社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF ENVIRONMENT
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

THE STUDY ON AIR POLLUTION MONITORING SYSTEM IN THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA

FINAL REPORT
Summary

June 1999

JAPAN ENVIRONMENT ASSESSMENT CENTER CO. LTD., TOKYO

1151147 [4]

In this report, project costs are estimated based on February 1999 prices with an exchange rate of 1 US$= DEN 53.5 (=JPY 125).

PREFACE

In response to a request from the Government of the Former Yugoslav Republic of Macedonia, the Government of Japan decided to conduct a development study on Air Pollution Monitoring System in the Former Yugoslav Republic of Macedonia and entrusted the study to the Japan International Cooperation Agency.

JICA selected and dispatched a study team headed by Mr. Tatsuo Hiratani of Japan Environment Assessment Center Co., Ltd. to the Former Yugoslav Republic of Macedonia, four times between October 1997 and March 1999, and prepared this final report headed by Mr. Motoji Katsuta of Japan Environment Assessment Center Co., Ltd. between April and June 1999. In addition, JICA set up an advisory committee headed by Mr. Shigenobu Obayashi, a senior adviser to director general of Planning Division of Air Quality Bureau, Environment Agency, between the beginning of the study and September 4, 1998 and by Mr. Takeru Tsuchiya, a senior adviser to director general of Planning Division of Air Quality Bureau, Environment Agency between September 4, 1998 and the end of the study, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of the Former Yugoslav Republic of Macedonia and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Former Yugoslav Republic of Macedonia for their close cooperation extended to the study.

June 1999

Kimio Fujita
President
Japan International Cooperation Agency

June 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

LETTER OF TRANSMITTAL

We are pleased to submit to you the final report entitled "The Study on Air Pollution Monitoring System in the Former Yugoslav Republic of Macedonia".

This report has been prepared by the Study Team in accordance with the contracts signed on October 1 1997, March 2 1998, January 4 1999 and May 28 1999 between Japan International Cooperation Agency (JICA) and Japan Environment Assessment Center Co., Ltd. (JEAC).

This Study aims at giving technical assistance in environmental management which the Government of Macedonia has tackled positively, setting air pollution monitoring system as one of the top priorities in National Environmental Action Plan. The contents of the Study are to formulate a planning for framework of the nationwide air pollution monitoring system, to elaborate a detailed plan of air pollution monitoring system in the selected model city, and to carry out technology transfer to the Counterpart personnel.

This report presents an optimal plan for the Former Yugoslav Republic of Macedonia to achieve above aims. The plan has been formulated through surveys, analyses, and assessment on the aspects of present and future trends in environment and monitoring system, organization system, EU Directives, socio-economic and industrial conditions. The biggest attention is paid on the plan for air monitoring system which is intended to show maximum effect with minimum budget for MOE to carry out the environmental management.

On the premise that existing measurement points are used as a complement to automatic continuous monitoring stations, it is recommended that two additional stations in model city Skopje, in which four stations were set in the course of the Study, and eight stations in seven other cities be established to construct air pollution monitoring network.

We wish to express grateful acknowledgments to your Agency, Ministry of Foreign Affairs, and Environment Agency. We also wish to express our sincere appreciation to Macedonian Agencies concerned including the Ministry of Environment, Ministry of Science, and Ministry of Foreign Affairs, who extended utmost cooperation to the Team. Finally, we acknowledge our deep gratitude to the Embassy of Japan in Austria, JICA Austria Office, and Japan Information Center in Macedonia for their variable suggestions and assistance.

Very truly yours,

勝田基嗣

Motoji Katsuta
Team Leader
The Study on Air Pollution Monitoring System
in the Former Yugosiav Republic of Macedonia

THE STUDY ON AIR POLLUTION MONITORING SYSTEM
IN THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
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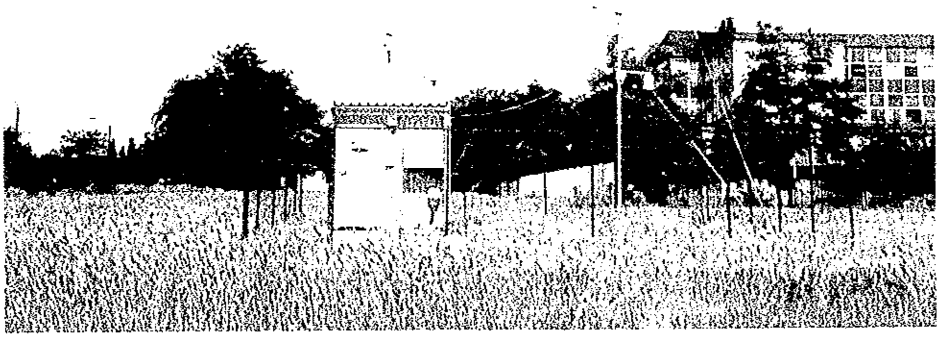
ACRONYMS AND ABBREVIATIONS

ACRONYMS

EPA or US EPA	: United States Environment Protection Agency
IEZ	: Institute of Environment “Zelezara”
IHP	: Institute for Health Protection
JICA	: Japan International Cooperation Agency
MOE	: Ministry of Environment
MUPCE	: Ministry of Urban Planning, Construction and Environment
RHI	: Republic of Hydrometeorological Institute
PPNE	: Protection and Promotion of Natural Environment

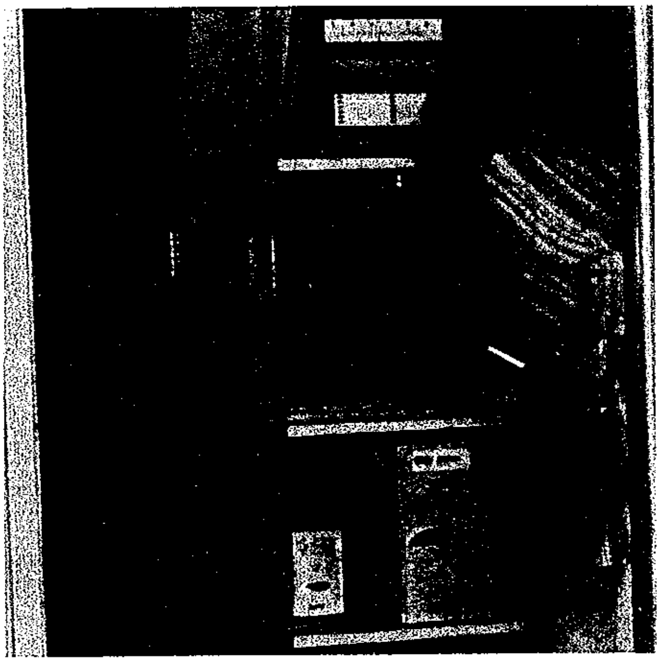
ABBREVIATIONS

AQM	: Air Quality Monitoring
APMC	: Air Pollution Monitoring Center
AVR	: Automatic Voltage Regulator (Voltage Stabilizer)
CALPUFF	: California Puff Model
CEM	: Continuous Emission Monitoring
EIA	: Environmental Impact Assessment
EoI	: Exchange of Information
FWD	: Framework Directive
GIS	: Geographical Information System
IEE	: Initial Environmental Examination

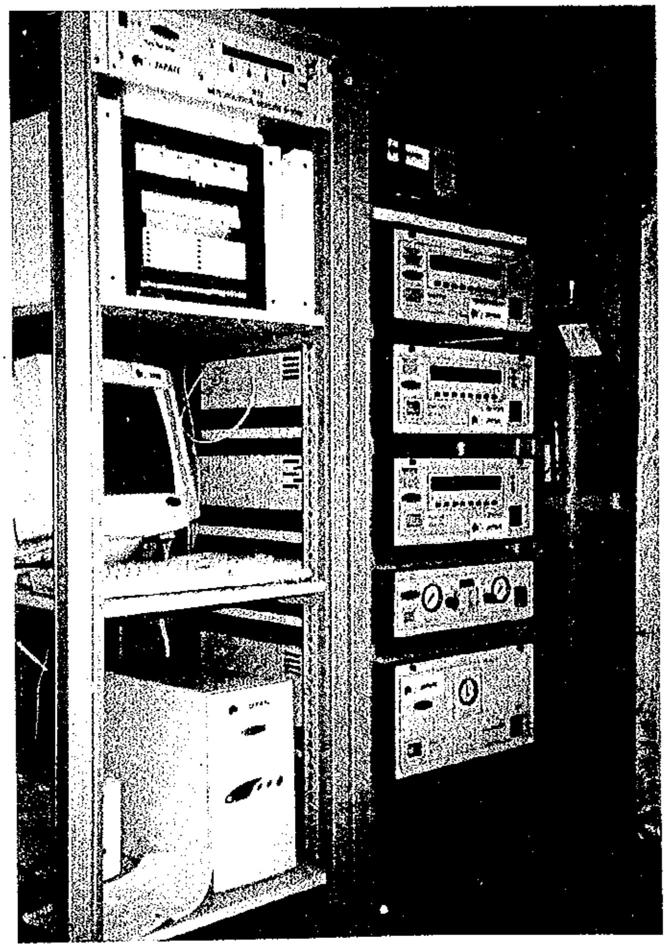


Ambient air quality monitoring station which was procured for the Study.
(Station 4 : Lisice)

Inside of the station



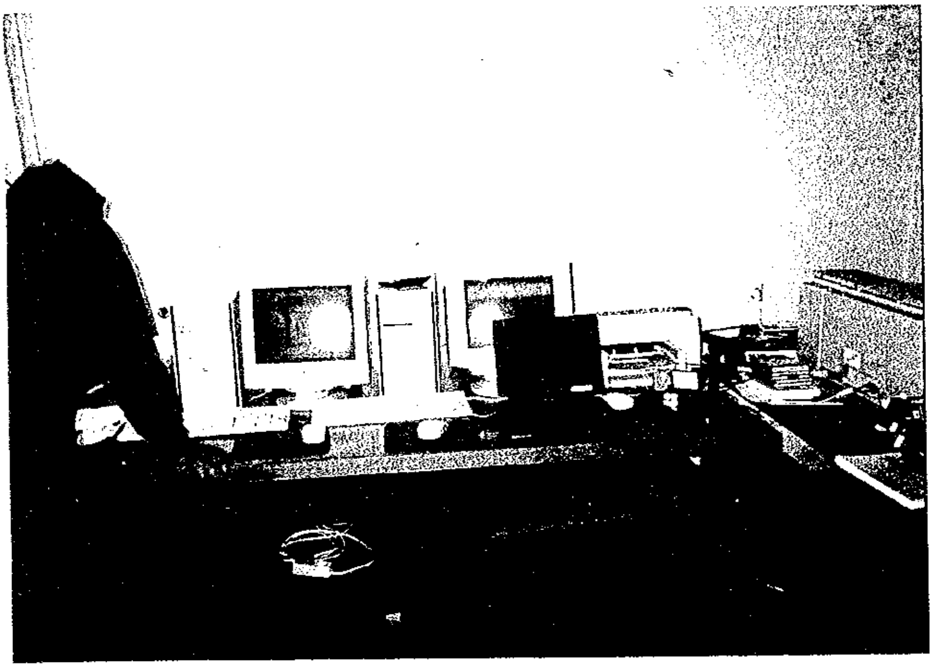
Data logger and recorder



Meteorological instruments,
SPM, SO_2, NOx, CO instruments
and calibrator in the station.

Central Station

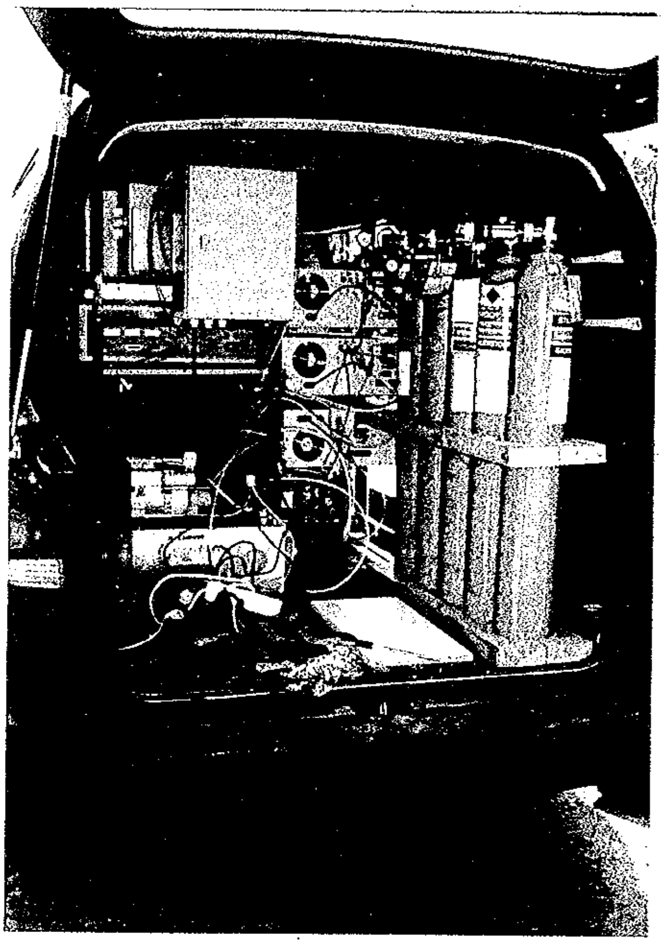
(Ministry of Environment: Information Center)



Data acquisition and processing system which was procured for the Study.

Operational training of flue gas dust sampler.

Monitoring car for Stationary sources



Monitoring instruments

Exhaust gas measurement of stationary sources

I. Outline of the Study

(1) Background and Course

Many of the cities of Macedonia, including its capital, Skopje, are located in basins surrounded by mountains. The meteorological conditions unique to such basins are thus causing air pollution called "stagnation", due to gases emitted from factories, automobiles and households, often posing a serious problem to Macedonia. Especially in some industrial cities including Skopje and Veles, such air quality aggravation is serious especially in winter period when basin fogs generate.

The Government of Macedonia is adopting various air pollution measures. However, due to lack of an automatic monitoring method, there still exist many problems such as being unable to respond immediately to the aggravation in the concentration of air pollution. Besides getting a better understanding of the present situation of air pollution, it is also important to make improvements in the monitoring system for the enactment of regulatory laws as well as assessments of improvement.

Under these circumstances, the Government of Macedonia has requested the Government of Japan for cooperation in constructing an air pollution monitoring system. In response to this request, "The Study on Air Pollution Monitoring System in the Former Yugoslav Republic of Macedonia" (hereinafter referred to as "the Study"), was carried out by a Study Team from Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Ministry of Environment (hereinafter referred to as "MOE"), together with the cooperation of other Macedonian authorities concerned, from October 1997.

(2) Objectives of the Study

The objects of this Study are to provide advice on the establishment of a nationwide air pollution monitoring systems, to formulate a detailed plan for air pollution monitoring with respect to a selected model city, to carry out technology transfer to the Counterpart personnel of the Government of Macedonia during the Study, and to support the decision-making on environmental policies of the Macedonia.

Target Year of Planning

Present stage	:	urgently required monitoring
First stage	:	within 5 years
Second stage	:	within 10 yeas

II. Results of the Study

1. Selection of the Model City

(1) Present State of Air Pollution in Macedonia

The general meteorological characteristics of the major industrial cities are influenced by the topological characteristics of the basin or valley, and the condition in which the atmosphere remains stagnant, is a factor for serious air pollution in winter period.

(2) Selection of the Model City and its Bases

Skopje city, the capital of the Macedonia, was selected as the model city through a number of consultation with the concerned personnel of the Macedonian side concerning analyses of the present state of air pollution and characteristics of emission sources.

Skopje city, the center of socio-economy and industries of the Macedonia, suffers from most serious air pollution due to heating during winter because of its topographical and meteorological conditions and also due to automobiles and plant emission gases.

(3) Present State of Air Pollution in Skopje

Pollutants such as SO_2, SPM, NOx and CO exceed environmental standard by far in winter because of meteorological and topographical conditions peculiar to Skopje and additional heating pollution counted as an emission source.

(4) Present State and Tasks of Monitoring System

SO_2, black smoke, dust fall and wind direction and speed are measured in the major cities covering almost all over the country. Construction and everyday monitoring of nationwide automatic continuous monitoring network which enables immediate response to deterioration of environmental concentration are necessary at least for the major cities.

2. Recommendations for Framework of Air Pollution Monitoring System Planning

(1) Aims for Framework of Nationwide Monitoring System

The basic aims of setting framework for nationwide monitoring system on the existing monitoring system and conditions of air pollution are defined as follows:

- To understand the level of air pollution and judge whether environmental standards are cleared or not.
- To take countermeasures in emergency case.
- To satisfy the requirement of EU Directives.

(2) Organization and Institution Planning

In order to monitor air pollution effectively in the model city as well as nationwide, to respond to the urgent requirements such as announcement of alarm in case of stagnation episode and to manage all the monitoring system, it is recommended that Air Pollution Monitoring Center (APMC) be established under the Environmental Consulting Center of the MOE as a specific organization for monitoring of air pollution and its countermeasures. The organization and major works on APMC is as follows.

Item	Contents
Works	- AQM and continuous emission monitoring (CEM), data collection and its screening - Judging whether the standards are cleared or not - Data collection related to emission source and meteorology - Management of monitoring data in data bank - Maintenance and management of monitoring instruments - Public Information Distribution - Announcement of warning (24 hour shifting of personnel)
Organization	- AQM Section - CEM Section - Data Management Section - Maintenance Section
Personnel	- Two administrative managers - Six environmental engineers for monitoring, analysis, data management and maintenance - Two electronics engineers for computation and communication - Outsourcing of maintenance to local agent
Personnel Development	- Short-term training such as training and lecture held by manufacturer and by newly employed researcher or technical adviser - Medium- and long-term training such as 3 to 6 months training at environmental monitoring course, engineer training in university and receiving of foreign expert

(3) Implementation Planning

Implementation schedule is divided into the following three stages; the present stage of the urgently required monitoring covered with the present monitoring system in the model city, the first stage within five years and the second stage within ten years. The implementation schedule on each stage is as follows.

Stage	Type of System	Number
First stage	AQM system	10 stations
	CEM system	5 stations
	Mobile monitoring system	1 set
	Auto-exhaust gas inspection system	1 set
	Data acquisition and processing system including data bank	1 set
	Improvement in analytical instruments of the IEZ (first phase)	1 set
Second stage	Improvement in analytical instruments of the IEZ (second phase).	1 set

(4) Estimation for Project Expenses

1) Cost Estimation on Each Implementation Schedule

Cost estimation on each implementation schedule for establishment of monitoring system is as follows.

Unit : US$

Item \ Stage & Year	First Stage		Second Stage				
	1	2 to 5	6	7	8	9	10
Initial investment cost							
AQM system	2,109,100	-	-	450,900	450,900	601,200	601,200
CEM system	561,300	-	-	-	-	-	-
Mobile monitoring	278,730	-	-	-	-	227,000	227,000
Auto-exhaust gas inspection	87,640	-	-	-	-	65,000	-
Data acquisition and processing for APMC	150,500	-	-	-	150,000	-	-
Subtotal	3,187,270			450,900	600,900	893,200	828,200
Annual O & M Cost							
Spare parts & consumables	143,370	143,370	143,370	143,370	143,370	143,370	143,370
Fee of service engineer & transportation (outsourcing case)	96,000	96,000	96,000	96,000	96,000	96,000	96,000
Subtotal	239,370	239,370	239,370	239,370	239,370	239,370	239,370
Other investment cost							
Improvement in analytical instrument for IEZ	536,940	-	253,660	-	-	-	-
Total	3,963,580	239,370	493,030	690,270	840,270	1,132,570	1,067,570

2) Annual Cost Estimation for Maintenance and Management

The annual estimated cost for the maintenance and management of nationwide monitoring system through the outsourcing to the local agent is US$ 239,370.

3) Source for Operation and Maintenance Cost for Monitoring Equipment and Materials

The maintenance and management cost for monitoring stations will be about 4% of the fund of the Environment and Nature Protection and Promotion in 2002 and it can therefore be said that the fund as a source will be sufficient.

(5) Evaluation

With the establishment of the monitoring system, prompt comprehension of air pollution concentration will become possible. From the administrative point of view, it will be possible to conduct environmental management efficiently and support the decision of environmental policy aimed at environmental improvement.
Further, the official and prompt announcement of pollution concentration in accordance with public awareness program will be a cause for concern about environmental problem. The environmental improvement will be effective as a result.
Therefore it is desirable that this plan will be carried out step by step with the confirmation of the effect.

I. Outline of the Study

1. Background and Course

The Former Yugoslav Republic of Macedonia (hereinafter referred to as "Macedonia") is an inland country that gained its independence from the Former Yugoslavia in September 1991. Its area comprises of approximately 25.700 km^2. The population is approximately two million.
Most of the cities, including the capital of Skopje, are located in basins surrounded by mountains. As a result, stagnation which is a meteorological condition characteristic of basins often occurs. Emitted gases from factories, automobiles and residential households cause air pollution which is a severe problem. At industrial cities such as Skopje and Veles, severe air pollution often occurs during winter when basin fogs are generated.

The Government of Macedonia is adopting various air pollution measures. However, due to lack of an automatic monitoring method, there still exist many problems such as being unable to respond immediately to the aggravation in the concentration of air pollution. Besides getting a better understanding of the present situation of air pollution, it is also important to make improvements in the monitoring system for the enactment of regulatory laws as well as assessments of improvement. Rebuilding the economy with the aim of EU entry and having appropriate environmental management are also important.
Based on the situations at present, the issues with the highest priority now are to receive support from the World Bank to draw up the "National Environmental Action Plan: NEAP" and to restructure the air pollution monitoring system.

Under these circumstances, the Government of Macedonia has requested the Government of Japan for cooperation in constructing an air pollution monitoring system. In response to this request, "The Study on Air Pollution Monitoring System in the Former Yugoslav Republic of Macedonia" (hereinafter referred to as "the Study"), was carried out by a Study Team from Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Ministry of Environment (hereinafter referred to as "MOE"), together with the cooperation of other Macedonian authorities concerned, from October 1997.

During the period of the Study, the MOE separated from the Ministry of Urban Planning, Construction and Environment (hereinafter referred to as "MUPCE") to become a new, independent the ministry. This, in fact, reflects active efforts of the Macedonia to solve environmental problems.

2. Objectives of the Study

The objects of this Study are to provide recommendation on the establishment of a nationwide air pollution monitoring systems, to formulate a detailed plan for air pollution monitoring with respect to a selected model city, to carry out technology transfer to the Counterpart personnel of the Government of Macedonia during the Study, and to support the decision-making on environmental policies of the Macedonia.

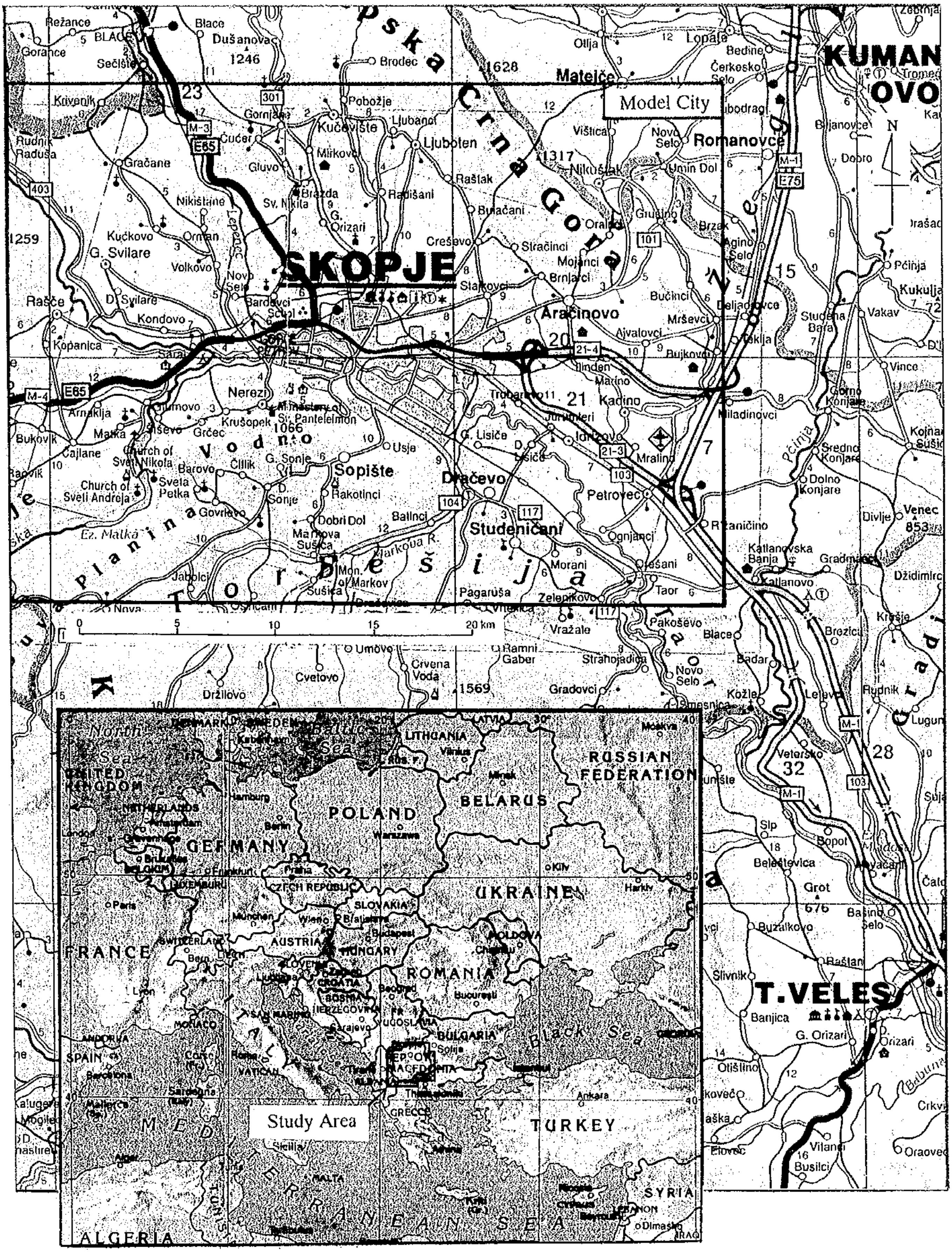


Figure 1.1 The Location of Study Area and Model City

II. Results of the Study

1. Selection of the Model City

1.1 Present State of Air Pollution in Macedonia and Bases of Selection of the Model City

(1) European Union Legislation and Program Related to Air Quality

European Union (EU) requests the member states to implement the necessary monitoring and reporting according to the EU Directives and Decisions. The EU Directives and Decisions are regarded as the main tool for the environmental policy of the member states and associated countries.
The Government of Macedonia aims at being a full member of EU up to 2020. It is therefore necessary to satisfy the requirements for the monitoring and reporting. The major legislation and program related to air quality stipulated in the EU Directives and Decisions are the following filed.

a) Air Quality Monitoring

- The Compound-Specific Directives (CSD): SO_2, SPM, Pb, NO_2 and O_3 (1980-95).
- The Exchange of Information (EoI) Decisions of 1976, 1982 and 1995.
- The draft Council Directive on ambient air quality assessment and management ("Framework Directive, FWD") of 1995.

b) Ambient Air Quality Standards (air quality guidelines)

- SO_2 (EC Directive 80/779/EEC)
- NOx (85/203/EEC)
- Lead in the air (82/884/EEC)
- Ozone Thresholds (92/72/EEC)

c) Air Emission Standards

The Limitation of Emissions of Certain Pollutants into the Air from Large Combustion Plants (88/609/EEC)

d) Air Pollution from Industrial Plants

On the Combating of Air Pollution from Industrial Plants (84/360/EEC)

e) Air Emission Inventory System

CORINAIR program

(2) Present State of Organization and Institution in Macedonia

1) Organization of Ministry of Environment

The agency in charge of environmental protection had been the Ministry of Urban Planning, Construction and Environment (MUPCE), but Ministry of Environment (MOE) separated and became an independent ministry at the end of December 1998. This reflects strong intention of the Government of Macedonia which lays emphasis on environmental policies. The MOE is seriously examining sources of funding as well as additional staff. It also plans to establish several related agencies for systematic environmental administration.

2) Law, Regulation and Institution

a) Environmental Standards Related to Air Quality and Monitoring Methods

The environmental standards are established for 13 items under the current Law on Protection against Air Pollution. However, only two items, SO_2 and black smoke, are continuously monitored (daily average).

b) Air Emission Regulation Measures

The following are regarded as policy-defined time-horizons for the introduction of specific emission-regulating measures.

- New legislation on Air Quality (to replace the 1974 Law on Air Pollution) - by 1999
- Amendment of the 1996 Act on Environment to establish a viable funding system for environmental policies - by 1999
- Updating and completion of the Standard Register of Emitters - by 1999
- Developing local environment action plans, more intensively involving local governments into environmental protection - by 1999
- Introduction of market-based instrument into air pollution control policies, such as the Polluter Pays Principle - by 2002
- Introduction of natural gas in place of oil in thermal power and heating plants - by 2002

- Phasing out the use of leaded gasoline - by 2007

c) State of Organization of Enterprises Related to Air Quality Preservation

Industries have made little effort to establish policies for environmental preservation so that no active environmental implementation has been practiced.

d) Alarm System on Air Pollution

Industrial cities such as Skopje and Veles have stipulated the procedure for alarm and regulation by municipal government at the time of critical air pollution. For example, the Skopje City Assembly promulgated the procedures in 1990.

3) Present state and Problems for the Establishment of Pollution Control

a) Revision of monitoring methods for determination of air pollution concentrations which are essential for establishment of environmental standards

After cross checking with SO_2 standard gas, the concentration of SO_2 was found lower by 20% than the previously recorded values. Based on this observation, continuous monitoring along with dynamic calibration with standard gas is desirable.
By taking advantage of the new monitoring system, the standard monitoring method should be modified so that prompt response to serious pollution conditions can be achieved by referring to the standards of EU Directives and WHO. It is recommended to establish environmental standards suitable for Macedonia.

b) Operation and Management of Monitoring System

The Skopje City Assembly established a alarm announcement standard in October 1990, based on the air pollution prevention law. The announcement of alarm is invoked in case an inversion is produced and continues more than 24 hours with an average wind velocity of less than 2 m/s or that meteorological conditions are predicted to continue for more than 24 hours. It is necessary to establish and operate the monitoring system capable of collecting these data and judging the alarm criteria accurately.

c) Operational Improvement of Environmental Impact Assessments

Because existing data of the initial environmental examination (IEE) and the monitored data have not been evaluated, the environmental impact assessment (EIA) is not performed completely, although it is enacted.
It is also recommended not only to screen documents formally but also to establish EIA methodology, including participation and agreement of residents.
- Selection of project type requires EIA
- Development of EIA methodology for the development activity impacting the environmental capacity

d) Establishment of Air Pollution Control Facilities and Tax Incentives

Although a dust collector is installed at both cement and heating plants as the facility countermeasure, the concentration of black soot is high. It is therefore desirable to improve the efficiency of pollution control facilities or to apply more effective new facilities. At the same time the establishment for tax-exempt incentives for the corporation is also desirable for the installation of the facility. The facility countermeasures for emission sources at the small- and medium- sized industries are hardly prepared. It is desirable to support and promote these industries for the establishment of air pollution control facilities through long-term, low rate financing and a supplement of interest by a financial subsidiary.

e) Public Relations to the Citizenry

In order to improve the environmental issues, it is greatly important to spread the importance of environmental preservation and urge the citizen to awaken to it. The public relations to the citizenry are a means for that purpose, and in many cases, the mass media such as radio, TV, and newspaper are very effective.
MOE has already announced the conditions of air pollution to the mass media when required, and it is expected that such public relations will be more promoted. For example, opening of web-site via Internet, which has recently become popular, seems to be effective.
Positive public relations are desirable so that the citizens understand the importance of environmental issues properly.

(3) Population and Territorial Structure

According to the last data, the population of the Country stood at 1,998,000 in 1997. Population growth and its change in these urban communities from 1961 to 1994 are described in Figure 2.

In 1994 there were nine urban communities with populations over 30,000 in descending order of size; Skopje, Bitola, Kumanovo, Prilep, Tetovo, Titov Veles, Stip, Ohrid, and Strumica. Urbanization effects have been most pronounced for the same nine communities, especially for Skopje where fast population and urban growth have been observed.

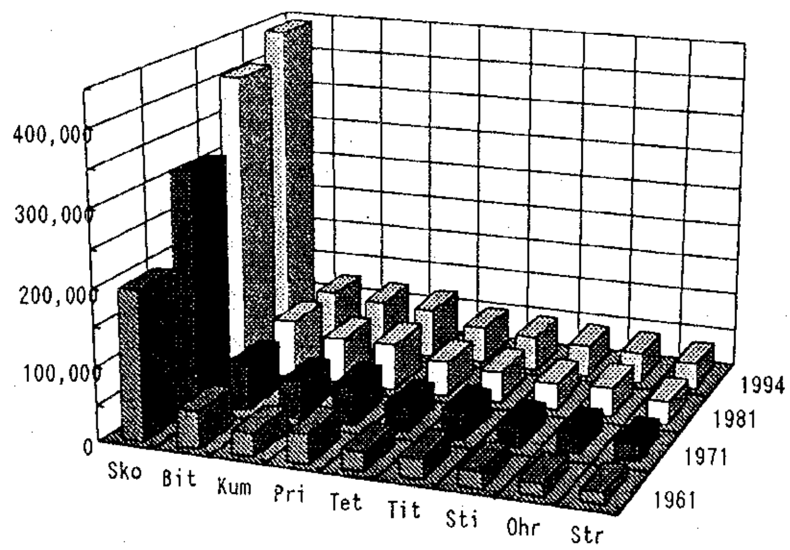


Figure 2 Population Growth of Urban Communities over 30,000 (1961-1994)

(4) Air Pollution Condition in Macedonia

1) Meteorological Characteristics in the Major Industrial Cities

The general meteorological characteristics of the major industrial cities are influenced by the topological characteristics of the basin or valley, and the condition in which the atmosphere remains stagnant, is a factor for serious air pollution in winter period. In addition, wind blows along the valley and the velocity of the wind is generally low. Temperature inversion occurs frequently in winter period, and also in summer time depending on meteorological conditions.

Meteorological characteristics in the major industrial cities are shown in Table 1.

Table 1 Meteorological Characteristics in the Major Industrial Cities

		Skopje	Veles	Bitola	Tetovo
Temperature (℃)	Mean Annual	12.5	13.4	11.3	11.0
	Mean Annual during the Winter	Below 0	3.2	5.7 *	0.9
	Absolute Maximum	41.5	-	17.0 **	-
	Absolute Minimum	-25.6 (January)	-	-29.4 (January)	-
Temperature Inversion Characteristic in Winter Time		A temperature inversion of 10°C sometimes occurs between the mountainous area and the lowland areas.	The frequency of occurrence of temperature inversion is much lower than the other three cities.	Temperature inversion occurs frequently.	Temperature inversion occurs frequently from late autumn to early spring. It also occurs in summer time.
Wind Direction	Predominance	W	N / NW	N / S	N / NE
	Frequency (%)	12.4	16.8 / 15.2	18.9 / 13.4	22.0 / 9.0
Average Wind Speed (m/s)		2.5	2.7 / 2.0	2.2 / 3.7	1.5 / 2.2
Fog (days/year)		63	13	21	34
Duration of the Solar Radiation (hrs/year)		2102	2148	2344	1876
Annual Average Precipitation (mm)		365	469	599	784
Climatic Characteristics		The average altitude of basin is 260 m, with its topographic and climatic characteristics of the valley. Strong temperature inversion layer occurs during the winter period and under anticyclone conditions.	The frequent penetrations of cold continental air mass during the winter period of the year, result in low air temperature. The wind direction is largely influenced by topography.	The average altitude is 660 m and the climate is influenced by the Mediterranean climate. The temperature shows the characteristics of the continental climate with extreme temperature fluctuations.	The altitude is 462 m. Because of the high mountainous areas in the north and north west, the influence of the Adriatic-sea climatic does not reach the valley.

Note: The evaluation periods of each data do not necessarily coincide. Source: NEAP

* Annual average of minimum temperature

** Annual average of maximum temperature

2) Characteristics of Ambient Air Quality in the Major Cities

Characteristics of ambient air quality in the major cities are shown in Table 2.

Table 2 Characteristics of Ambient Air Quality in the Major Cities

City (Pollution Level)	Pollutants	Unit	Annual Average Value	Daily Average Maximum	Days Exceed MPC	Characteristics of Ambient Air Quality
Skopje (XXX)	SO_2	$\mu g/m^3$	23	414	14days	· The annual average values change by years. · All pollutants except Ox and dust fall show considerably high concentration in winter. · Especially air pollution caused by SO_2 and BS at the time of stagnation is serious. · The number of days with BS concentration sxced MPC is much bigger than the one for SO_2 concentration. · Dust fall exceed MPC at almost all locations.
	BS	$\mu g/m^3$	38	362	92days	
	Dust Fall	mg/m^2(*1)	192	786	11months	
	NO_2	$\mu g/m^3$	9	123	1day	
	CO	mg/m^3	10	37	125days	
	Ox	$\mu g/m^3$	166	433	many days	
	Pb(14data)	$\mu g/m^3$	0.9	2.0	7data	
Veles (XXX)	SO_2	$\mu g/m^3$	54	405	47days	· The annual average of SO_2 concentration is about twice as much as that of Skopje. No seasonal variation can be detected. · The concentration of BS is not especially high compared with other locations. · Heavy metal pollution in ambient air and soil came to light. The extent of pollution is around 10 to dozens of times as high as the control area.
	BS	$\mu g/m^3$	14	179	14days	
	Dust Fall	mg/m^2	166	641	2months	
	Pb	$\mu g/m^3$	0.77		many cases	
Bitola (XXX)	SO_2	$\mu g/m^3$	8	33	0	· The concentration of BS exceeds MPC. Although those of SO_2 rarely exceed MPC recently, those data not always stand for Bitola city. · Impacts on human bodies due to coal and coal ash dust are concerned in Bilijanik Village and other places which are located near the power station.
	BS	$\mu g/m^3$	14	124	18days	
	Dust Fall	mg/m^2	80	348	1month	
Tetovo (XX)	SO_2	$\mu g/m^3$	3	18	0	· The concentration of BS exceeds MPC many times a year, but those of SO_2 rarely exceed MPC in recent years.
	BS	$\mu g/m^3$	23	192	29days	
Kumanovo (XX)	SO_2	$\mu g/m^3$	7	66	0	· Dust fall exceed MPC only once at a point among four points in the city.
	BS	$\mu g/m^3$	14	103	10days	
	Dust Fall	mg/m^2	103	301	1month	
Shtip (X)	SO_2	$\mu g/m^3$	8	55	0	· The annual average value of the concentration of dust fall exceeds MPC. Although dust fall shows considerably high concentration, SO_2 and BS show low concentration levels.
	BS	$\mu g/m^3$	13	103	6days	
	Dust Fall	mg/m^2	410	1176	9months	
Prilep (XX)	SO_2	$\mu g/m^3$	9	59	0	· Dust fall shows considerably high concentration similar to the case of Shtip city. The concentration of BS exceeds MPC many time a year.
	Black Smoke	$\mu g/m^3$	17	153	24days	
	Dust Fall	mg/m^2	424	777	8months	

Note : *NEAP data (1994) are used for SO_2、 black smoke(BS)、 NO_2 and Ox.
Other data based on IHP data (mainly 1996).

* Pollution Levels (according to NEAP)

XXX : critical

XX : significant

X : unsatisfactory

* MPC : Environmental Standards (Maximum permitted concentration)

SO_2 : 150$\mu g/m^3$、 BS : 50$\mu g/m^3$、 Dust fall : 300mg/m^2/month、 NO_2 : 85$\mu g/m^3$

CO : 1 mg/m^3、 Ox : 125$\mu g/m^3$、 Pb : 0.7$\mu g/m^3$

(*1) dust fall : mg/m^2/month

(5) Outline of Emission Source Facilities in the Major Cities

1) Skopje

The number of factories of many kinds concentrates in Skopje, being the center of Socio-economy and industry.
Central heating plants, iron and steel mills, cement plants etc. are installed with dust collecting equipment for flue duct emissions. However, almost all emission source facilities are not installed with dust collecting equipment. Except for those installed in some establishment of iron works, any full-scale toxic gas removal equipment is not installed entirely.
The fuel burnt in various emission source facilities in Skopje is mostly heavy oil which contains about 2% sulfur. The consumption of coal and gases was found to be little.
For individual household heating, firewood and electric heaters are mainly used. Coal is used less than 10% of the total number of household and natural gas is not used.
The operating ratios of emission source facilities in the plants are lower than 30 to 40 %. These emission source facilities are the major sources of air pollution.

2) Veles

The MHK "Zletovo" metal smelting plant as the stationary emission source is located about 1 km northwest from the center of the city in the same basin and is smelting zinc and lead. As byproducts, cadmium, chromium and sulfuric acid are produced. At present, 30 to 40 % decrease in production is observed compares with full-production time.
Coke is used as the fuel (55,000 to 65,000 ton per year). For emission control, electric precipitators, bag filters, cyclones, wet flue gas desulfurization facilities and other facilities and systems are used. However, removal efficiency is poor and soil contamination, farm produce pollution and livestock contamination caused by this smelting plant have become serious problems.

3) Bitola

Stationary emission sources include the "Bitola MPGC" coal mining and thermal power station (225 MW x 3 units, two 250 m stacks) which is the largest coal mining and power station in Macedonia located 12 km northeast of the city.
In the summer, since almost all electric power is supplied by hydraulic power generation, this plant has a minimum load.
At present, desulfurization and denitration facility are not installed in the plant. As a result, the emissions from this plant affect a wide area. However, because of the tall

stacks, pollution caused by air emission is considered not to be as serious as widely believed. Nevertheless, the morbidity of respiratory system diseases caused by coal dust as well as by the dispersal of ashes from the coal ash storage piles is high in Biljanik Village. The same is true for other places which are located quite near to the coal yard. The situation is serious concerning extensive damage to health.

4) Tetovo

Stationary emission sources include a textile factory at one end of the city and a metal chemical plant "JUGOHROM" emitting chromium in Jegunovce Village which is located in the northern part of the valley, more than 10 km distant from the city.
Exhaust gases are emitted from its stacks without any prior treatment. Particles containing heavy metals precipitate in the neighborhoods of the metal chemical factory. Under peculiar meteorological conditions, NO_2, SO_2 and other gaseous substances affect not only the entire region of Tetovo, but also regions as far as valleys in the northwestern part of Skopje.

(6) Traffic Conditions and Emission of Harmful Pollutants

Automobiles are the only means of transport and superannuated buses are used for public transport in Skopje. Even for private cars, most of them are superannuated. This, in turn, causes further heavy air pollution due to NOx, CO, VOC and SPM. At present, the use of leaded gasoline is a problem.
Approximately 40% of all vehicles in the Country are centered in Skopje.

(7) Effects on the Environment as a Result of Air Pollution

1) Effects on Health Due to Air Pollution

a) Skopje

The rate of morbidity for respiratory diseases in the Macedonia shows the highest value among the overall morbidity rate for all diseases and is also particularly high among children. Chronic respiratory diseases due to imperforation of respiratory organs is the top factor for death among this age-group.

b) Veles

Pb, Zn and Cd smelter are located next to residential areas, making it one of the most dangerous areas. In 1986, a clinical check on the workers from these refineries found out that symptoms such as multi-causal changes in the intestinal organs, changes in the urine and symptoms of high blood pressure can be found among 20 to 40% of them. Moreover, the morbidity rate for respiratory diseases among residents after these smelter started operating has remarkably increased than before.

2) Impacts that Air Pollution has on the Natural Environment

As for the soil contamination of Veles, even at a point 700 m away from the refineries, Pb and Cd exceeded the plant toxicity limit value (Pb: 100 mg/kg, Cd: 3 mg/kg) by 1.5 to 3.6 times. The value for Zn also exceeded the plant toxicity limit.

(8) Selection of the Model City and its Bases

Skopje city, the capital of the Macedonia, was selected as the model city through a number of consultation with the concerned personnel of the Macedonian side concerning analyses of the present state of air pollution and characteristics of emission sources.

- Skopje city, the center of socio-economy and industries of the Macedonia, suffers from most serious air pollution due to heating during winter because of its topographical and meteorological conditions and also due to automobiles and plant emission gases.
- Automatic continuous monitoring stations owned by metal smelting plant were set in two points in Veles. However, only British samplers unable to cope with emergencies were used in Skopje.
- Veles, Tetovo and Bitola etc. expect a great effect based on the countermeasures in factories which take a leading part. Skopje needs to be covered with overall countermeasures. It is required to construct monitoring system earlier in order to examine the measures.

Discussions were taken place as to whether or not to include Veles, which had serious air pollution problems as in Skopje, as a model city. However, Veles being 40 km away from Skopje, had different emission source conditions of pollutants. As a result, Veles was not included as a model city. It was decided to take up Veles in recommendations on the construction of a nation-wide air quality monitoring network.

1.2 Present State of Air Pollution in Skopje

(1) Installation of Air Pollution Monitoring Equipment

Four new Air Quality Monitoring (AQM) stations were installed.
Based on the analysis of existing data and monitored data and results of site work, diagnosis was carried out on the current quality as well as the quantity of the monitoring equipment owned by Macedonia. Then the equipment necessary for carrying out of this Study was installed.
Table 3 shows monitoring items in monitoring stations installed in the model city.

Table 3 New AQM Stations and Monitoring Items

Equipment	Name of Monitoring Station (Location)	Monitoring Items
AQM	Station 1 (Gazi Baba)	SO_2, NO, NO_2, NOx, CO, SPM, Wind Direction and Speed, Temperature, Humidity
	Station 2 (Center)	SO_2, NO, NO_2, NOx, CO, SPM, Wind Direction and Speed, Temperature, Humidity
	Station 3 (Karpos)	SO_2, NO, NO_2, NOx, CO, SPM, O_3 Wind Direction and Speed, Temperature, Humidity
	Station 4 (Lisice)	SO_2, NO, NO_2, NOx, CO, SPM, O_3, Wind Direction and Speed, Temperature, Humidity, Solar Radiation
	Central Station (:MOE)	Data Collection and Processing
	Public Information (Shopping Street)	Public Information System
CEM	IEZ	SO_2, NO, NO_2, NOx, CO, O_2, Dust, Gas Temperature, Gas Velocity, etc.
Laboratory	RHI	AAS, Air Sampler for Organic Compounds, etc.

Notes: • All data acquired at AQM stations are transmitted to the MOE (Central Station) by radio telemeter system for processing and major data are shown on the street after transmitted from Central Station to Public Information System.

(2) Outline of the Study Monitoring Air Pollution

Figure 3 shows the location of new AQM stations installed in the course of the Study and existing measuring points.
In this Study, the following surveys related to ambient air quality as well as monitoring air pollution were also carried out.

a) Upper-layer meteorological survey,

b) Survey of concentration distribution of wide-area ambient air quality
c) Survey of suspended particulate matter(SPM) and measurement of its components.
d) Roadside ambient air quality survey

(3) Result of Automatic Continuous Monitoring

1) Meteorological Condition

West and East wind directions are prevailing throughout a year. In addition, the wind speed is low. In August, the average daily temperature is about 30℃ and the highest hourly value is about 40℃. However, it continued recording about –10℃ throughout several days in the last half of December.
Upper-layer meteorology during winter, the inversion layer phenomenon occurs very frequently and strong (exceed 4℃/100 m). In some cases, the phenomenon continued for a few days.

2) Ambient Air Quality

Table 4 shows the outline of environmental standard and automatic measurement results.

SO_2:

In none of AQM stations, SO_2 exceeds MPC in the non-heating season. However, it exceeds MPC by far in winter since heating pollution becomes one of a pollution sources. As a result, serious air pollution is caused by the factor mentioned above and by meteorological and topological conditions peculiar to Skopje.

NO_2, SPM and CO:

In some cases, those three parameters go beyond MPC even in summer. Excessive high concentration can be observed sometimes like SO_2 case in winter.

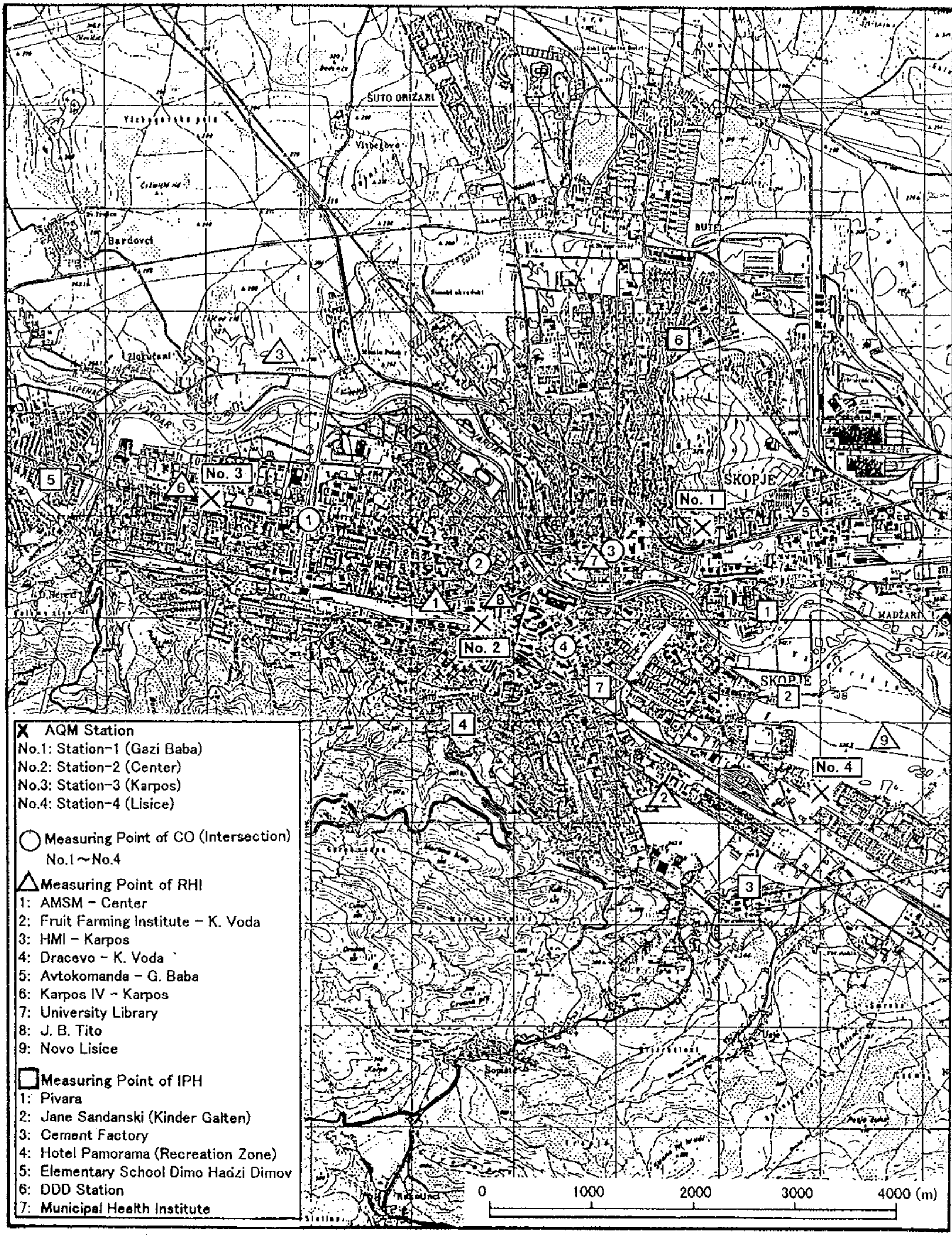


Figure 3 The Location of New AQM Stations and Existing Measuring Points

Table 4 Outline of Environmental Standard and Automatic Measurement Results

Components	Kind of Value	Non-Heating Season				Heating Season				MPC Daily/ for Minute
		Gazi Baba	Center	Karpos	Lisice	Gazi Baba	Center	Karpos	Lisice	
SO_2 (ppb)	Monthly Ave. (Max)	13	10	11	9	46	42	66	36	56 / 188
	24 hours Ave.(Max.)	26	19	32	16	181	112	304	100	
	1 hour (98%)	35	22	35	34	165	131	309	115	
	1 hour (Max.)	82	38	46	44	233	204	387	137	
NO_2 (ppb)	Monthly Ave. (Max)	11	19	16	14	33	33	27	29	44 / 44
	24 hours Ave.(Max.)	17	30	25	32	80	84	78	72	
	1 hour (98%)	30	46	39	45	92	102	97	88	
	1 hour (Max.)	43	63	58	53	122	180	127	109	
NOx (ppb)	Monthly Ave. (Max)	16	46	29	48	76	132	64	135	– / –
	24 hours Ave.(Max.)	31	78	53	93	145	245	171	277	
	1 hour (98%)	58	164	115	198	222	438	222	588	
	1 hour (Max.)	127	254	197	285	655	830	304	999	
CO (ppm)	Monthly Ave. (Max)	0.6	1.5	1.1	1.2	2.8	4.5	5.1	4.0	0.86 / 2.58
	24 hours Ave.(Max.)	1.0	2.7	2.6	2.6	6.2	8.6	13.6	7.4	
	1 hour (98%)	1.5	5.1	3.1	5.2	8.3	11.3	14.9	11.9	
	1 hour (Max.)	2.2	10.4	5.3	6.5	12.7	13.9	18.4	17.9	
O_3 (ppb)	Monthly Ave. (Max)	–	–	38	33	–	–	26	21	– / 63
	24 hours Ave.(Max.)	–	–	53	54	–	–	47	32	
	1 hour (98%)	–	–	85	77	–	–	49	54	
	1 hour (Max.)	–	–	106	95	–	–	70	90	
SPM ($\mu g/m^3$)	Monthly Ave. (Max)	64	87	74	69	182	164	188	213	Black Smoke 50/ 150
	24 hours Ave.(Max.)	105	244	125	125	614	512	727	600	
	1 hour (98%)	149	209	164	164	653	525	738	646	Dust 150/ 500
	1 hour (Max.)	266	1360	279	340	791	647	887	817	

Note:

(light shading) Exceeding Ambient Air Quality Standard (Black Smoke and Gaseous Components)

(dark shading) Exceeding Ambient Air Quality Standard (Dust)

MPC: Maximum Permitted Concentration

Monthly Average: Average Value of Total Hourly Data for a Month.

Monthly Average (Max): Maximum Value of Monthly Average During a Season Concerned.

24 hours Average: Average Value of Total Hourly Data for a Day.

24 hours Average (Max): Maximum Value of 24-hour Average During a Season Concerned.

1 hour (98%): Maximum Value of Hourly Data (98%) for aMonth During a Season Concerned

1 hour (Max): Maximum Value of Hourly Data (Max) During a Season Concerned.

A comparison between 1 hour value and standard 1 minutu value was made for reference.
Marked data exceed standards even for 1 hour value.

Table 4 Outline of Environmental Standard and Automatic Measurement Results

Components	Kind of Value	Non-Heating Season				Heating Season				MPC Daily/ for Minute
		Gazi Baba	Center	Karpos	Lisice	Gazi Baba	Center	Karpos	Lisice	
SO_2 (ppb)	Monthly Ave. (Max)	13	10	11	9	46	42	66	36	56
	24 hours Ave.(Max.)	26	19	32	16	161	112	304	100	188
	1 hour (98%)	35	22	35	34	165	131	309	115	
	1 hour (Max.)	82	38	46	44	233	204	387	137	
NO_2 (ppb)	Monthly Ave. (Max)	11	19	16	14	33	33	27	29	44
	24 hours Ave.(Max.)	17	30	25	32	80	84	78	72	44
	1 hour (98%)	30	46	39	45	92	102	97	88	
	1 hour (Max.)	43	63	58	53	122	180	127	109	
NOx (ppb)	Monthly Ave. (Max)	16	46	29	48	76	132	64	135	—
	24 hours Ave.(Max.)	31	78	53	93	145	245	171	277	—
	1 hour (98%)	58	164	115	198	222	438	222	588	
	1 hour (Max.)	127	254	197	285	655	830	304	999	
CO (ppm)	Monthly Ave. (Max)	0.6	1.5	1.1	1.2	2.8	4.5	5.1	4.0	0.86
	24 hours Ave.(Max.)	1.0	2.7	2.6	2.6	6.2	8.6	13.6	7.4	2.58
	1 hour (98%)	1.5	5.1	3.1	5.2	8.3	11.3	14.9	11.9	
	1 hour (Max.)	2.2	10.4	5.3	6.5	12.7	13.9	18.4	17.9	
O_3 (ppb)	Monthly Ave. (Max)	—	—	38	33	—	—	26	21	—
	24 hours Ave.(Max.)	—	—	53	54	—	—	47	32	63
	1 hour (98%)	—	—	85	77	—	—	49	54	
	1 hour (Max.)	—	—	106	95	—	—	70	90	
SPM ($\mu g/m^3$)	Monthly Ave. (Max)	64	87	74	69	182	164	188	213	Black Smoke
	24 hours Ave.(Max.)	105	244	125	125	614	512	727	600	50/ 150
	1 hour (98%)	149	209	164	164	653	525	738	646	Dust
	1 hour (Max.)	266	1360	279	340	791	647	887	817	150/ 500

Note:

(light shading) Exceeding Ambient Air Quality Standard (Black Smoke and Gaseous Components)

(dark shading) Exceeding Ambient Air Quality Standard (Dust)

MPC: Maximum Permitted Concentration

Monthly Average: Average Value of Total Hourly Data for a Month.

Monthly Average (Max): Maximum Value of Monthly Average During a Season Concerned.

24 hours Average: Average Value of Total Hourly Data for a Day.

24 hours Average (Max): Maximum Value of 24-hour Average During a Season Concerned.

1 hour (98%): Maximum Value of Hourly Data (98%) for aMonth During a Season Concerned

1 hour (Max): Maximum Value of Hourly Data (Max) During a Season Concerned.

A comparison between 1 hour value and standard 1 minutu value was made for reference.
Marked data exceed standards even for 1 hour value.

(4) Analysis of High Concentration Air Pollution

The data from four AQM stations established in Skopje for the Study show very high concentrations of air pollution by SO_2 and SPM.
Table 5 shows the outline of the measured result of SO_2 and SPM during extra-high concentration, and Figure 4 shows the variation diagram of SO_2, SPM and wind direction and speed.

Especially, at Karpos station from December 28 (1998) to January 3 (1999), the highest of the SO_2 daily average values was 810μg/m³ and of the SPM daily average values was 726μg/m³.
At Karpos station, there are some days that go beyond the Third Stage of Alarm Criteria during stagnation in winter. An excess of Alarm Criteria causes severe air pollution as it continued several days.
In concluding the mechanism of present air pollution, it is caused because of unusual weather conditions such as hit by the largest cold wave, temperature inversion, and continuation of dense fog and low wind velocity, under the specific topographical conditions.
This continuation of cold wave is an important factor for the increase of fuel consumption at the heating plants and household heating.

Table 5 Outline of Measured Results of SO_2 and SPM During Extra High Concentration Times

Unit: μg/m³

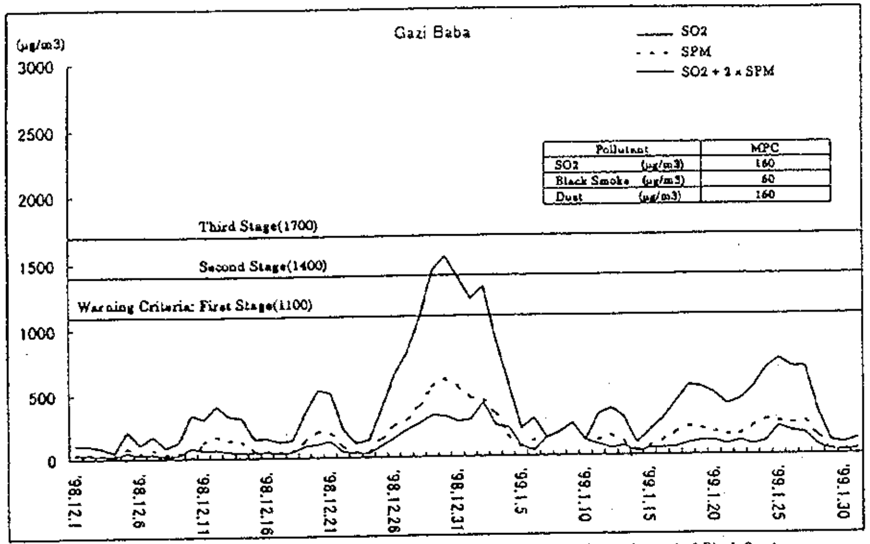
	Kind of Value	Gazi Baba	Center	Karpos	Lisice	MPC
SO_2	Average (24 hours)	420	297	810	260	150
	1 hour	606	531	1,029	356	-
SPM	Average (24 hours)	614	512	726	600	150 *1
	1 hour	791	647	887	816	-
Date for Exceedance of Alarm Criteria	First Stage	Dec. 31, Jan. 1,2	Dec. 29, 30	Jan. 1 to 3	Dec. 29, 31, Jan. 1, 2	1,100 *2
	Second Stage	Dec. 29, 30	-	Dec. 28	Dec. 30	1,400 *2
	Third Stage	-	-	Dec. 29 to 31	-	1,700 *2

Note)

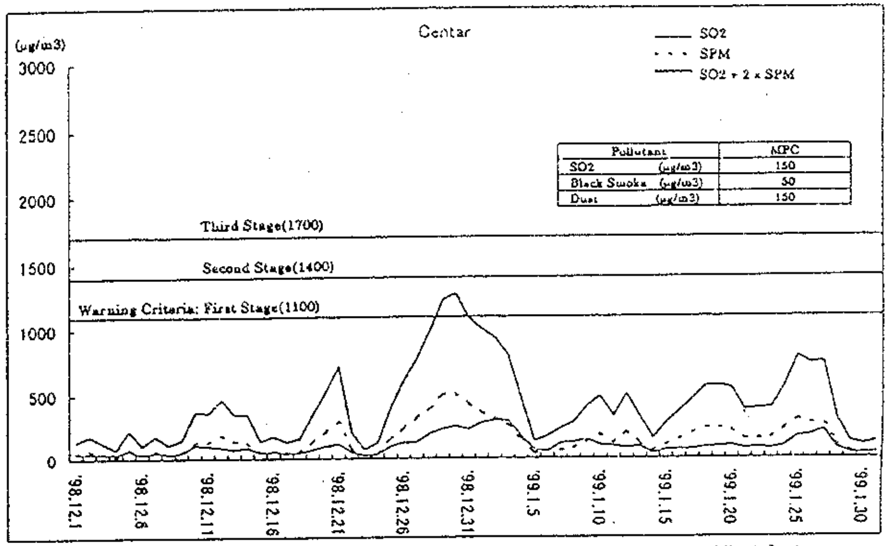
*1 Environmental Standard (MPC): Dust-150μg/m³, Black Smoke-50μg/m³

*2 Calculation of Alarm Criteria:

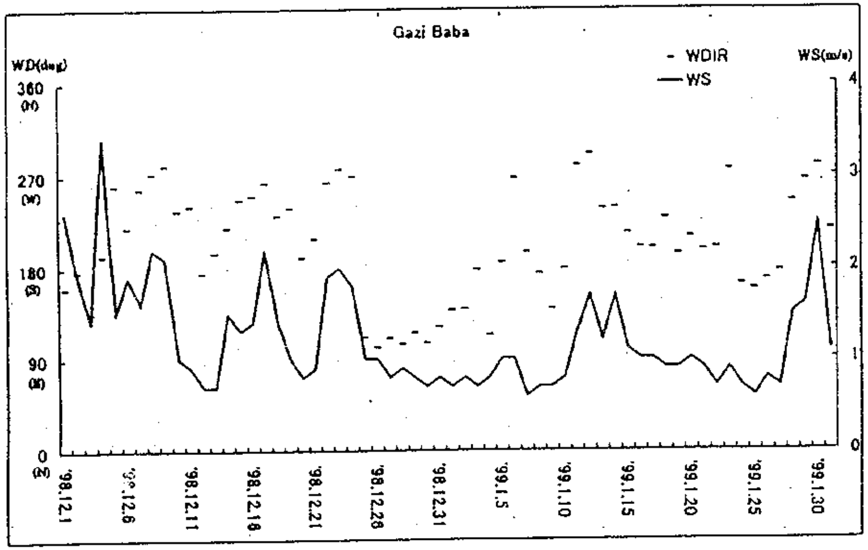
SO_2 concentration +BS concentration x 2 (μg/m³)



* Warning Criteria is usually calculated as SO2 + 2 x Black Smoke, but SPM is used here instead of Black Smoke.



* Warning Criteria is usually calculated as SO2 + 2 x Black Smoke, but SPM is used here instead of Black Smoke.



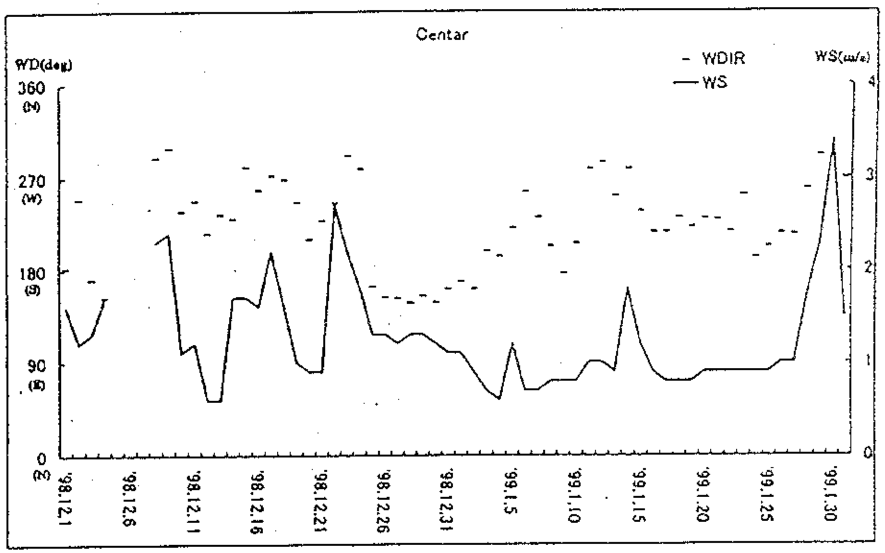


Figure 4 (1) Variation Diagram of SO_2 and SPM Concentration and Wind Direction and Speed

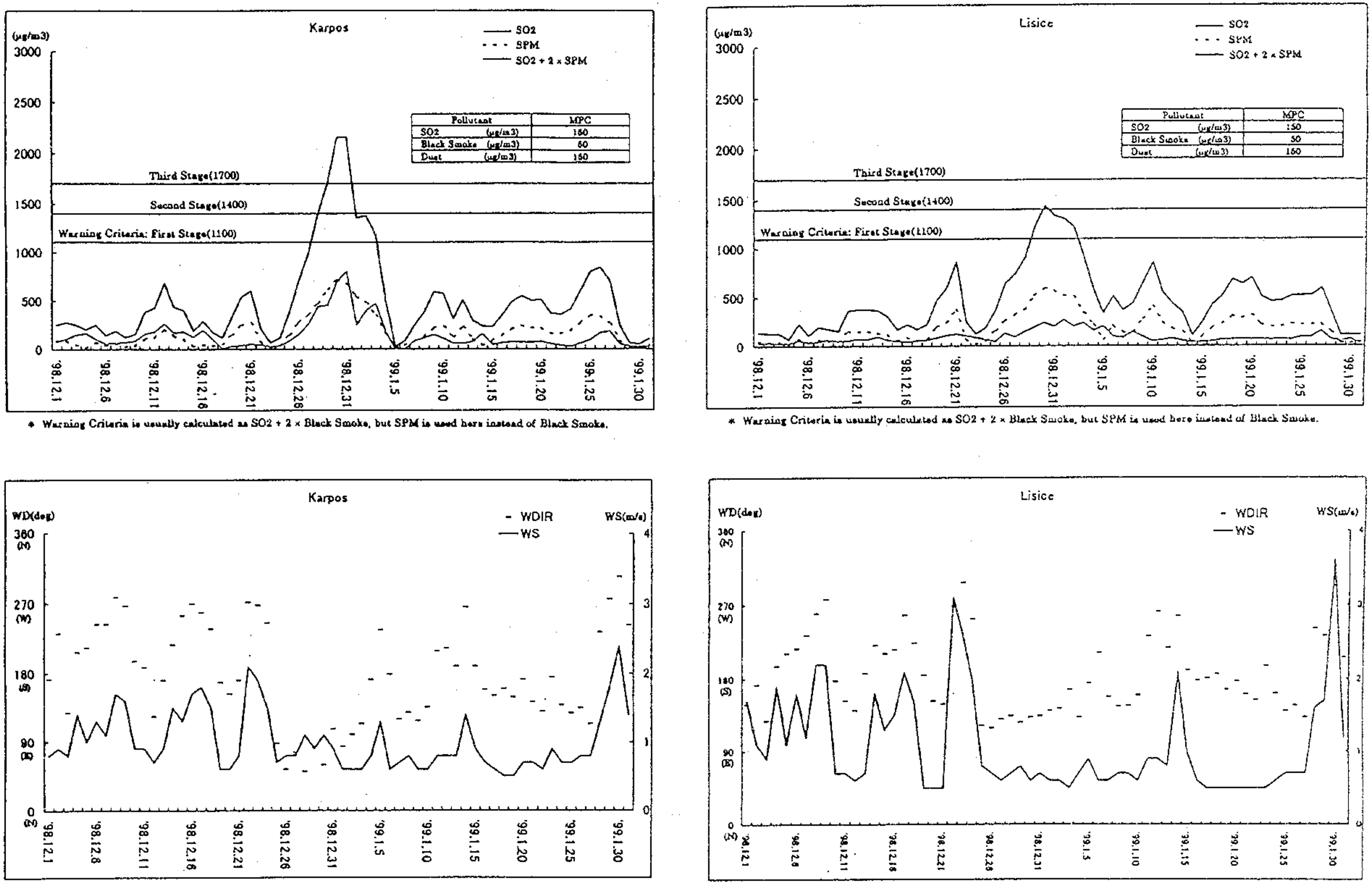


Figure 4 (2) Variation Diagram of SO_2 and SPM Concentration and Wind Direction and Speed

(5) Survey of Stationary Sources

The pollution sources subject to the Study area consist:

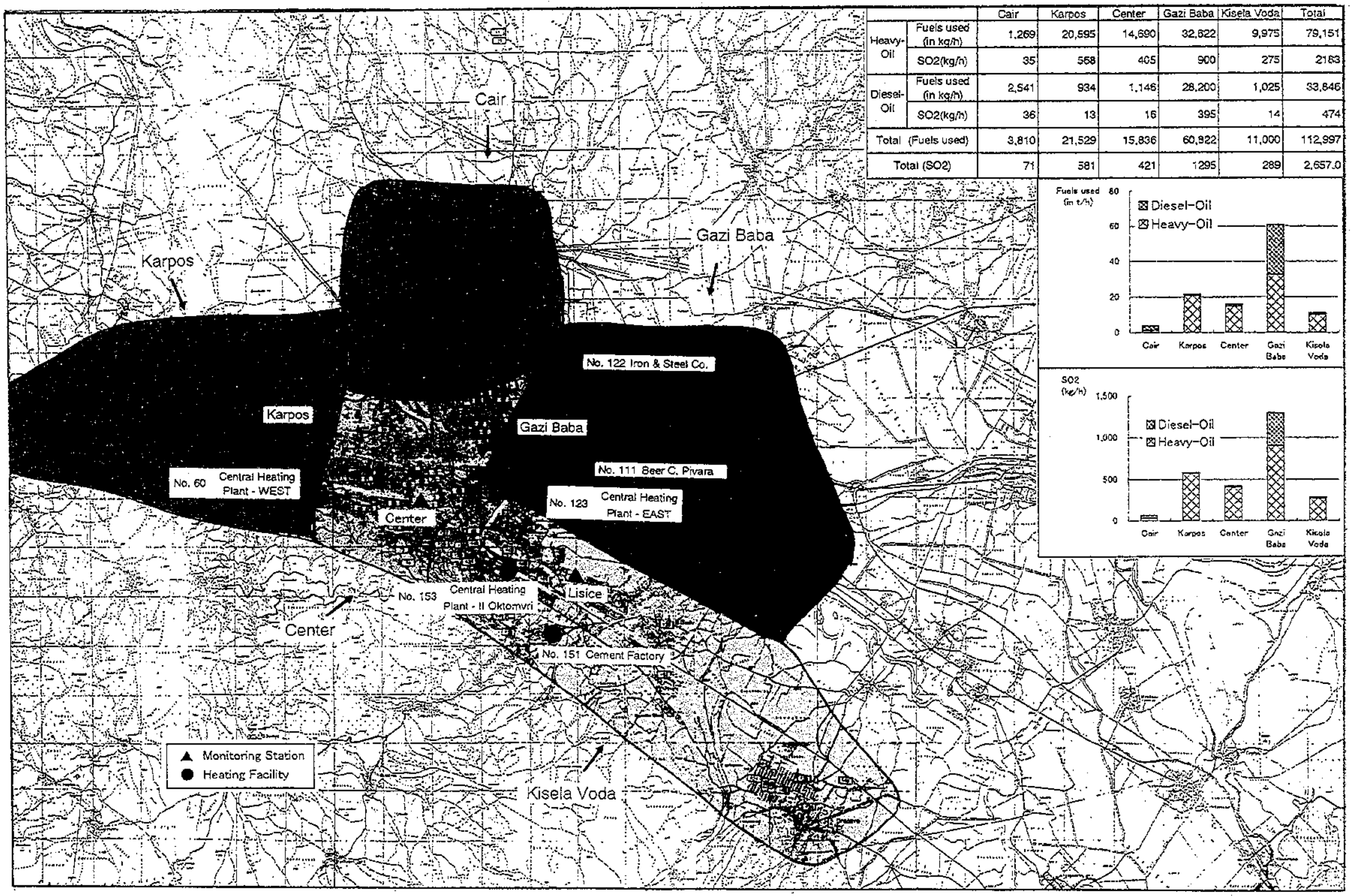
- Stationary sources: factories, heating plants
- Area sources: household heating, small factories, roadways
- Mobile sources: automobiles

The location and volume of fuel consumption of the major stationary sources and SO_2 emissions by each area are shown in Figure 5.
The materials such as existing information and the survey results as follows were used for estimation of emission volume and pollution sources.

- Questionnaire and visit survey to stationary sources
- Measurement of exhaust gas from combustion facilities
- Survey of heating facilities including household heating
- Analysis of fuels

The operation rates, which varies among facilities is 30 to 40% of regular time on average. Heavy oil is mainly used as a fuel, while coal and firewood are hardly used. The contents of sulfur in heavy oil at two heating plants are 1.33% and 1.43%. However, the imported heavy oil has poor quality. The content of sulfur in some cases is over 2%. Besides, the content of sulfur in diesel oil is 0.26%.

The content of oxygen in exhaust gases is very high (there are cases with more than 10 % O_2).
At many facilities, the concentration of each component exceeds MPC and there are some cases which CO and dust exceed MPC extremely. There are also a number of cases whereby the concentration of SO_2 exceeds MPC by 2 to 3 times and for the case of NOx, the maximum value is about two times than that of MPC.
Most of stacks are as low as 10 to 20m. It is unfavorable concerning the pollutants contribution to the ground.
Outline of results of pollutant concentration in exhaust gases from process boiler and heating facilities is shown in Table 6.



		Cair	Karpos	Center	Gazi Baba	Kisela Voda	Total
Heavy-Oil	Fuels used (in kg/h)	1,269	20,595	14,690	32,622	9,975	79,151
	SO2(kg/h)	35	568	405	900	275	2183
Diesel-Oil	Fuels used (in kg/h)	2,541	934	1,146	28,200	1,025	33,846
	SO2(kg/h)	36	13	16	395	14	474
Total (Fuels used)		3,810	21,529	15,836	60,922	11,000	112,997
Total (SO2)		71	581	421	1295	289	2,657.0

Figure 5 The location and Volume of Fuel Consumption of Major Stationary Sources and SO_2 Emissions

Table 6 Outline of Results of Pollutant Concentration in Exhaust Gases from Process Boilers and Heating Facilities

(Unit: mg/m^3)[*3]

Type of Fuel	Item	SO_2	NOx	CO	Dust
Heavy Oil	Average	3020	359	114	91
	Maximum	5940	741	388	250
	MPC [*2]	400 or 1700	350	170	50 or 150
Diesel Oil	Average	1060	104	17	5
	Maximum	1400	131	26	16
	MPC	400 or 1700	350	170	50 or 150
Natural Gas [*1]	Average	56	169	25	0
	MPC	1700	200	100	50 or 150

Note: [*1] Only one case was measured for natural gas.

[*2] There are some cases where MPC differs depending on types and scales of combustion facilities.

[*3] Measured values in mg/m^3 are calculated on 3% O_2

(6) Survey of Mobile Sources

Roughly 40% of all vehicles in the Country are concentrated in Skopje and the level of air pollution in Skopje caused by mobile emission sources is estimated to be very high. In the survey, wide-scale examinations were carried out on the traffic volume of the whole of Skopje region. According to the results, there are significant differences in the variation patterns of the hourly traffic volumes between weekdays and holidays. Roughly 90% of all vehicle are passenger cars. Others are buses, trucks and so on. The outline of the survey results is as follows.

- The traffic volume for weekdays shows an increase after 7:00 in the morning and this continues until midday. After that, it continues to decrease from midnight to sunrise. On the other hand, the traffic volume for holidays, was found to have its peak at around 0:00 p.m. and 11:00 p.m., reflecting a distribution pattern consisting of two peak times.
- As for the traffic volume during peak hours, the number of vehicles along major roadways was calculated to be from 3,000 to 8,000 vehicles per hour. There were also cases whereby the number of vehicles at cross-junctions were found to exceed 100,000. At maximum level, it recorded approximately 95,000 vehicles per day even in holidays.

1.3 Present State of Monitoring System

(1) The Structure of Monitoring System in MOE

Presently, the MOE is conducting the management and supervision of the automatic monitoring station. However, one of the staff members is temporary transferred out of RHI in addition to 2 members from MOE.

At first, the 2 staff members from MUPCE also held other posts in other departments, and hence the system of the management and supervision of the monitoring station was thin and scarce. In the new organization, the Environmental Information Center of the Department of Environment will be in charge.

However, the most important thing about monitoring is to acquire highly reliable data. The maintenance and management of the measuring instrument has to be conducted habitually everyday in order to ensure that the measuring can function normally. In addition, the acquired data must be checked to see whether they are correct or not. Also, the making of a daily report and a monthly report and the management of data are required. Concerning all these works, it will be impossible to manage and supervise the monitoring station only by the person-in-change in Environmental Information Center at present. In carrying out of the management of the monitoring for the air pollution control administration, there is a need to adjust a responsible monitoring system in an early stage.

(2) Present State of Monitoring System

1) Skopje

a) Ambient Air Quality Monitoring

Figure 3 shows a location of Air Quality Monitoring (AQM) stations and measuring points in Skopje.

The Republic Hydrometeorological Institute (RHI, nine locations) and Institute for Public Health (IPH, seven locations) are conducting monitoring of SO_2 and black smoke using British samplers.

Total acid is monitored using multiple samplers at points No. 1 to 3 of the IPH.

CO concentration in air is monitored in two seasons per year (April and November) at four intersections in the central area of Skopje.

The Karpos IV (No. 6) measuring point of the RHI monitors SO_2, black smoke, NOx, O_3 and Ox for 24 hours. Additionally, the RHI has been monitoring concentrations of particulate substances and Pb and other heavy metals at intersections and monitoring points in Skopje.

Analyzed pollutants and the methods of analyses are as follows.

SO_2: Absorptiometry (Pararosaniline method)

Total Acid: Neutralization titration method

NOx: Absorptiometry (Saltzman method)

Ox and O_3: Absorptiometry (5%-KI solution method)

CO: Absorptiometry (Palladium chloride solution method)

Pb: Filter collection controlled potential electrogravimetry

Heavy metals: Atomic absorption spectrometry

The meteorological observation point in Skopje is monitoring surface meteorology, such as wind direction, wind speed, temperature, humidity and rainfall at HMI-Karpos (No.3) measuring point of the RHI.

At the airport, upper meteorology such as vertical distribution of wind direction, wind speed and temperature is additionally monitored every day at 1:00 a. m..

The RHI-Skopje collects these data and meteorological data from the Landsat and supplies meteorological information to the general public.

b) Air Emission Sources Monitoring

Only some large plants monitor emission sources. Those plants and factories that monitor emission sources are cement plants, central heating plants, iron and steel plants and some others.

The monitoring items of these major plants and factories are as follows:

-Exhaust gas temperature
- CO: Infrared absorption method (portable equipment)
- SO_2: Infrared absorption method
- NOx: Infrared absorption method
- Dust: Light-scattering method (collection on filter paper, and monitoring intensity of light reflection of photoirradiation)

Air emission gas in the stuck is monitored every week.

2) Nationwide and the Major Cities

Throughout Macedonia, the RHI has installed the same monitoring equipment (British samplers) as those in Skopje in other 11 cities. Similarly, the IPH has installed sampler in six cities. Alarm announcement and regulation of vehicular traffic will be carried out in case the air pollution condition worsens in the industrial cities such as Skopje and Veles, in an effort to control air pollution.

The RHI monitors the meteorology of almost the whole of Macedonia.

(3) Tasks and Recommendations for Monitoring System

The present tasks for monitoring system are as follows.

1) In Skopje, it has become possible to respond the aggravated environmental concentration immediately due to the introduction of the automatic continuous monitoring system for ambient air quality. For other places over the Macedonia, at least in the major cities, constructing a national network of automatic continuous monitoring and all-time monitoring are necessary. The existing monitoring stations will be continuously utilized in order to supply the automatic continuous monitoring data.
2) Continuous monitoring of emission gas from factories has not been conducted. For example, a system is desired to be constructed such that the major factories can be made obliged to continuously monitor emission gas and not only for the factories, data should also be transferred by telemeter so that the MOE can manage and supervise the data on a real-time basis. It is indispensable to increase the number of mobile monitoring car in order to monitor factories throughout the Macedonia.
3) Automobiles are one of the major causes of air pollution. At present, automobile inspection system is not fully functioning and measurement of emission gas is not conducted in the Macedonia. Introduction of monitoring system for automobile emission gas is desirable.
4) Among pollutants, only SO_2, black smoke and dust fall are monitored throughout the Macedonia. Since there are insufficient number of monitoring items of pollutants, it is desirable that NOx, CO, O_3 and hydrocarbon etc. are included.
5) The MOE declared to take appropriate countermeasure concerning human and economic resources for maintenance and management of future monitoring system. Immediate adjustment of the system is required.
6) It is recommended to redefine the standard method as well as environmental standard. For example, it is recommended to redefine what should be the criteria (total oxidant, photochemical oxidant and O_3) for a standard. For Pb, solution absorption method and filter paper sampling method were examined and the former is recommended as the standard method. Although the solution absorption is a favorable method, reexamination is desirable including definition of the standard.
7) As a result of accuracy evaluation, it became clear that British sampler had various error factors. However, favorable data was found to be obtained taking the error factors into consideration. In order to improve accuracy, continuous examination is necessary taking the result of evaluation into consideration.
8) Data accumulation and processing of ambient air quality and meteorological data is performed within the routine work without problem. However, data is not adequately utilized or accumulated in accordance with the intended purpose. As a future direction,

a data bank and processing system should be installed and utilized. The installation of the automatic continuous monitoring equipment and data processing system under this Study will facilitate quick evaluation of concentration of air pollutant and meteorological fluctuations and will enable processing of a variety of data. These systems should be utilized in the future and the services of supplying data to ordinary citizens and concerned organizations as the need arises should be enhanced.

1.4 Prediction of Air Quality by Air Quality Simulation Model

(1) Objectives for Development of an Air Modeling Program

Air simulation modeling provides a rational (scientifically based) method for estimating source contributions, which can then be used to determine the effectiveness of emission reduction alternatives in meeting Macedonian ambient air quality objectives.

The method can also be applied numerous times to answer "what if" question for future year emission changes. In the Study the objectives for air quality modeling were to develop an example modeling approach and methodology which could be used by the Macedonian Side:

- as a basis upon which further refinements to modeling could be developed
- to develop similar approaches for other cities within Macedonia
- to examine control strategy effectiveness in meeting air quality objectives

To meet these objectives air quality modeling study was performed for Skopje for a base year (1998), one future-year (2008) without additional control measures, and one future-year (2008) with implementation of control measures.

(2) Modeling Approach

Two general classes of air quality models were used in the Study.

An air quality dispersion model which simulates the dispersion of air pollutants once they are released into the environment by simulating all of the physical process which take place in the atmosphere (dispersion, transport, deposition, chemical transformation). However, the model is dependent upon reliable measures of emissions and meteorology. Emission estimates are usually reasonably known for CO, SO_2 and NO_2, but are often poorly known for Suspended Particulate Matter (SPM).

To confirm and support the calculated conclusions regarding SPM source contribution from the dispersion model a receptor model is used.

A receptor model examines ambient measurement of SPM for their chemical constituents and compares observed chemical composition to those of emission source profiles to establish source contribution. To successfully apply the method with a high degree of confidence requires many ambient measurement samples and their subsequent chemical analysis and emission source profile information.

A long-term dispersion model was used to simulate the annual average concentration for the pollutants of SO_2, SPM, CO and NO_2. The USEPA's ISC3 air quality model was selected for simulating long-term averages.

To simulate hourly SO_2 concentrations during a typical SO_2 episode the CALPUFF (California Puff) modeling system was selected. The most widely used receptor model, the Chemical Mass Balance model (CMB) was used in the Study.

Receptor models are generally contrasted with dispersion models which use estimates of pollutant emissions rates, meteorological transport, and chemical transformation mechanisms to estimate the contribution of each source to receptor concentrations. The two types of models are complementary, with each type having strengths which compensate for the weakness of the other.

(3) Model Result

1) Long-term Dispersion Modeling

For the long-term modeling comparisons were made between modeled and observed for each monitoring site for SO_2.

Source conditions inputs for simulation model and its results are as follows.

Figures 6 and 7 show the observed and the modeled SO_2 concentration.

For the future year (2008) each stationary point source was increased by 20% to reflect additional industrial growth based on the request of the Macedonian Side, while area sources (domestic heating and small-sized source) remained constant. The control strategy was to switch from oil to natural gas for all of Skopje heating plants.

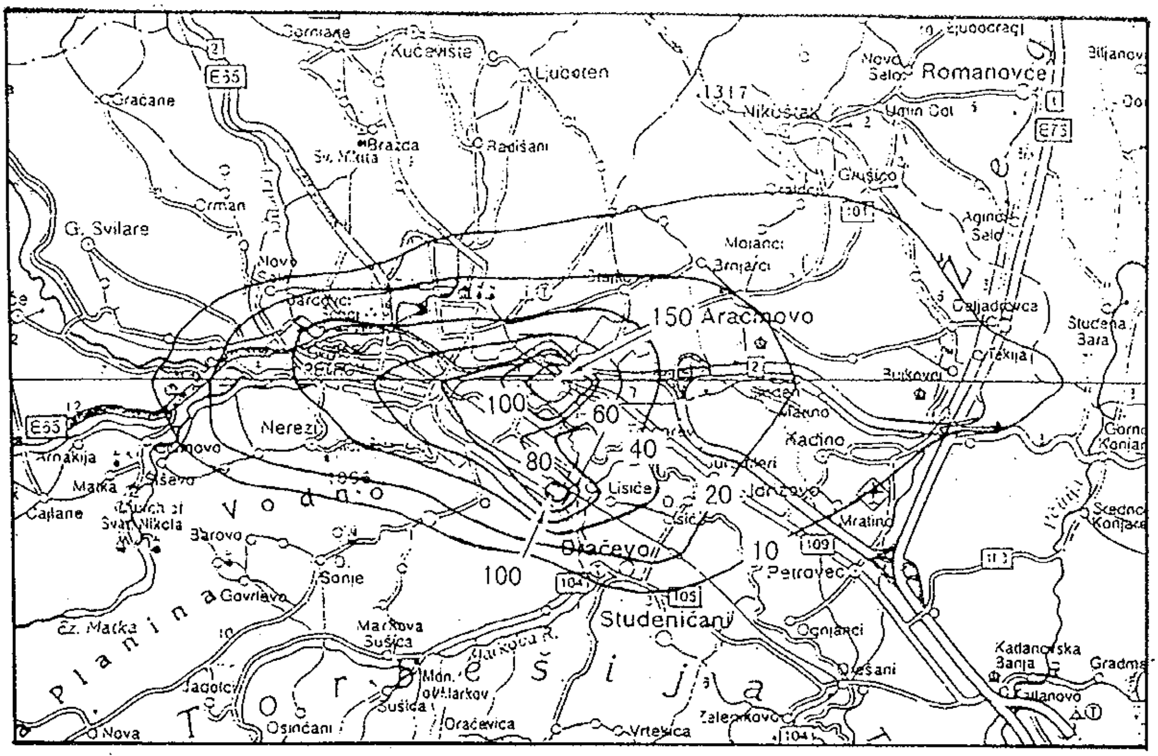


Figure 6 Annual Average SO_2 Concentration (observed) in $\mu g/m^3$

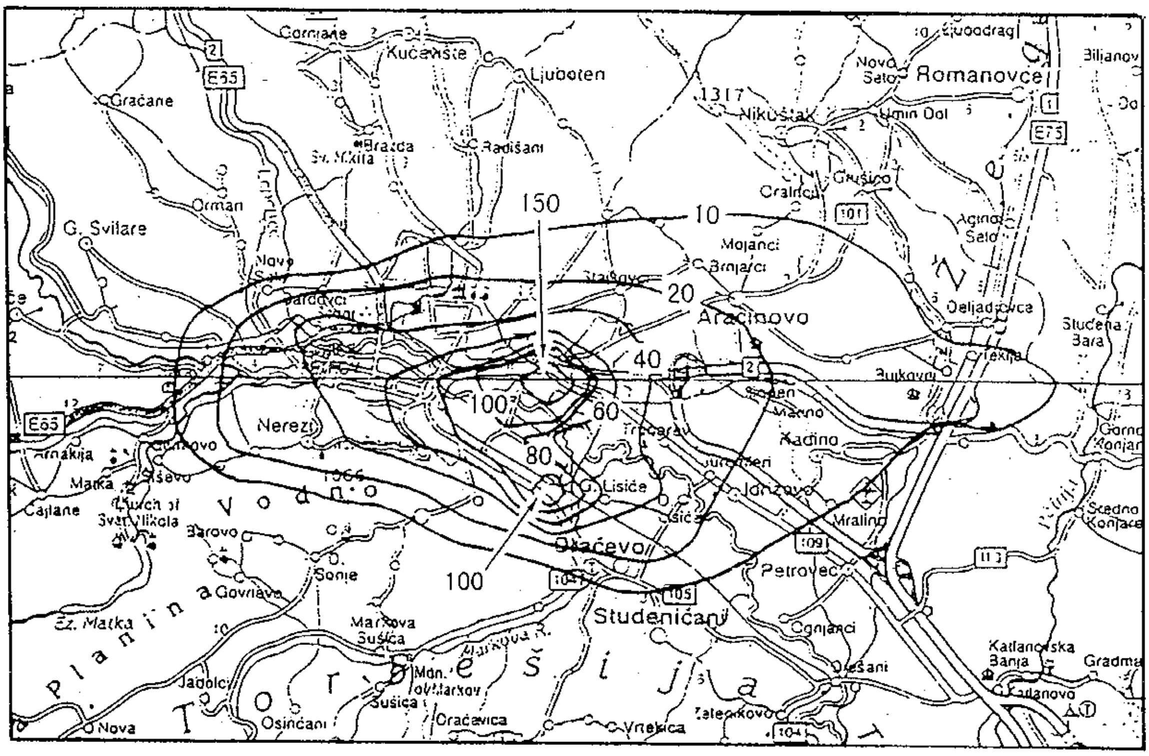


Figure 7 Annual Average SO_2 Concentration (modeled) in $\mu g/m^3$

<Model Result>

For all pollutants, including SO_2, the change in emissions and the switching from oil to natural gas for all of heating plants resulted in little change to the annual average concentrations. This is because the heating plants contribute little to the overall SPM, NO_2, and CO, emissions. Additionally, these sources only operate for half the year and are emitted from relatively tall stacks. This enables pollutants to be widely dispersed throughout the area. The source contribution from the heating facilities for SO_2 is much smaller in 2008 than for 1996 with the control strategy implemented. However, the 20% growth for other combustion sources erodes the benefit of the control strategy, with a net result of little change in the modeled SO_2 concentration.
Conversion of fuel from the heavy oil to low sulfur fuel at other combustion sources is therefore needed.

2) Short-term Dispersion Modeling

Short-term modeling of Skopje were compared with monitored 24-hour average SO_2 concentrations for both January 14 and 15, 1998.
Results of present state and future forecast by simulation model are shown in Figure 8 and Figure 9.

<Model Result>

Results showed that the peak modeled SO_2 site (Hotel Panorama) had almost no contribution from the heating plants thus the net result of the control strategy at this location is a net increase from the base year because of the growth in emissions by 20 % from combustion sources.
On the other hand, the site that saw the biggest net reduction in average concentration of 313 $\mu g/m^3$ was Karpos IV measuring point because almost three-quarters of the concentration in the base year is attributable to emissions from the heating plants. Thus conclusions about the merit of a particular control strategy effectiveness have to carefully examine the spatial changes in concentration to determine the overall benefit from a particular strategy.

January 14, 1998

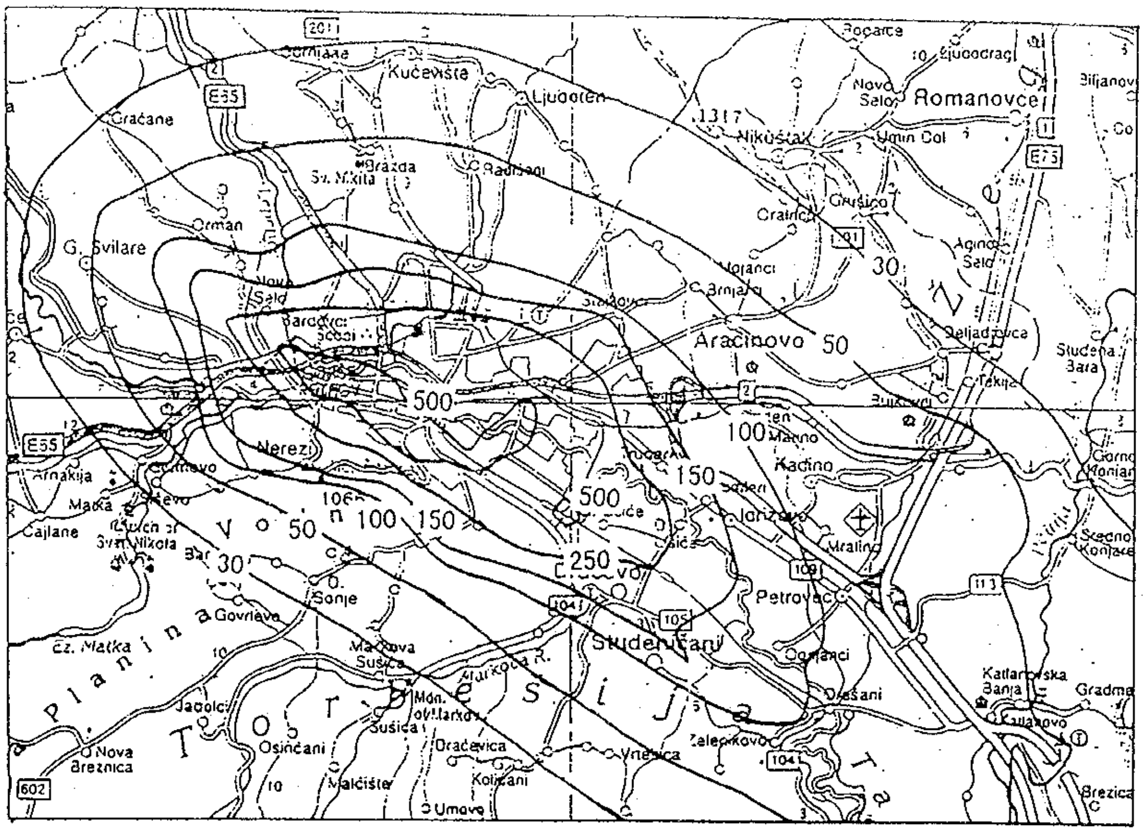


Figure 8 24-hour Average Spatial Distribution of SO_2 Concentration in μg/m³

January 14, 2008

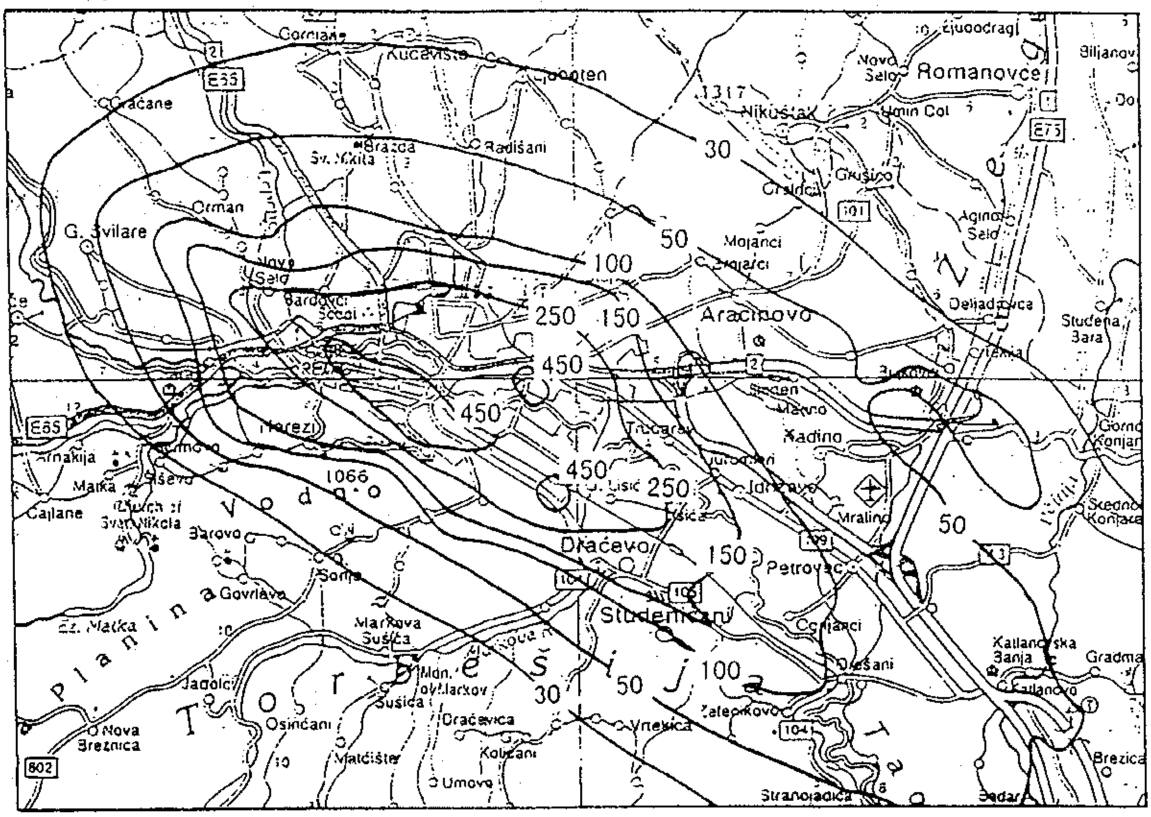


Figure 9 24-hour Average Spatial Distribution of SO_2 Concentration in μg/m³

3) Receptor Modeling

To estimate the sources of the trace elements measured at the three sites (RHI, Residential area and rail way station) factor analysis was performed using data for twelve elements from 56 samples collected between December 25, 1997 to February 21, 1998.

a) Br

High fluctuations in the Br (Bromine) average is not surprising as Br concentrations can be considerably influenced by local Br emissions from automobile exhaust.

b) S, Cl, K, Ca and Fe

Good correlation is observed between S (Sulfur), Cl (Chlorine), K (Potassium), Ca (Calcium) and Fe (Iron), suggesting that these elements were carried together in the same air mass, either because they arise from a single type of source, or because the spatial and temporal distributions of emissions from contributing source types are similar to those of SO_2 in Skopje.

Particulate sulfur is expected to be primarily the result of secondary sulfate, whose origin is SO_2 from the combustion of oil.

Potassium (K) is known to be more abundant in smoke from wood burning. These two findings suggest that the correlation of S and K arise from stagnation conditions in cold weather, resulting in an accumulation in the atmosphere over Skopje of concentrations of heating source emissions over a long enough time period for some fraction of the SO_2 to oxidize to sulfate (one to two days).

Ca and Fe are not commonly associated with heating sources, and thus may represent another source of fine particles that accumulate during stagnation (cement manufacturing is possibility included here).

c) Al, Si, K, V, Mn and Fe

There is also a good correlation between Al (Aluminum), Si (Silica), K, V (Vanadium), Mn (Manganese) and Fe. Fe, Mn, and K are all present in the aluminosilicate phase (e.g., crustal dust or rock).

d) Br and Pb

Also, as expected, Br and Pb (Lead) show a strong correlation, as both are present in fixed ratios in the exhaust of vehicles fueled with leaded gasoline.

e) Specific Source Categories

The specific source categories that are apparent, based on knowledge of elemental abundance in emissions, include mobile sources, crustal material, heating with oil and wood, and potentially refuse incineration. The elements providing the most useful information in identifying the principal components included Pb, Br, Al, Si, K, V, Mn, S, and Zn.

2. Recommendations for Framework of Air Pollution Monitoring System Planning

2.1 Framework of Nationwide Monitoring System

Based on the results obtained through the Study on the selection of the model city, it is easily judged that the considerable air pollution is existing in the major cities of the Country, and furthermore, air emission in winter caused by heating facilities, stationary sources using low quality fuel and mobile sources are the major causes of air pollution.

With regard to the existing monitoring system, it is noticed that the equipment installed at those cities are not responsive in emergency case.

To solve this problem, it is recommended that the nationwide monitoring system shall be established using latest system.

The basic aims of setting framework for nationwide monitoring system on environmental administration are defined as follows:

- To understand the level of air pollution and judge whether environmental standards are cleared or not
- To take countermeasures in emergency case
- To satisfy the requirement of EU Directives

The framework of system is summarized as follows.

- Setting up of additional ten Air Quality Monitoring (AQM) stations
- Installation of five Continuous Emission Monitoring (CEM) stations

- Introduction of one mobile monitoring system
- Establishment of Air Pollution Monitoring Center (APMC) including data bank system
- Introduction of auto-exhaust gas inspection system
- Improvement in analytical instruments of the Institute of Environment "Zelezara" (IEZ) (first phase and second phase)

2.2 Organization and Institution Planning

In order to monitor air pollution effectively in the model city as well as nationwide, to respond to the urgent requirements such as announcement of alarm in case of stagnation episode and to manage all the monitoring system, it is recommended that Air Pollution Monitoring Center (APMC) be established under the Environmental Consulting Center of the MOE as a specific organization for monitoring of air pollution and its countermeasures.
Table 7 shows the outline of the APMC.

Table 7 Outline of APMC

Item	Contents
Works	- AQM and continuous emission monitoring (CEM), data collection and its screening - Judging whether the standards are cleared or not - Data collection related to emission source and meteorology - Management of monitoring data in data bank - Maintenance and management of monitoring instruments - Public Information Distribution - Announcement of warning (24 hour shifting of personnel)
Organization	- AQM Section - CEM Section - Data Management Section - Maintenance Section
Personnel	- Two administrative managers - Six environmental engineers for monitoring, analysis, data management and maintenance - Two electronics engineers for computation and communication - Outsourcing of maintenance to local agent
Personnel Development	- Short-term training such as training and lecture held by manufacturer and by newly employed researcher or technical adviser - Medium- and long-term training such as 3 to 6 months training at environmental monitoring course, engineer training in university and receiving of foreign expert

2.3 Maintenance and Management Planning

(1) Method for Maintenance and Management

It is desirable that the specialized engineers of the MOE carry out basically all the maintenance and management works including checks, inspection and calibration for AQM stations and monitoring instruments. It is necessary to keep up with the rapid progress in the monitoring instruments, as well as the computer technology of the improved monitoring system in the developed countries. Monitoring instruments at AQM stations in the model city are completely different in the structure and principle from the existing equipment such as the British sampler in Macedonia. The present monitoring instruments apply the state-of-the-art electronics and physical technology and it therefore takes considerably some time to acquire the operation and maintenance (O & M) techniques. There are two options to maintain and manage the present AQM stations as follows:

1) Maintenance and Management by MOE

Simple maintenance and management of the monitoring instruments such as replacement of filter paper according to the given specification are being provided by the MOE.

2) Outsourcing to Local Agent

In case all the maintenance and management works of AQM stations are outsourced to the local agent, it is possible to secure the operation of monitoring instruments and the acquisition of monitoring data, and to save the time and manpower for patrolling, trouble shooting, etc..

(2) Outline of Maintenance and Management

For continuous monitoring of air pollutants, automatic air pollution monitoring instruments have to be effectively and reasonably operated with high reliability. Basic maintenance works for monitoring instruments to keep accuracy of value and high reliability are summarized in Table 8.

Table 8 Major Items and Schedule for Maintenance Works

Check	Purpose	Frequency	Content
Daily check	Continuous normal operation of automatic monitoring instruments	Minimum once/week	1. Check of operation status of monitoring instruments 2. Replacement of consumables 3. Calibration 4. Cleaning
Periodical check (Close check) (Check of trans-mission accuracy)	Maintenance of Functions and prevention of trouble (keep accuracy within standards)	Minimum once/year	1. Inspection of flow path 2. Inspection of detector 3. Inspection of control and transmission systems 4. Inspection of amplifiers and recorders
Emergency check	Rapid and prompt check for trouble shooting when malfunc-tion or breakdown	At the time of emergency	1. Identification of breakdown and its minor repairs 2. Identification of cause and repair by manufacturer
Function test	Prevention of trouble and to secure the continuous main-tenance and data evaluation (required thorough comprehen-sion of equipment characteristics)	When purchas-ing equipment and when necessary	1. Equipment function test (standard gas) 2. Equipment stability test (fluctuation of flow, zero, span drift, etc.) 3. Validation of monitoring data
Calibration with standard gas	Determination of the accuracy range	When necessary	1. Check with standard gas 2. Compile calibration curve

2.4 Personnel Development Planning

Enough attention should be paid to the operation of the APMC because the newly established monitoring system differs from the existing one from the technical viewpoint. That is to say, hardware such as monitoring instruments and computer equipped with microchip and software to run the hardware are introduced into the monitoring system. It is difficult to cope with the existing techniques in O & M of monitoring instruments and extensive knowledge about the overall environment is required. It is therefore necessary for the administrative officers and engineers to receive the step-by-step training and re-education for the operation of the APMC.

1) Short-term Training

Short-term training includes the followings:

- Training held by manufacturer at site
- Lecture and training by newly employed researcher or technical adviser such as professor of university

2) Medium- and Long-term Training

Medium- and long-term training include the followings:

- Three to six months training at environmental monitoring institution
- Training of engineer at environmental department to be established in university
- Receiving of foreign expert

2.5 Implementation Schedule Planning

(1) Nationwide Air Pollution Monitoring

1) Air Quality Monitoring (AQM) System

In order to select the municipalities for the establishment of nationwide AQM system, it is reasonable to investigate the level of damage to human health by the municipality based on the existing materials first and then to give priority to the serious air-polluted industrial or major municipalities for its selection. Based on the National Environmental Action Plan (NEAP) report and the field survey, it is recommended that AQM stations be established in the following municipalities including the model city, Skopje; Bitola, Tetovo, Kichevo, Kumanovo, Ohrid, Prilep and Lazaropole.

2) Mobile Monitoring System

It is recommended that another mobile monitoring car equipped with the dilution method which is able to monitor both ambient air quality and emission sources be introduced for the monitoring of other industrial municipalities and large-scale stationary emission sources nationwide, taking into consideration the cost effectiveness. The mobile monitoring car will be based on the Institute of Environment "Zelezara" (IEZ) of the MOE in Skopje and will monitor the nationwide municipalities and emission sources if required.

3) Continuous Emission Monitoring (CEM) System

It is recommended that, stations at two heating plants and one cement factory in Skopje, the smelter in Veles and the coal-fired thermal power Station in Bitola be monitored continuously because the air pollution caused by emission from those plants has already been observed and has considerable impact on the surroundings.

(2) Implementation Schedule

Implementation schedule is divided into the following three stages; the present stage of the urgently required monitoring covered with the present monitoring system in the model city, the first stage within five years and the second stage within ten years. Table 9 shows the implementation schedule.

Table 9 Outline of Establishment of Nationwide Air Pollution Monitoring System

Stage	Type of System	Number of Station
First stage (within five years)	AQM system	Ten stations in total: - Two more stations in Skopje - Two stations in Bitola - One station each in Tetovo, Kichevo, Kumanovo, Ohrid, Prilep and Lazaropole
	CEM system	Five stations in total: - Three stations for two heating plants and one cement factory in Skopje - One station for smelter in Veles - One station for coal-fired thermal power plant in Bitola
	Mobile monitoring system	Another mobile monitoring car to be stationed in Skopje
	Auto-exhaust gas inspection system	One set
	Data acquisition and processing system including data bank	One set at the APMC
	Improvement in analytical instruments of the IEZ (first phase)	One set
Second stage (within ten years)	Improvement in analytical instruments of the IEZ (second phase). As for the monitoring equipment and materials, it is reasonable to expand the monitoring capability step-by-step during the second stage, based on the results of pollution level to be obtained through AQM and mobile monitoring, and the monitoring capability at that moment.	

(3) Procurement of Equipment and Materials

As a result of procurement of equipment and materials necessary for the Study and the Site Works throughout the four seasons, various results and findings were obtained. Figure 10 shows the points to consider for the procurement of monitoring equipment and materials in future. Concerning the procurement of monitoring equipment and materials in order to establish the air pollution monitoring system, the proceeds of any loan of international financial institutions may be applicable.

Selection of Equipment and Materials

1. Temperature for container; Enough insulation for container 100 mm or more thick
2. Air conditioner of container; Two air conditioners in case of failure
3. Wind vane anemometer; Ultrasonic wind-vane anemometer with a built-in heater to avoid freezing
4. Monitoring range; Enough range for large concentration fluctuations of air quality
5. SPM meter ; Careful attention to selection of SPM meter because the effect of humidity is one of the probable error factor
6. Self-diagnosis and remote control function; Self-diagnosis and remote control function are advantageous for preventing failures.
7. EU legal system; Items and specifications in compliance with EU legal system

Considering Points for Procurement of Equipment and Materials

Procurement Procedures under International Financial Institution

1. Exchange of loan agreement between borrower and financial institution
2. Preparation of terms of reference
3. Procurement of consultant
4. Preparation of equipment list, technical specification and price quotation
5. Prequalification
6. Preparation of bidding documents
7. Invitation of shortlisted bidders
8. Evaluation of bids
9. Award of contract
10. Manufacturing, delivery and installation
11. Inspection and commissioning
12. Training
13. Operation of air pollution monitoring system

Procurement of Equipment and Materials

1. Bidding for Procurement; Prequalification and two-stage bidding comprising technical and financial proposals are desirable.
2. Technical specification; Clearly understandable specification is the sole means to prevent trouble with the manufacturer, describing the details of equipment, quantity, specifications, delivery, etc.
3. Preparation of estimated price; Consumables and spare parts, necessary accessories, delivery, installation, inspection, training, warranty, etc.

Bidding

1. Bidding procedures; International competitive bidding, limited international bidding, local competitive bidding, international shopping, direct contracting
2. Prequalification
3. Two-stage bidding; Technical and financial proposals
4. Bidding documents; Invitation of bid, instruction to bidders, form of bid, conditions of contract (both general and special), technical specifications, list of goods or bill of quantities and drawings, necessary appendices and detailing
5. Selection of successful bidder; opening, examination, evaluation, preparation of evaluation report, award of contract
6. Commissioning; Inspection, performance test, training
7. After sales service

Figure 10 Considering Points for Procurement of Equipment and Materials

2.6 Estimation for Project Expenses

(1) Cost Estimation for Equipment and Materials

The total estimated cost for the establishment of nationwide air pollution monitoring system including the model city during both first and second stage will be US$ 3,977,870.
Table 10 shows the summary of cost estimation.

Table 10 Summary of Cost Estimation for Nationwide Monitoring System

Stage	Item	Cost Estimation (US$)			
		Equipment & Materials	Consumables	Spare Parts	Sub-total
1st	AQM	2,041,800	41,900	25,400	2,109,100
1st	CEM	520,500	28,000	12,800	561,300
1st	Mobile monitoring	255,100	22,430	1,200	278,730
1st	Auto-exhaust gas inspection	78,500	5,240	3,900	87,640
1st	Software for data acquisition and processing for APMC	148,000	2,500	-	150,500
1st	Improvement in analytical instruments for IEZ (1st phase)	536,940	-	-	536,940
2nd	Improvement in analytical instruments for IEZ (2nd phase)	253,660	-	-	253,660
1st Stage Total		3,580,840	100,070	43,300	3,724,210
2nd Stage Total		253,660	-	-	253,660
Total		3,834,500	100,070	43,300	3,977,870

Lifetime of monitoring instruments is 7 to 10 years approximately and the renewal of present monitoring instruments will be taken place at the end of second stage. It is therefore necessary to secure the budget for the renewal about US$ 150,300 per AQM station, US$ 227,000 per mobile monitoring car, US$ 65,000 for auto-exhaust gas inspection and US$ 150,000 for the APMC.

(2) Annual Cost Estimation for Maintenance and Management

The annual estimated cost for the maintenance and management of nationwide monitoring system through the outsourcing to the local agent is US$ 239,370.
Table 11 summarizes the annual cost estimation for the maintenance and management by the item.

Table 11 Annual Cost Estimation for Maintenance and Management

Item	Cost Estimation (US$)
Consumables	100,070
Spare parts	43,300
Service engineering fee	48,000
Transportation	48,000
Total	239,370

(3) Source for Operation and Maintenance (O & M) Cost for Monitoring Equipment and Materials

The MOE asserts that the Ministry will appropriate major O & M cost and also a part of fund of the Environment and Nature Protection and Promotion (NEPP) is scheduled to be allocated as a source for the maintenance and management cost for monitoring stations. The fund is allowed to be spent for the environmental improvement and nature preservation only and its principal source is 2 to 4 % of insurance required at the time of registration of automobile. It is expected that the fund is amounted to US$ 1,750,000 in 1998 and US$ 5,800,000 in 2002 due to the revenue from toll road fees and the introduction of environmental tax. The maintenance and management cost for monitoring stations will be about 4% of the fund and it can therefore be said that the fund as a source will be sufficient.

(4) Cost Estimation on Each Implementation Schedule

Table 12 shows cost estimation on each implementation schedule for establishment of monitoring system.

Table 12 Cost Estimation on Each Implementation Schedule

Unit : US$

Item \ Stage & Year	First Stage				
	1	2	3	4	5
Initial investment and renewal cost					
AQM system	2,109,100	-	-	-	-
CEM system	561,300	-	-	-	-
Mobile monitoring	278,730	-	-	-	-
Auto-exhaust gas inspection	87,640	-	-	-	-
Data acquisition and processing for APMC	150,500	-	-	-	-
Subtotal	3,187,270				
Annual O & M Cost					
Spare parts & consumables	143,370	143,370	143,370	143,370	143,370
Fee of service engineer & transportation (outsourcing case)	96,000	96,000	96,000	96,000	96,000
Subtotal	239,370	239,370	239,370	239,370	239,370
Other investment cost					
Improvement in analytical instrument for IEZ	536,940	-	-	-	-
Total	3,963,580	239,370	239,370	239,370	239,370
Item \ Stage & Year	**Second Stage**				
	6	7	8	9	10
Initial investment and renewal cost					
AQM system	-	450,900	450,900	601,200	601,200
CEM system	-	-	-	-	-
Mobile monitoring	-	-	-	227,000	227,000
Auto-exhaust gas inspection	-	-	-	65,000	-
Data acquisition and processing for APMC	-	-	150,000	-	-
Subtotal		450,900	600,900	893,200	828,200
Annual O & M Cost					
Spare parts & consumables	143,370	143,370	143,370	143,370	143,370
Fee of service engineer & transportation (outsourcing case)	96,000	96,000	96,000	96,000	96,000
Subtotal	239,370	239,370	239,370	239,370	239,370
Other investment cost					
Improvement in analytical instrument for IEZ	253,660	-	-	-	-
Total	493,030	690,270	840,270	1,132.570	1,067,570

2.7 Evaluation

With the establishment of the monitoring system, prompt comprehension of air pollution concentration will become possible. From the administrative point of view, it will be possible to conduct environmental management efficiently and support the decision of environmental policy aimed at environmental improvement.

Further, the official and prompt announcement of pollution concentration in accordance with public awareness program will raise public concerns about environmental problem. The environmental improvement will be effective as a result.
Therefore it is desirable that this plan will be carried out step by step with the confirmation of the effect.

III. Technology Transfer

1. Technology Transfer on the Study

Technology transfer has been carried out through joint survey with the Counterpart. It has been carried out along with each step of the Study.

- Method of Evaluation for Data Accuracy and Examination of the Cause of Error
- Selection Method of Locations for Monitoring
- Procedures of Installation and Calibration of Continuous Monitoring Instruments
- Method for the Maintenance and Management of Continuous Monitoring Instruments
- Measuring Method for Flue Gas Using Continuous Monitoring Instruments with Dilution Method
- Data Confirmation and Format

2. Technology Transfer Seminar

<Contents of the Seminar>

1) Administration of Air Pollution Control
   - Historical Background of Air Pollution
   - Framework of Air Pollution Control
   - State of Air Quality
   - Regulatory Measures Concerning Pollution Control for Stationary Sources

2) Air Pollution Control Management and Sustainable Development
   - Statutory Context and Trade Issues
   - Industry's Proactive Pollution Combating Efforts
   - Delegation of Enforcement Power and Responsibility
   - Fugitive Emission Control Technology

3) Design, Construction and Maintenance for Air Quality Monitoring System
   - Design, Construction and Maintenance for Air Quality Monitoring System
   - Selected Measuring Methods for Monitoring System of EU, Japan and Other Countries

4) Definition of Measured Values
   Collection of Measured Values, Contents of Definition Work and Judging/Processing of Abnormal Values

5) Public Awareness Program (Environmental Education Program)
   - Environmental Education in School
   - Retraining for Teachers, Leaders and Scholars
   - Enlightenment of Citizens
   - Environmental Education in Companies
   - Environmental Education within Japan and Policy Measures Related to Environment Study

6) General Description of Environmental Impact Assessment in Japan
   - Role of Environmental Impact Assessment
   - Future Directions and Environmental Impact Assessment Problems Pointed Out in the Past
   - Outline of the Newly-established Environmental Impact Assessment Law

7) Other Items Related to Air Quality Monitoring

8) Dispersion and Receptor Modeling in Air Quality Management
   - Dispersion Modeling
   - Receptor Modeling

Various findings and skills which were gained through this Study along with technology transfer seminar are expected to make the best use of, and improved and widely transmitted to the person concerned in the Macedonian side from now on. It is important to make the most of the facilities that were contributed for a long time. In order to do so, proper maintenance and management and budget for them are required.
Taking MOE's positive attitude into consideration, maintenance and management of facilities will not be a big problem.
The results of technology transfer seminar and training would be an aid for environmental management that MOE positively promotes. Besides, it is certain of that MOE would make the most of the information about planning AQM including related institutions.

IV. Recommendations

(1) Organization and Institution

1) As for the establishment of monitoring system, attention must be paid to the attitude of EU Directives and the establishment of regular reporting system. Attention must be also paid to the environmental information of EU which is open to the public.

2) The monitoring system and its function should be completed for the proper monitoring management in the near future. The more mutual cooperation between relevant organization, companies are also desired.

3) Emission standard should be re-examined by the source type and scale. The effective height of emission sources, with a further classification of whether the facilities are existing or new should be added. For existing facilities, it may be reasonable to regulate these in stages over a specified grace period.

4) In terms of evaluation time of the air quality standard, include an 1-hour value in addition to the daily average and 1-minute values. In terms of Ox, include an 8-hour value as an evaluation time in addition to the 1-hour value.
The CO standard is strict at 1 mg/m^3. This should be relaxed to the WHO level which is 10 mg/m^3 (8-hour value) and 30 mg/m^3 (1-hour value).
Black smoke is already stipulated as particle matter. SPM should be added in addition to black smoke.

5) Now that it is possible to accumulate 1-hour value, alarm system on air pollution should be reviewed including operations and the evaluation time. SPM should be added to the item.

6) Environmental education aims at everyone including school education from primary school is desirable.

(2) Emission Sources and Air Pollution Monitoring

- There is a need to examine the alarm announcement system for emergency cases, including public holidays.
- In order to raise the public awareness on environmental problems, it is necessary to look into the effective use of mass media for such purposes.
- It is necessary to pay attention and cope with the present tasks of monitoring systems in order to improve them.

(3) Recommendations for Establishment of Monitoring System

- Having cooperation with local agent, training adequate personnel and securing a source of revenue are indispensable for maintenance and management of monitoring equipment and materials.
- It is requested to make the most of existing data and AQM data, and to build up the connection with those agencies concerned.
- It is essential to analyze the data and information fully for the best location of AQM stations.
- In selecting and procuring equipment, detailed knowledge on equipment and materials based on careful survey are required. Concerning procurement of equipment and materials including preparation of specification, it is necessary to ask consultant for assistance in order to ensure smooth progress.
- Looking at Macedonia as a whole, maintenance requires many hands and a large amount of budget. In order to solve such difficulties in maintenance, it is recommended that remote control technology be applied to the maintenance service.

(4) Air Pollution Control measures and Practical Use of AQM Data

Air pollution control should be taken inclusively. Because air pollution occurs mostly in winter, effective investigation is required for the use of natural gas and low sulfur fuel oil as a main fuel, and for the request to factories of fuel conversion in an emergency. It is necessary to make the most of the data obtained from AQM for above purposes.