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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
Main Report**

June 1999

JAPAN ENVIRONMENT ASSESSMENT CENTER CO. LTD., TOKYO



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 Yugoslav Republic of Macedonia



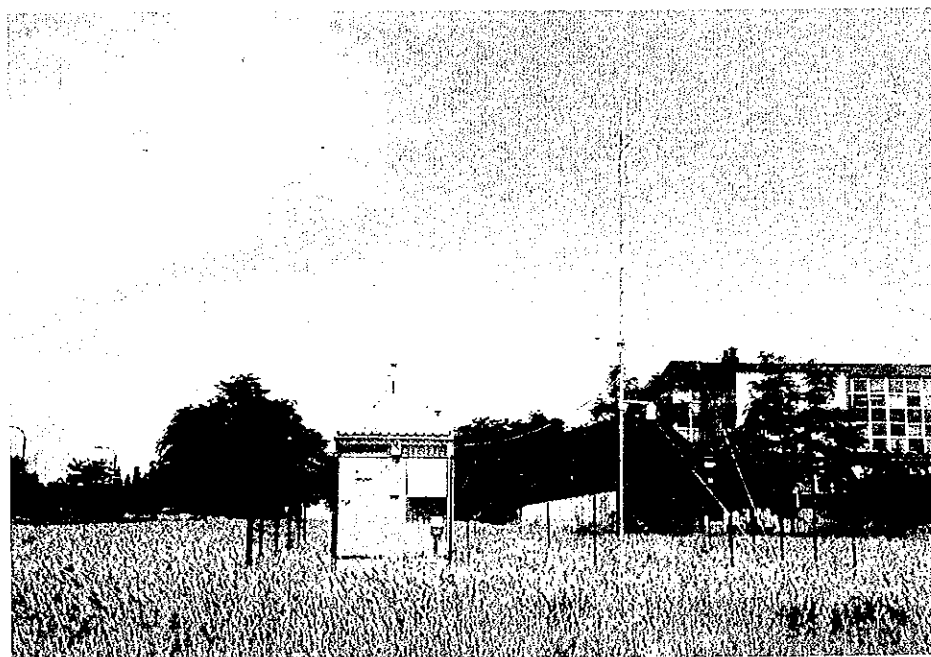
Station 1 (Gazi Baba) which locates on the emission source free hill-top is deemed basically as background station but sometimes under the influences of steel plant emission.



Station 2 (Center) locates in the central part of Skopje, being subject to mobile emission source about 40 m apart from the trunk roadway.

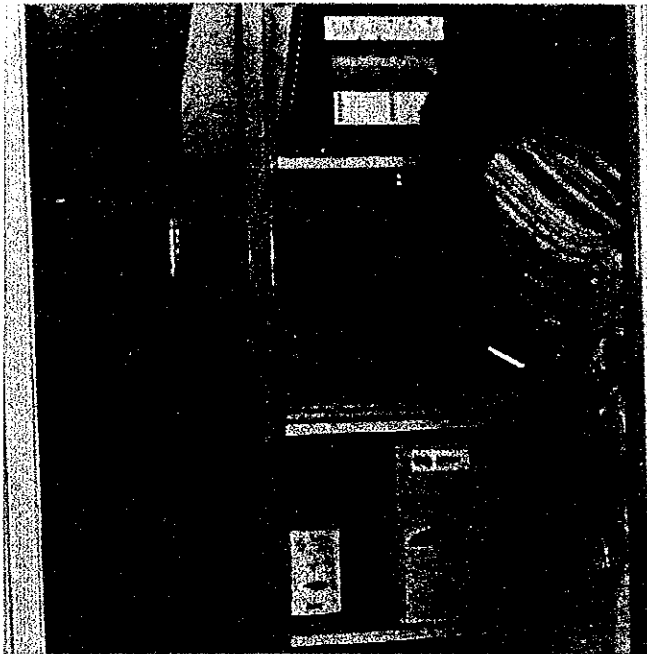


Station 3 locates in Karpos, west end of Skopje, where there are influences of mobile, stationary sources as well as emission from the western heating plant.

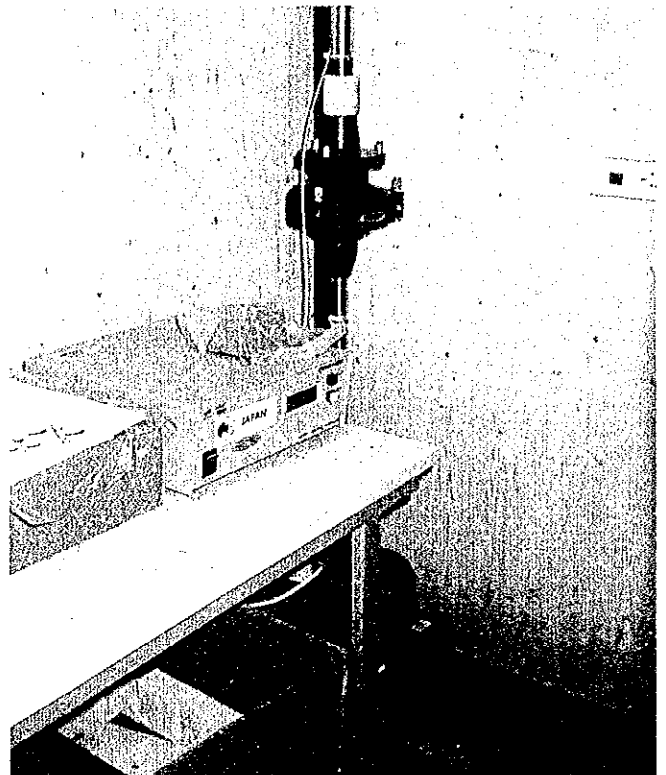


Station 4 locates in Lisice to the east of Skopje where there are a cement manufacturing plant, newly developed residential town and other stationary sources.

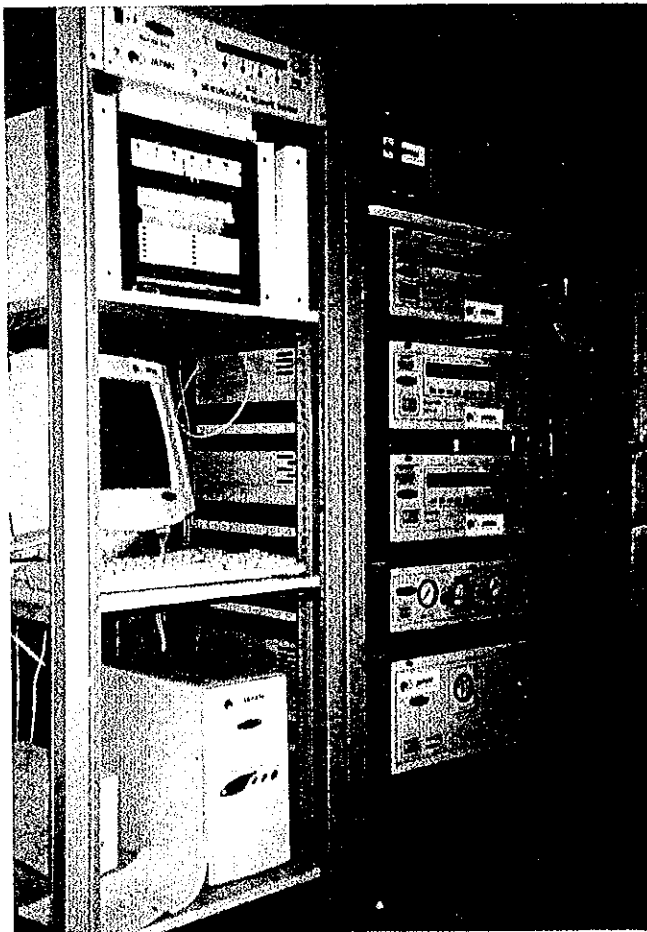
Instruments in the Monitoring Station



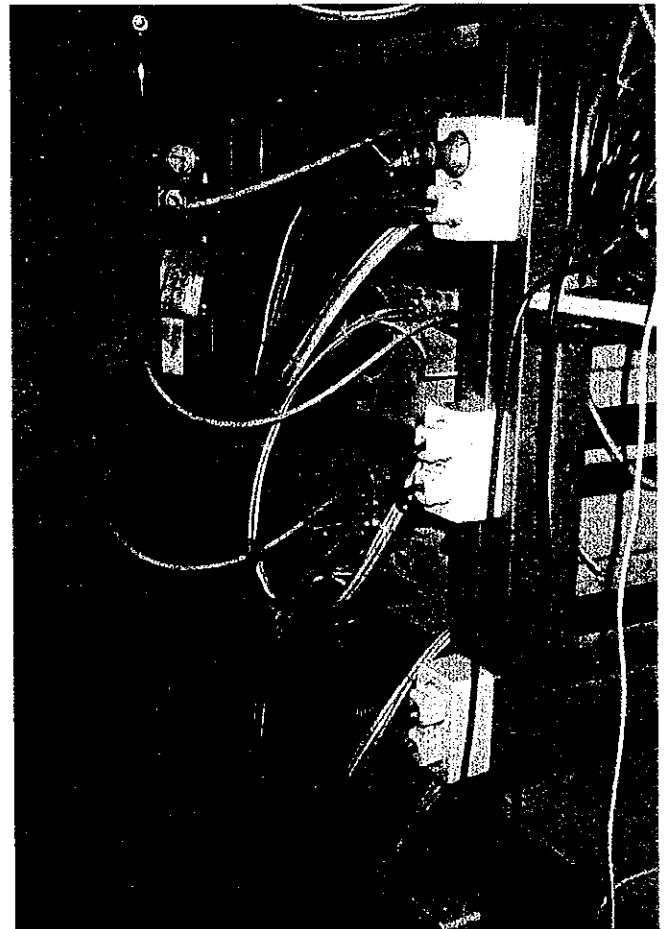
Data logger and recorder



High volume air sampler for SPM

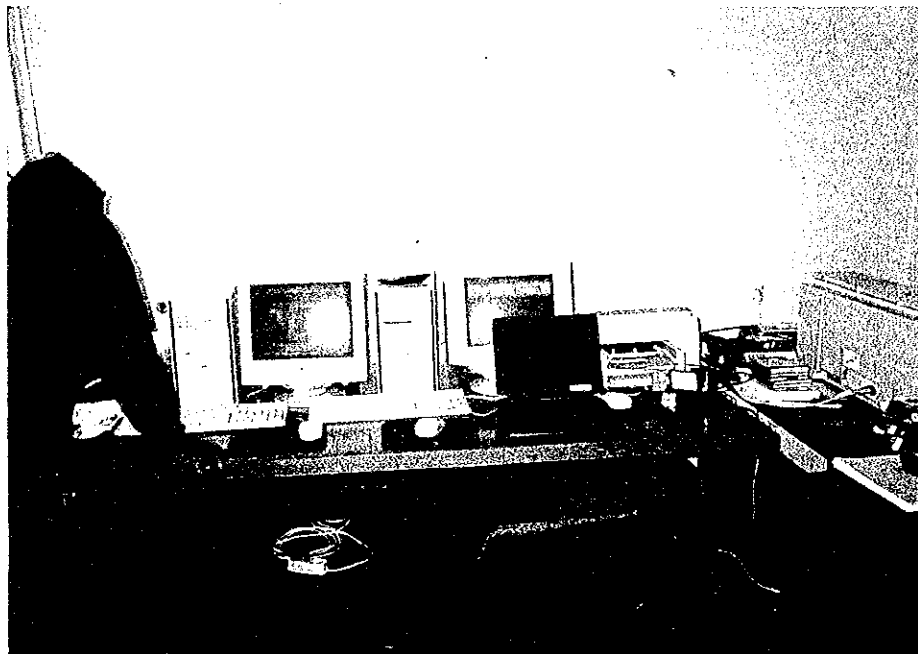


Air quality monitoring instruments
(SPM, SO₂, NO_x, CO, calibrator)
and meteorological instrument

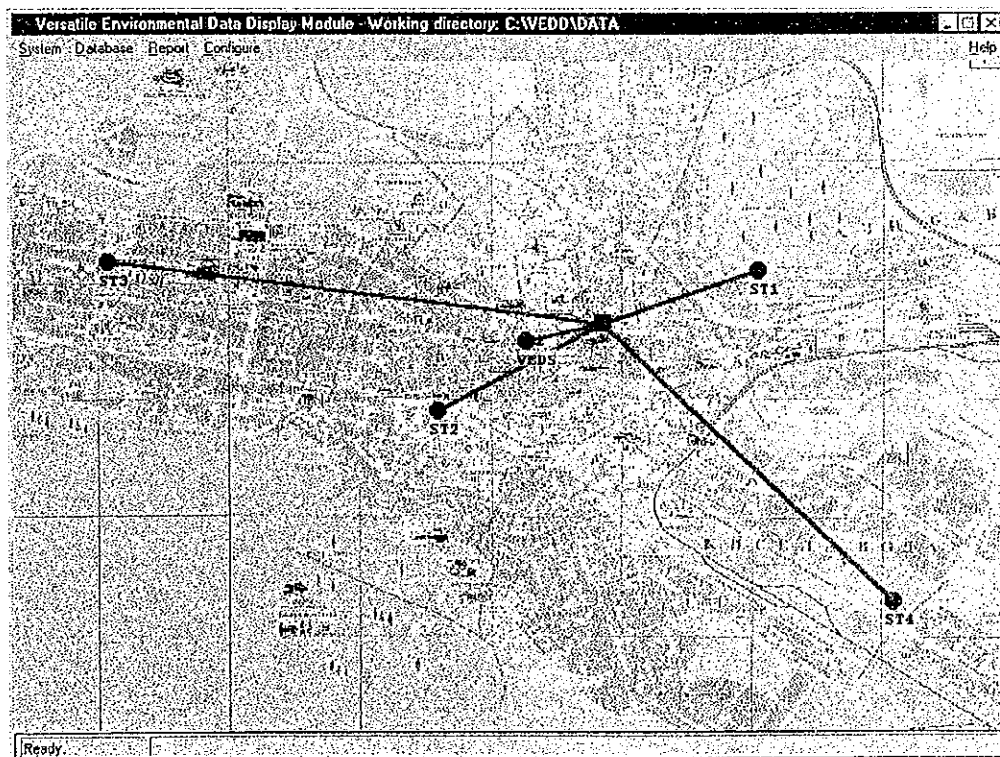


Backside of monitoring instruments
and glass manifold for the sample air (left)

Central Station (Ministry of Environment: Information Center)



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



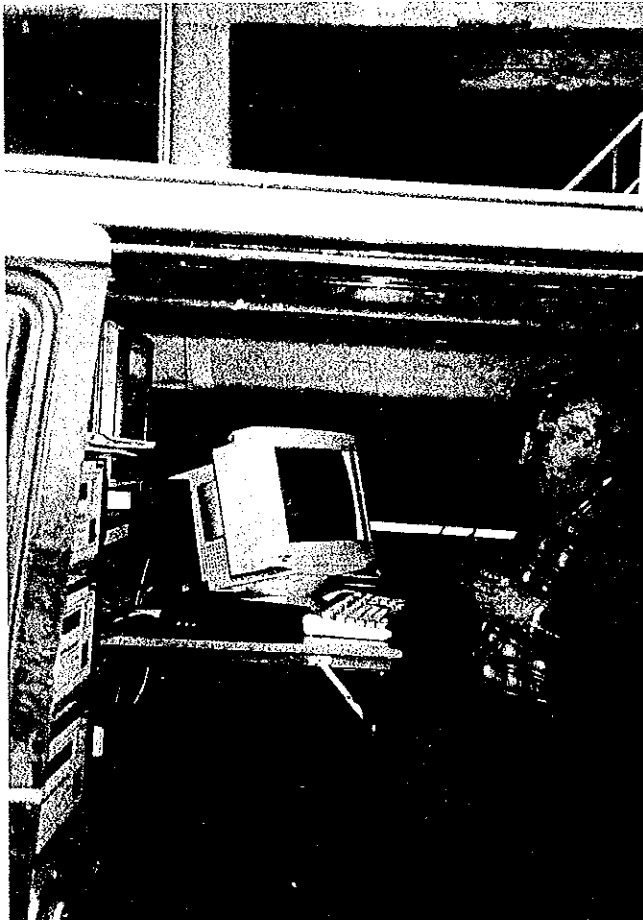
GIS Page

The status of AQM Station on GIS Page at the Central Station. At the Central Station, the system not only acquires data from station but also transmit them to the Public Information System.

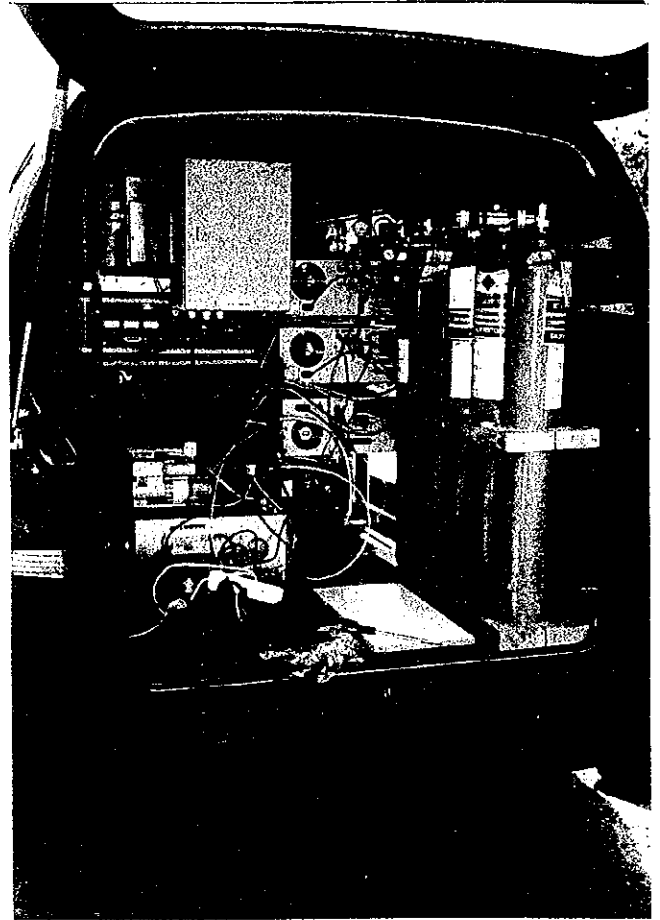
Stationary source monitoring car



The monitoring car
can monitor both flue
gas and ambient
air quality.

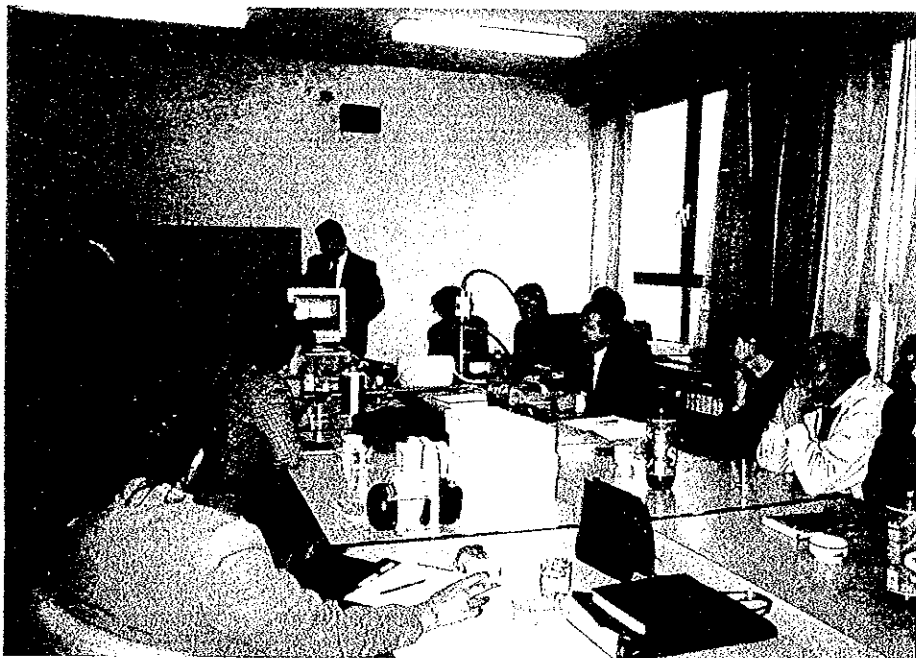


Control end of monitors



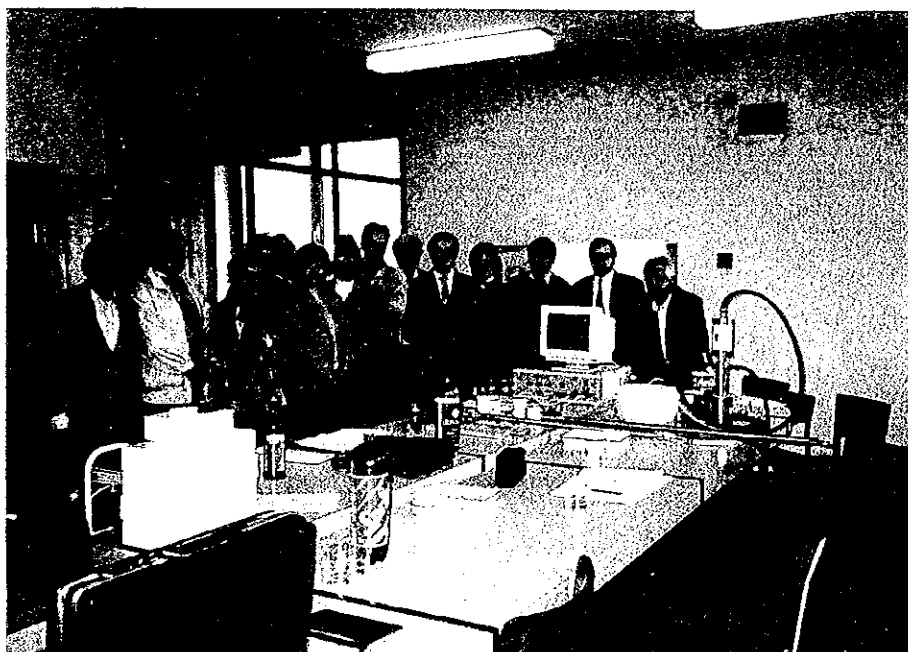
Monitoring instruments

Operational training of flue gas dust sampler



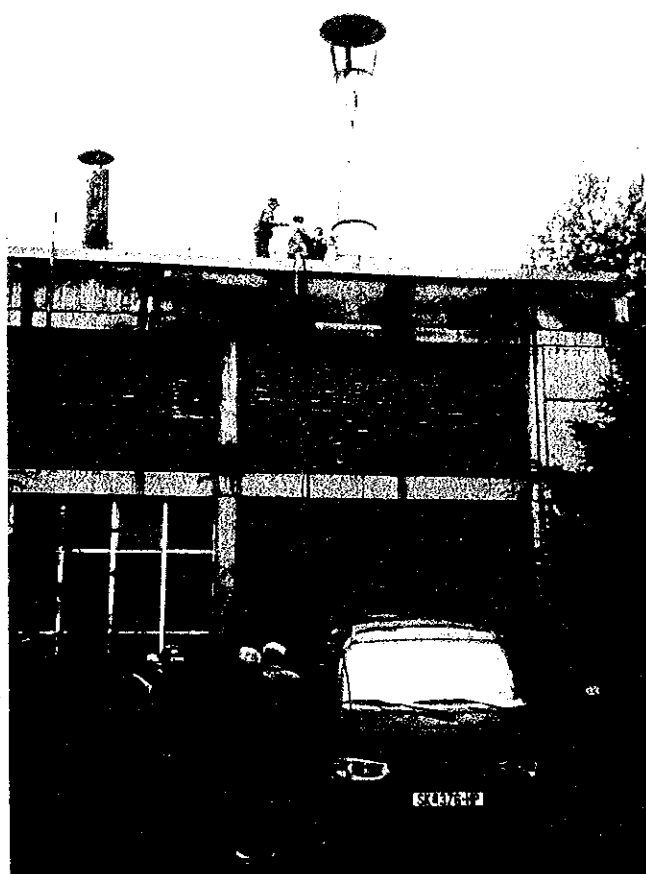
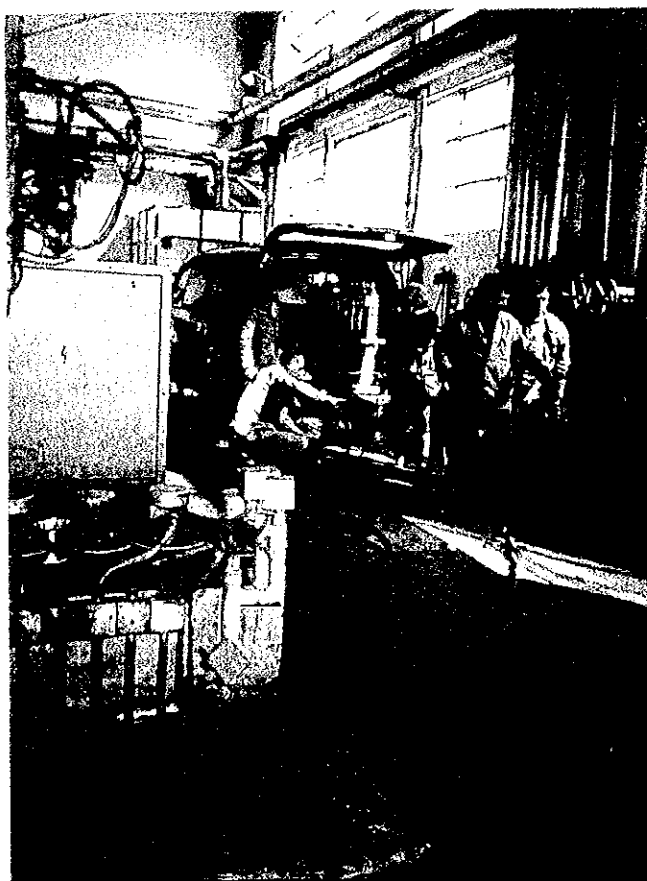
The training conducted at Institute of Environment "Zelezara".

Scenery of the session of isokinetic dust sampling.



Isokinetic dust sampler for flue gas and it trainers and trainees.

Survey Scenes for Stationary Sources(1)



Scenery at chemical industry (Alkaloid)



Scenery at a steel mill



The survey was conducted in cooperation with Institute of Environment "Zelezara".

Survey Scenes for Stationary Sources(2)



Installation of Sampling Probe

A sampling hole for this specific survey was newly installed in the combustion facility at each factory. Where to set the hole is important.

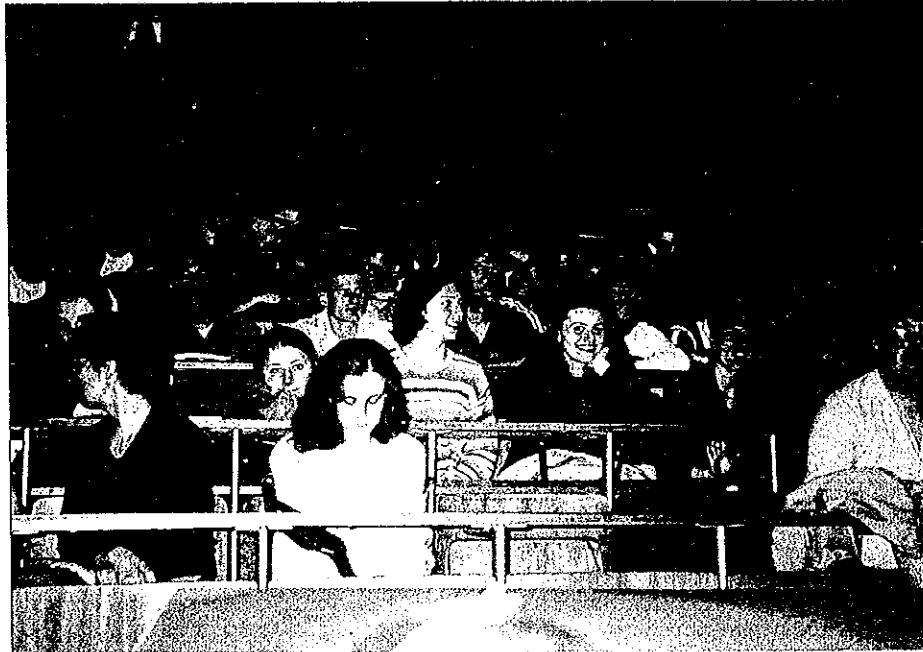
Sampling hole



Data are not only recorded on the recording paper but also stored and processed in the data logger.

Measuring site of exhaust gas

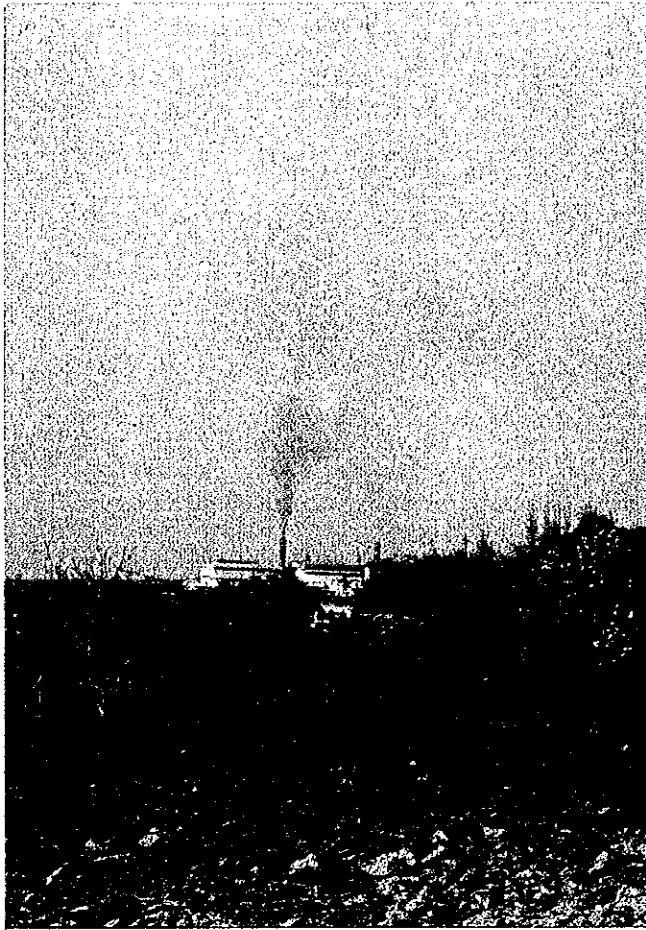
Traffic survey



Responding to the cooperation requested by the Study Team, approximately 450 students proactively joined the traffic survey at selected 75 roadway locations and intersections. Prior to surveys, technical meetings were held with respect to procedures and basic sciences involved and safety-ness. And also active discussions were taken place leading to environmental awareness development during activities.



While the traffic survey, ambient air quality as well as meteorological parameters such as NO , NO_2 , wind direction and speed, were measured to grasp the influences on air quality by traffic. The survey was reported largely in the country though the media coverage.



City of Kavadarci area is well known vineyard in Barkhan, which need to be protected from particulate emission from the Plant.

View of Ferro-Nickel smelter at Kavadarci



The molten slag is being discharged directly from smelter, and forms hill. The protection methods of soil and ground water against heavy metal contamination are inadequate.

View of slag disposal site

The coal fired power station at Bitola



The power station having the capacity of 675MW maintains the largest scale in Macedonia but drops down to the minimum in Summer. The plant locates adjacent to open pit coal mine as well as ash depositing site.

At the foot of mountains (right- center), the wind scatters dust in to the sky from ash site.

**The Study on Air Pollution Monitoring System
in the Former Yugoslav Republic of Macedonia
FINAL REPORT
Main Report**

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Riference

ACRONYMS AND ABBREVIATIONS

ACRONYMS

AERC	: Aichi Environmental Research Center (Aichi Prefectural Government in Japan)
EA	: Planning Division of Air Quality Bureau, Environment Agency
EPA or US EPA	: United States Environment Protection Agency
FAO	: United Nations Food and Agriculture Organization
IEZ	: Institute of Environment "Zelezara"
IHP	: Institute for Health Protection
IPH	: Institute for Public Health
JICA	: Japan International Cooperation Agency
MAFWE	: Ministry of Agriculture, Forestry and Water Economy
MD	: Ministry of Development
ME	: Ministry of Economy
MF	: Ministry of Finance
MFA	: Ministry of Foreign Affairs
MH	: Ministry of Health
MOE	: Ministry of Environment
MS	: Ministry of Science
MTC	: Ministry of Transport and Communication
MUPCE	: Ministry of Urban Planning, Construction and Environment
PHARE	: Poland and Hungary Aid for Reconstruction Economy
RHI	: Republic of Hydrometeorological Institute
PPNE	: Protection and Promotion of Natural Environment

ABBREVIATIONS

AQM	: Air Quality Monitoring
AAS	: Atomic Absorption Spectrophotometer
ADC	: Analog-to Digital Converter
ALV	: Andersen Type Low Volume Sampler
APMC	: Air Pollution Monitoring Center
AVR	: Automatic Voltage Regulator (Voltage Stabilizer)
BS	: Black Smoke
bps	: baud per second
C-ele	: Elemental Carbon
C-org	: Organic Carbon
CALMET	: California Meteorological Model
CALPUFF	: California Puff Model
CEM	: Continuous Emission Monitoring
cfm	: cubic feet per meter
CIF	: Cost, Insurance, and Freight
CLD	: Chemiluminescence Detection Method
CMB 7	: Chemical Mass Balance 7
CO	: Carbon Monoxide
CSD	: Compound Specific Directives
EIA	: Environmental Impact Assessment
EMAS	: European Management System
EMP	: Environmental Management Plan
Eol	: Exchange of Information
EWS	: Engineering Work Station
FA	: Factor Analysis
FID	: Flame Ionization Detector Method for GC
FOB	: Free on Board
FWD	: Framework Directive
GC	: Gas Chromatograph
GF-AAS	: Graphite Furnace Atomic Absorption Spectrophotometer
GIS	: Geographical Information System
GJ	: Gigajoule, 10 ⁹ J
GMT	: Greenwich Mean Time

GL	: Ground Level
HAPS	: Hazardous Air Pollutants
IC	: Ion Chromatograph
ICB	: International Competitive Bidding
ICP	: Inductively Coupled Plasma Optical Emission Spectrophotometer
IEE	: Initial Environmental Examination
I/O	: Input/Output
ISC 3	: Industrial Source Complex Model 3
ISDN	: Integrated Services Digital Network
ISO	: International Standard Organization
IT/R	: Interim Report
JIS	: Japan Industrial Standard
LAN	: Local Area Network
LCD	: Liquid Crystal Display
LPG	: Liquefied Petroleum Gas
MJ	: Megajoule, 10 ⁶ J
MMS	: Main Meteorological Station
MODEM	: Modulator-demodulator
M/P	: Master Plan Study
MPC	: Maximum Permitted Concentration
MPQ	: Maximum Permitted Quantities
ND	: Not Detected, Analytical Data Below a Limit of Detection
NDIR	: Non-Dispersive Infrared Analyzer Method
NEAP	: National Environmental Action Plan
Nm ³	: Gas Volume at the Normal Condition: 0 °C and 1 atmospheric pressure
NMHC	: Non-methane Hydrocarbon
NO ₂	: Nitrogen Dioxide
NO _x	: Nitrogen Oxides
O ₃	: Ozone
ODBC	: Open Database Connectivity
O & M	: Operation and Maintenance
Org.	: Organic
Ox	: Oxidant
PAH	: Poly-aromatic Hydrocarbons
PM	: Particulate Matter
PM _{2.5}	: Particulate Matter under 2.5 micron
PM ₁₀	: Particulate Matter under 10 micron

PVC	: Polyvinyl Chloride
SO ₂	: Sulfur Dioxide
SPM	: Suspended Particulate Matter
S/R	: Supporting Report
TEA	: Toliethanolamine
TTFA	: Target Transformation Factor Analysis
UNEP	: United Nations Environment Programme
VOC	: Volatile Organic Compounds
UPS	: Uninterrupted Power Supply
UV	: Ultraviolet Fluorescence Method
UV-VIS SP	: Ultraviolet-Visible Spectrophotometer
XRF	: X-ray Fluorescence Method

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Chapter 1

Chapter 1 Introduction

1.1 Background of the Study

The Former Yugoslav Republic of Macedonia (hereinafter referred to as "Macedonia") became independent from former Federal Republic of Yugoslavia in September, 1991, and is an inland country with a population of approximately 1,998,000 (1997), occupying the land area of 25,715km².

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 the Former Yugoslav Republic of Macedonia (hereinafter referred to as "the Government of Macedonia") has taken a series of air pollution prevention measures to combat against this problem. However, a number of problems still remain intact such as a lack of immediate corrective action to cope with the aggravating air pollution. In addition to capability of monitoring the changing status of air pollution, there is an urgent need to undertake the following actions; re-examination of system for enforcing regulatory laws and ordinances, reconstruction of the national economic plan with the aim of European Union (EU) market entry, and execution of appropriate environmental management. Under these circumstances, Macedonia has formulated the National Environmental Action Plan (NEAP) with the cooperation extended by the World Bank and placed its top priority on the construction of an air pollution monitoring system.

This is why that 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 Japan International Cooperation Agency (hereinafter referred to as "JICA") conducted a preliminary study for the period of February 16 through March 7, 1997, and reached an agreement on the Scope of Work (S/W) with the Macedonian side to conduct the Study on Air Pollution Monitoring System in the Former Yugoslav Republic of Macedonia.

1.2 Outline of the Study

1.2.1 Objectives of the Study

In response to the request by the Government of Macedonia,

- 1) to formulate a planning for framework of the nation-wide air pollution monitoring system,
- 2) to elaborate a detailed plan of air pollution monitoring system in the selected model city, and
- 3) to carry out technology transfer to the Counterpart personnel of the Government of Macedonia in the course of the Study.

1.2.2 Study Area and Model City

Figure 1.1 shows the location of the Study area which covers approximately 25,715 km² of the entire land of Macedonia and the Model City, the capital of Macedonia, Skopje.

1.2.3 Work Flow and Time Schedule of the Study

Figure 1.2 outlines the work flow and time schedule of the Study.

Compared with the original plan, the overall study plan has progressed earlier due to the second site study which was undertaken earlier than planned.

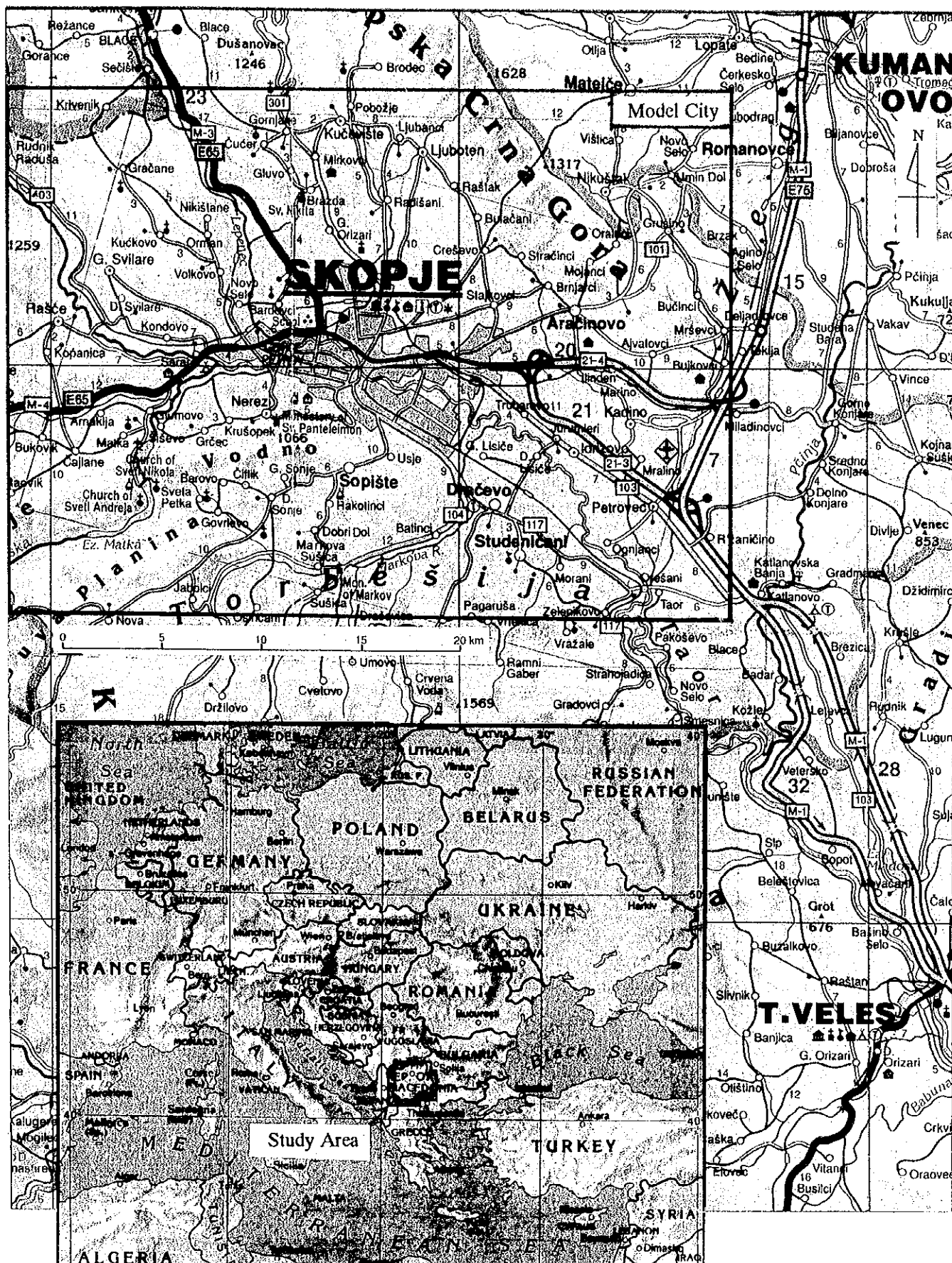


Figure 1.1 The Location of Study Area and Model City

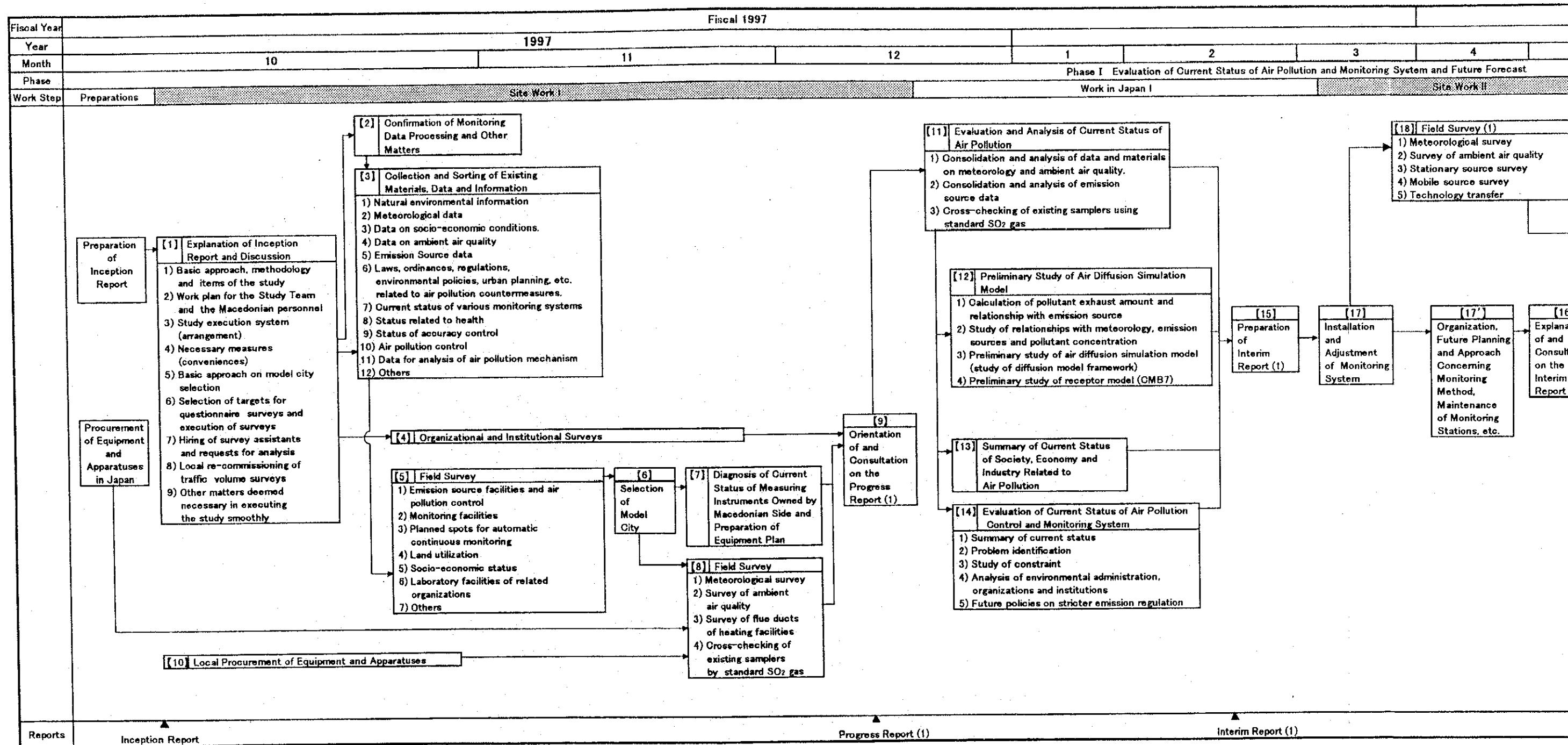


Figure 1.2 Work Flow and Time Schedule of the Study

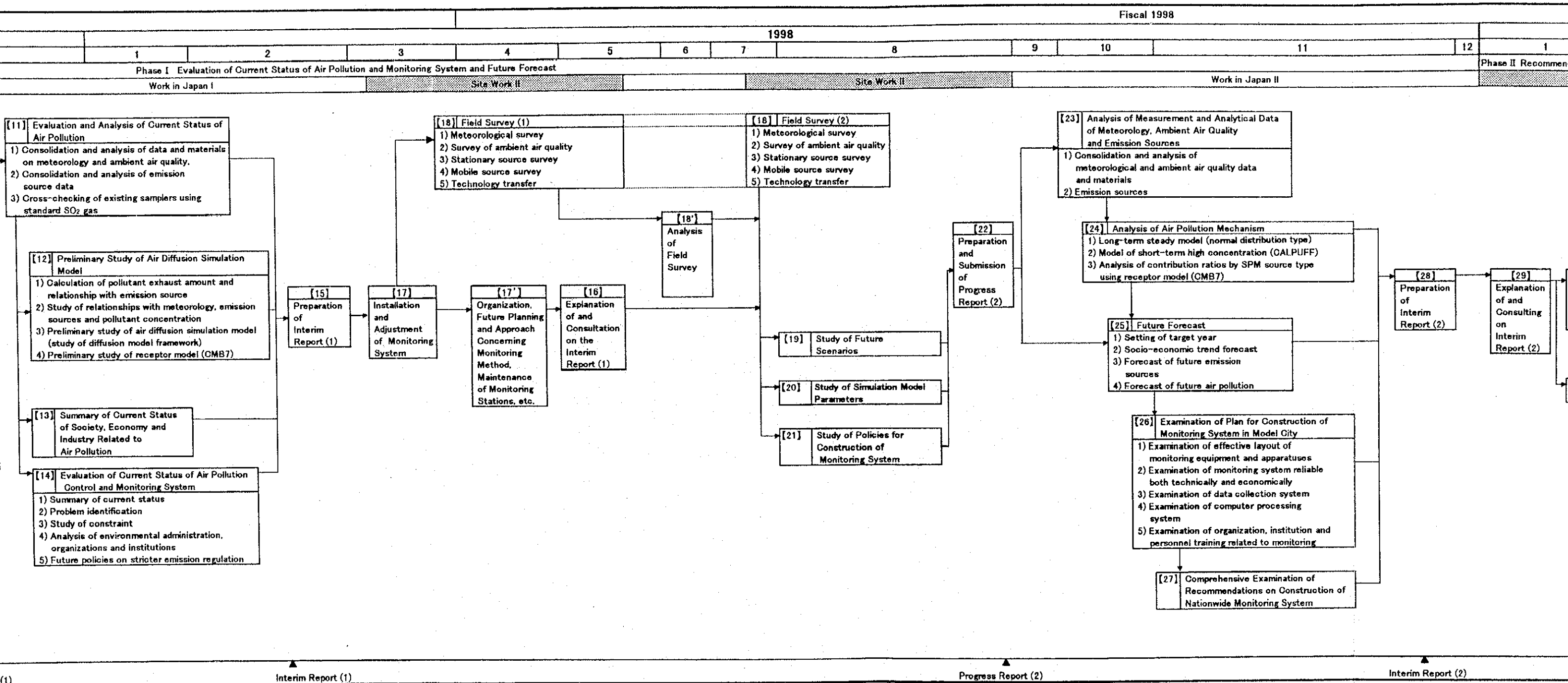
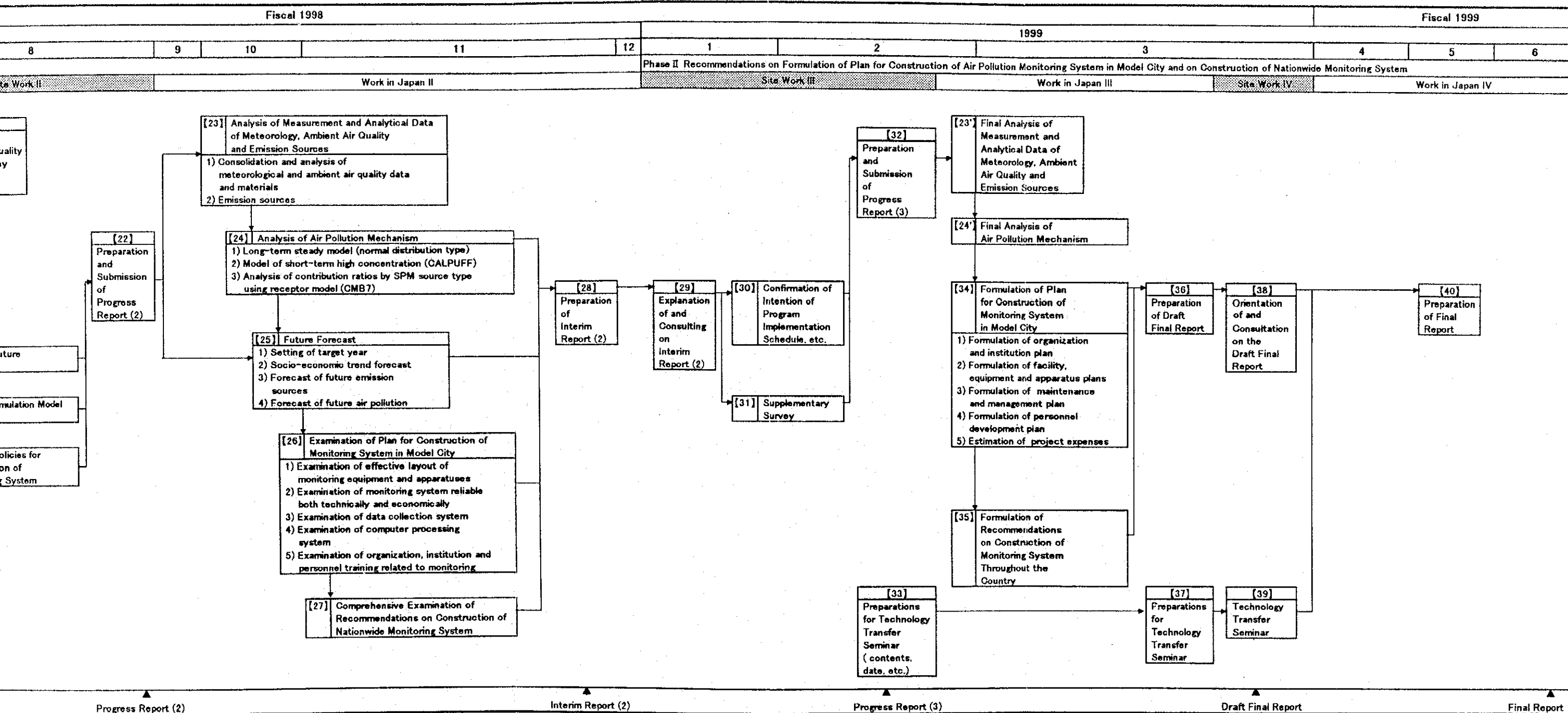


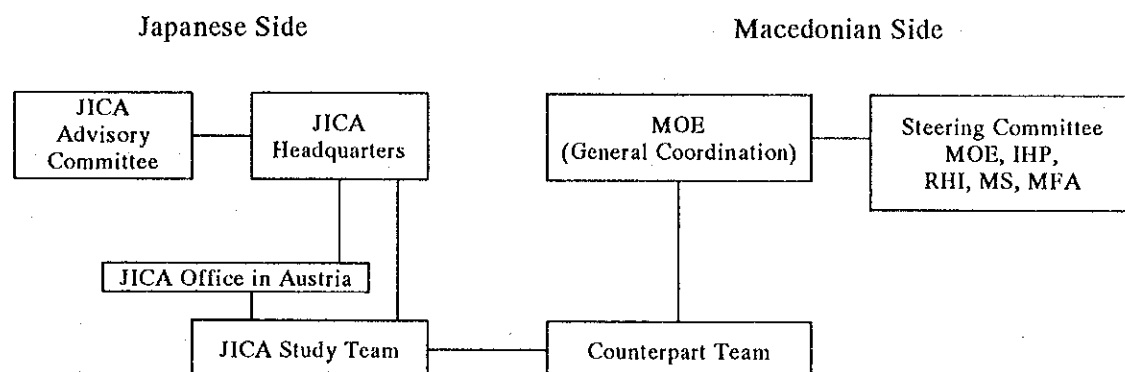
Figure 1.2 Work Flow and Time Schedule of the Study



1.3 Study Organization

1.3.1 General

A general organization for the execution of the Study is as follows.



Note: JICA: Japan International Cooperation Agency
 MOE: Ministry of Environment
 IHP: Institute for Health Protection
 RHI: Republic Hydrometeorological Institute
 MS: Ministry of Science
 MFA: Ministry of Foreign Affairs

1.3.2 Japanese Organization

(1) JICA Study Team

Name	Field in Charge	Company
Mr. Tatsuo HIRATANI	Team Leader / Environmental Public Administration (A) (predecessor)	JEAC
Mr. Motoji KATSUTA	Ditto (successor)	JEAC
Mr. Masaki MORI	Vice Leader / Monitoring Planning	JEAC
Mr. Edward CARR	Survey on Meteorology / Air Pollution Mechanism Analysis (B)	SAI
Mr. Minoru HIRAO	Survey on Air Pollution / Equipment Planning	JEAC
Dr. Trajce STAFILOV	Survey on Pollution Source	IC

Dr. Robert IRESON	Air Pollution Mechanism Analysis (A)	SAI
Mr. Kazuyuki YAMAKAWA	Organization and Institution	JEAC
Dr. Attila GERGELY	Economical and Financial Analysis / Environmental Public Administration (B)	HIIA
Mr. Toru OGURA	Coordinator	JEAC

Note: JEAC: Japan Environment Assessment Center Co., Ltd.
 SAI: ICF Kaiser Consulting Group System Applications International, Inc.
 IC: CMUS Institute of Chemistry
 HIIA: Hungarian Institute of International Affairs
 The assignment for Team Leader was changed from Mr. HIRATANI to Mr. KATSUTA in May 1999.

(2) Advisory Committee

<u>Name</u>	<u>Field in Charge</u>	<u>Present Post</u>
Mr. Shigenobu OBAYASHI	Chairman / Air Quality Control (predecessor)	EA
Mr. Takeru TSUCHIYA	Ditto (successor)	EA
Mr. Shinichi IMAI	Air Quality Monitoring	AERC

Note: EA: Planning Division of Air Quality Bureau, Environment Agency
 AERC: Aichi Environmental Research Center

(3) JICA Headquarters

<u>Name</u>	
Mr. Kazuhiro FUKUDA	Second Development Study Division, Social Development Study Department (predecessor)
Mr. Yoshimasa ISHII	Ditto (predecessor)
Mr. Kazunobu SUZUKI	Ditto (successor)

1.3.3 Macedonian Organization

Members of the Macedonian Steering Committee and Counterpart Team are as follows:

(1) Ministry of Environment (MOE)

Mr. Metodija DIMOVSKI	Assistant Minister for Environment Coordinator
Ms. Katica VASILEVA	Survey on Air Pollution / Air pollution Mechanism Analysis
Mr. Goran ARSOV	Team Leader / Monitoring Planning / Equipment Planning

(2) Institute for Health Protection (IHP)

Dr. Dragan GJORGJEV	Monitoring Planning / Organization and Institution
Dr. Mihail KOCUBOVSKI	Survey on Air Pollution/Monitoring Planning / Equipment Planning
Dr. Pavle FILJANSKI	Survey on Pollution Source / Organization and Institution

(3) Republic Hydrometeorological Institute (RHI)

Mr. Slavko KIROVSKI	Organization and Institution / Survey on Meteorology
Mr. Zoran KARAMANOLEVSKI	Survey on Air Pollution / Equipment Planning
Ms. Radmila BOJKOVSKA	Survey on Air Pollution/ Monitoring Planning / Air Pollution Mechanism Analysis

(4) The Government Office Concerned

1) Ministry of Science (MS)

Office for International Scientific and Technical Cooperation

Dr. Sergej MILOSHEVSKI	Director
Ms. Zvezda GEORGIEVSKA	Councilor

2) Ministry of Foreign Affairs (MFA)

Ms. Ana TRAJKOVSKA	Director
Ms. Vera MEDRANO	Councilor