application of the Central Environmental Protection Fund (CEPF)

8.4 Implementation Program

Considering priorities of proposed source control measures and their relation with the institutional measures, an implementation program for the air pollution control plan is proposed as shown in Table 8.3.

Table 8.1 Summary of Air Pollution Control Measures and Simulation Results

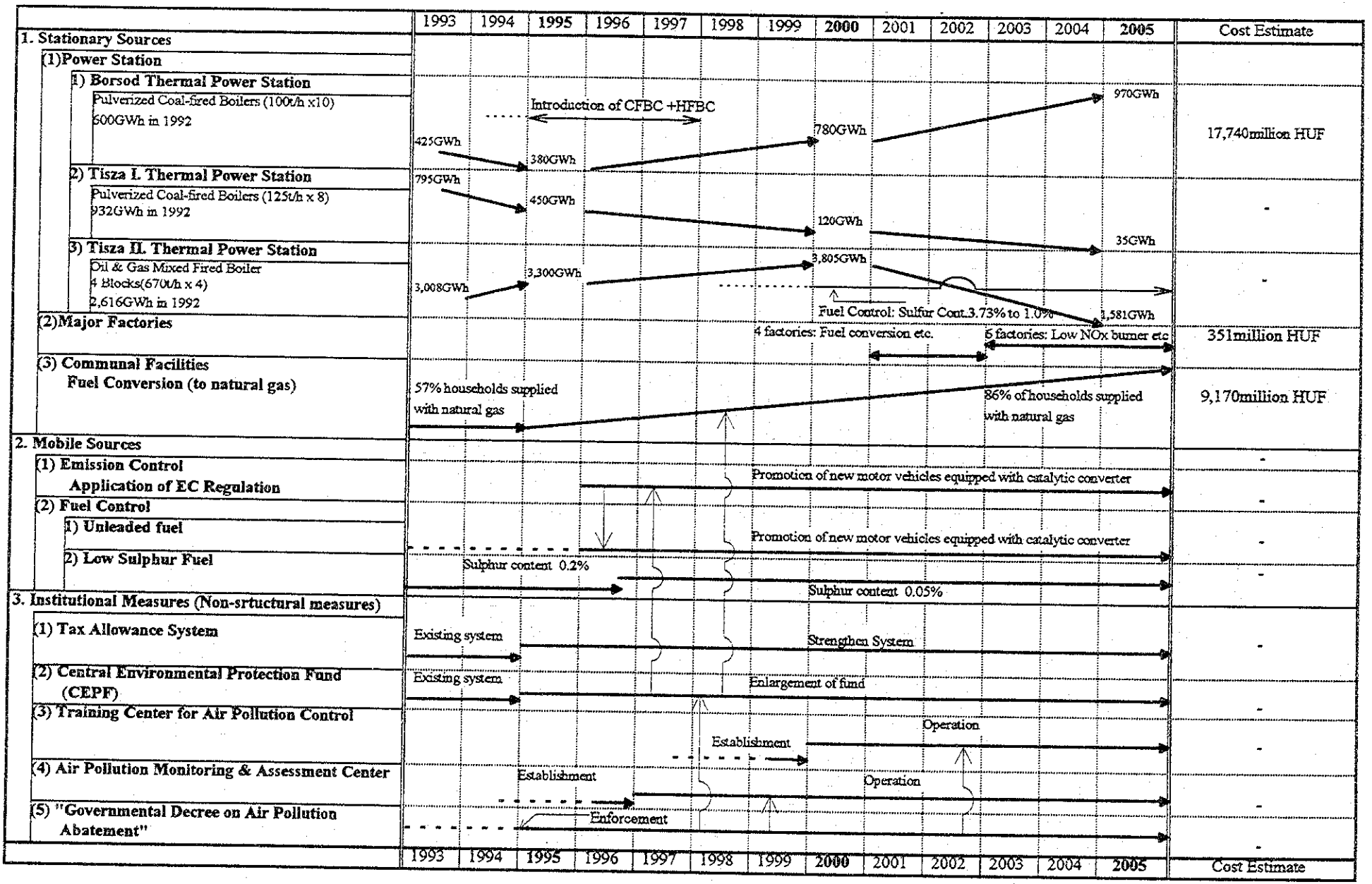
	Present (1992)	Case F-0 (2005) Without Measure	Case F-1 (2005) With Existing Measures	Case F-2 (2005) With Additional Measures
Bored P.S.	· Pulverized Coal -Fired Boiler 100t/h x 10 · 600GWh · Pollutant Emission : SO2 31,300t/y (1.0) NOx 2,100t/y (1.0)	· Same Facilities and Fuel as Present · 970GWh (1.62times) · Pollutant Emission : SO2 40,600t/y (1.30) NOx 2,800t/y (1.30)	· Circulation Fluidized Bed Combustion + Hibrid Fluidized Bed Combustion · 970GWh · Pollutant Emission : SO2 9,700t/y (0.31) NOx 1,700t/y (0.80)	Same as Case F-1 · Pollutant Emission : SO2 9,700t/y (0.31) NOx 1,700t/y (0.80)
Tizsa I. P.S.	· Pulverizes Coal -Fired Boiler 125t/h x 8 (in 1992 6 boilers operated) · 932GWh (1.0) · Pollutant Emission : SO2 35,000t/y (1.0) NOx 2,900t/y (1.0)	· Same Facilities and Fuel as Present · 35GWh (0.04) · Pollutant Emission : SO2 7,000t/y (0.20) NOx 600t/y (0.20)	Same as Case F-0 · Pollutant Emission : SO2 7,000t/y (0.20) NOx 600t/y (0.20)	Same as Case F-1 · Pollutant Emission : SO2 7,000t/y (0.20) NOx 600t/y (0.20)
Tizsa II. P.S.	· Oil & Gas Mixed Fired Boiler 4 Blocks (670t/h x 4) · 2,616GWh (1.0) · Pollutant Emission : SO2 15,000t/y (1.0) NOx 3,100t/y (1.0)	· Same Facilities and Fuel as Present · 1,581GWh (0.60) · Pollutant Emission : SO2 9,200t/y (0.61) NOx 1,900t/y (0.61)	· Same Facilities as Present · 1,581GWh (0.60) · "S" Contents 3.73% to 1.0% · Pollutant Emission : SO2 2,400t/y (0.16) NOx 1,900t/y (0.16)	Same as Case F-1 · Pollutant Emission : SO2 2,400t/y (0.16) NOx 1,900t/y (0.16)
Major factories	· Fuel Consumption Solid 92,000t/y, Liquid 120,000t/y Gas 1,080Mm3 · Pollutant Emission : SO2 3,400t/y (1.0) NOx 2,900t/y (1.0)	· Fuel consumption increases 28.5% from the present · Pollutant Emission : SO2 2,200t/y (0.64) NOx 2,800t/y (0.99) · Some factories close down	· Fuel save by about 10% from case F-0 · Measures to reduce SO2, NO2 or Dust in 4 factories · Pollutant Emission : SO2 2,000t/y (0.59) NOx 1,600t/y (0.25)	· Measures to reduce SO2 or NO2 in 6 factories in addition to Case F-1 · Pollutant Emission : SO2 1,800t/y (0.53) NOx 1,500t/y (0.23)
Communal Facilities	· 178,000 Households · 57% of Households Supplied with Natural Gas · Pollutant Emission : SO2 13,100t/y (1.0) NOx 2,500t/y (1.0)	· 178,000 Households · 57% of Households Supplied with Natural Gas · Pollutant Emission : SO2 13,100t/y (1.0) NOx 2,500t/y (1.0)	· 178,000 Households · 78% of Households Supplied with Natural Gas · Pollutant Emission : SO2 4,500t/y (0.34) NOx 1,400t/y (0.56)	· 178,000 Households · 86% of Households Supplied with Natural Gas · Pollutant Emission : SO2 3,000t/y (0.23) NOx 1,200t/y (0.48)
Motor Vehicles	· 106,300 Vehicles Registered in Baz County · 2.3% of Motor Vehicles Equipped with Catalytic Converter · Pollutant Emission : SO2 260t/y (1.0) NOx 3,000t/y (1.0)	· 40% of Traffic Volume Increase Over Present · 6.8% of Motor Vehicles Equipped with Catalytic Converter · Pollutant Emission : SO2 370t/y (1.42) NOx 4,100t/y (1.37)	· 40% of Traffic Volume Increase Over Present · 100% of Motor Vehicles Equipped with Catalytic Converter · Pollutant Emission : SO2 110t/y (0.42) NOx 2,200t/y (0.73)	Same as Case F-1 · Pollutant Emission : SO2 110t/y (0.42) NOx 2,200t/y (0.73)
Air Pollution Condition	SO2: A.A.C. Max:100>70 (NS) Total Emission 98,000t/y (1.0) NO2: A.A.C. Max.: 38<70 (S) Total NOx Emission 16,500t/y (1.0)	SO2: A.A.C. Max:100>50 (NS) A.C.H. Max:173>50 (NS) Total Emission 72,400t/y (0.74) NO2: A.A.C. Max:45<70 (S) A.C.H. Max:53<70 (S) Total NOx Emission 14,700t/y (0.89)	SO2: A.A.C. Max:34<50 (S) A.C.H. Max:59>50 (NS) Total Emission 25,700t/y (0.26) NO2: A.A.C. Max:31<70 (S) A.C.H. Max:37<70 (S) Total NOx Emission 9,500t/y (0.57)	SO2: A.A.C. Max:25<50 (S) A.C.H. Max:41<50 (S) Total Emission 24,000t/y (0.24) NO2: A.A.C. Max:29<70 (S) A.C.H. Max:34<70 (S) Total NOx Emission 9,200t/y (0.56)

A.A.C : Annual Average Concentration (unit: $\mu g/m^3$) 、 A.C.H. : Average Concentration in Heating Season (unit: $\mu g/m^3$) 、 NS : Not Stisfying Standard、 S : Satisfying Standard, P.S.: Power Station

Table 8.2 Costs of the Proposed Stationary Source Control Measures

Emission Source	Name or No.	Source Facility	Control Measure	Initial Cost (million HUF)
Thermal power plants	Borsod	Boilers	Introduction of a circulating fluidized bed combustion (CFBC) boiler (460 t/h x 1)	14,740
			Conversion of existing 4 boilers into hybrid fluidized bed combustion (HFBC) type (100 t/h x 4)	1,330
			Ash disposal site for HFBC	1,670
	Tisza I	Boilers	Drastic reduction of output	-
	Tisza II	Boilers	Use of low-sulfur fuel oil	-
Factories	02/1	Boilers	Increased use of natural gas	-
	03/0	Tunnel kiln	Fuel change from coal to natural gas	-
			Use of quality coal as raw material	-
	04/1	Incinerator	Two-stage combustion	2
	09/2	Incinerator	Two-stage combustion	2
	15/1	Forge furnaces	Remodeling of 8 forge furnaces to the Rath type	160
	15/2	Electric furnaces	Suction devices and dust collectors for 3 furnaces	62
		Heating furnace	Furnace retrofitting and recuperator	62
	17/1	Cement kiln	Low-NOx burner	32
	23/1	Nitric acid lines	Denitration equipment for 3 lines	31
Households		Home heating by coal	House connection of gas supply pipe and heating equipment for 52,400 households	9,170

Table 8.3 Implementation Program of Air Pollution Control for Sajo Valley Area



9. Recommendations

(1) Implementation of New Legal Systems for Air Pollution Control

The Hungarian Government is preparing new legal systems for air pollution control. Implementation of the new regulations and standards would undoubtedly contribute to improvement of air quality in Hungary including the Sajó Valley area. For the successful implementation, the following is recommended.

1) Fostering qualified persons in appropriate institutions in various areas including combustion control, air pollution control, air quality measurement and data processing, air quality assessment, public awareness development, and environmental data administration.

2) Effective utilization of the Central Environmental Protection Fund (CEPF) and strengthening the preferential taxation system to promote air pollution abatement measures including gasification of home heating and energy saving.

(2) Air Quality Monitoring

Ambient air quality monitoring is the foundation of air pollution control management. The Sajó Valley area is now covered by the monitoring network of 16 automatic measuring stations for air quality and meteorology. Important tasks for maximization of functions of the existing monitoring network and for effective utilization of the monitored data include the following:

1) Proper operation and maintenance of measuring equipment and data transmission devices

2) Data examination and processing for evaluation of the air quality

3) Data management for utilization in various works concerning air pollution control

4) Preparation of monthly summary and annual report of the monitoring data

5) Publicity of the state of air quality for stimulating public awareness towards air quality improvement

For strengthening the capability of performing above tasks, close cooperation of the institutions involved in the monitoring and adequate allocation of human resources and budget are recommended.

(3) Energy Saving

Energy consumption per unit output in Hungary is generally much higher in comparison to other developed countries. It also applies to many plants in the Sajó Valley area. To promote energy saving in plants, the following are recommended:

1) Actual status of energy efficiency should be evaluated in each plant. For this purpose, key combustion parameters such as fuel consumption rate and oxygen concentration of combustion gas have to be measured accurately. A fuel flow meter or an appropriate device for determining the fuel consumption rate should be installed on combustion facilities that do not have one currently. Since flue gas measuring ports for number of combustion facilities are provided at inappropriate positions where actual oxygen concentration of the combustion gas is not possible to measure due to air intrusion, the port should be provided at an appropriate place such as the boiler outlet.

2) The oxygen concentration and the temperature of exhaust gas were found to be high at number of combustion facilities, indicating dissipation of heat energy into atmosphere. Amount of air supply should be controlled at an appropriate level, and air intrusion into combustion chamber should be prevented. Waste heat of flue gas should be utilized as much as possible by employing appropriate energy saving devices.

3) Each plant should have an organization to pursue maximum energy utilization efficiency under a director who takes full responsibility in energy saving. It is desirable that the Government prepare guidelines for energy diagnosis and rationalization of energy utilization to be implemented by plants.

(4) Improvement of Borsod Power Plant

Borsod Power Plant is a large pollutant emission source at present with out-dated facilities, but its importance as an energy supplier in the Sajó Valley area will be increased in the future. Therefore, substantial improvements of this power plant in pollution control and energy efficiency are indispensable. An improvement plan has been prepared by the Hungarian Electricity Companies (MVM Rt.) on the basis of the energy policy of the Government in which utilization of the local coal is intended for Borsod Power Plant. Implementation of the improvement plan should be promoted by paying attentions to the following:

1) New installation of the circulating fluidized bed combustion (CFBC) system planned by MVM Rt. is considered to be appropriate and necessary for improvement of the

plant under the policies of the Government.

2) Conversions of existing 4 boilers into the hybrid fluidized bed combustion (HFBC) type have been also planned by MVM Rt. Meanwhile, the Government has proposed a regulation that the sulfur removal efficiency of the HFBC system be 60 % or more. The HFBC system was developed by Institute for Electric Power Research (VEIKI) and successfully applied in Ajka Power Plant using the coal produced near Ajka. However, the sulfur removal efficiency of 60 % was not confirmed by the combustion test of the Study Team conducted at Ajka Power Plant in which the Borsod coal was used. Although the efficiency of 60 % is said to be guaranteed by VEIKI in the application the HFBC system to Borsod Power Plant, careful studies are recommended for its success.

(5) Prevention of Emissions of Harmful Substances

In the Sajó Valley area, there are several chemical plants that emit harmful substances such as HCl, H_2SO_4, NH_3, phosgene, and chlorobenzene. Emissions of these substances must be controlled strictly for the safety of people rather than in view of air pollution control. Since these plants have their own plans to eliminate such harmful emissions, their urgent implementation is strongly recommended.

(6) Air Quality Simulation

The degree of influence to the ground level pollutant concentration is not always proportional to the scale of the emission source. Therefore, air quality simulation, such as that employed in this study, is useful for air pollution control planning. For a simulation model to be reliable, accuracy of data on ambient air quality, meteorology, and pollutant emission sources is critically important. Therefore, works to improve these data should be continued systematically. Wide-spread utilization of available simulation models and further development of models for particular purposes, such as analysis of short-term high pollutant concentration phenomenon, are recommended.

Conversion of SO_2 Concentration Unit

ppm ⟶ mg/m ^{3}		mg/m^3 ⟶ ppm	
ppm (ppb)	mg/m^3 (μg/m^3)	mg/m^3 (μg/m^3)	ppm (ppb)
1	3	1	0
2	5	2	1
3	8	3	1
4	11	4	2
5	13	5	2
6	16	6	2
7	19	7	3
8	21	8	3
9	24	9	3
10	27	10	4
20	53	20	8
30	80	30	11
40	106	40	15
50	133	50	19
60	160	60	23
70	186	70	26
80	213	80	30
90	240	90	34
100	266	100	38
200	532	200	75
300	799	300	113
400	1,065	400	150
500	1,331	500	188
600	1,597	600	225
700	1,863	700	263
800	2,130	800	301
900	2,396	900	338
1,000	2,662	1,000	376
2,000	5,324	2,000	751
3,000	7,986	3,000	1,127
4,000	10,648	4,000	1,503
5,000	13,311	5,000	1,878
6,000	15,973	6,000	2,254
7,000	18,635	7,000	2,629
8,000	21,297	8,000	3,005
9,000	23,959	9,000	3,381
10,000	26,621	10,000	3,756

Note: The unit conversion was made by the following equation
using the condition of 20°C and 1.013×10^5 Pa.

$$SO_2\ [ppm] = 22.4/64 \cdot (273+20)/273 \cdot SO_2\ [mg/m^3]$$

Conversion of NO_2 /NO_x Concentration Unit

ppm → mg/m^3		mg/m^3 → ppm	
ppm (ppb)	mg/m^3 (μg/m^3)	mg/m^3 (μg/m^3)	ppm (ppb)
1	2	1	1
2	4	2	1
3	6	3	2
4	8	4	2
5	10	5	3
6	11	6	3
7	13	7	4
8	15	8	4
9	17	9	5
10	19	10	5
20	38	20	10
30	57	30	16
40	77	40	21
50	96	50	26
60	115	60	31
70	134	70	37
80	153	80	42
90	172	90	47
100	191	100	52
200	383	200	105
300	574	300	157
400	765	400	209
500	957	500	261
600	1,148	600	314
700	1,339	700	366
800	1,531	800	418
900	1,722	900	470
1,000	1,913	1,000	523
2,000	3,827	2,000	1,045
3,000	5,740	3,000	1,568
4,000	7,654	4,000	2,091
5,000	9,567	5,000	2,613
6,000	11,480	6,000	3,136
7,000	13,394	7,000	3,658
8,000	15,307	8,000	4,181
9,000	17,221	9,000	4,704
10,000	19,134	10,000	5,226

Note: The unit conversion was made by the following equation
using the condition of 20°C and 1.013×10^5 Pa.

$$NO_2\ [ppm] = 22.4/46 \cdot (273+20)/273 \cdot NO_2\ [mg/m^3]$$