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
Supporting Report

June 1999

JAPAN ENVIRONMENT ASSESSMENT CENTER CO. LTD., TOKYO

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

The Study on Air Pollution Monitoring System
in the Former Yugoslav Republic of Macedonia
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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 Comunication
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 Fright
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
EoI	: 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, 10^9J
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, 10^6J
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
NOx	: 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
PM2.5	: Particulate Matter under 2.5 micron
PM10	: 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 25,715km^2.
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 km^2 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.

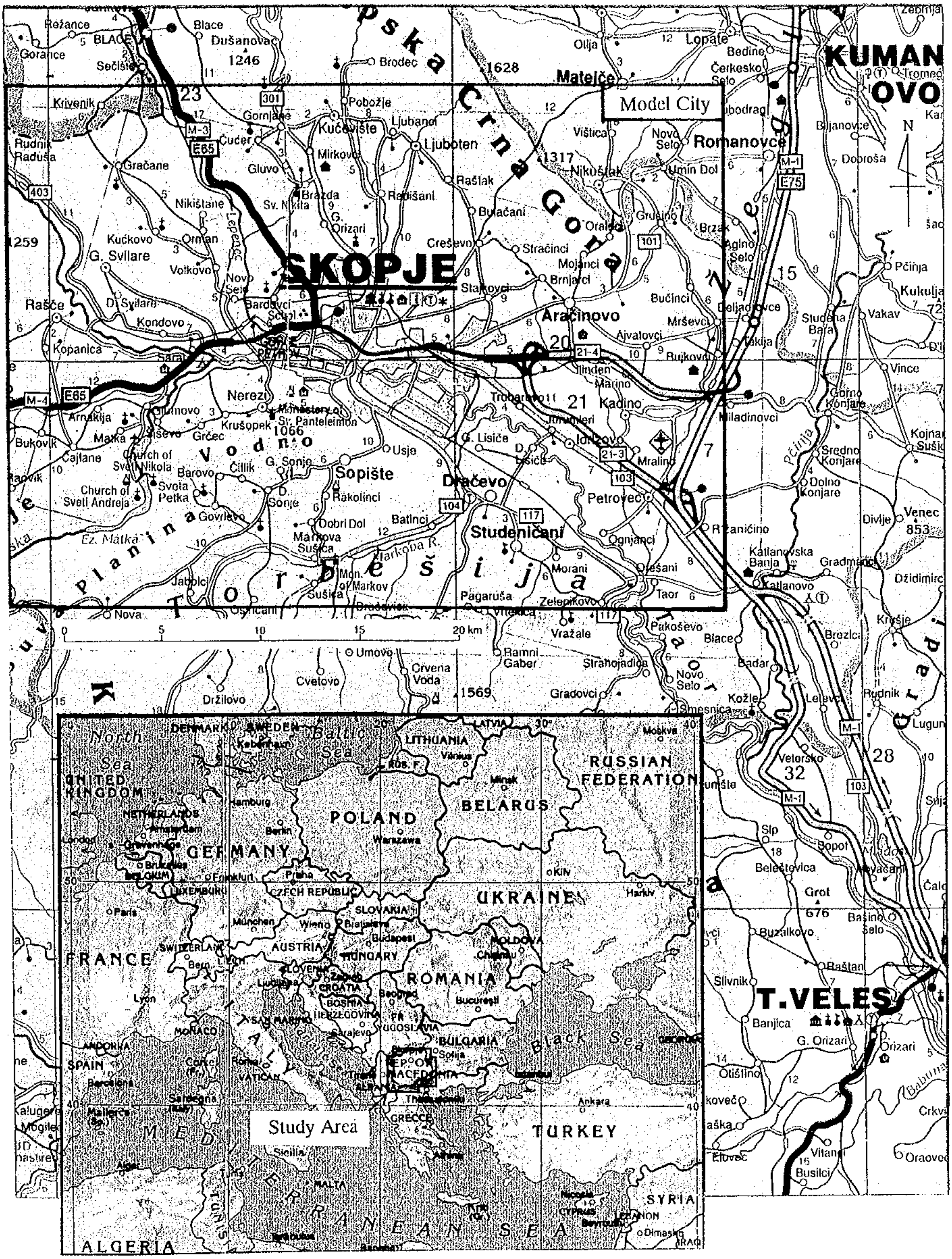


Figure 1.1 The Location of Study Area and Model City

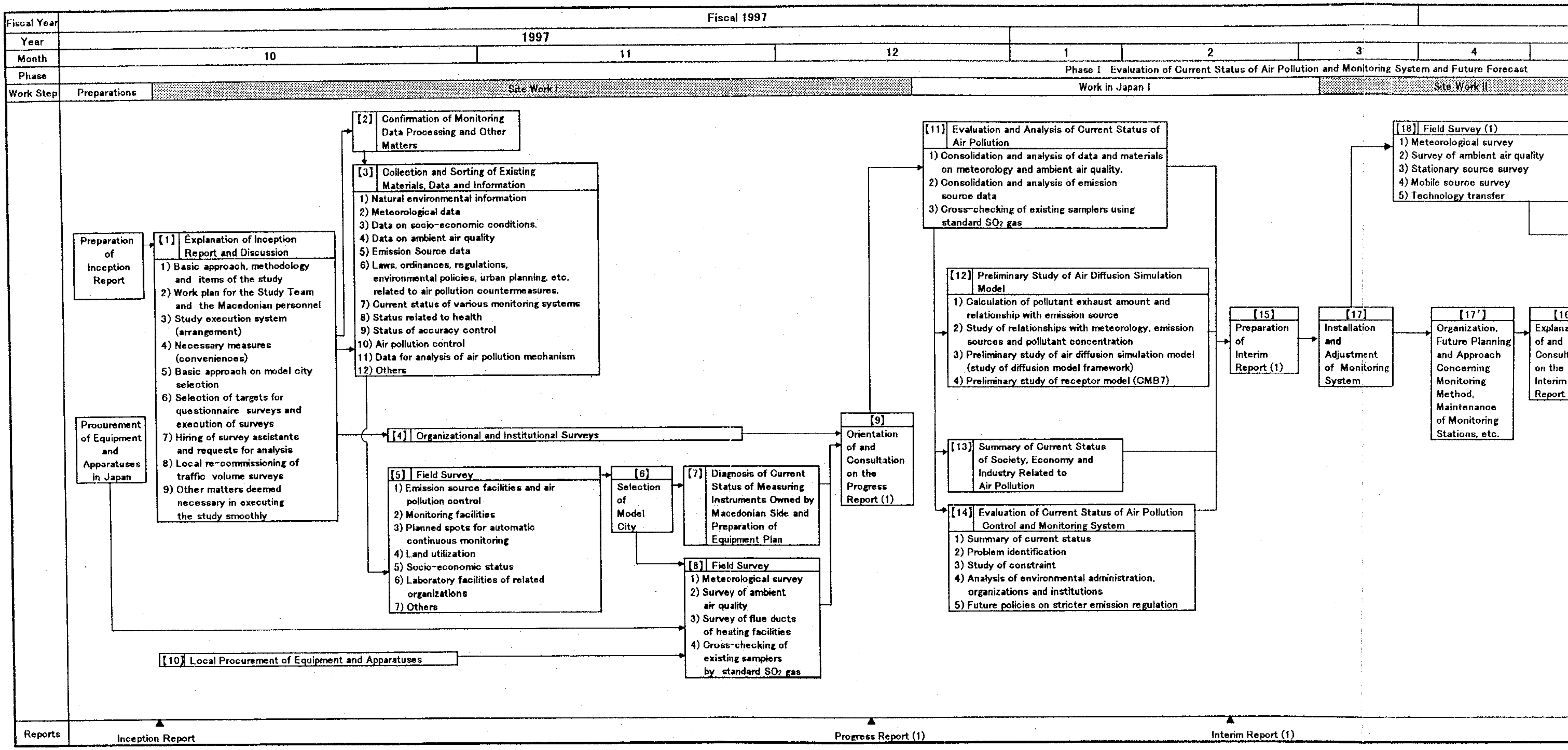


Figure 1.2 Work Flow and Time Schedule of the Stud

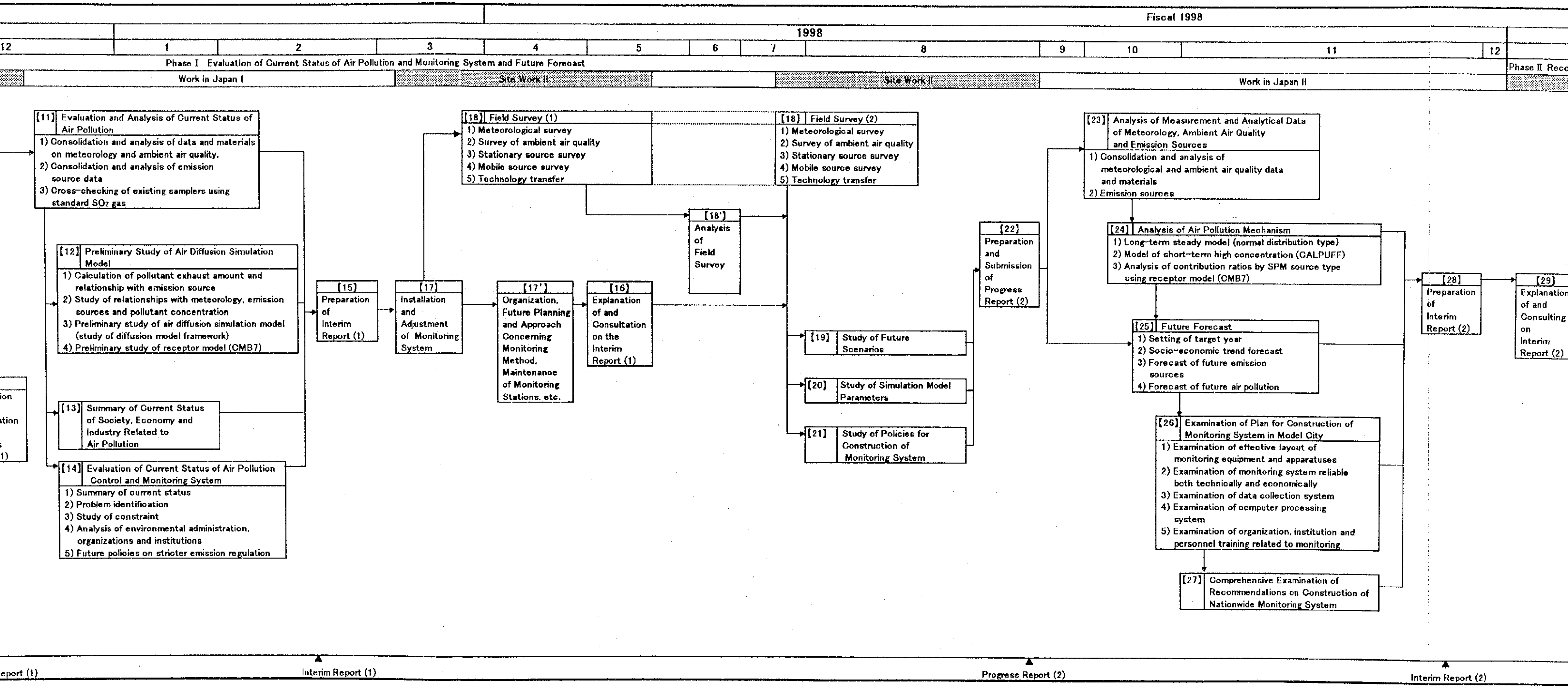
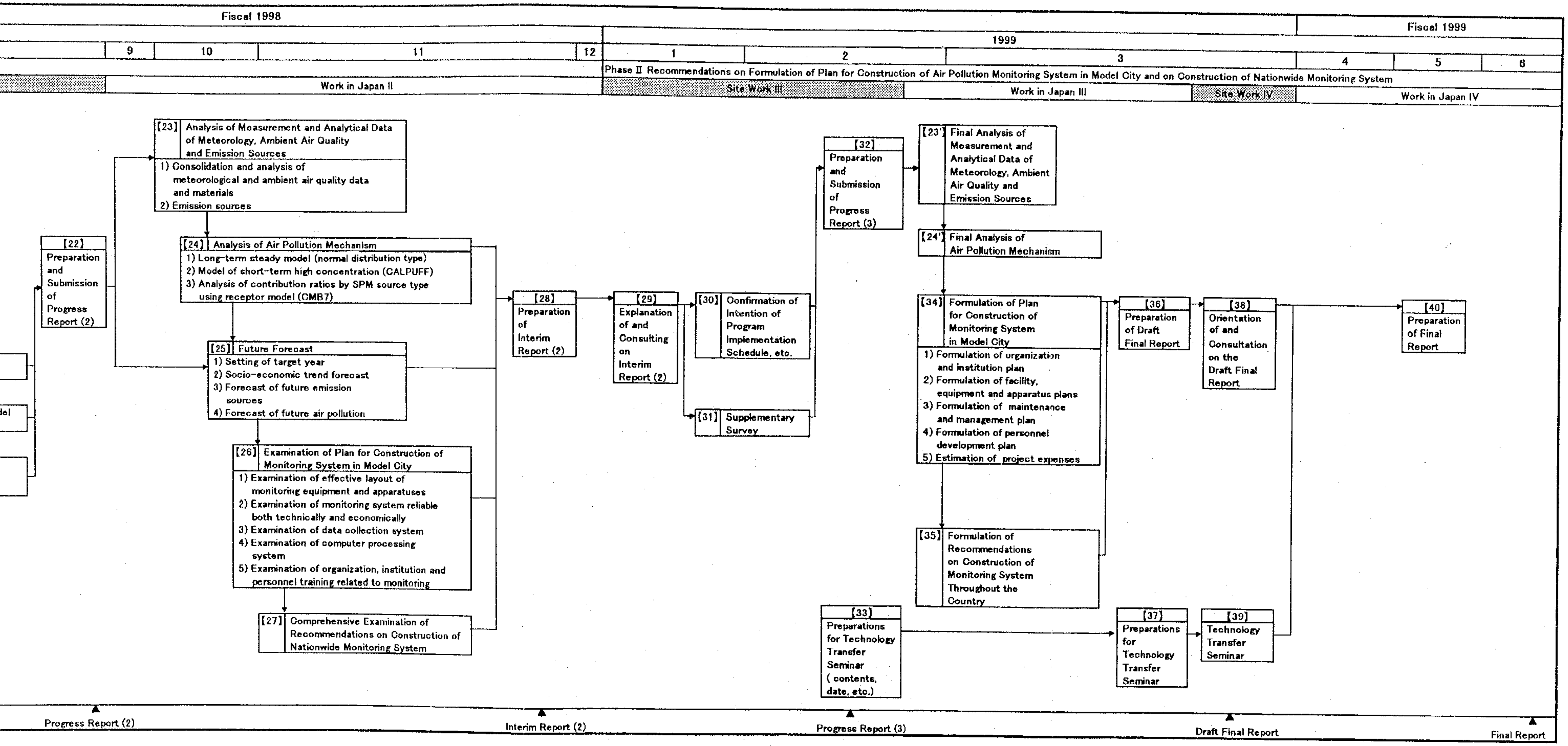


Figure 1.2 Work Flow and Time Schedule of the Study


Fiscal 1998
Fiscal 1999
1999
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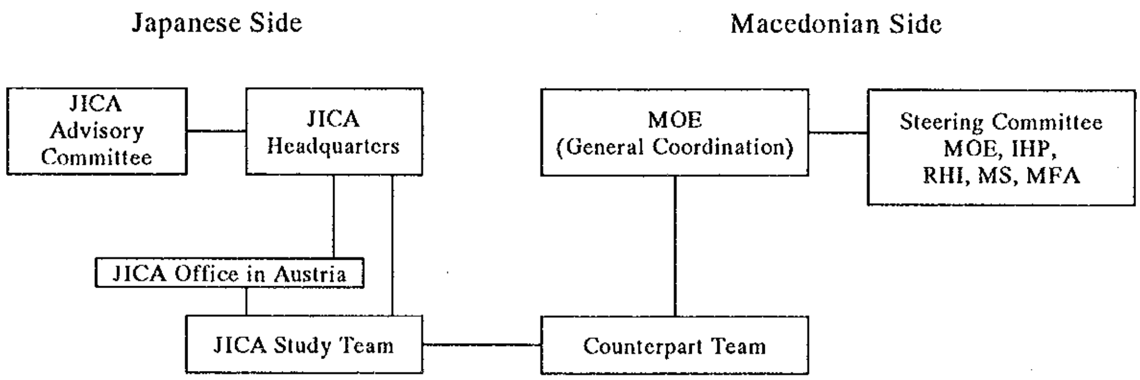
6
Phase II Recommendations on Formulation of Plan for Construction of Air Pollution Monitoring System in Model City and on Construction of Nationwide Monitoring System
Work in Japan II
Site Work III
Work in Japan III
Site Work IV
Work in Japan IV
[22] Preparation and Submission of Progress Report (2)
[23] Analysis of Measurement and Analytical Data of Meteorology, Ambient Air Quality and Emission Sources
1) Consolidation and analysis of meteorological and ambient air quality data and materials
2) Emission sources
[24] Analysis of Air Pollution Mechanism
1) Long-term steady model (normal distribution type)
2) Model of short-term high concentration (CALPUFF)
3) Analysis of contribution ratios by SPM source type using receptor model (CMB7)
[25] Future Forecast
1) Setting of target year
2) Socio-economic trend forecast
3) Forecast of future emission sources
4) Forecast of future air pollution
[26] Examination of Plan for Construction of Monitoring System in Model City
1) Examination of effective layout of monitoring equipment and apparatuses
2) Examination of monitoring system reliable both technically and economically
3) Examination of data collection system
4) Examination of computer processing system
5) Examination of organization, institution and personnel training related to monitoring
[27] Comprehensive Examination of Recommendations on Construction of Nationwide Monitoring System
[28] Preparation of Interim Report (2)
[29] Explanation of and Consulting on Interim Report (2)
[30] Confirmation of Intention of Program Implementation Schedule, etc.
[31] Supplementary Survey
[32] Preparation and Submission of Progress Report (3)
[33] Preparations for Technology Transfer Seminar (contents, date, etc.)
[23'] Final Analysis of Measurement and Analytical Data of Meteorology, Ambient Air Quality and Emission Sources
[24'] Final Analysis of Air Pollution Mechanism
[34] Formulation of Plan for Construction of Monitoring System in Model City
1) Formulation of organization and institution plan
2) Formulation of facility, equipment and apparatus plans
3) Formulation of maintenance and management plan
4) Formulation of personnel development plan
5) Estimation of project expenses
[35] Formulation of Recommendations on Construction of Monitoring System Throughout the Country
[36] Preparation of Draft Final Report
[37] Preparations for Technology Transfer Seminar
[38] Orientation of and Consultation on the Draft Final Report
[39] Technology Transfer Seminar
[40] Preparation of Final Report
Progress Report (2)
Interim Report (2)
Progress Report (3)
Draft Final Report
Final Report

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

Name	Field in Charge	Present Post
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

Name	
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

Chapter 2

Chapter 2 Social and Economic Situation

2.1 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. On the other hand, the Government of Macedonia is aiming to be a full member of EU up to 2020. It is therefore necessary to satisfy the requirements for the monitoring and reporting. The legislation and program related to air quality stipulated in the EU Directives and Decisions include the following fields. The details are described below:

- Air Quality Monitoring
- Ambient Air Quality Standards
- Air Emission Standards
- Air Pollution from Industrial Plants
- Air Emission Inventory System

2.1.1 Air Quality Monitoring

The EU Directives and Decisions related to air quality stating requirements on the air quality monitoring and assessment are the followings (Source: Ref. 2-1):

- The Compound-Specific Directives (CSD): SO_2 and SPM, Pb, NO_2, 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

The EoI Decision only sets reporting requirements, no monitoring requirements.
The requirements are summarized in the following paragraphs.

(1) The Present Compound-specific Directives

CSD for SO_2, TSP/Black Smoke (BS), Pb, NO_2 and O_3, issued during the period from 1989 to 1995, require in principle that all exceedances of the limit values are detected, and thus require that a thorough assessment process should support the selected sites of the monitoring system.

The statistics to be reported, in addition to the exceedances, are mean, median, 98-percentile and maximum values (for either 1-hour or 24-hour basic sampling resolution and 99.9-percentile for 1-hour sampling resolution).

The data should be reported within six months of the next reporting year. (Calendar year for Pb, NO_2 and O_3; Tropical year- April to March -for SO_2, TSP, BS).

For ozone, the Directive requires that exceedances of alarm values are reported without delay to the public, and within one month to the Commission.

(2) The Present Draft Exchange of Information Decision

EoI requires a similar extent of reporting, and specifies the following:

- Detailed network and site description.
- Reporting of 31 compounds in addition to those of the CSD, to the extent that they are measured. The additional compounds include for instance CO, NOx, acidity, VOC and specific organic compounds, heavy metals (seven of them), organic contents of particles.
- The data files of specified format should be delivered to the data base manager within October 1 of the next year.

(3) The Draft Framework Directive on Ambient Air Quality

FWD requires that the air quality is assessed relative to the limit values which are in effect at any time. The required reporting relative to the draft FWD is as follows.

1) The member states shall provide annually a list of exceedance of limit values in all areas, within nine months of the next year.
2) The Commission shall annually publish the list referred to above. Information shall be given on the nature and origin (sources) of the pollution, and assessment techniques used, and also on the measures in place, or planned, to improve air quality to within acceptable limit values.
3) The compounds are those for which EU limit values are given, plus additional compounds:

- Pollutants covered by directives : SO_2, NO_2 and NOx, BS, SPM (PM10), Pb, O_3
- Other pollutants for consideration : CO, Cd, Acid deposition, Benzene, PAH (BaP), As, F, Ni.

Tables 2.1 to 2.3 show requirements from CSD, EoI and FWD.

Table 2.1 Requirements from Compound-specific Directives (CSD)

Compound	Coverage		Reporting	
	Spatial	Time	Parameters	Time schedule
SO_2, SPM (89/427/EEC)	In principle, full coverage, since all exceedances should be detected. - Where there is exceedance - Where prevention of further increase is necessary - In specially protected areas	Year round	24-hour average, median 98 percentile, annual average	Six months after reference year
Pb (82/884/EEC-Lead)	As above	Year round	Annual average	Six months after new year
NO_2 (85/203/EEC-NO_2)	As above	Year round	As for SO_2, SPM	As above
O_3 (92/72/EEC) (Simultaneous measurements of NOx and VOC recommended)	- Selected sites of expected highest exposure - Additional sites, to provide info. on O_3 formation	Year round	1-hour, 8-hour, 24-hour: maximum, mean, 98 percentile, number, date, duration of exceedances	- Immediate info. to the public - Report six months after new year

The CSD Directives also require reporting of the reasons for exceedances, and implemented policies to avoid reoccurrence ("Article 3 zones").

Table 2.2 Requirements from Draft EoI Decision
(EU, The Council, and No. 12122/2/95, Rev. 2)

The Exchange of Information Concerns:

- Networks and station descriptions
  - * geographic representativity
  - * local influences
  - * methods
  - * data logging, transfer, etc.
- Measurement data and statistics.

Compounds to be reported

			No.
· Classic, 24 hour	:	SO_2, acidity (AF), SPM, PM_{10}, black smoke, Pb	6
· Classic, 1 hour	:	NOx, NO_2, CO, O_3	4
· Inorganic gases, 24 hour	:	H_2S, CS_2, NH_3	3
· Metals, 24 hour	:	Hg, Cd, Ni, Cr, Mn, As	6
· Organic gaseous, 24 hour	:	VOC(T), VOC(NM), benzene, toluene, styrene, butadiene 1,3	6
		formaldehyde, PAN, CH_2-CH-CN, C_2HCl_3, C_2Cl_4, CH_2Cl_2, VC	7
· Organic particles, 24 hour	:	BaP, PAH	2
· Wet deposition, 1 month	:	N- and S-deposition, acid dep.	3
Total			37

Sites to be reported

- All sites established under the Compound-specific Directives.
- Additional sites, selected by member states, for additional compounds.
- Sites operated under the 1982 EoI Directive.

Statistics

- Concentrations in air : average, median, 98%ile (99.9%ile for 1-hour values), maximum
- For ozone : as above, but statistics for 8-hour values in addition (99.9%ile not required)
- Deposition : monthly averages.

Reporting time-frame

Data files should be transferred to the Commission before October 1 the year after the reference year.

Table 2.3 Requirements to Monitoring and Reporting from the Draft Framework Directive (FWD) (Council Directive 95/9514/EC)

Air Quality Assessment

The FWD requires that Air Quality Limit Values (AQLV) are set. Once they are set, the air quality in member states should be assessed as follows:

- Measurement is mandatory
  - in agglomerations with more than 250,000 inhabitants (or population density >xxx inhabitants per km^2. xxx to be decided by the member states)
  - in zones with conc. >x % of AQLV. (x to be determined)
  - in other zones with conc. >AQLV
- If levels are < x% of the limit values, combined measurement and modeling may be used.
- If levels are < y% of the limit values, techniques of modeling or objective estimation might be used alone. (y to be determined).

"Assessment" is here understood as involving full description of the air quality, i.e. spatial coverage to detect exceedances.

Reporting

Member states shall provide

- Annually a list of areas with AQ exceeding AQLV, within 9 months of a calendar year.

The Commission shall publish

- Annually, the list of areas referred to above
- A report on air quality in the EU, every 3 year.

Compounds

1. Pollutants covered by EU Directives : SO_2, NO (and NOx), BS, SPM (PM_{10}), Pb, O_3
2. Other pollutants of consideration : CO, Cd, benzene, PAH(BaP), As, Ni, Hg

Information to be reported on Action Plans

- Localization of exceedances
- General information of those areas
- Responsible authority
- Nature and assessment of pollution
  - previous concentration trends
  - assessment techniques
- Origin of the pollutants (sources)
- Analysis of the situation
  - factors responsible for excess
  - details of possible measures
- Details of previous measures (before FWD)
- Details of present measures (after FWD)
- Details of planned measures
- References to information, data, and reports.

2.1.2 Ambient Air Quality

In order to help public authorities to manage and reduce health hazards and other risks from air pollutants, EU shows guidelines and limit values for most of the common pollutants (Source: Ref. 2-2). Table 2.4 shows EU air quality guidelines.

Table 2.4 European Union Air Quality Guidelines

Name of Substances	Reference period	Limit value (to be met by 1.4.83)
Sulfur dioxide EC Directive 80/779/EEC	one year (median daily values)	120 μg/m³ if smoke less than 40 μg/m³ (150)* 80 μg/m³ if smoke more than 40 μg/m³ (150)*
	winter (median daily values)	180 μg/m³ if smoke less than 60 μg/m³ (200)* 130 μg/m³ if smoke more than 60 μg/m³ (200)*
	year, peak (98 percentile of daily values)	350 μg/m³ if smoke less than 150 μg/m³ (250)* 250 μg/m³ if smoke more than 150 μg/m³ (250)*
Suspended particulate matter (SPM)	one year (median of daily values)	80 μg/m³
	winter (median daily values)	130 μg/m³
	year, peak (98 percentile of daily values)	250 μg/m³
Name of Substances		**Guides values**
Black smoke	one year (median of daily values)	40-60 μg/m³
	24 hours mean	100-150 μg/m³
Sulfur dioxide	24 hours mean	100-150 μg/m³
	one year mean	40-60 μg/m³
Name of Substances	**Reference period**	**Limit value (to be met by 1.7.87)**
Nitrogen dioxide: EC Directive 85/203/EEC	1 year (98 percentile of 1-hour means)	200 μg/m³
		Guides values
	1 year (50 percentile of 1-hour means)	50 μg/m³
	1 year (98 percentile of 1-hour means)	135 μg/m³
Name of Substances	**Reference period**	**Limit value (to be met by 9.12.87)**
Lead in the air: EC Directive 82/884/EEC	annual mean	2 μg/m³
Ozone Thresholds: EC Directive 92/72/EEC	1 year (98 percentile of 1-hour means)	200 μg/m³
Health protection	8 hours mean	110 μg/m³
Vegetation protection	1 hour mean	200 μg/m³
	24 hours mean	65 μg/m³
Population information	1 hour mean	180 μg/m³
Population warning	1 hour mean	360 μg/m³

( )*: measured by the gravimetric method

Source: Ref. 2-2

2.1.3 Air Emission Standards

The Limitation Of Emissions Of Certain Pollutants Into The Air From Large Combustion Plants (EC Directive 88/609/EEC) (Source: Ref. 2-3)

(1) Existing Plants

Member States had to reduce total annual emissions of SO_2 and NOx from existing plants by phase. Tables 2.5 and 2.6 show emission ceiling and targets for SO_2 and NOx from existing plants.

Table 2.5 Emission Ceiling and Targets of Emissions of SO_2 from Existing Plants

Member State	SO_2 Emission by Large Combustion Plants 1980 kilo ton	Emission Ceiling kilo ton			% Reduction Over 1980 Emissions			% Reduction Over Adjusted 1980 Emissions		
		Phase			Phase			Phase		
		1	2	3	1	2	3	1	2	3
		1993	1998	2003	1993	1998	2003	1993	1998	2003
Belgium	530	318	212	159	-40	-60	-70	-40	-60	-70
Denmark	323	213	141	106	-34	-56	-67	-40	-60	-70
Germany	5,000	3,000	2,000	1,500	-40	-60	-70	-	-	-
Greece	303	3,20	3,20	3,20	6	6	6	-45	-45	-45
Spain	2,290	2,290	1,730	1,440	0	-24	-37	-21	-40	-50
France	1,910	1,146	764	5,73	-40	-60	-70	-40	-60	-70
Ireland	99	124	124	124	25	25	25	-29	-29	-29
Italy	2,450	1,800	1,500	900	-27	-39	-63	-40	-50	-70
Luxembourg	3	1.8	1.5	1.5	-40	-50	-60	-40	-50	-50
Netherlands	299	180	120	0	-40	-60	-70	-40	-60	-70
Portugal	115	232	270	206	102	135	79	-25	-13	-34
UK	3,883	3,106	2,330	1,553	-20	-40	-60	-20	-40	-60

Table 2.6 Emission Ceiling and Targets of Emissions of NOx from Existing Plants

Member State	NOx Emission (as NO_2) by Large Combustion Plants 1980 kilo ton	Emission Ceiling kilo ton Phase 1 1993	Phase 2 1998	% Reduction Over 1980 Emissions Phase 1 1993	Phase 2 1998	% Reduction Over Adjusted 1980 Emissions Phase 1 1993	Phase 2 1998
Belgium	110	88	66	-20	-40	-20	-40
Denmark	124	121	81	-3	-35	-10	-40
Germany	1,090	872	654	-20	-40	-	-
Greece	36	70	70	98	94	0	0
Spain	366	368	277	1	-24	-20	-40
France	400	320	240	-20	-40	-20	-40
Ireland	28	50	50	79	79	0	0
Italy	580	570	428	-2	-26	-20	-40
Luxembourg	3	2.4	1.8	-20	-40	-20	-40
Netherlands	122	98	73	-20	-40	-20	-40
Portugal	23	59	64	157	178	-8	0
UK	1,016	864	711	-15	-30	-15	-30

(2) New Plants

The Directive established emission limits for SO_2, NOx and particulate for new plants (those granted a construction license after July 1, 1987) with thermal input of at least 100 MW^{th}, depending on the type of fuel. And also rates of desulfurization are designated. Emission limit values are shown in Tables 2.7 to 2.9 and rates of desulfurization is shown in Table 2.10.

Table 2.7 Emission Limit Values for SO_2 for New Plants

Type of Fuel	Thermal Capacity (MW)	Emission Limit Values (mg/Nm³)
Solid fuels	100>x>500	-4 x +2,400
	≧500	400
Liquid fuels	50 to 300	1,700
	100>x>500	-6.5 x +3,650
	≧500	400
Gaseous fuels in general		35
Liquefied gas		5
Low calorific gases from gasification of refinery residues, coke oven gas, blast-furnace gas		800
Gas from gasification of coal		-

Table 2.8 Emission Limit Values for NOx for New Plants

Type of Fuel	Emission Limit Values (mg/Nm^3)
Solid in general	650
Solid with less than 10% volatile compounds	1,300
Liquid	450
Gaseous	350

Table 2.9 Emission Limit Values for Dust for New Plants

Type of Fuel	Thermal Capacity (MW)	Emission Limit Values (mg/Nm^3)	Remarks
Solid fuels	≧500	50	
	<500	100	
Liquid fuels	all plants	50	
Gaseous fuels in general	all plants	5	as a rule
		10	for blast furnace gas
		50	for gases produced by the steel industry, which can be used elsewhere

Table 2.10 Rates of Desulfurization for New Plants

Thermal Capacity (MW)	Rate (%)
100 to 175	60
175 > x > 500	0.154 x + 13
≧500	90

2.1.4 Air Pollution from Industrial Plants

On The Combating Of Air Pollution From Industrial Plants (EC Directive 84/360/EEC) (Source: Ref. 2-3)

The Directive provides a framework for further measures and procedures designed to prevent or reduce air pollution from industrial plants within the member states. The types of industrial plants and important polluting substances are listed in the Directive.

(1) List of Industrial Plants

Establishment or other stationary plants used for industrial or public utility purposes which are likely to cause air pollution are listed in Table 2.11.

Table 2.11 Categories of Industrial Plants

1. Energy Industry 1.1 Coke ovens 1.2 Oil refineries (excluding undertakings manufacturing only lubricants from crude oil) 1.3 Coal gasification and liquefaction plants 1.4 Thermal power station (excluding nuclear power stations) and other combustion installation with a normal heat output of more than 50 MW.
2. Production and Processing of Metals 2.1 Roasting and sintering plants with a capacity of more than 1,000 tons of metal ore per year 2.2 Integrated plants for the production of big iron and crude steel 2.3 Ferrous metal foundries having melting installation with a total capacity of over 5 tons 2.4 Plants for the productions and melting of non-ferrous metals having installations with a total capacity of over 1 ton for heavy metals or 0.5 ton for light metals
3. Manufacture of Non-metallic Mineral Products 3.1 Plants for production of cement and rotary kiln lime production 3.2 Plants for production and processing of asbestos and manufacture of asbestos-based production 3.3 Plants for the manufacture of glass fiber or mineral fiber 3.4 Plants for the production of glass (ordinary and special) with capacity of more than 5,000 tons per year 3.5 Plants for the manufacture of coarse ceramics notably refractory bricks, stoneware pipes, facing and floor bricks and roof tiles
4. Chemical Industry 4.1 Chemical plants for the production of olefins, derivatives of olefins, monomers and polymers 4.2 Chemical plants for the manufacture of other organic intermediate products 4.3 Plants for the manufacture of basic inorganic chemicals
5. Waste Disposal 5.1 Plants for the disposal of toxic and dangerous waste by incineration 5.2 Plants for the treatment by incineration of other solid and liquid waste
6. Other Industries Plants for the manufacture of paper pulp by chemical methods with a production capacity of 25,000 tons or more per year

(2) List of Polluting Substances

The list includes sulfur and nitrogen compounds; carbon monoxide; organic compounds including hydrocarbons; heavy metals; dust; asbestos; glass and mineral fibbers; and chlorine and fluorine compounds. Table 2.12 shows the substances that are designated in the Directives.

Table 2.12 Most Important Polluting Substances

1	Sulfur dioxide and other sulfur compounds
2	Oxides of nitrogen and other nitrogen compounds
3	Carbon monoxide
4	Organic compounds, in particular hydrocarbons (except methane)
5	Heavy metals and their compounds
6	Dust, asbestos (suspended particulate and fibers), glass and mineral fibers
7	Chlorine and its compounds
8	Fluorine and its compounds

2.1.5 Air Emission Inventory System

CORINE AIR is a program to establish an inventory of emissions of air pollutants in Europe. It was initiated by the European Environment Agency Task Force and was part of the **CORINE** (**CO**o**R**dination d'**IN**formation **E**nvironnementale) work program set up by the European Council of Ministers in 1985. A first generation was provided to compile the EC emission inventory for 1985 (CORINAIR 85) (Source: Ref. 2-4).

(1) CORINAIR 90

1) Objection

CORINAIR 90 has produced an emission inventory for eight pollutants covering 31 European countries. Table 2.13 shows the collaborating countries for the CORINAIR 90.

The European Environment Agency (EEA) has four main goals;

a) to produce objective, reliable and comparable information for both those concerned with European Policy and the European public,

b) to support the Commission, the Council and the European Parliament in preparing and evaluating environmental measures,

c) to co-ordinate the EIONET and publish a European state of the environment report every three years, and

d) to liaise with relevant national, regional and global environmental programmes and institutes.

The emission inventory work helps to meet all these goals. The collection of data and its transformation into useful information are fundamental to an emission inventory. The European approach to producing inventories for the continent has been a collaborative one with both institutes in each country and regional organizations involved.

Table 2.13 Countries Collaborating in CORINAIR 90

EU Countries		Other	
Austria	Italy	Malta	Hungary
Belgium	Luxembourg	Norway	Latvia
Denmark	Netherlands	Switzerland	Lithuania
Finland	Portugal	Albania	Poland
France	Spain	Bulgaria	Slovakia
Germany	Sweden	Croatia	Slovenia
Greece	UK	Czech Republic	Romania
Ireland		Estonia	Russia

2) System

The CORINAIR system is based on the four dimensional aspects which need to be specified according to objectives of each inventory.

a) Substances

The system dealing mainly with acidification, photochemistry and greenhouse effects, the selected substances have been SO_2, NOx, NMVOC, CH_4, CO, CO_2, N_2O and NH_3.

b) Emitters

More than 240 emitting activities are defined in the Selected Nomenclature for Air Pollution (SNAP). Emitters corresponds to relevant combination of SNAP activity + fuel (for energy related activities) + supplementary rubric (optional).

Fuels are defined in NAPFUE and rubrics are free for more splits by produces of inventories.
Main emitters are classified as Large Point Sources (LPS) according to specifications to be adapted with inventory objective. Individual information is collected for LPS.
Remaining emitters are classified as Area Sources (AS) for which activity rates and emission factors are requested.
The general formula used is:

$$E = \Sigma \, [\, A_{i,f,r} \times Ef_{i,f,r,p}]$$

where E is the total emission for a pollutant-p
$A_{i,f,r}$ is a representative value of the activity-i
$Ef_{i,f,r,p}$ is the emission factor assigned to activity-i, fuel-f, rubric-r and pollutant-p.

For LPS, emissions are determined either from direct emission estimations, measurement, balance, or from calculation by the mean of emission factors.

c) Geographical Resolution

The system is based on administrative territorial units defined by EUROSTAT (NUTS levels 0 to III or equivalent for non-EU countries) because statistics are generally more available at this scale than at any grid square. Moreover, this resolution fits fairly well with modelers need in Europe.
Nevertheless, a lot of air emission inventory requests to mainly deal with the national level only.
A special allocation procedure involved socio-economical data (e.g. population, area, employment, number of houses) is provided to perform activity rate estimation at territorial unit levels for which the requested data are not available.

d) Time

There is interest for high time resolution (e.g. modernization of photochemistry) but such figures can be more easily produced from an annual basis which fits with most of the main uses of air emission inventories.

3) Processing Overview

The system includes the following steps:

- National/producer level definitions/specifications for source categories, fuels,

territorial units, pollutants, LPS, surrogate data, units, ...
- Collection of data (activity rate, emission factors, fuel characteristics, LPS information, comments, surrogate data, ...)
- Data transmit (allocation procedure, emission calculation, checking)
- Each national database is examined by the CORINAIR Technical Unit for checking on consistency and completeness. Analysis of emission factor discrepancies enable to detect irrelevant figures and to help to increase their relevancy.
- All validated national database are transferred to EEA ORACEL System and constitute the centralized CORINAIR database.
- Outputs such as reports, maps, database, are produced.

It is to be noticed that bottom-up and top-down approaches are used respectively for LPS and AS allocation.
Practically, two approaches are used:

- One for countries who export data from their national specific system to CORINAIR database (Dbase format). When the national system dose not cover all data requests, the CORINAIR software may be used for completion of the database.
- Other countries use the CORINAIR software to achieve their CORINAIR emission inventories.

(2) CORINAIR 94

1) Background

End of 1994 the EEA's European Topic Center on Air Emissions (ETC/AEM) took over the CORINAIR program and finalized several reports on the results of CORINAIR 90. The results of CORINAIR 90 provided the most detailed, complete, consistent and transparent European air emission inventory.

There still remained gaps and inconsistencies in CORINAIR 90 and the process to deliver the final data took too long, consequently improved inventory system is proposed, e.g.: give priority to national totals which are split in the same detailed source nomenclature (SNAP) for different reporting purposes (UNECE/EMEP, UN-FCCC/IPCC), collect and report (preliminary) data within twelve months, make use of consistent energy statistics, improve the software, give intensive assistance to participating countries. The proposals were followed by another report "Recommendations for Revised Data System for Air Emission Inventories". In 1996 the ETC/AEM started the 1994 air emission inventory making use of new software, which was improved based on the two reports mentioned.

2) Large Point Sources Specifications for the System

The Definition of the criteria of LPS for the system is as follows:

Criteria No.	Definition
1	Combustion plant with a thermal capacity ≧ 300 MW The thermal capacity considered here is the maximum of energy possibly consumed during one time unit (here MJ/s) whatever the actual use of the plant is.
2	Any refinery Each of the main plants included will be treated as separate parts of the refinery. Combustion plants within a refinery will be considered as part of a LPS whatever the thermal capacity is.
3	Workshops include in integrated steel plant with a production capacity ≧3 x 10^6 Mg of steel/year. (Mg = ton) Each main workshop or type of process will be treated as a part of the whole steel plant. Combustion plants too whatever the thermal capacity is.
4	Any sulfuric acid plant
5	Any nitric acid plant
6	Paper pulp production plant when the capacity is ≧ 100,000 Mg/year of pulp plant whatever the thermal capacity is.
7	Painting car plants when the capacity is ≧ 100,000 passenger cars/year or equivalent when only pieces of cars are painted. If other plants on the same industrial site has to be included in LPS (e.g. combustion plans), it will be considered only one LPS including several parts (e.g. one part for car painting and a second part dealing with combustion plant).
8	International airports when the amount of LTO cycles is ≧100,000/year. One LTO cycle = one landing and one taking off. Due to the specificity of such a LPS, air traffic is treated as a separate part of possible other plants on the same site (e.g. combustion plant which constitute another part, only if the LPS criteria is respected for this plant).
9	Any plant when the top of the stack is ≧100m whatever the emissions are.
10	Any plant when annual emission exceed: a. 1,000 Mg/year for SO_2, NOx, NMVOC, NH_3 b. 1,000 Mg/year for N_2O c. 3,000 Mg/year for CH_4 d. 5,000 Mg/year for CO e. 300,000 Mg/year for CO_2 Criteria b, c, d, e are recommended but optional, while the criteria is requested.

When LPCD (Large Combustion Plant Directive) inventory is requested

11 New combustion plants with a thermal capacity ≧ 50 MW.
Cf. criteria 1 for definition of thermal capacity.
New means: granted by local authorities from July 1, 1987.
Each plant will be considered as a LPS.
Note: combustion plants ≧300 MW for already at least with criteria 1.

12 Existing combustion plants with a thermal capacity ≧ 50 MW and not yet considered as LPS because fitting with other criteria, will be considered all together as a special LPS.
Existing means: granted by local authorities before July 1, 1987.

Optional - When relevant for national considerations

13 Any plant which presents specific interest from the export of point view.

Note:
If one plant is a LPS for one pollutant it is a LPS for all pollutants (e.g. a plant is emitted more than 1,000 Mg/y of SO_2 but less than 1,000 Mg/y for other pollutants: this plant will be considered as a LPS and all pollutant will be within this LPS.

2.2 Present State of Organization and Institution in Macedonia

2.2.1 Administration

(1) Organization of Ministry of Environment

Ministry of Environment (MOE) was officially established at the end of December 1998. After the environmental protection agency, the MOE was separated and became independent. Although the MOE has 40 staff members, it will increase the staff to 120 under its expansion program. The MOE is not only considering personnel but also considering seriously securing of sources.
Figure 2.1 shows the present and future organization of the MOE. It is expected that a number of agencies relevant to the MOE will be founded to substantiate and implement environmental policies smoothly.
The MOE is now examining the legal system for environmental conservation. It also eagerly expects to enhance its monitoring network and establish an intelligent management system integrated with a data bank system on environmental information.

The MOE says that under the current stagnant economy, it is hard to encourage large factories to monitor gases emitted from their stacks at their own expense and submit data to the national and local governments. The MOE intends to make every effort for a better future of Macedonia, focusing on the importance of environmental conservation, while it also recognizes that they have many things to settle such as financial issues.

The MOE has expressed its view that international cooperation is essential to Macedonia which is now in a financially difficult situation, although Macedonia needs to establish its own monitoring system and environmental management system and to promote environmental conservation measures. Therefore, the MOE tries to improve environmental administration organizations including local governments and legal systems, as well as to secure new sources of its revenue besides that from the national budget.

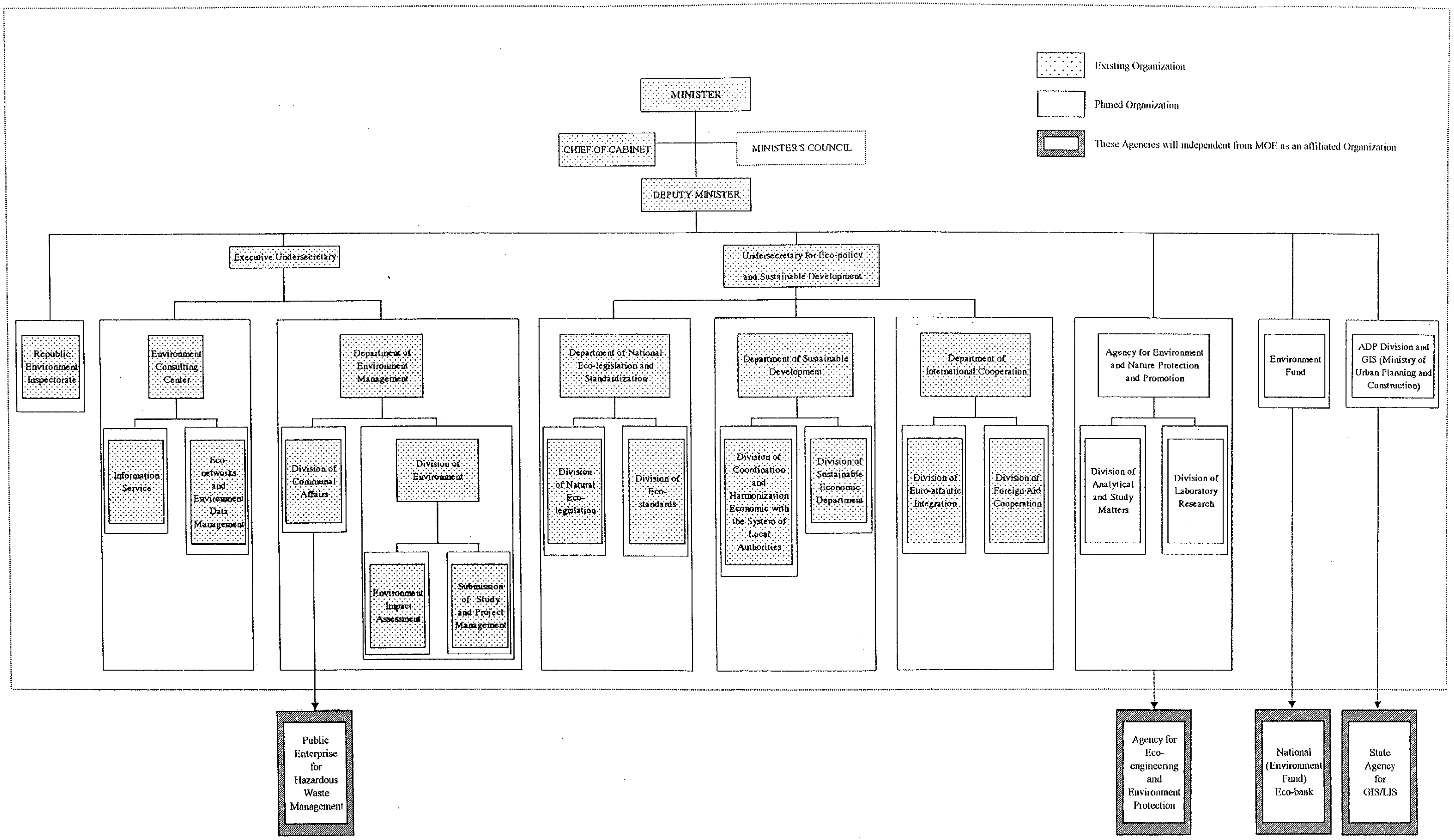


Figure 2.1 Organizational Scheme of the MOE

(2) Other Environmental Organizations

Other relevant institutions are as follows:

- Institute for Health Protection
- Republic Hydro-meteorological Institute
- Republic Health Care Institute and its subsidiaries at municipal level
- Occupational Health Institute
- Preventive Medical Care Institute
- Mining Institute
- Veterinary Institute
- Republic Institute for Natural Rarities Preservation
- Center for Application of Radioisotopes in the Industry
- Hydro-Biological Institute
- Construction Institute
- Institute for Earthquake Engineering and Engineer Seismology
- Central Institute for Occupational Safety
- Fires and Environmental Protection
- Statistical Office

1) Institute for Health Protection (IHP)

The IHP is a public health care organization for highly specialized preventive and protection measures in Macedonia and covers activity fields such as epidemiology, hygiene, social medicine, drug control, and contemporary laboratory researches in microbiology, toxicological chemistry and pharmacology, radiobioecology and radiobiodosimetry.

The most significant activities of the organization are to:

- monitor the health condition of the population, the reasons for occurrence and spreading of communicable and other diseases of socio-medical importance.
- monitor and evaluate sanitary-hygienic condition of water supplied to the population and study the effect of the environmental factors on the health of people.
- research for factors influencing diseases associated with nutrition and food products.
- establish doctrinaire-methodological rules for harmful biological as well as chemical agents.
- do information networking and statistical research in the field of preventive health care.

The foundation of the organization dates back to the period immediately after the

Second World War and it has played a vital role in supplying hygienic tap water to households. The organizational schematic and locations of health institutes under the control of the IHP are as shown in Figure 2.2.
Also noteworthy is that the IHP maintains collaborative relationship with numerous international organizations such as WHO, FAO, UNICEF, WB, European Health Environmental Center.

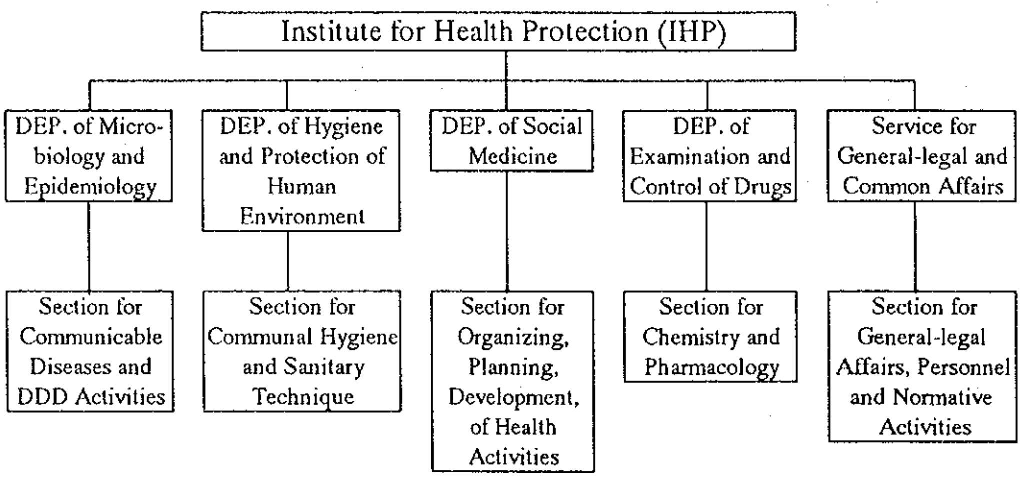


Figure 2.2 Organizational Scheme of the IHP

2) Republic Hydro-meteorological Institute (RHI)

The RHI is a research institute to study hydrometeorology and climatic conditions of Macedonia independently from ministries. It also supplies hydrometeorological and climatic information to municipalities as well as to the army.
There are 14 main synoptical stations, 15 main climatological stations, 17 regular climatological stations, an aerological station and 187 precipitation stations.
It became a member of the World Meteorological Organization (WMO) in 1993.
The organization consists of four departments; Meteorological Department, Hydrological Department, Hail Suppression and Weather Modification Department, and Department for Legal Administrative and Financial Matter. As for air and water quality monitoring, the Section for Water and Air and Soil Quality Monitoring of Ecology is responsible. The organization scheme is as shown in Figure 2.3.

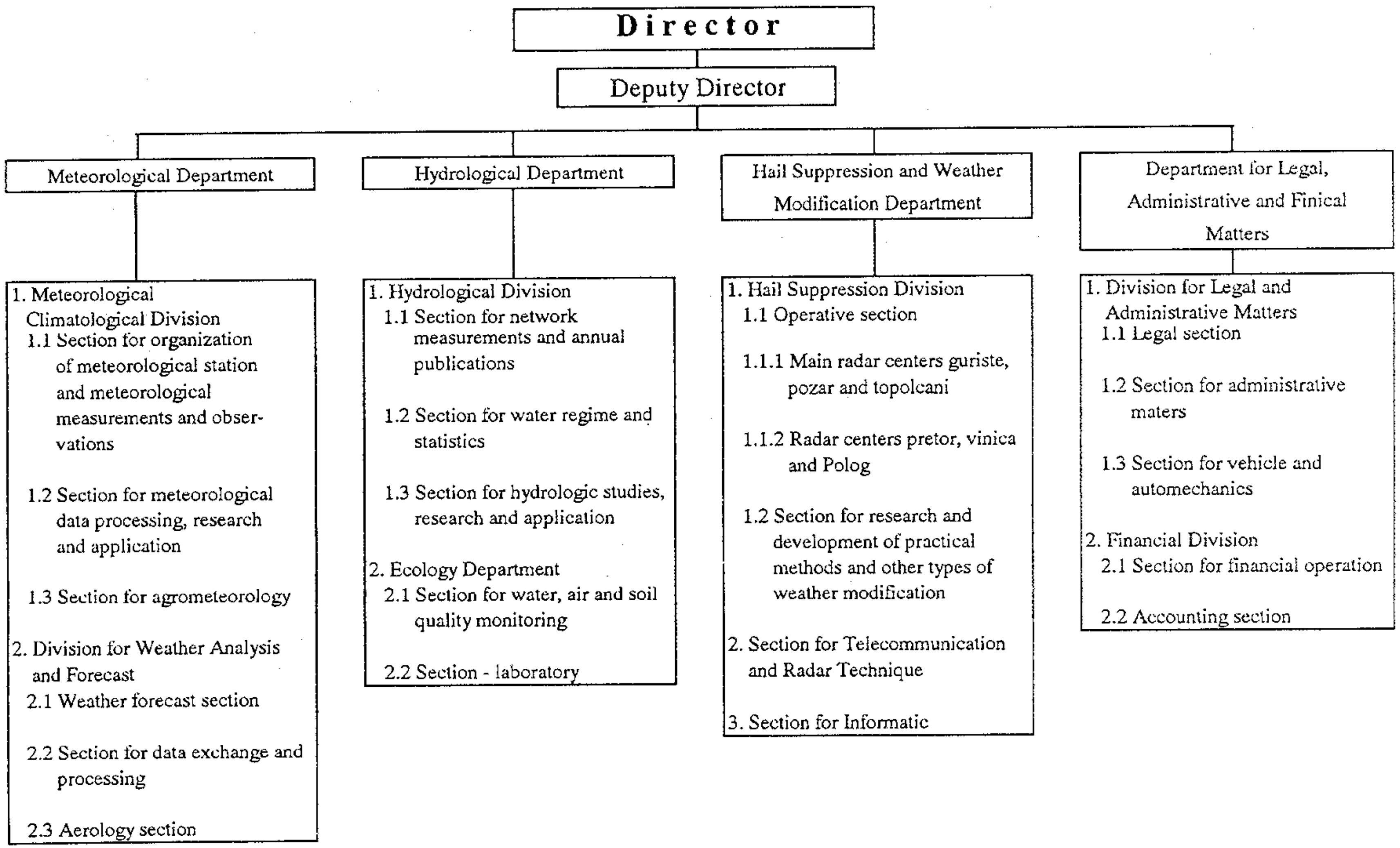


Figure 2.3 Organizational Scheme of the RHI

3) Local Autonomous Government

Macedonia is today divided into 123 administrative provinces, and maintains the self-governing jurisdiction to make their own policies specific to each locality.
Budgetary sources of such local government are land tax and revenue from public interest works run by local governments, the style of which often takes the form of amalgam of local municipal assembly and administrative organs. They offer functional and public services such as public health, education, city water service, sewage and municipal waste treatment, public transportation, environmental and river management, traffic control, roadway construction and maintenance, and many others.
The local government assembly members are elected by free voting from the candidates while the chairman as well as vice chairman of assembly are elected from among the members of assembly. As for Skopje, there are 70 assembly members, led by one chairman and two vice chairmen. The administrative structure includes the assembly and it has the Environmental Management Committee which is mainly responsible for policy making in the field of environmental management. There is no expert in the committee to represent inspectorate job or analytical works. Analytical works are mostly subcontracted to external organs with expertise. For example, quality checks on imported fuels are subcontracted to Skopje University and monitoring of ground water to the RHI every yearend.

2.2.2 Law, Regulation and Institution

(1) Law on Protection of Air Pollution

As stated above, it is expected that the institute for environmental protection to be established may be integrated into that of EU type in future. Looking back on EU approach adopted in the past, the regulations related to air pollution started with regulating vehicle exhaust gas, and then defined particular substances contained in vehicle fuels. For particular facilities (such as factories with high volume of combustion capacity), emission standards for SO_2, SPM, Pb and NOx are already established.
In terms of legal framework, air pollution control in Macedonia is based on the Law on Protection of Air Pollution, and enhanced by the Act Environment and Nature Protection and Promotion. The legal regulations established under the above-mentioned laws are shown in the following list:

- Standard for ambient air quality
- Standard for emission control of stationary pollution sources

- Fine imposing system for stationary pollution sources
- Standard for emission control of mobile sources
- Standard for fuel quality
- Financial aid arrangement for promotion of protecting environment and nature

The Government of Macedonia strongly hopes for an improvement in environment-related laws and regulations. The MOE has been making their best effort to make the environment assessment system more effective and productive.

(2) Emission Standards

Emission gases from the combustion plants for heating of buildings, for the production of process heating or for production of steam are regulated by Maximum Permitted Concentration (MPC). The values of the regulation are stipulated as follows (Data Book pp.D2-1 to D2-20).

1) Solid Fuel

a) Coal, Briquettes, Coke (MPC in mg/m^3 for 7% of O_2)

Table 2.14 MPC for Coal, Briquettes, Coke

Pollutants or Referent Value	1-50 MWth	50-300 MWth	Over 300 MWth
*Smoke tar number according JUS M. P. 020	30	30	30
*Solid particles in mg/m^3	50	50	50
*Carbon monoxide (CO) in mg/m^3	250	250	250
*Sulfuric oxides calculated as SO_2 in mg/m^3	2,000	400	400
*Emission part of sulfur (from the total amount) for combustion plants with grating or firing with dust (%)	-	60	10
*Emission part of sulfur (from the total amount) for combustion plants with fluidic layer (%)	15	15	10
*Nitrogen oxides (NOx), as NO_2 in mg/m^3	500	400	300
*Gases of inorganic compounds of fluorine, as F in mg/m^3	30	30	15
*Gases of inorganic compounds of chlorine, as HCl in mg/m^3	200	200	100

The boilers up to 1 MW limitations given in JUS M. E6110-1978 should be applied.

b) Wood Briquettes (MPC in mg/m³ for 11 % of O_2)

Table 2.15 MPC for Wood Briquettes

Pollutants or Referent Value	1-50 MWth	50-300 MWth	Over 300 MWth
*Smoke tar number according JUS M. P. 020	30	30	30
*Solid particles in mg/m³	50	50	50
*Carbon monoxide (CO) in mg/m³	250	250	250
*Nitrogen oxides (NOx), as NO_2 in mg/m³	500	400	300
*Organic matters as total organic carbon, in mg/m³	50	50	50

The boilers up to 1 MW limitations given in JUS M. E6110-1978 should be applied.

2) Liquid Fuels (MPC in mg/m³ for 3% of O_2)

Table 2.16 MPC for Liquid Fuels

Pollutants or Referent Value	1-50 MWth	50-300 MWth	Over 300 MWth
*Smoke tar number according JUS B. H. 8,270			
-for heavy oil	2	2	2
-for other oils	1	1	1
*Carbon monoxide (CO) in mg/m³	170	170	170
*Nitrogen oxides (NOx), as NO_2 in mg/m³	350	250	150
*Sulfuric oxides SOx, as SO_2 (in mg/m³) for fuel oil according to JUS B.HO 500	1700	400	400
*Emission part of sulfur (%) (from the total amount)	-	60	15
*Gases of inorganic compounds of fluorine, as HF (in mg/m³)	-	-	-
*Gases of inorganic compounds of chlorine, as HCl (in mg/m³)	5	5	5

Heavy oil for fuel cannot be used in plants with up to 5 MW.
The boilers up to 1 MW limitations given in JUS M. E6110-1978 should be applied.

3) Gas (MPC in mg/m³ for 3 % of O_2)

Table 2.17 MPC for Gaseous Fuels

Pollutants or Referent Value	1-50 MWth	50-300 MWth	Over 300 MWth
*Smoke tar number according JUS B. H. 8,270	0	0	0
*Solid particles in mg/m³	0.5	0.5	0.5
*Carbon monoxide (CO) in mg/m³	100	100	100
*Nitrogen oxides (NOx), as NO_2 in mg/m³	200	200	200

The boilers up to 1 MW limitations given in JUS M. E6110-1978 should be applied.

For combustion plants for desulfurization or denitrogenation it is permitted to work without such facilities at least 240 hours per year, with maximum 72 hours continuous year, with maximum 8 hours continuously.

(3) Standards and Methods Related to Air Quality Monitors

1) Environmental Standards

The currently enforced Law on Protection of Air Pollution provides an environmental standard for 13 items. Table 2.18 lists the environmental standard of Macedonia.
The environmental standards are important criteria for the basis of environment protection. However, only 2 items, namely SO_2 and BS, are continuously monitored and only daily average values are monitored and recorded (Data Book pp.D2-21 to D2-25).

Table 2.18 Standards for 13 Parameters

Pollutants	MPC in mg/m^3 For Minute Value	MPC in mg/m^3 Daily Average Value
1. SO_2	0.5	0.15
2. Sulfur ion calculate as H_2SO_4 Hydrogen ion calculated as H^+	0.3 0.006	0.1 0.002
3. Black Smoke	0.15	0.05
4. Pb and its compounds (except tetra-ethyl) as Pb	/	0.0007
5. Lead Sulfide (PbS)	/	0.0017
6. As (non-organic compounds), except arsenhydrate calculated as As	/	0.003
7. Carbon disulfide (CS_2)	0.03	0.01
8. CO	3.0	1.0
9. NO_2 compounds	0.085	0.085
10. Fluor (calculated as fluorine) in gas phase (HF)	0.02	0.005
11. Ox	0.125	/
12. Hydrocarbon (corrected on methane)	0.125	/
13. Ash and inert dust till 300 mg/m^3 daily	/	/

Table 2.19 shows ambient air quality standards at Macedonia compared with that of EU, of WHO and of Japan.

Table 2.19 Comparison of Ambient Air Quality Standards

		Macedonia		EU		WHO	Japan
		For Minute Values	Daily Average Values	Limiting Values	Guiding Values *13		
SO_2 (μg/m³)	10-min. Values					500	
	1 hour Values					350	286
	24-hour Values	500	150		100-150	125	114
	Winter (Oct.-Mar.)			130/180 *5 (50% values)			
	Annual Average Values			80/120 *6 (50% values) 250/350 *7 (98% values)	40-60	50	
NO_2 (μg/m³)	1 hour Values					400	
	24-hour Values	85	85			150	82-123
	Annual Average Values			200 (98% values)	50 (50% values) 135 (98% values)		
CO (μg/m³)	15-min. Values					100,000	
	30-min. Values					60,000	
	1 hour Values					30,000	
	8-hour Values					10,000	25,000
	24-hour Values	3000	1000				12,500
SPM (BS) (μg/m³)	1 hour Values						200
	24-hour Values	150 *1	50 *1		100-150	70,120 *14	100
	Winter (Oct.-Mar.)			130 (50% values)			
	Annual Average Values			80 (50% values) 250 *8 (98% values)	40-60		
Ox (μg/m³)	1 hour Values			200 *9 180 *10 360 *11		150-200	128
	8-hour Values			110 *12		100-120	
	24-hour Values	125		65 *9			
Pb (μg/m³)	24-hour Values		0.7 (1.5 *4)				
	Annual Average Values			2		0.5-1.0	
CS_2 (μg/m³)	24-hour Values	30	10			100	
H_2S (μg/m³)	24-hour Values	8	8			150	
H_2SO_4 (μg/m³)	24-hour Values	300 *2 6 *3	100 *2 2 *3			10 *15 (H2SO4, or equivalent to conversion into acid)	

Note: See next page

Notes:

*1: BS is by Standard British reflectometric method.
*2: Conversion into H_2SO_4
*3: Conversion into H ion
*4: EPA standard of USA, for reference.
*5: 130 when BS > 60 μg/m³, 180 when BS ≦ 60 μg/m³
BS is under a regulation of black smoke of OECD.
*6: 80 when BS > 40 μg/m³, 120 when BS ≦ 40 μg/m³.
*7: 250 when BS > 150 μg/m³, 350 when BS ≦ 150 μg/m³.
*8: Every member nations must try all kinds of methods not to go beyond this value three days in a row. BS is under a regulation of black smoke of OECD. Limiting values should be kept since they are set in order to protect human health.
*9: Threshold values to protect flora
*10: Threshold values to inform residents
*11: Threshold values to warn residents
*12: Threshold values to protect health
*13: Guide values are set in order to prevent human health and environment from bad influence in a long-run.
*14: This value is applied when SO_2 and PM10 coexists.
*15: This is the reference value because of existing uncertain points in influence and of the absence of a guideline.
1 mg/m³ = 1,000 μg/m³

2) Monitoring Methods

The law enforced at present is the Law on Protection of Air Pollution which went into force in 1974. In accordance with article 24 of this law, the RHI has been monitoring the relationship between meteorology and air pollution for more than ten years for survey and research purposes. The data collected as a result of monitoring is reported to the concerned agencies and organizations.
The RHI monitors SO_2 and Black Smoke (BS) at 20 locations simultaneously throughout the Country. Nine of these locations are located in Skopje and some of these nine locations monitor NOx and O_3 as well.
Monitoring is performed periodically everyday from 7:00 a.m. to 7:00 a.m. on the following day. Average values for 24-hour period are recorded.
In addition to monitoring by the RHI, the IPH belonging to the MH conducts monitoring at 12 locations in accordance with Section 110 of the Law on Health

Protection and with Section 45 of the Law on the Government of Macedonia. Seven of these twelve locations are located in Skopje. The items monitored by the IPH are the same as those monitored by the RHI. However, total acidity is also monitored in three locations. Furthermore, the IPH is also monitoring CO, dust fall and heavy metals, such as Pb and Zn.

CO is monitored twice each year, during spring and autumn, at four intersections in Skopje to survey the influence by automobile emissions. Influence by Pb in gasoline and by other heavy metals are also monitored twice each year, similarly during spring and autumn, at one location in Skopje.

(4) Environmental Protection Measures

The Government of Macedonia is taking the following environmental protection measures:

- Monitoring of air quality throughout the Country with a focus on Skopje.
- Alarms are issued when the air quality deteriorates.
- Regulation of plant operation and vehicular traffic to prevent damage to health of the residents.
- Conversion of fuels by the business entities and plants and installation of environmental protection equipment and systems.

(5) Menu of National Environmental Action Plan

The three objectives of National Environmental Action Plan (NEAP Ref. 2-5) are listed as below:

- Public health
- Improving the environment for a higher quality of life
- Protecting natural resources to ensure continuous development

Macedonia is now in the process of planning for an environmental control system which will fulfill the EU standards, and is necessary for Macedonia to join the EU. It is necessary for the NEAP to meet the needs of the present world.

Therefore, reconsiderations must be carried out to see if NEAP meets the needs of development projects. Environmental protection must be placed as one of the most important issues in many of the projects to be given priority.

The background of the drawing up of NEAP is mentioned by the following items:

- Connection of large plants and central heating plants in Skopje to natural gas system. (3 years)
- Complete removal of SO_2 and other pollutants emitted by the MHK Zletovo smelting plant in Veles by revamping or rebuilding its exhaust gas treatment system. (3 years)
- Fuel conversion to natural gas when a natural gas system is completed. (3 years)
- Purification of dust and exhaust gases and waste heat recovery in the Yugohrom metal chemical plant in Jegunovce. (3 to 5 years)
- Moving of the residents in Biljanik Village near the coal mine and power station to Bitola. (3 years)
- Encouragement and subsidy of environmental protection equipment investments. (3 years)
- Enactment of environmental laws in accordance with the EU laws. (3 years)
- Environmental education and training for personnel. (3 to 5 years)
- Environmental courses in school education from elementary school to university levels. (3 years)
- Replacement of old vehicles with new vehicles by providing tax incentives. (10 years)
- Fuel conversion to natural gas in large cities. (3 to 10 years)
- Non-leading of gasoline. (3 to 10 years)
- Development of new energy sources. (3 to 10 years)
- Preparation for energy conservation programs in all fields. (3 years)
- Construction of an information system and creation of a database by implementing new environmental monitoring systems and organizational reform of environmental agencies. (Urgently)

(6) Air Emission Regulation Measures

Air emission regulation measures are policy-based projections on conditions which are likely to have more immediate influence on future air pollution emission levels. The following are regarded as policy-defined time-horizons for the introduction of specific emission-regulating measures (Ref. 2-6):

- 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 heavy oil in thermal power and heating plants - by 2002
- Phasing out of leaded gasoline - by 2007

(7) Activity of Enterprise

Operation activity at most of the factories in the Country has been reduced mainly because of the superannuated facilities. Enterprises are making every efforts to comply with environmental standards as part of their management policy and to carry out active environmental control measures.

At the moment, emission monitoring and ambient air quality monitoring are carried out at only some of the factories. Although most of the factories understand that there is a need for coming up with control measures for the protection of air quality, they face a lack of funds and expertise in this area. As a result, business reorganization is not carried out at most of these factories.

(8) 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 on October 26, 1990.

Figure 2.4 shows the air pollution alarm system.

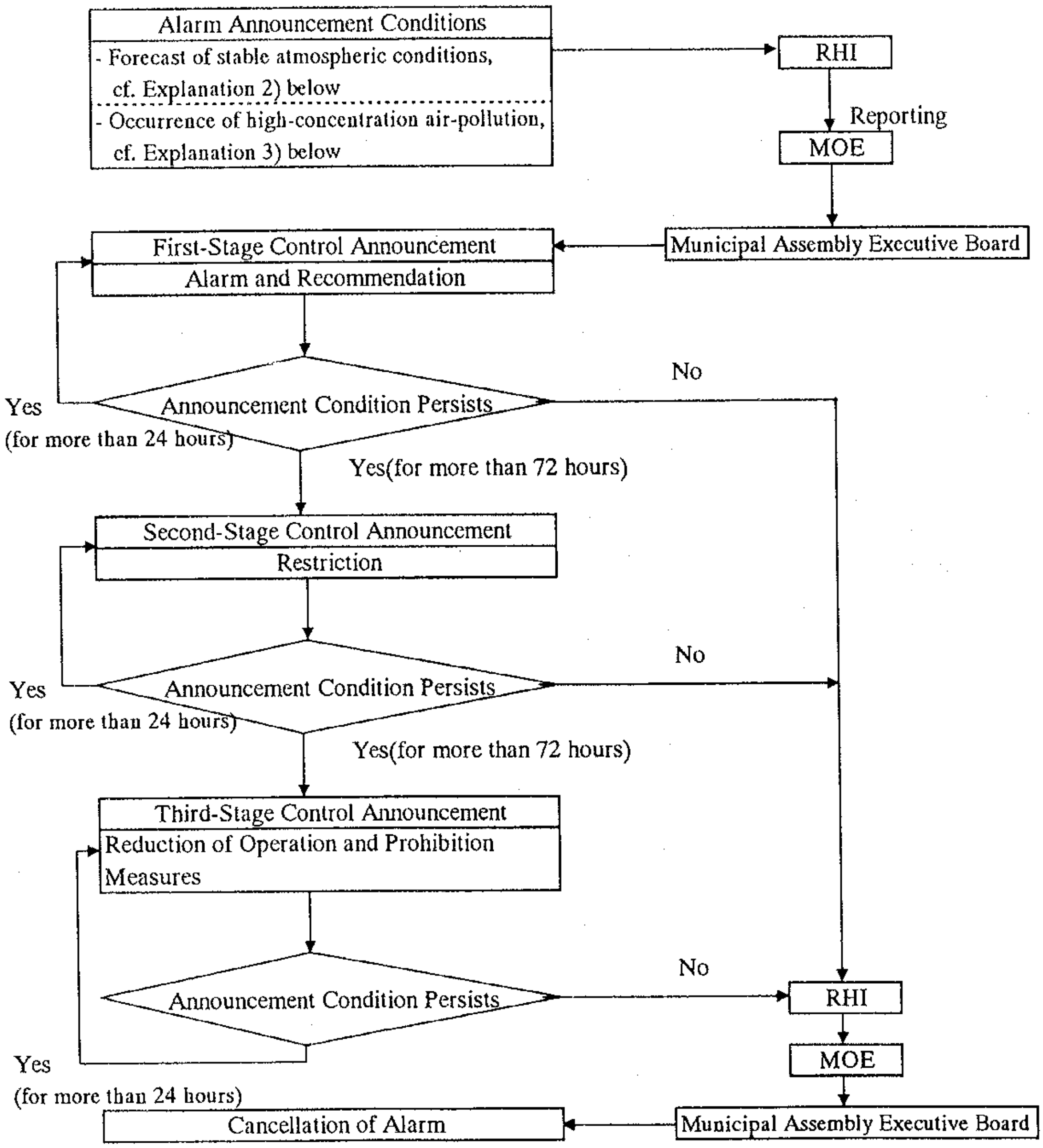


Figure 2.4 Air Pollution Alarm System

1) Regulatory Measures for Air Emission Sources

Business entities subject to regulatory measures are all individuals as well as corporations involved in production and servicing activities which are likely to emit air pollution in Skopje. Those who fail to comply with regulatory norms will be penalized.

a) Factories
b) Heating furnaces and industrial boilers
c) Stores and manufacturing plants
d) Automobiles and other pollutant emitting facilities
e) Warehouses, transportational means
f) Solid and liquid fuels' manufacturing plants
g) Combustion furnaces regardless of their capacities
h) Permanent and temporary smoke emitting facilities

2) Alarm Announcement Conditions (Forecast of Stable Atmospheric Conditions)

They correspond to meteorological forecast that meet the three conditions below.

a) Formation of surface inverse temperature profile
b) Wind velocity less than 2m/s for longer than 24 hours
c) When conditions mentioned above are likely to continue for more than 24 hours

3) Alarm Announcement Conditions (Occurrence of High Concentration Air Pollution)

Alarm shall be announced corresponding to high concentration air pollution when the monitored values exceed any of the condition described in Table 2.20 and/or Table 2.21. When the state of air pollution does not improve after announce, alarm for next stage will follow.

Table 2.20 Alarm Criteria of High Concentration Air Pollution (1)

Average (24 hours) (mg/m^3)	First Stage	Second Stage	Third Stage
SO_2 Concentration + 2 × BS Concentration	1.1	1.4	1.7

Table 2.21 Alarm Criteria of High Concentration Air Pollution (2)

Concentration (3 hours) (mg/m³)	First Stage	Second Stage	Third Stage
NOx	0.6	1.0	1.4
CO	30.0	45.0	60.0
SO_2	0.60	1.20	1.80

Remarks: Alarm shall be made when monitored values exceed the criterion level at more than half number of monitoring sites or when monitored values exceed the criterion level at 2 neighboring sites. Neighboring means two monitoring site within a square of 4 km x 4 km.

4) Fist Stage Control Announcement (Alarm and Recommendation)

a) Alarm to citizens about restriction of house ventilation and outdoor activities
b) Recommendation of use of non-polluted fuels to owner of heating facilities
c) Restriction of traffic volume

The alarm and recommendation shall be announced from city assembly executive committee to all officers in charge of sanitation and health, science institutions, plant specialists, controllers of traffic volume, etc..

5) Second Stage Control Announcement (Restriction)

a) Traffic restriction of specified vehicles in designated areas or that of all vehicles for a certain period of time
b) Restriction of specified fuels at households or business entities
c) Restriction of outdoor meetings, sports, cultural events and others
d) Stricter health check and health promotion measures and awareness enhancement

Those restrictions mentioned above will be determined by traffic controllers and competent authorities at both federal as well as municipal level.

6) Third Stage Control Announcement (Reduction of Operation and Prohibition Measures)

a) Publicly designated heating plants, boilers and factories shall stop operation at 10 hours later after alarm announcement.
b) Stoppage of traffic of vehicles designated by public control organs.

Prior to announcement of third stage alarm, the municipal executive committee orders the department of sanitation and health to reinforce regulatory measures and to fulfill obligations.

2.3 Population and Territorial Structure

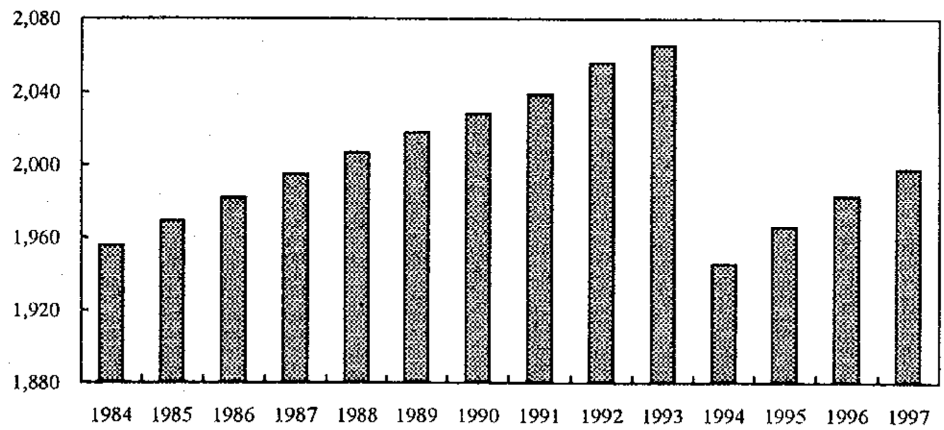
2.3.1 Population

According to the last census, the population of the Country stood at 1,998,000 in 1997. Mid-year population time series corrected for comparability for the last ten years are included in the latest Statistical Yearbook 1997 (Ref. 2-7) and in "Macedonia in Figures 1998" (Ref. 2-8). The population statistics approximated thereby are shown in Table 2.22 and Figure 2.5.

Table 2.22 Mid-year Total Population (1984-1997)

(× 1,000)

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Population	1,956	1,969	1,982	1,995	2,007	2,018	2,028	2,039	2,056	2,066	1,946	1,966	1,983	1,998



Note: According to the 1994 Census Act, the Census also covered the citizens of the Macedonia absent abroad one year or more (but they are not included in the total population).
Data from previous censuses include persons living abroad more than one year, in th total population.

Figure 2.5 Mid-year Total Population (1984-1997)

In the post-war period the rate of natural increase of the population had its peak in 1948 with 26.3 per 1,000 inhabitants and has been continuously declining since 1954. For the period from 1987 to 1997 the trend of natural increase is shown in Table 2.23 and Figure 2.6.

Table 2.23 Rate of Natural Increase of the Population (1987-1997)

(×1,000)

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Rate/1,000	11.6	11.2	10.1	9.7	9.8	8.4	8.1	9.1	8.0	7.7	6.4

Sources: Refs. 2-7 (p.87), 2-8 (p.10) and 2-9 (p.6)

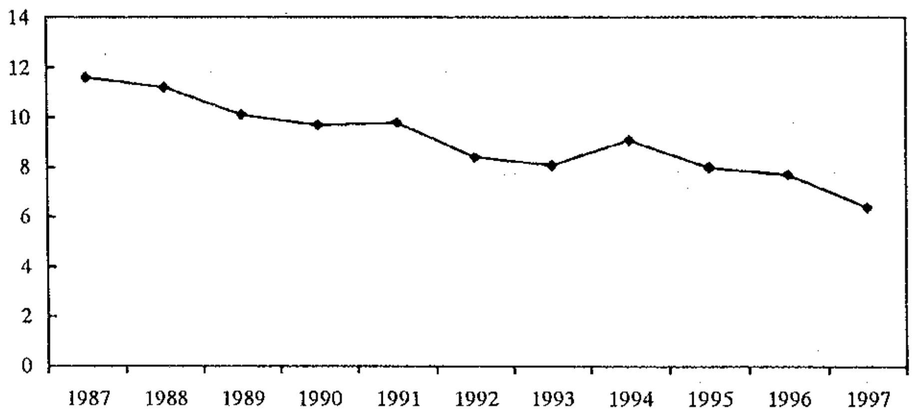


Figure 2.6 Rate of Natural Increase of the Population (1987-1997)

2.3.2 Territorial Structure

(1) Structure

From 1976 to 1995 the Country was administratively divided into 34 municipalities. However, under the 1996 "Act for the Territorial Division in the Republic of Macedonia and Determining the Units of Local Self-government", the Country has been divided into 123 municipalities since September 14, 1996. Much of the relevant statistics are published according to the 34 regional divisions and the environmental administration intends to maintain this more aggregated pattern of regional subdivision for its policy purposes now and probably in the future. Therefore, basic regional population indicators are shown here in Table 2.24 in the 34-grid distribution.

Table 2.24 Basic Regional Population Indicators

Municipalities 34 divisions	Total Population, 1994	Index of Change, 1991/1953	Index of Change, 1991/1981	Density, 1994	Local Communities, 1995
Skopje	545,228	264	112	293	166
Berovo	19,829	100	101	24	16
Bitola	108,203	121	90	63	131
Brod	11,022	63	95	12	54
Valandovo	12,092	109	110	36	16
Vinica	19,063	129	107	43	15
Gevgelija	34,817	156	110	46	32
Gostivar	108,181	176	115	79	86
Debar	25,452	158	117	95	27
Delcevo	25,287	117	108	43	36
Demir Hisar	10,524	60	80	24	36
Kavadarci	41,937	151	107	37	45
Kicevo	52,958	134	107	64	84
Kocani	48,538	149	104	84	44
Kratovo	10,898	70	92	29	30
Kriva Palanka	25,129	75	95	35	43
Krusevo	12,005	93	95	59	23
Kumanovo	127,814	151	107	106	99
Negotino	23,156	134	110	31	23
Ohrid	60,763	151	103	58	67
Prilep	94,183	113	99	51	85
Probistip	16,650	114	109	51	37
Radovis	30,525	119	108	41	32
Resen	17,681	96	93	24	40
Sveti Nikole	21,444	85	101	33	28
Struga	62,679	165	111	115	44
Strumica	91,047	160	108	95	75
Tetovo	172,171	194	111	158	100
Veles	65,942	113	101	42	67
Shtip	50,714	159	112	58	30
Republic Total	1,945,932	156	107	76	1,611

(2) Urbanization

While Table 2.24 provided a view on overall population concentration processes, the processes of urbanization have been of more direct impact for their environmental consequences. The changes in the proportion of urban population within the total population are shown in Table 2.25.

Table 2.25 Changes in the Proportion of Urban Population within Total Population

Year	1971	1981	1991	1994
Urban Population (%)	49	55	58	60

Source: Ref. 2-7 (p.91)

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. Population growth and its dynamics in these urban centers is described in Table 2.26 and Figure 2.7.

Table 2.26 Population Growth of Urban Communities over 30,000 (1961-1994)

City / Year	1961	1971	1981	1994
Skopje	197,341	312,980	408,143	444,299
Bitola	49,001	65,035	78,507	77,464
Kumanovo	31,845	47,809	63,098	71,853
Prilep	39,611	50,757	63,639	68,148
Tetovo	25,357	35,745	46,523	50,344
Titov Veles	27,154	36,525	43,193	46,798
Stip	20,269	27,224	36,230	41,730
Ohrid	16,492	26,369	39,093	41,146
Strumica	15,949	23,034	29,263	34,067

Source: Ref. 2-7 (p.130)

Urbanization effects have been most pronounced for the same nine communities, especially for Skopje where fast population and urban growth, when combined together, have put the most intense amount of strain on environmental capabilities.

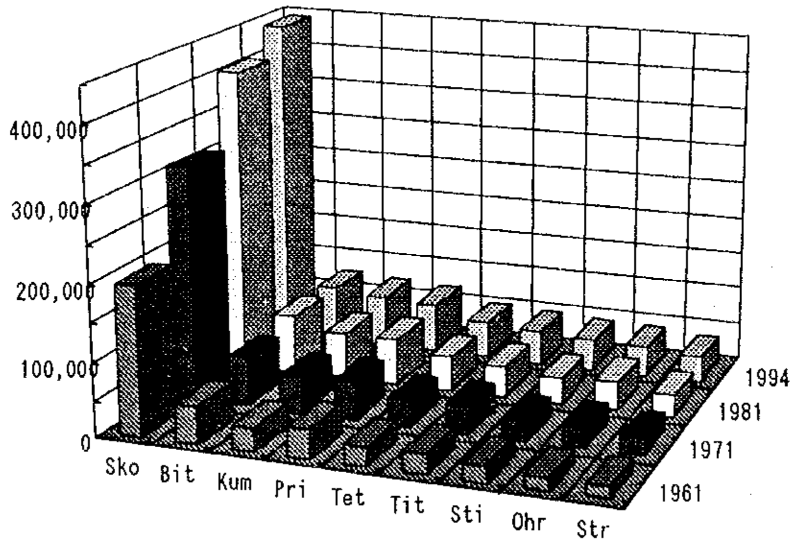


Figure 2.7 Population Growth of Urban Communities over 30,000 (1961-1994)

The quality of the air has been regarded as "Relatively Satisfactory" in only two out of the nine urban communities cited. The four most polluted cities are among the six largest ones: Skopje, Bitola, Kumanovo and Veles; their combined population was 641,000 or about one third of the total population of the Country in 1994. In three out of the six- in Skopje, Bitola and Veles -the relative air pollution due to industrial sources has been declared as "critical" (NEAP). In 1993, 77% of all the CO_2 and almost 90% of all the SO_2 emissions in the Country originated in these three cities.

(3) Land Use

A 1995 government publication summarized the structure of land use in national level. It is shown in Table 2.27. The same government publication cited that there were 66,802 ha of irrigated land, and cultivable areas, gardens, orchards and vineyards which amounted to 51.27 % of the Country's agricultural area. The system of land use as well as its regulation is undergoing significant changes.

The existing Physical Plan of Macedonia was approved in 1982. This Plan established the rules for land use, including construction regulations and those for infrastructural development.

In 1995, preparations for a New Physical Plan for the Country were made and a new Law on Physical and Urban Development Planning was passed by legislation in February 1996. However, the 1982 Plan was approved for up to the year 2000 and it is still regarded as effective. Therefore it is relevant to review some of its basic statistics and provisions.

Table 2.27 The Structure of Land Use (1995)

Type of Use	Percentage
Arable	5 %
Permanent Crops	5 %
Meadows and Pasture	20 %
Forest and Woodland	30 %
Other	40 %
Total	100 %

Source: Ref. 2-10

The total territory of the Country is 2,571,000 ha. According to the 1982 Plan, productive terrain including forest and agricultural land covers 2,278,944 ha, or approximately 89% of the total territory of the Country.

In the mid-1990's, agricultural land constituted about 50 %, or approximately 1,300,000 ha of the Country's total land area. The functional distribution of total land area is displayed in Table 2.28 (Data Book Figure D2.1 and D2.2).

Table 2.28 The Structure of Agricultural Land Use (1995)

Land-use Categories	Percentage
Pastures	50 %
Farmland	42 %
Vineyards and Orchards	4 %
Meadows	4 %

Source: Ref. 2-5

The plan projects an increase of forest land 961,810 to 1,179,550 ha, or 42 to 51 % of total productive terrain, while it envisages a decrease of agricultural land; 1,317,134 to 1,099,394 ha, or from a former 58 % to less than 50 % of total productive terrain. According to the plans, pastures will be reduced 662,977 to 508,977 ha, or 50 to 46 % of agricultural land and farmland likewise 654,157 to 590,417 ha, or 50 to 45 % of agricultural land. Due to the decline of this rural population and agricultural activity, fallow and uncultivated land has been on the increase (comprising about 160,000 ha, or 30 % of arable land in 1993). In the mid-1990's, about 70 % of the arable land was privately owned. Plans are being implemented for further privatization.

The amount of non-productive land with 292,356 ha or 11 % of the Country's territory will not be changed. The share of eroded and rocky areas, however, will be reduced 140,451 to 104,145 ha, i.e. by about 25 %. (In the mid-1990's about 38% of the total land area was classified as severely eroded, with soil loss averaging around 17,000,000 m^3 in a year.) The plan envisages an increase in water surfaces 83,211 to 94,511 ha (with the latter covering 32 % of non-productive land). The portion of mining areas will almost be tripled, 5,400 to 14,600 ha, with the latter covering 5 % of non-productive terrain. The projected size of inhabited land is up 46,000 to 56,000 ha, the latter amounting to 19 % of non-productive terrain or to 2.2 % of the total territory of the Country.

The land area covered by infrastructure is intended to be enlarged 17,294 to 23,000 ha. (In the "New Physical Plan" the main road network is to be expanded by 1,100 km to a total length of 3,000 km, with the latter to cover an area of 5,400 ha. The local road network is projected to expand to 7,500 km, with an area coverage of 8,300 ha. Railroads are expected to expand to 1,100 km, with an area coverage of 1,350 ha.)

Apart from the national physical plan, there are distinct physical plans for certain regions and municipalities, such as those for the regions of Eastern Macedonia, Polog, Ohrid-Prespa, Mariovo and Skopje, and for certain national parks, like those of Mavrovo, Galichica and Pelister. The General Plan for Municipalities (1996) covered 25,785 ha of urban area, with 11,819 ha of housing area - 8,245 ha for residential, 1,938 ha for communal structures, and 1,636 ha for combined functions. The industrial area is 1,973 ha. Zoning is indicated in the plans for the central city, service and warehousing, sports and recreation functions respectively.

No environment-specific zoning regulation have been introduced into the land use system. About 6.6 % of the total land area is under some protection stipulated by the Law on Natural Rarities Preservation (including three national parks with a combined are of 108,000 ha, five special reserve areas with nearly 9,000 ha, 14 plants and animal reserves covering about 63,000 ha and one world heritage Site with 38,000 ha; cf. Ref. 2-7 p.36), but no legal provision has yet been provided for the demarcation and management of "environmentally-sensitive" areas.

2.4 Health

2.4.1 Statistical Data

(1) Health Condition

One of the areas where environmental pollution effects are most detrimental to human welfare, and are therefore to be controlled and abated, is human health. Those are considerable methodological problems in relating specific health indicators to specific environmental factors. However, much effort has been spent on establishing causal links between environmental and health conditions in general, and the link between air pollution and respiratory diseases in particular.

First, the general health condition of the population must be concluded. Life expectancy in 1992 stood at 74.4 years for women and at 70.1 years for men, in 1995 to 1997 at 74.5 and 70.3 years, respectively, considerably lower than in most industrialized countries (for OECD countries in 1995 it ranged 76.4 to 72.5 years for men and between 82.3 and 79.2 years for women).
Though there is a slight improvement distinctive of for the period from 1992 to 1997, complemented with other indices. Those data imply deterioration in the Country.

For a more structured assessment of public health and health care trends, mortality and morbidity indices are usually considered to be the most important ones. Observing national level mortality for the ten years period from 1984 to 1993 in general, a recent study has found the following fluctuating trends; stagnation around the 7.1 ‰ level in the years from 1984 to 1987, a slight decrease to 6.9 ‰ in the years from 1988 to 1990, a marked increase to 7.3 ‰ in 1991 to 7.8 ‰ local peak in 1992 and a similarly high, but slightly reduced 7.6 ‰ in 1993 (Ref. 2-5 p.1). Complemented with the data obtained from the IHP and from the Statistical Office during Site Works, the trends in general mortality for the years from 1984 to 1996 (except for 1994, for which year data are absent) are shown in Table 2.29 and Figure 2.8.

Table 2.29 National Level Trends in General Mortality Rate (1984-1997)

Years	Mortality per 1,000 Inhabitants	Years	Mortality per 1,000 Inhabitants
1984	7.1	1991	7.3
1985	7.1	1992	7.8
1986	7.1	1993	7.5
1987	7.1	1994	N/A
1988	6.9	1995	8.4
1989	6.9	1996	8.1
1990	6.9	1997	8.3

Sources: Refs. 2-5 (p.1), 2-8 (p.10)

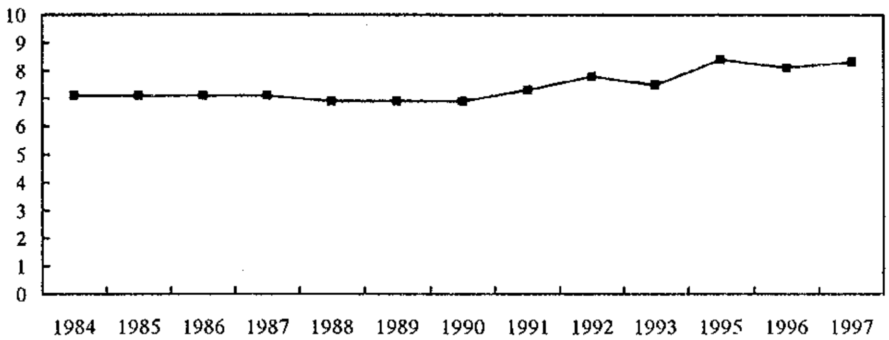


Figure 2.8 National Level General Mortality Trends (1984-1997)

For respiratory system-specific mortality, there are data for the six years period from 1991 to 1997 (1994 being an exception again). Along with the number of deaths and percentage in all deaths, respiratory system-specific mortality changes are shown in Table 2.30 and Figure 2.9, the latter indicates a slowly, but definitely rising trend again, after the decline in 1993.

Table 2.30 Number of Deaths, Percentage of Deaths due to Respiratory Diseases and Respiratory-specific Mortality per 1,000 Inhabitants (1991-1997)

Year	Number of Deaths	Percentage of Deaths	Respiratory-specific Mortality
1991	878	5.9	43.1
1992	892	5.6	43.4
1993	732	4.7	35.3
1994	N/A	N/A	N/A
1995	727	4.5	37.5
1996	776	4.8	39.0
1997	788	4.8	39.5

Source: Ref. 2-11 (p.74)

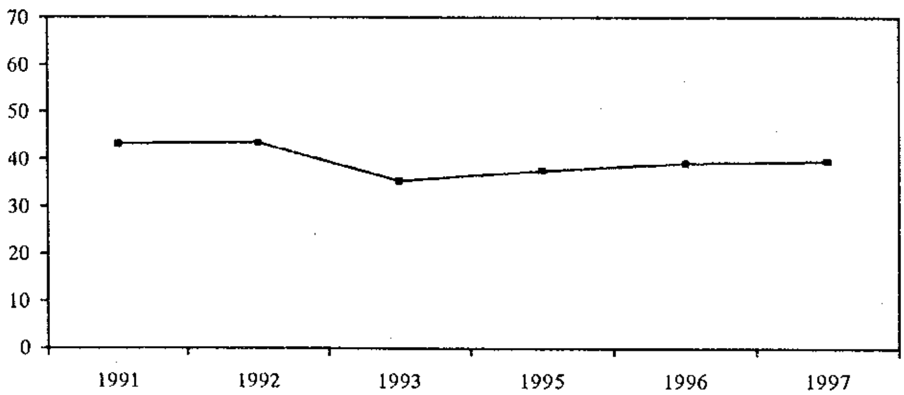


Figure 2.9 Respiratory-specific Mortality Rate per 1,000 Inhabitants (1991-1997)

(2) Causes of Death

Among the most frequent causes of death for the years from 1991 to 1997, respiratory diseases were third highest after circulatory system diseases and cancer, among the twelve International Classification of Diseases (ICD) standard categories for the causes of death. In 1997, 4.75 % of all the death cases in the Country could be attributable to respiratory diseases.

There are obvious uncertainties about these data and their causal interpretation: cause-of-death statistics have its well-known problems (it is based on the statement of the person reporting the death); local numbers are sometimes too sparse to be amenable to statistical treatment; even if diagnoses were sufficiently reliable and numbers statistically significant, the causal link between Respiratory System Attributed (RSA) cause of death and air quality is not a direct one (smoking and other factors plausibly intervene, while air quality may exert influence on causes of death other than those classified as "respiratory"); people are increasingly mobile and their respiratory problems are not necessarily attributable to the conditions momentarily prevailing in the locality where their death is reported. Even "perfect data" for a single year could not provide a basis for identifying trends, or simply for inferring a distribution more stable or robust in time and space (for which purpose time-series data would be needed). Reservations notwithstanding, data on the territorial distribution of respiratory system attributed causes of death may be still instructive to inspect, even for the single year of 1997 for which they are available. A scrutiny of municipality-level data suggests that in about half of the municipalities in 57 of a total of 123, 5 % or more of all the reported local death cases were attributed to respiratory system problems in 1997. In 15 municipalities 10 % or more (i.e. more than double the national average) of all the local deaths were attributed to respiratory system disorders. If those municipalities where respiratory-indicated death cases were less than five for the given year, they are excluded. Municipalities with 10 % or higher incidence of RSA cases of death among total cases of death (municipalities with less than five RSA cases excluded), in descending order, can be listed as shown in Table 2.31.

Table 2.31 RSA Cases of Death (1997)

Municipality	Death (%)
Cegrane	23
Lipkovo	16
Labunista	16
Rosoman	14
Staro Nagoricane	13
Kamenjane	12
Demir Kapija	12
Petrovec	11
Studenicani	11
Ilinden	11
Sipkovica	10

Source: Calculations from the raw data in Ref. 2-11 (pp.74-79)

The percentages for Skopje with 4.8 % and for its municipalities in 1997 were not so high, but still above the national average as presented in Table 2.32. Aggregate data mask considerable variations within Skopje. Conditions seem to be most deteriorated in the municipalities of Cair, Kisela Voda and Center, with data significantly higher than either Skopje or Country averages. For reasons like those referred to above, cause-of-death statistics are not likely to provide data specific enough in themselves to implicate causal effects of air quality, but taken with other data they may point up needs for monitoring and policy priorities within Skopje especially for the municipalities of Cair, Kisela Voda and Center. The indicative value of the data cited is accentuated by the fact that they refer to a year when the polluting potential of industry was still relatively low, due to economic transition and restructuring.

Table 2.32 Incidence of RSA Cases of Death among Total Cases of Death (1997)

Skopje / Municipalities / Republic	Death (%)
Skopje average	4.81
Cair	6.49
Kisela Voda	5.71
Center	5.33
Gazi Baba	4.20
Karpos	3.65
Suto Orizari	3.62
Dorce Petrov	0.17
Republic Average	4.75

Source: Calculations from the raw data in Ref. 2-11 (pp.74-79)

Even more pronounced is the weight of respiratory disorders in the statistics of morbidity. From 1984 to 1993 the overall trend in recorded outpatient morbidity was that of a decline, somewhat accelerated from 1991: the 1984 rate of 1,704 ‰ (with a local peak of 1,757 ‰ in 1986) decreased - partly due to changes in the public health system - to 944 ‰ by 1993. For 1994 the rate increased again to 1,163 ‰ and to 1,308 ‰ in 1995. Yearly data are given in Table 2.33. The corresponding trend is depicted in Figure 2.10 (1985 excepted).

Table 2.33 Total Morbidity Rate per 1,000 Inhabitants (1984-1995)

Year	1984	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Morbidity (‰)	1,704	1,757	1,608	1,670	1,557	1,716	1,469	1,125	943	1,163	1,308

Source: Ref. 2-12

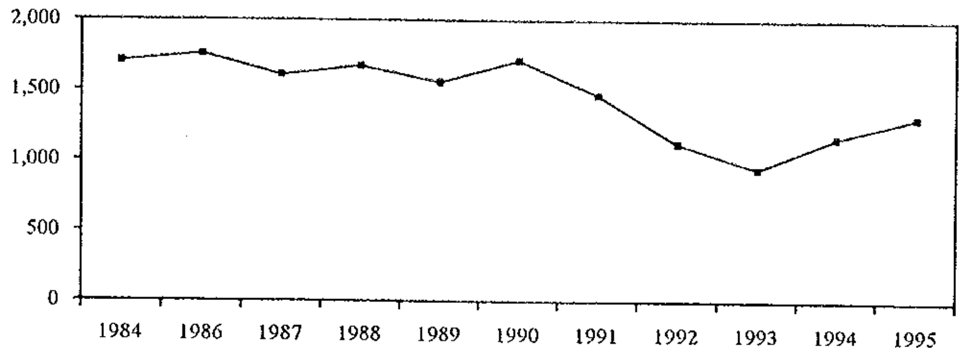


Figure 2.10 Total Morbidity Rate per 1,000 Inhabitants (1984-1995)

When respiratory and pulmonary system-specific morbidity is analyzed, it is often pointed out that these disorders dominate the morbidity structure of the Country. The prevalence of respiratory and pulmonary diseases in the morbidity structure is a long-term trend as reflected by the health service statistics in Table 2.34 and Figure 2.11.

Table 2.34 Respiratory and Pulmonary Morbidity Rates per 1,000 Inhabitants (1986-1995)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Morbidity (‰)	888	774	836	781	848	742	581	473	518	630

Source: Ref. 2-12

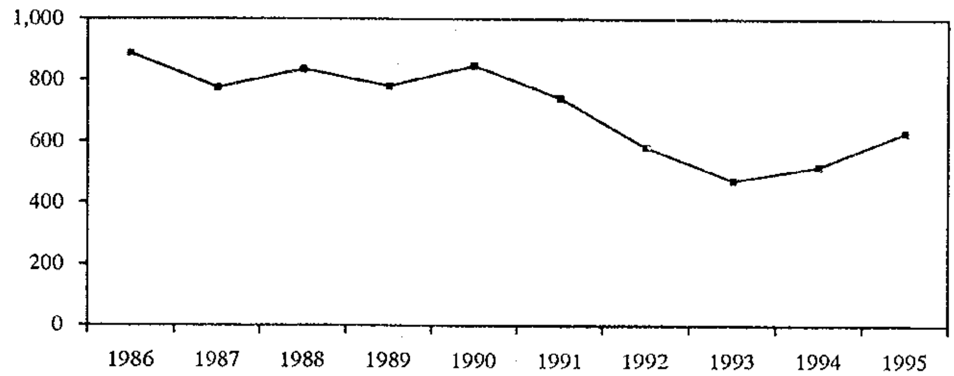


Figure 2.11 Respiratory and Pulmonary Morbidity Rates per 1,000 Inhabitants (1986-1995)

(3) Number of Patients

A check on the number of patients admitted by hospitals for pulmonary diseases and tuberculosis (TB) in 1995, 1996 and 1997 (the years for which this indicator has been available) suggests a rising trend as shown in Table 2.35 and Figure 2.12.

Table 2.35 Number of Patients Received by Hospitals for Pulmonary Diseases and TB (1995-1997)

Year	1995	1996	1997
Patients Received	2,018	2,228	2,253

Source: Ref. 2-7

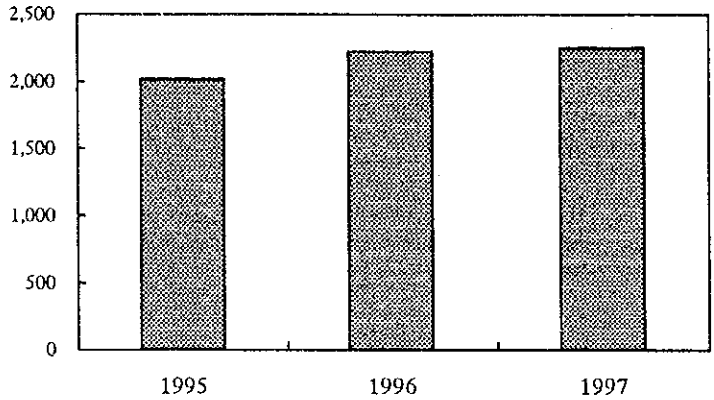


Figure 2.12 Number of Patients Received by Hospitals for Pulmonary Diseases and TB (1995-1997)

The index of the days of inpatient care for persons discharged from hospitals for pulmonary diseases and TB indicates a rise and subsequent moderate decline for the same years, as presented in Table 2.36 and Figure 2.13.

Table 2.36 Days of Inpatient Care for Persons Discharged from Hospitals for Pulmonary Diseases and TB (1995-1997)

Year	1995	1996	1997
Number of Days	86,351	90,637	84,175

Source : Ref. 2-7

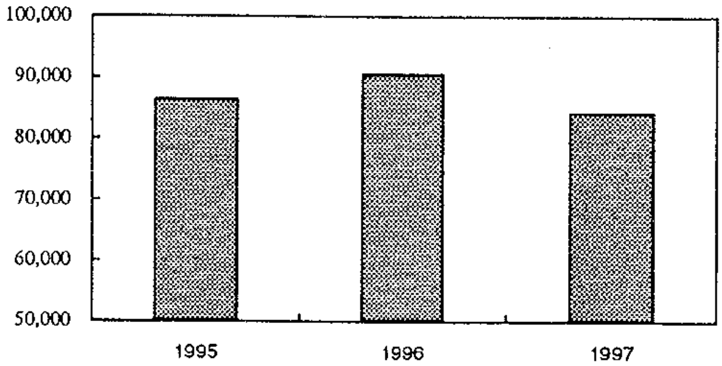


Figure 2.13 Days of Inpatient Care for Persons Discharged from Hospitals for Pulmonary Diseases and TB (1995-1997)

The data on the number of patients admitted to Institutes for Pulmonary Diseases and TB for children as well as the data on inpatient days of patients discharged from the same Institutes seem to support the above trends, but such data have not been available for 1995 (therefore combined indices have not been feasible to compute). The above data are not sufficient for ascertaining longer term trends in the same indicators (e.g. to check whether the value for 1996 is part of a longer trend or indicates just a local deviation from the trend).

National level figures again show marked regional, seasonal, age-group and other variations. Specific morbidity rates are highest in densely populated urban zones in the winter periods and especially extant in the 0 to 14 age-groups, exceeding the 700 ‰ and in Skopje and Veles exceeding even the 1,000 ‰ levels. The morbidity of respiratory diseases of the child population is as the top of the morbidity structure of the Country - as a recent analysis has concluded (Ref. 2-5, pp.III/3-4). An 1998 report of the National Institute of Health Protection has pointed out a markedly higher incidence of non-specific respiratory morbidity in the pre-school than in the school age population. (Ref. 2-13) Also the correlation between average monthly concentrations of Black Smoke (BS) and SO_2 and chronic respiratory diseases was found most robust in infant morbidity. (In the case of children smoking habits can be largely ignored, therefore causal links between air pollution and respiratory morbidity are less problematic to establish.) The data from the Institute for Respiratory Diseases in Children in Skopje on the inpatient treatment of children for acute respiratory problems and obstructive syndromes clearly highlighted the extent of risks and consequences, as observable in Table 2.37 and Figure 2.14.

Table 2.37 Treatment of Children for Acute Respiratory Problems in Skopje (1986-1993)

Year	1986	1987	1988	1989	1990	1991	1992	1993
Number of Patients	1,982	1,871	2,099	2,438	2,299	2,398	2,450	2,120
Average Number of Treatment Days	15.5	17.2	15.4	16.0	14.9	16.3	18.6	16.2

Source: Ref. 2-5 (p.III-4)

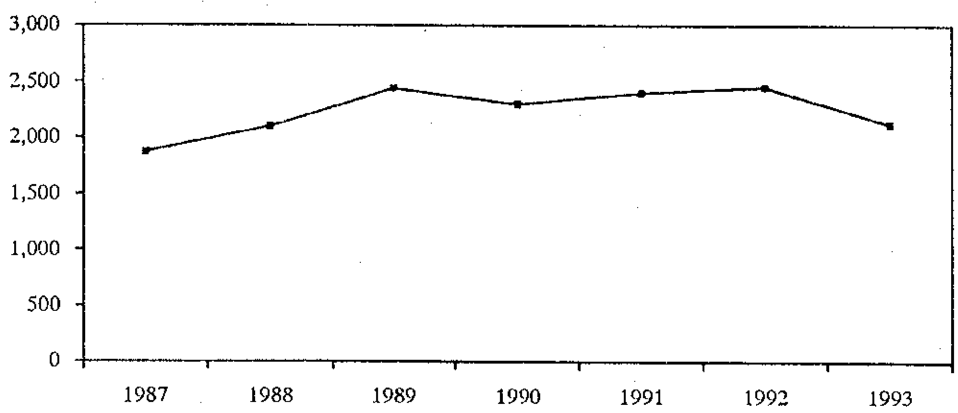


Figure 2.14 Treatment of Children for Acute Respiratory Problems in Skopje (1986-1993)

Looking across the year, the morbidity rate is high for the first and fourth half-yearly period which also happen to be the heating season. During the winter season, children contract bronchitis repeatingly over and over again. It is said that for 1984, the proportion of elementary school children being treated at clinics has reached 96.6%. Table 2.38 shows the number of outpatients from the younger age-group being treated for respiratory diseases in Skopje. It is obvious that effects of complex pollution due to SO_2, NOx and SPM are the main causes for such diseases.

Although the data only include that for specific targets mainly like infants and children, the effects on health for the sick and elderly are also thought to be big.

Table 2.38 Quarterly Rate of Ambulant Cases in the Institute for Respiratory Diseases in Children, 1989-1993 (only patients from Skopje area)

	Quarter Period	Total	Sex Mail	Fem.	Age 0-6	7-14	15-19	Diagnosis URD	ABE	Bron.	TB
1989	IV	2,420	1,502	927	1,566	826	37	178	1,557	666	28
1990	I	3,115	1,857	1,258	2,253	781	81	170	2,101	837	5
	II	2,437	1,468	969	1,837	540	59	95	1,572	764	6
	III	1.507	896	611	1,137	344	26	101	1,087	307	12
	IV	1,888	1,165	723	1,491	367	30	117	1,410	351	10
1991	I	2,351	1,427	924	1,871	419	61	165	1,617	559	10
	II	2,000	1,166	834	1,518	453	29	98	1,320	582	0
	III	1,550	962	588	1,074	434	42	109	1,075	363	3
	IV	2,428	1,475	953	1,844	535	49	180	1,654	593	1
1992	I	1,868	1,148	720	1,483	360	25	74	1,272	521	1
	II	1,778	1,027	751	1,389	366	23	135	1,182	447	14
	III	925	954	358	657	273	22	101	641	199	11
	IV	1,940	1,131	809	1,564	358	18	98	1,380	453	9
1993	I	2,038	1,193	854	1,163	760	115	558	983	493	4

URD: Upper respiratory diseases

ABE: Asthma-bronchitis-emphysema

Bron.: Bronhopneum

TB: Tuberculosis

Respiratory and pulmonary diseases as reported by outpatient or inpatient services do not necessarily exhaust all pathogenic effects of air pollution. While malignant diseases, as such are a category of mortality and morbidity statistics distinct from respiratory and pulmonary ones, a medical doctor of the Institute of Radiotherapy and Oncology (Skopje) stated in a daily newspaper during Site Work I: the number of cancer patients has doubled in the past two decades, and air pollution and smoking are certainly among the primary causes of the expansion (Ref. 2-14).

2.4.2 Cases of Effect

NEAP carries out investigation on the effects that air pollution has on health and the results are summarized as below:

(1) Veles

- Although Pb, Zn and Cd smelters can be found located next to the residential area and, making it one of the most dangerous areas, there has not been much discussion over this issue and no effective protection measures has been taken either. This is due to a lack of funds from both the government and plants and also due to a lack of any organization to carry out full investigations on the environment.

- In 1978, an investigation was carried out to study children exposed to heavy metal pollution from regions with air pollution as well as those from background regions. Although the concentrations of Pb and Zn present in the blood of these children were found to be within the permissive range, the concentration rate is higher for those from the polluted regions, as compared to that of the background region.
- In 1986, upon a clinical check on the workers from these smelters, the results reveal that symptoms such as multi-sense changes in the intestinal organs, changes in the urine and symptoms of high blood pressure can be found among 20 % to 40 % of the workers.
- The 1971 morbidity rate for respiratory diseases among residents before these smelters started operating, was 63.4%. However, after these smelters started operating in 1973, the rate increased greatly to 98.6%.

(2) Bitola

- The Bitola power station is located 12km away from the Bitola. Most of the severe impacts which have on the environment are those on the neighboring village. The Bitola power station has a stuck of 250m high, therefore, the gas emitted are diluted in terms of concentration. Although the emission volume for SO_2 is high, the environmental impacts which have on the ground are relatively little. The main problem, however, lies in the impact that each type of dust particles has on the neighboring areas. It was observed that an extremely large quantity of coal particles was found scattered in all directions whenever the wind blew.
- Coal slug and ash do not have desirable impacts on the human health of residents living nearby. Symptoms of pulmonary functional disorders and that of heart diseases are common.