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).

(1) The Present Compound-specific Directives (CSD)

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.

Table 2.1 shows requirements from CSD.

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").

(2) The Present Draft Exchange of Information Decision (EoI)

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

- 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.

Table 2.2 shows requirements from EoI.

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.

(3) The Draft Framework Directive (FWD) 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 2.3 shows requirements from FWD.

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. Table 2.5 shows emission ceiling and targets for SO_2 from existing plants (see Table 2.6 in Supporting Report (S/R) p.2-6 for NOx).

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

(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 for SO_2 are shown in Table 2.6 and rates of desulfurization is shown in Table 2.7 (see Tables 2.8 and 2.9 in S/R, p.2-9 for NOx and Dust).

Table 2.6 Emission Limit Values for SO_2 for New Plants

Type of Fuel	Thermal Capacity (MW)	Emission Limit Values (mg/Nm^3)
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 2.7 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 2.8.

Table 2.8 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 2.9 shows the substances that are designated in the Directives.

Table 2.9 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** (**COoR**dination d'**IN**formation Environnementale) 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.
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 programs 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.

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.
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.

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.

(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 in 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 (details are shown in S/R, p.2-15):

Criteria No.	Definition
1	Combustion plant with a thermal capacity $\geqq$ 300 MW
2	Any refinery
3	Workshops include in integrated steel plant with a production capacity $\geqq 3 \times 10^6$ Mg of steel/year. (Mg = ton)
4	Any sulfuric acid plant
5	Any nitric acid plant
6	Paper pulp production plant when the capacity is $\geqq$100,000 Mg/year of pulp plant whatever the thermal capacity is.
7	Painting car plants when the capacity is $\geqq$100,000 passenger cars/year or equivalent when only pieces of cars are painted.
8	International airports when the amount of LTO cycles is $\geqq$100,000/year.

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.

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.

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

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.

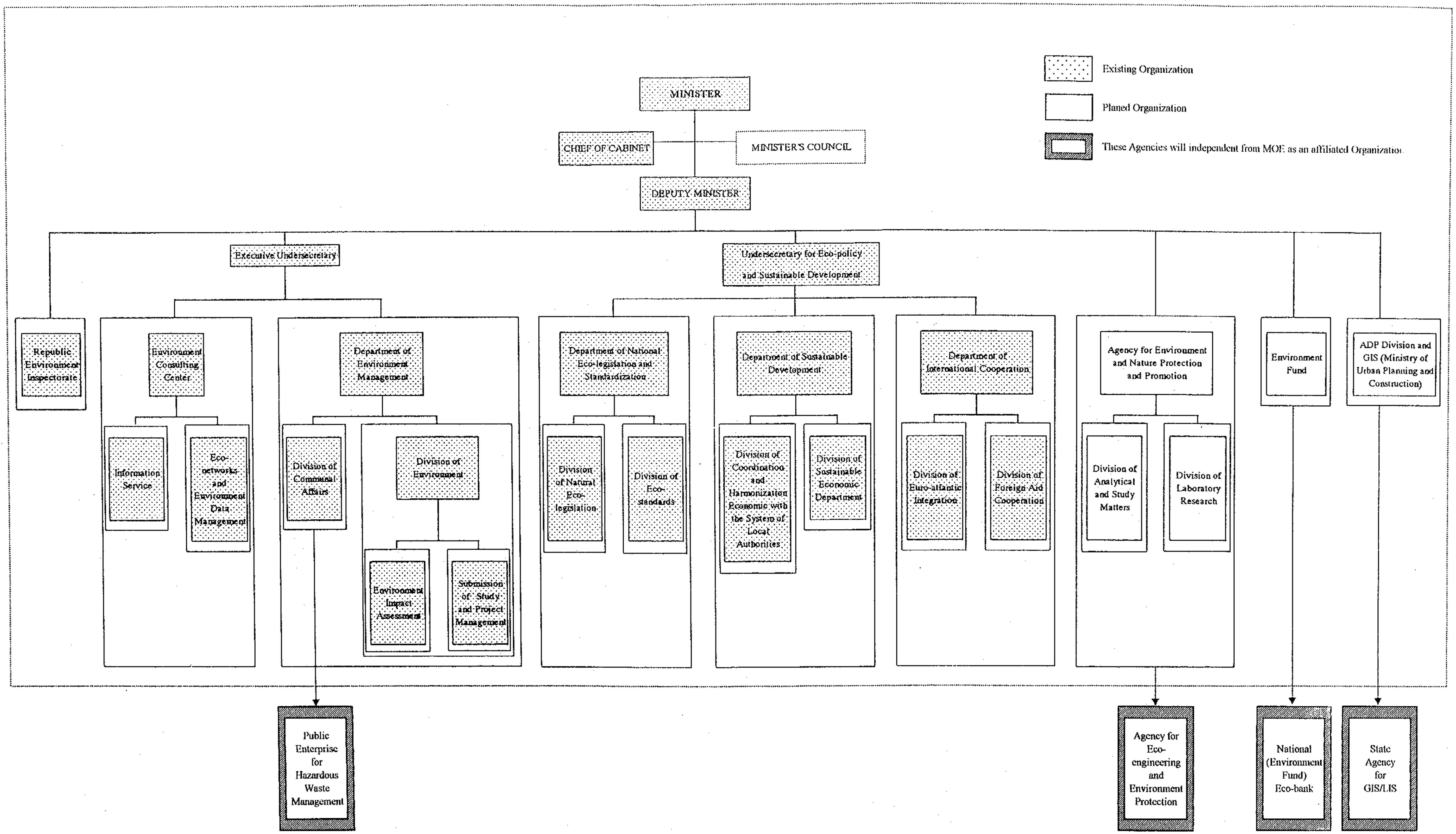


Figure 2.1 Organizational Scheme of the MOE

(2) Other Environmental Organizations

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 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.

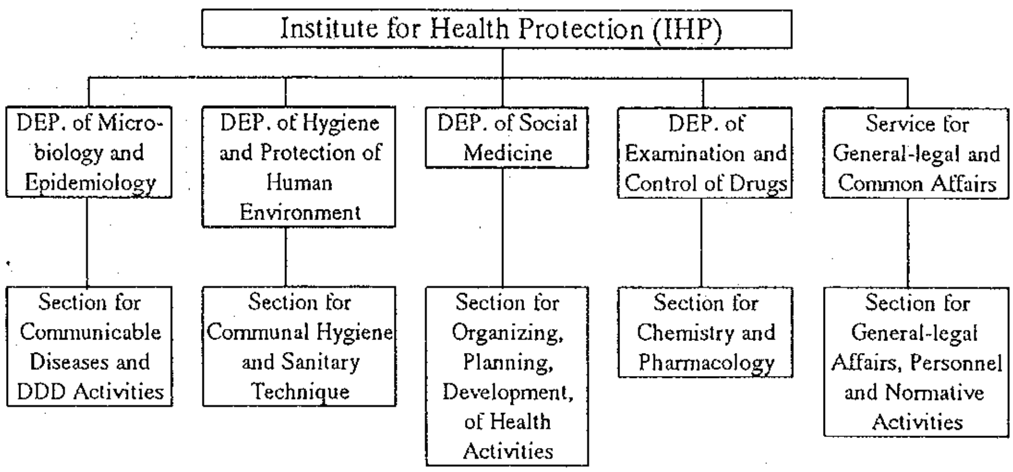


Figure 2.2 Organizational Scheme of the IHP

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 synoptically 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.

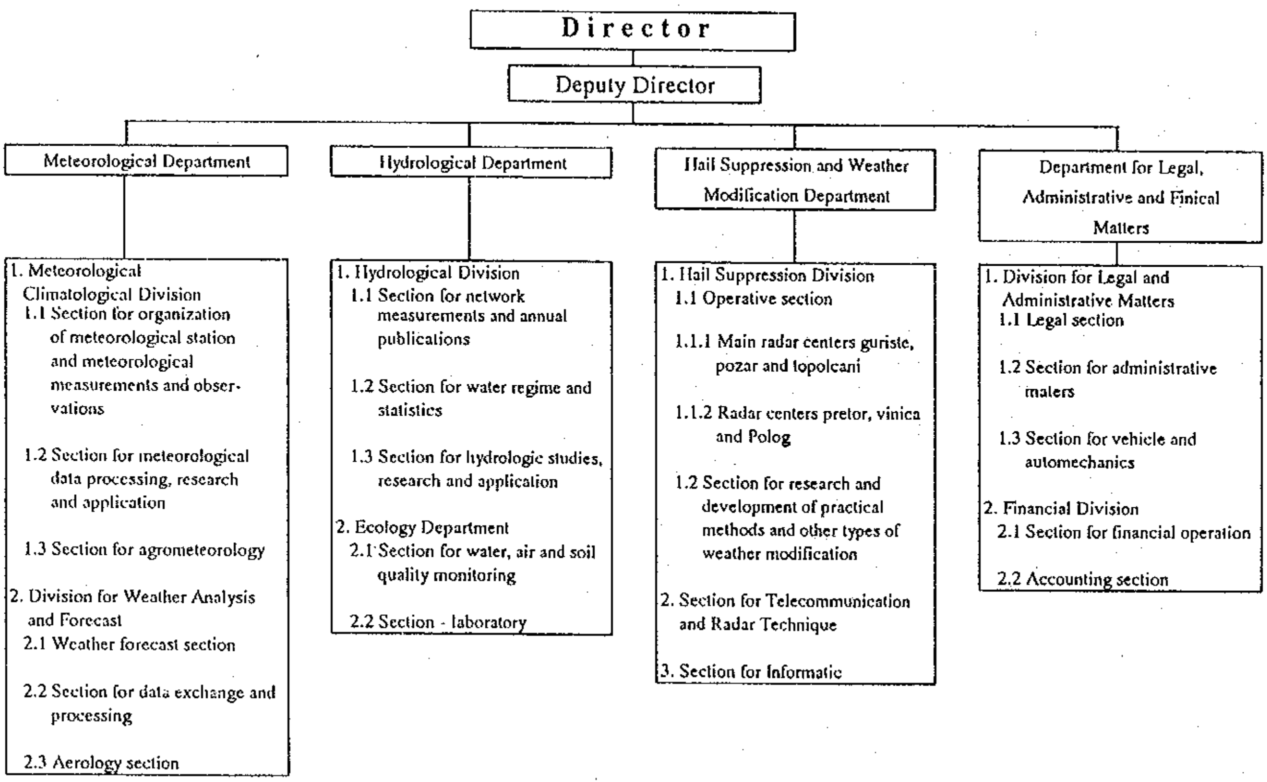


Figure 2.3 Organizational Scheme of the RHI

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 (emission standards are shown Table 2.14 to 2.17 in S/R pp. 2-23 to 2-25).

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) Standards and Methods Related to Air Quality Monitors

<Environmental Standards>

The currently enforced Law on Protection of Air Pollution provides an environmental standard for 13 items (Table 2.18 in S/R, p.2-26 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.

Table 2.10 shows ambient air quality standards at Macedonia compared with that of EU, of EU, of WHO and of Japan.

Table 2.10 Comparison of Ambient Air Quality Standards

		Macedonia		EU		WHO	Japan
		For Minute Values	Daily Average Values	Limiting Values	Guiding Values *13		
SO_2 ($\mu g/m^3$)	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 ($\mu g/m^3$)	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 ($\mu g/m^3$)	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) ($\mu g/m^3$)	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 ($\mu g/m^3$)	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 ($\mu g/m^3$)	24-hour Values		0.7 (1.5 *4)				
	Annual Average Values			2		0.5-1.0	
CS_2 ($\mu g/m^3$)	24-hour Values	30	10			100	
H_2S ($\mu g/m^3$)	24-hour Values	8	8			150	
H_2SO_4 ($\mu g/m^3$)	24-hour Values	300 *2 6 *3	100 *2 2 *3			10 *15 (H_2SO_4, or equivalent to conversion into acid)	

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 $\mu g/m^3$, 180 when BS ≦ 60 $\mu g/m^3$

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 SO2 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

(3) 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.

(4) 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)

(5) 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

(6) 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.

(7) 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 (Detail of the system is shown in S/R, pp. 2-31 to 2-34).

1) 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

2) 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 2.11 and/or Table 2.12. When the state of air pollution does not improve after announce, alarm for next stage will follow.

Table 2.11 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 2.12 Alarm Criteria of High Concentration Air Pollution (2)

Concentration (3 hours) (mg/m^3)	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.

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 Figure 2.4 (see Table 2.22 in S/R, p.2-35).

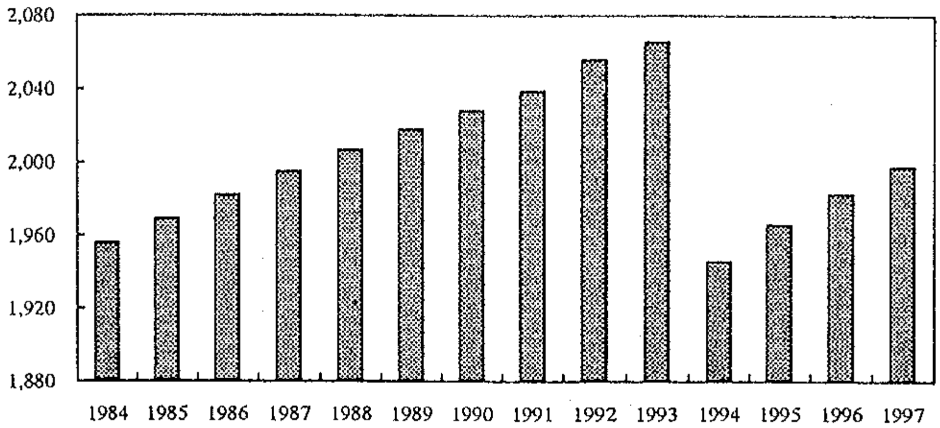


Figure 2.4 Mid-year Total Population (1984-1997)

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.

2.3.2 Territorial Structure

(1) Urbanization

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 2.13 (see Table 2.24 in S/R, p.2-37 for Regional Population).

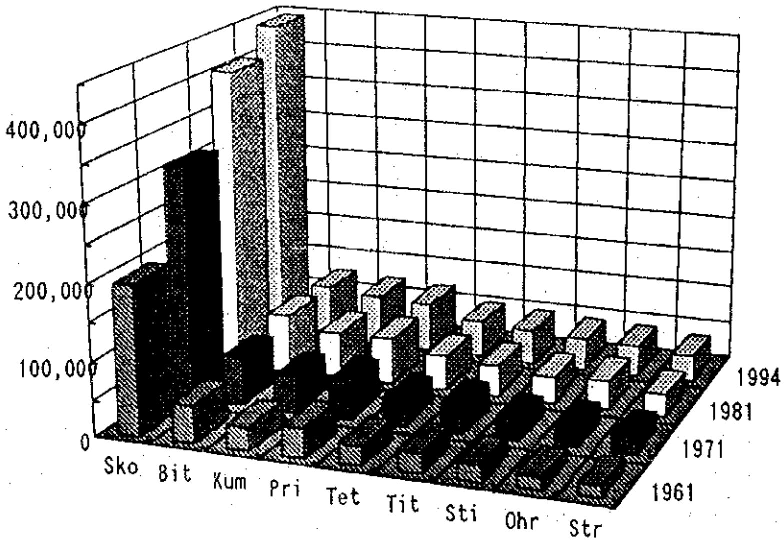
Table 2.13 Changes in the Proportion of Urban Population within Total Population

Year	1971	1981	1991	1994
Total (%)	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 are described in Figure 2.5. Urbanization effects have been most pronounced for the same nine communities, especially for Skopje where fast population and urban growth.



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

Figure 2.5 Population Growth of Urban Communities over 30,000 (1961-1994)

(2) Land Use

National level land use structure in the year 1995 is shown in Table 2.14. And 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 the 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 2.14 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. 2-9

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.

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, fourteen 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.

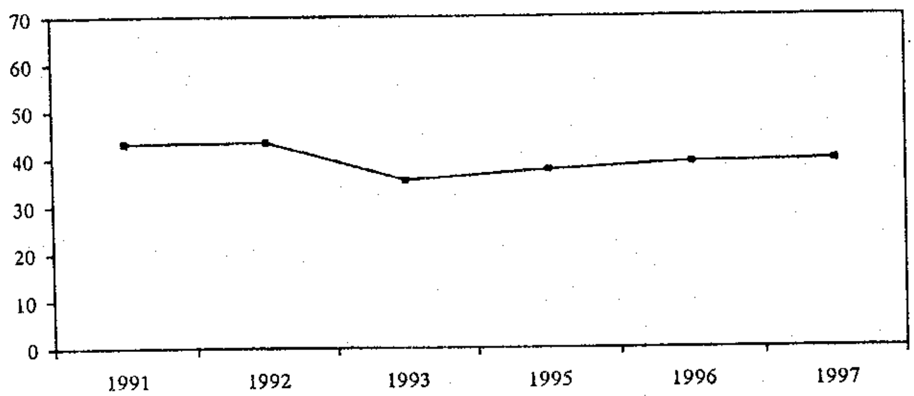
2.4 Health

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.

For respiratory system-specific mortality, there are data for the six years period from 1991 to 1997 (except for 1994, for which year data are absent). Along with the number of deaths and percentage in all deaths, respiratory system-specific mortality changes are shown in Figure 2.6, the latter indicates a slowly, but definitely rising trend again, after the decline in 1993 (see Table 2.30 in S/R, p.2-44).



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

Figure 2.6 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").

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. 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 2.15.

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 2.16. 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 2.15 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

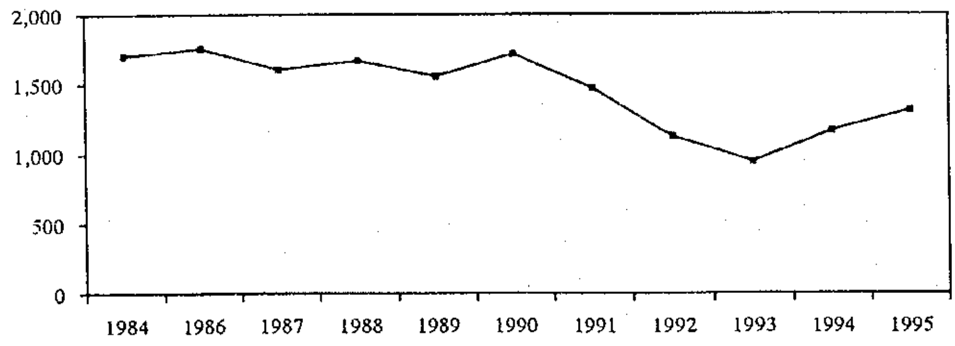
Source: Calculations from the raw data in Ref. 2-10 (pp.74-79)

Table 2.16 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. 2-10 (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 trend is depicted in Figure 2.7 (1985 excepted) (see Table 2.32 in S/R, p.2-46).

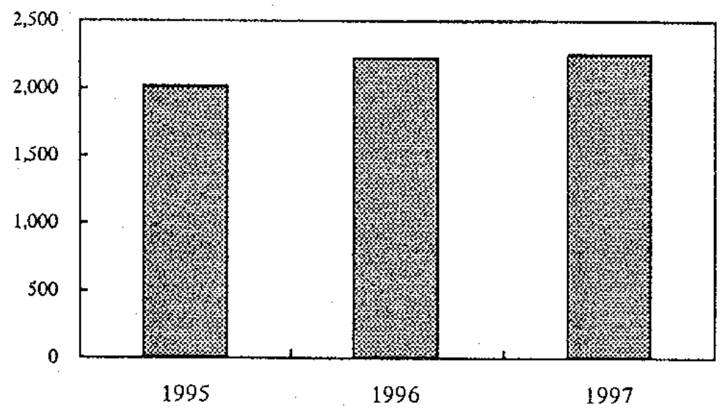


Source: Ref. 2-11

Figure 2.7 Total Morbidity Rate per 1,000 Inhabitants (1984-1995)

(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 suggests a rising trend as shown in Figure 2.8 (see Table 2-35 in S/R, p.2-48).



Source: Ref. 2-7

Figure 2.8 Number of Patients Received by 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. 2-12) Also the correlation between average monthly concentrations of BS and SO2 and chronic respiratory diseases was found robust in infant morbidity. The data from the Institute for Respiratory Diseases in Children in Skopje on the inpatient treatment of children for acute respiratory problems showed the extent of risks and consequences, as observable in Table 2.17 and Figure 2.9.

Table 2.17 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)

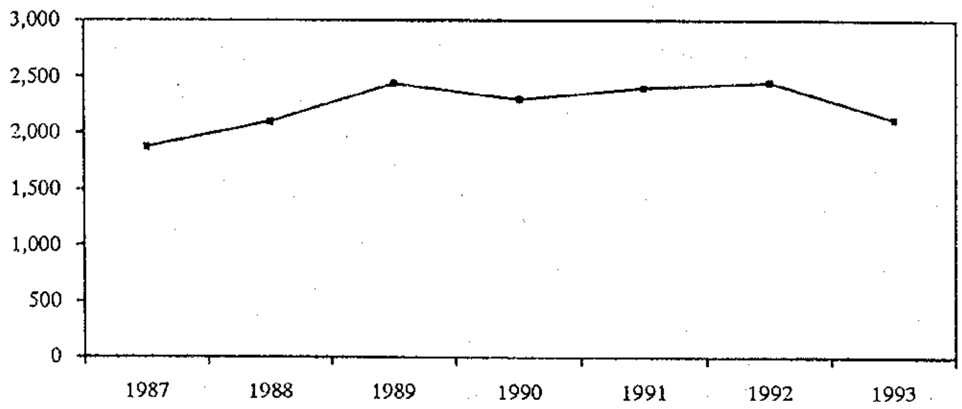


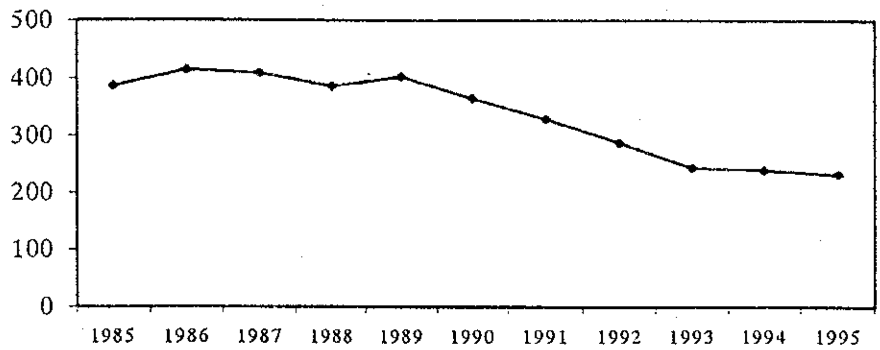
Figure 2.9 Treatment of Children for Acute Respiratory Problems in Skopje (1986-1993)

2.5 Economy

2.5.1 Overall Economic Trends

(1) Gross Domestic Product

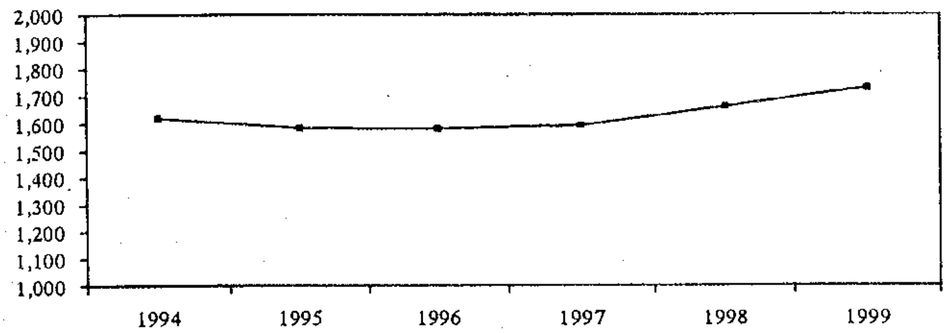
The index of overall economic dynamics most often cited these days is that of the Gross Domestic Product (GDP). Due to efforts in recent years, GDP accounting has resulted in indices at constant prices for the national economy of the Country for the years from 1990 to 1996. These data are qualified by the Statistical Office, however, as "preliminary" (partly attributable to the need of overhauling the system of economic statistics, partly to the extent of the informal economy). The latter was estimated by a government commissioned study at about 30 % in the autumn of 1997 (Ref. 2-7, pp.204-208). Therefore, for the purposes of longer-range comparison, first the "Social Product" indicator more customary in former "planned economies" is shown in Figure 2.10 (see Table 2.39 in S/R, p.2-53).



Source: Ref. 2-7 (p.201)

Figure 2.10 Total Social Product at 1972 Prices /1960=100/ (1985-1995)

Figure 2.11 shows the GDP per capita data in US$, which has been available for the years from 1994 to 1999 and show the trends well (for 1998 as estimated, for 1999 as projected) (see Table 2.40 in S/R, p.2-54).

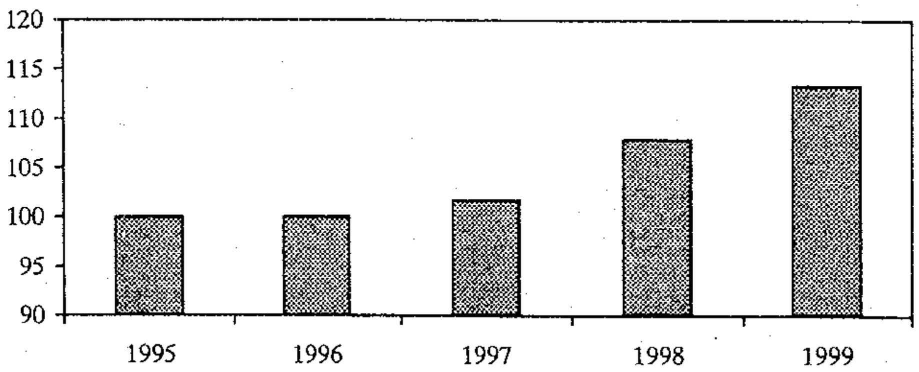


Sources: Refs. 2-8 (p.33), 2-15 (p.5)

Figure 2.11 Gross Domestic Product per Capita / US$ (1994-1999)

Shown in Figure 2.10, overall economic output was on the decrease from the mid-1980's, except for 1989. The GDP curves, especially the one for the GDP per capita, also suggest that from the mid-1990's economic decline may have turned into potential recovery and growth. As the latter is taking place, the double effect mentioned may be reversed in the coming years, both for more resources to mobilize for environmental purposes and for increasing environmental pollution.

In fact, as seen in Figure 2.12, real GDP growth rate figures (estimated for 1998, projected for 1999) well reflect a gradual resumption of growth since 1996 and the gathering momentum of the process since 1998 (in January 1999 views, 1998 rate may have been 5.0 in reality) (see Table 2.42 in S/R, p.2-56).



Source: Ref. 2-16

Figure 2.12 Real GDP Volumes / Year (1995=100)

(2) Ownership Structure

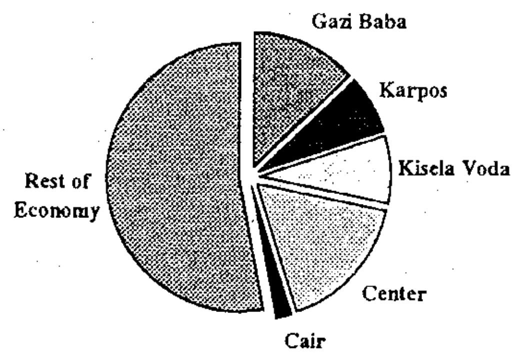
One of the most important institutional features of the economy, especially for its environmental consequences, is its ownership structure. A 1998 Privatization Report of the Agency of Macedonia for the Transformation of Enterprises with Social Capital cites the results of a survey done by the Payment Operations Service. According to the findings of the survey, by the second half of 1997 over 70 % of the total revenues, 80 % of all the profits of the Macedonian economy were already generated, and 60 % of the whole labor force was employed by the private sector. By December 31 1998, 1,311 companies were privatized with a total number of nearly 200,000 employees (198,862) and a total value of 33 million DEN. (Source: Ref. 2-14)

Since ownership relations are of utmost relevance for environmental conditions and policy regimes, the fact that the transformation of the Macedonian economy's progressed towards a market-type, privatized regime to this extent is of obvious importance for air-pollution and related policy-making.

As of January 1999, however, the process of privatization is not yet considered as finished: it is still going on for 181 enterprises, and for 80 enterprises it has not yet even begun. (Source: Ref. 2-13) Of special interest here is the "problem companies", for which the Agency of Macedonia for the Transformation of Enterprises with Social Capital has not found (foreign) investors: Many of these companies are not only heavy loss-makers, but also some of the worst polluters. The International Monetary Fund (IMF) is helping with the privatization of 12 of such companies (with a total work force of about 50,000), but this does not resolve the situation for all of them in the same category. A number of these companies have been seeking "rescue measures" from the new Government (in office since November 30, 1998), but the Prime Minister has clearly stated the negative options (Source: Ref. 2-13). All these have serious consequences for the clean-up of past environmental mitigation and for future chances of effectively controlling some of the worst polluters.

(3) Social Product

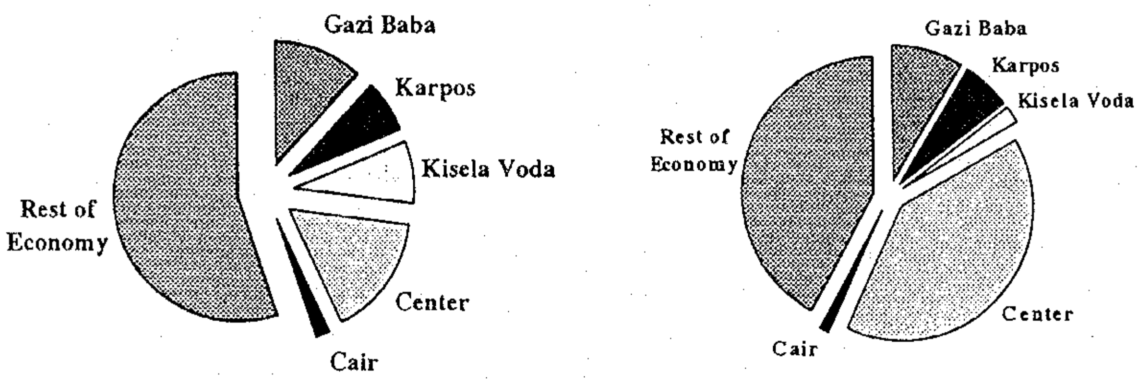
While the weight of Skopje and its municipalities in the national economy is obvious, from available statistics it can be circumscribed largely by Social Product, National Income Investment and Fixed Assets data. Figures 2.13, 2.14 reflect the share of Skopje and its municipalities in total Social Product, National Income, Investment and Fixed Assets for the year 1995, broken down by economic sectors.



Source: Ref. 2-7 (pp.278-288)

Figure 2.13 Share of Skopje and its Municipalities in Total Social Product / Current Prices (1995)

It is visible from the data showed in Figure 2.13 that Skopje and especially two of its municipalities, i.e. Center and Gazi Baba are highly preponderant in the national economy. Though there have not been data available on the temporal and more recent course of the process, it is obvious that the displayed measure of spatial concentration is a major factor in Skopje's environmental problems in its own right. The same can be observed from the National Income, Investment and Fixed Assets distributions as shown in Figure 2.14 (see Table 2.44 in S/R, p.2-59).



Source: Ref. 2-7 (pp.282, 288, 560)

Figure 2.14 Share of Skopje and its Municipalities in National Income and Total Realized Investment / Current Prices (1995)

Even in the absence of time-series statistics, the excessive representation of Skopje in all the dimensions quoted can be evidenced. This is most conspicuous in the case of investments, where Center alone had as much investment in 1995 as all the rest of the Country apart from Skopje, but it is also relevant to note that there is 3.72 times more Social Product produced in Center per inhabitant than the national average.

2.5.2 Industrial Trends

For a long-range view, Table 2.18 and Figure 2.15 show the total industrial production volume index in terms of Social Product accounting, from 1985 to 1995 with the base year of

1960 (=100).

Table 2.18 Total Industrial Production Volume/ Social Product/ 1960=100

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Volume	942	1,010	1,035	1,017	1,061	948	785	661	569	509	455

Source: Ref. 2-7 (p.201)

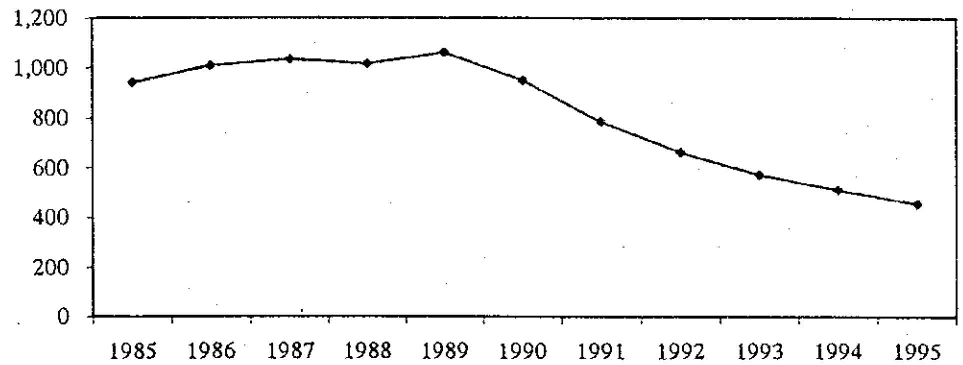
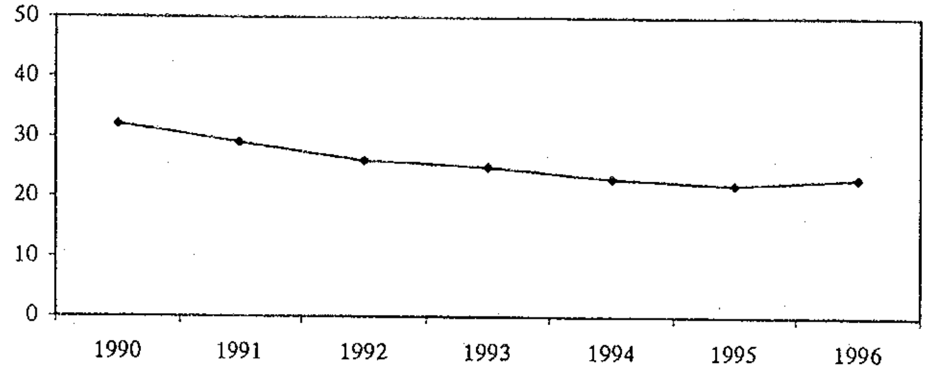


Figure 2.15 Total Industrial Production Volume/ Social Product/ 1960=100 (1985-1995)

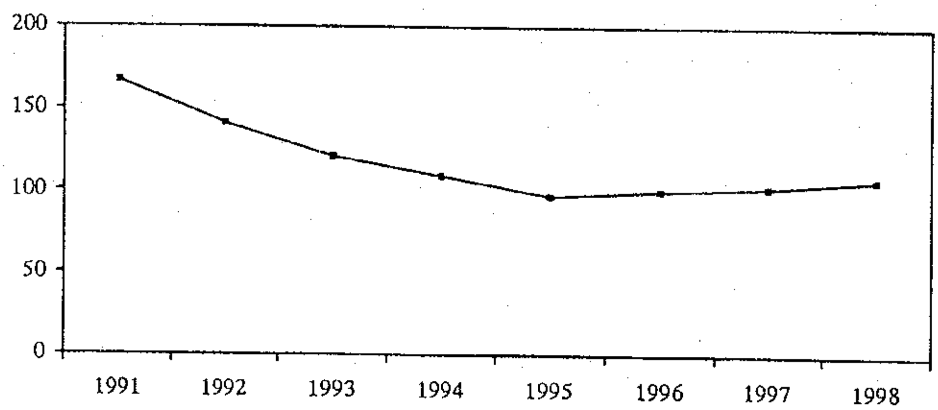
Not only has industrial production declined, the share of industry in the economy as a whole has shrunk. This is shown in Figure 2.16 (see Table 2.46 in S/R, p.2-61).



Sources: Refs. 2-7 (p.237), 2-14 (p.6)

Figure 2.16 Share of Industry and Mining in the GDP in 1990 DEN Per 1,000 (1990-1996)

For ascertaining any plausible future trend with the given shape of the above curves in Figure 2.16, the figures for 1997 and 1998 are important. The above indicators do not include data for 1997 and 1998, but as shown in Figure 2.17, Total Volume Indices are of orienting value (see Table 2.47 in S/R, p.2-61).



Source: Ref. 2-14 (pp.3, 7), * Preliminary figure in 1998 calculated from the 1998. I-X./1997. I-X. data

Figure 2.17 Index of the Total Volume of Industrial Production (1996=100)(1991-1998)

2.6 Energy

2.6.1 Energy Sector

(1) Energy Balance

The energy system has several unfavorable characteristics. Liquid fuels (a large share) have to be fully imported. Lignite reserves are rather limited (55 to 65 % of solid fuel demand has to be provided by import). The supply of gas is affected by several international and domestic factors, while hydroelectric facilities are in need of reconstruction and extension (see Table 2.50 in S/R, p.2-66).

(2) Electric Power

In the mid-1990's the productive capacities of the electric power system consisted of three thermal power stations with an installed capacity of 1,010 MW and a total output of 965 MW, of which 755 MW was coal-based, 210 MW was crude oil-based; six hydro-electric stations with a total installed capacity of 390 MW (and 721 million reservoir m^3) and six distributive hydroelectric stations with a total installed capacity of 30 MW (and 117 million reservoir m^3), utilizing about one fifth of total hydro-electric potential. (Ref. 2-16, p.19)

(3) Gas Supply

Of special importance are the gas pipeline and the communal heating systems.

The first phase of the gas pipeline system, from the Bulgarian border to Skopje was already completed. The trunk length of the pipeline is 165 km, with a working pressure of 40 kgf/cm^2 and with a capacity of 800 million m^3 in the main line. However, regular operation is expected to start no earlier than the year 2002.

The district heating system of Skopje has a connected consumption per customer unit of approximately 550 MW. Fuel conversion to gas was made experimentally in 1998 for four months, covering about 10 % of total time-proportional production by about eight million m^3 of gas, but totally gas-fueled operation is expected to start no earlier than the last part of the year 2001. Planned gas consumption for 2002 is approximately 300 million m^3 (Sources: Refs. 2-17 p.341, 2-6).

(4) Trend in Energy Production and Consumption

Long-term trends in energy production are shown in Figure 2.18.

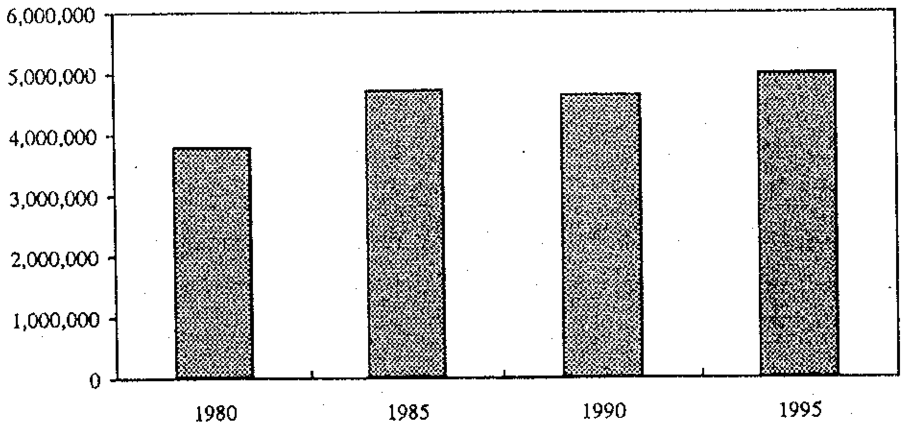


Figure 2.18 The Net Production of Electric Energy / E (GWh) (1980-1995)

More detailed trends in electric energy generation and consumption are shown in Figures 2.19, 2.20. The average growth rate of production in the period from 1991 to 1996 was 3 % (see Tables 2.51 and 2.52 in S/R, p.2-68).

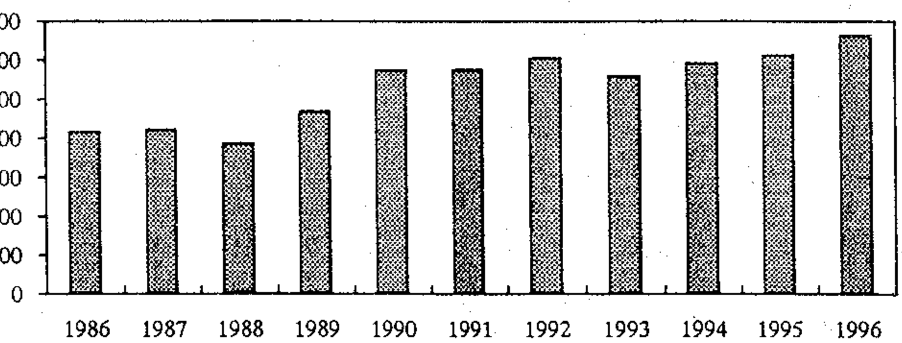
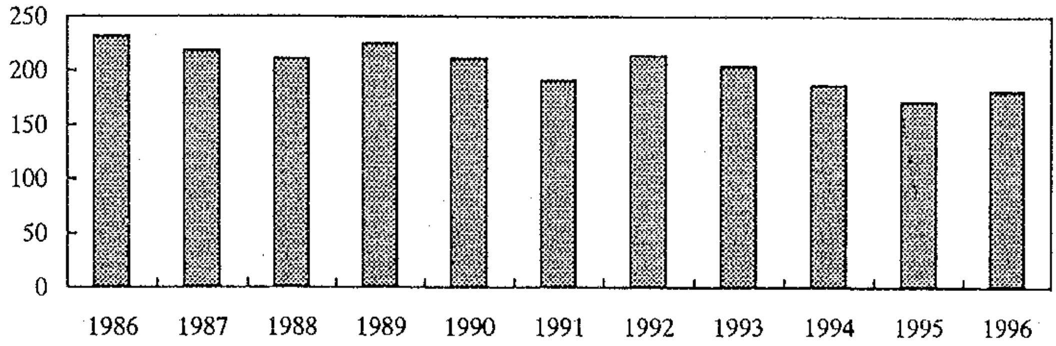


Figure 2.19 Trends in Electric Energy Generation / GWh (1986-1996)
1,000 MWh = 1 GWh

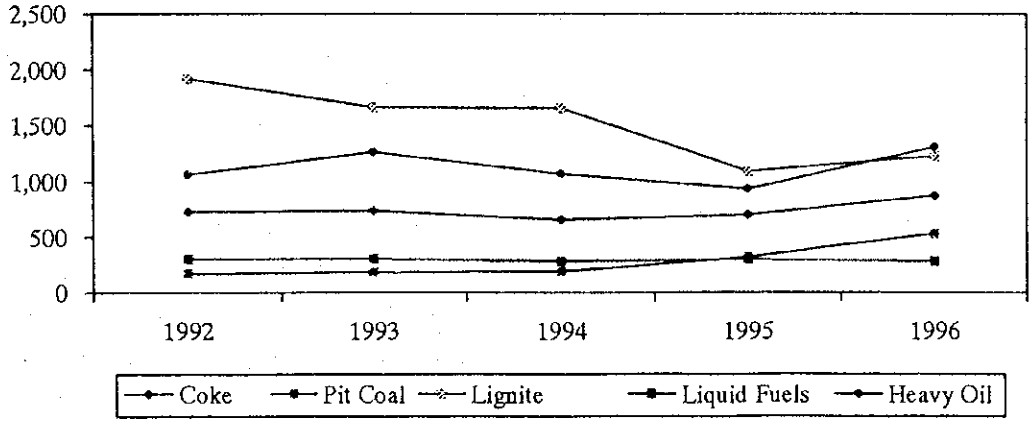
Source: Ref. 2-7 (p.380)



Source: Ref. 2-7 (p.380)

Figure 2.20 Trends in Electric Energy Consumption / 1970=100 (1986-1996)

Fuel consumption of industry by fuel type and the industrial consumption of electric energy from 1992 to 1996 are shown in Figure 2.21 (see Table 2.52 in S/R, p.2-69).



Source: Ref. 2-7 (p.399)

Figure 2.21 Fuel Consumption of Industry by Fuel Type (except brown coal) / 100 t (1992-1996)

2.7 Future Socio-economy

2.7.1 Setting Target Year

(1) Target Year

The Study Team set up a target year as 2008, 10 years later, for the purpose of implementing the Study. It is necessary to forecast future socio-economy in order to estimate emission sources and air pollution in the target year.

The Study Team and the Counterpart, as well as other parties concerned had discussed issues such as future scenarios, the organization plan and systems.

For example, as in the case of the Macedonia Academy of Science, the year 2020 was set to be the future target under the National Development Strategy (NDS). However, where environment-related problems are concerned, there is a need to address the problems at an early stage. Taking into consideration the long-term target of NEAP, the target year is therefore set at the year 2008, ten years from now.

It is necessary to set early, middle and long-term objectives (as shown by NEAP) for environmental measures and to carry out step by step all possible measures at present. In order to ensure the efficiency of such measures, facilities and equipment planning should be completed at an earlier stage.

(2) National Development Strategy

One of the critical ingredients for reliable forecasting is the existence of long-range time series for trend analysis of essential socio-economic processes. The most representative recent attempt at long-term forecasting, is the NDS report states in its chapter on Future Scenarios to the year 2020: "There are no good long-term time series of data" available. (Ref. 2-17, p.299). There are, however, projections based on approximate or indirect evidence, at varying degrees of "Optimism/pessimism" and plausibility, as well as policy statements and targets which may be of value in making judgments about the probable future course of socio-economic change. Representative base-scenarios for trends in essential socio-economic processes can be cited mainly from the NDS, supported by the United Nations Development Program and by the United Nations Department of Economic and Social Affairs.

2.7.2 Annual Growth Rate of GDP

(1) Forecast of GDP Growth Rate

Long-term global projections of the NDS, building on the foregoing trends envisage the status of the Country by the year 2020 as a full member of the European Union, with a modern democratic state and a developed, export-oriented market economy.

A scenario for GDP growth forecasts an annual average rate of 5.2 % for the period to 2002. Thereby the GDP per capita would reach US$ 2,783 by 2002, a level about 50 % higher than the amount for 1996. An optimistic scenario assumes 6 % rate average growth for the years from 1997 to 2002, the pessimistic one posits a rate of 4.2 %. (Ref. 2-17, pp.302-303) For the years from 2001 to 2010 the average annual rate of real growth is expected to be around 6 %. (Ref. 2-17, p.337) Inserting actual, estimated and policy-projected figures, respectively, for the years from 1996 to 1999 (Ref. 2-18), and base-scenario ones for the years from 2000 to 2008, annual growth rates can be shown as Table 2.19.

Table 2.19 Annual Growth Rate of GDP (1996-2008)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rate	0.8 [a]	1.0 [a]	6.0 [b]	5.0 [c]	5.2	5.2	5.2	6.0	6.0	6.0	6.0	6.0	6.0

Note; a: actual, b: estimated, c: policy-projected

According to the NDS, the real GDP during the period of 1989-2002 attendant growth rates are presented as shown in Figures 2.22 and 2.23.

The Country successfully survived strong economic stagnation. Economic growth is expected to follow. To maintain this optimistic scenario, international cost plus quality product competitiveness and scientific technologies are deemed essential.

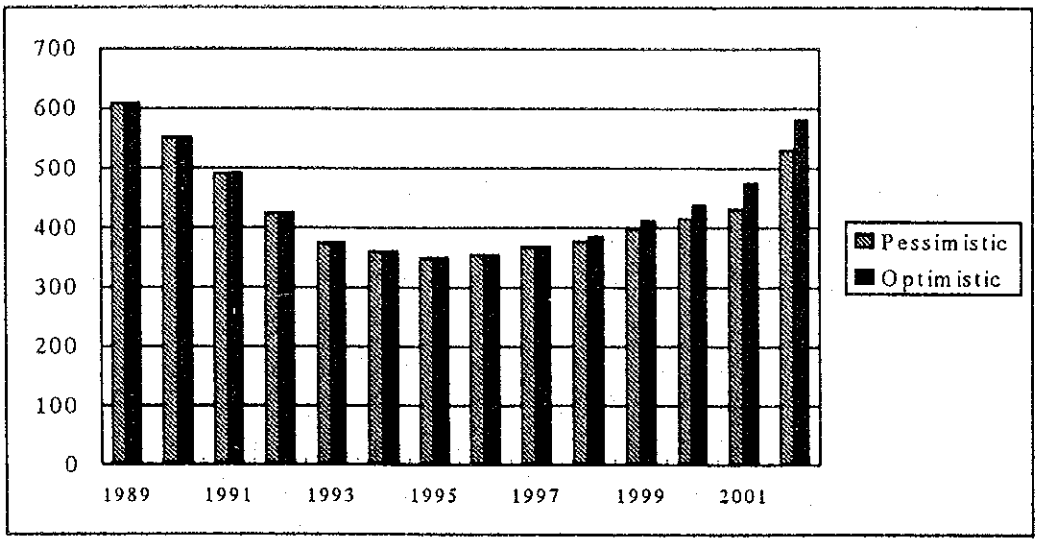


Figure 2.22 Real GDP Movement in Macedonia in a Period 1989-2002

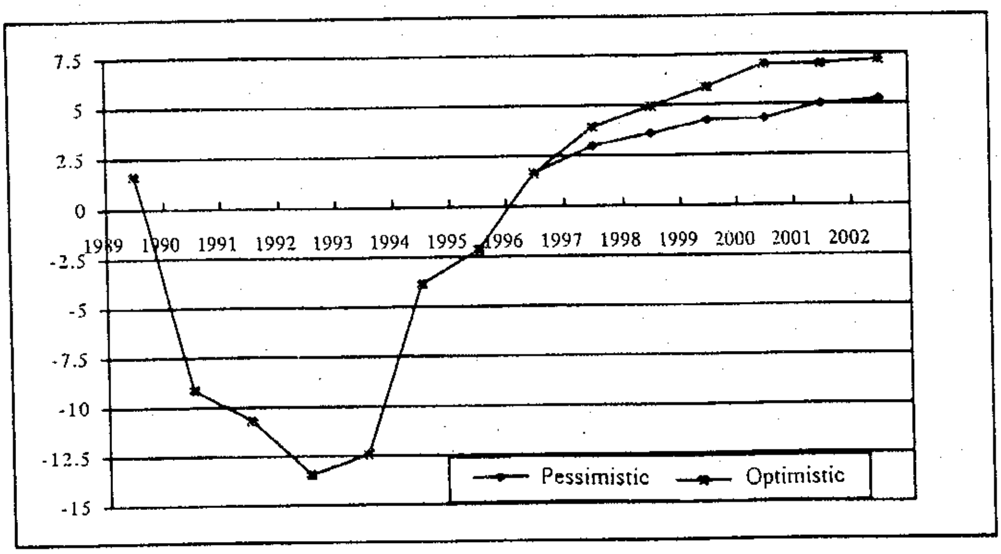


Figure 2.23 GDP Growth Rates

(2) Index of Industrial Production

The industrial scenarios of the NDS forecast a moderate 2 % average growth rate for total industrial production for the years from 1996 to 2000, and a rate of 6 % for the period from

2001 to 2010. This prognosis, however, seems to considerably underestimate the growth potential of Macedonian industry, especially for the years from 1996 to 2000.

The mid-1990's may have been a turning point for industrial production. If the trend reported by government statistics for the years from 1995 to 1998 is extrapolated at an officially projected 7 % rate of growth for 1999 and at an 8 % rate afterward, then the total volume of industrial production may follow the trend depicted in Figure 2.24.

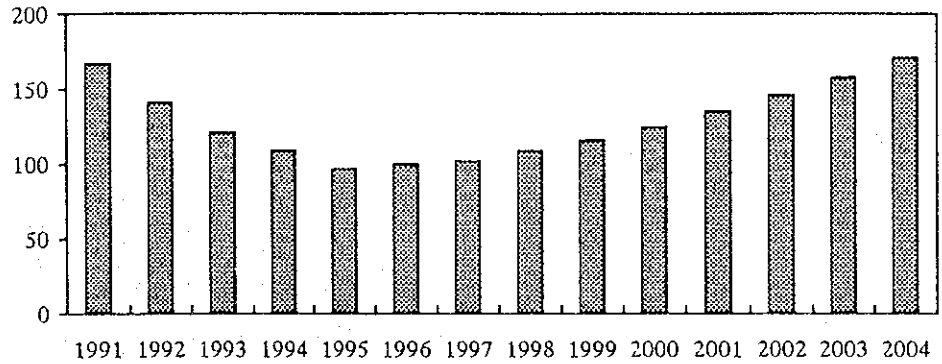


Figure 2.24 Index of the Total Volume of Industrial Production (1996=100) (1991-2004) (for 1999-2004 extrapolated)

If the trajectory displayed will materialize, the total volume of industrial production may re-approach its 1991 level by 2004.

2.7.3 Forecast of Fuel Consumption

It is the supply and demand of energy that is the barometer of economic growth. It is advantageous because it also includes an informal part of the economy.

Without grappling with energy conservation now, energy consumption will grow larger, generally corresponding to economic growth.

According to the NDS prognosis, energy production would grow by 2 % during the years from 1996 to 2000, and by 4 % in the period of 2001 to 2010. Basic metal industries and chemical industries, both highly relevant for future levels of air pollution, are expected to grow at faster rates: at 1.5 % for 1996-2000 and at 5 % for 2001-2010, and at 2 % for 1996-2000 and at 7.5 % for 2001-2010, respectively (Ref. 2-17, p.336). In the light of the foregoing considerations, however, these estimates may be in need of upward adjustment as well.

Toplifikacia forecasts the trend, evaluating every possible data hypothetically on the amount of consumed energy in Skopje of each fuel from 1995 to 2020 and from 2000 to 2010. Figure 2.25 shows these data in terms of heating values.

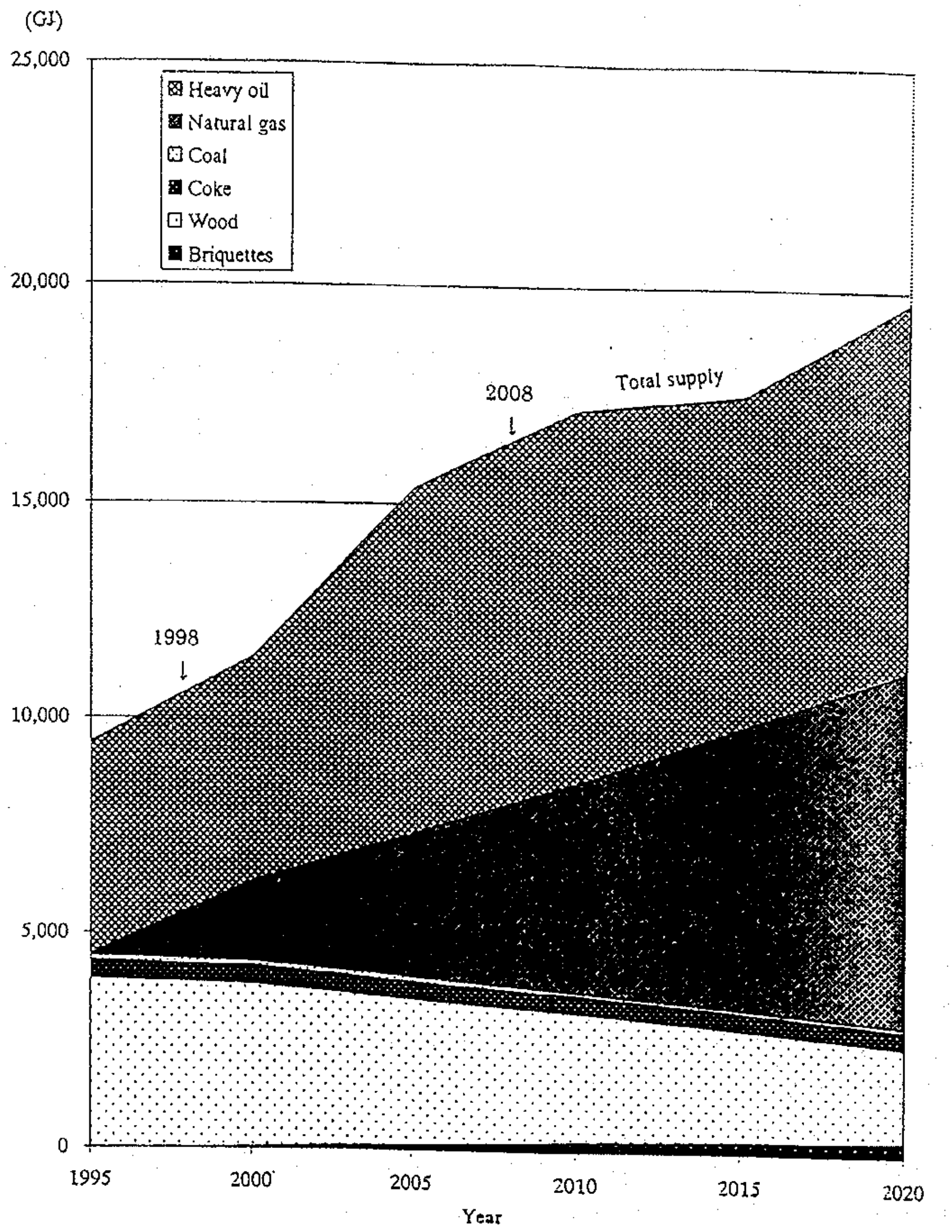


Figure 2.25 The Expected Trend in Fuel Consumption in Skopje (GJ based on heat values)

It is estimated that fuel consumption will increase 73 % (in units of heating value) from 1998 to 2008.

The calculated result shows the increasing use of heavy oil by 3,272 GJ and about 47% in total against an increase of total consumption 6,944 GJ. Consumption of natural gas will be expected to be 4,213 GJ, but fire wood use will decrease by 20%.

Chapter 3

Chapter 3 Selection of the Model City

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

3.1.1 Present State of Monitoring Equipment in Skopje City

(1) Ambient Air Quality Monitoring

Figure 3.1 shows a location map of measuring points in Skopje.
The Republic Hydrometeorological Institute (RHI, nine locations) and Institute for Public Health (IPH, seven locations) are conducting monitoring using British samplers.
Measurement of SO_2 and Black Smoke (BS) are based on manual measuring method. As for SO_2, one is based on the pararosaniline method, and the other, the acidic method. Both comply with International Standard Organization (ISO) standards and World Health Organization (WHO) selected methods.
Total acid is monitored at points No. 1 to 3 of the IPH. Multiple samplers are used.
CO concentration in air is monitored two seasons per year (April and November) at four intersections in the central area of Skopje.
The Karpos IV (No. 6) measuring point of the RHI monitors SO_2, BS, NOx, O_3 and Ox for 24 hours. Additionally, the RHI has been monitoring concentrations of particulate substances and Pb and other heavy metals at intersections and monitoring points in Skopje.

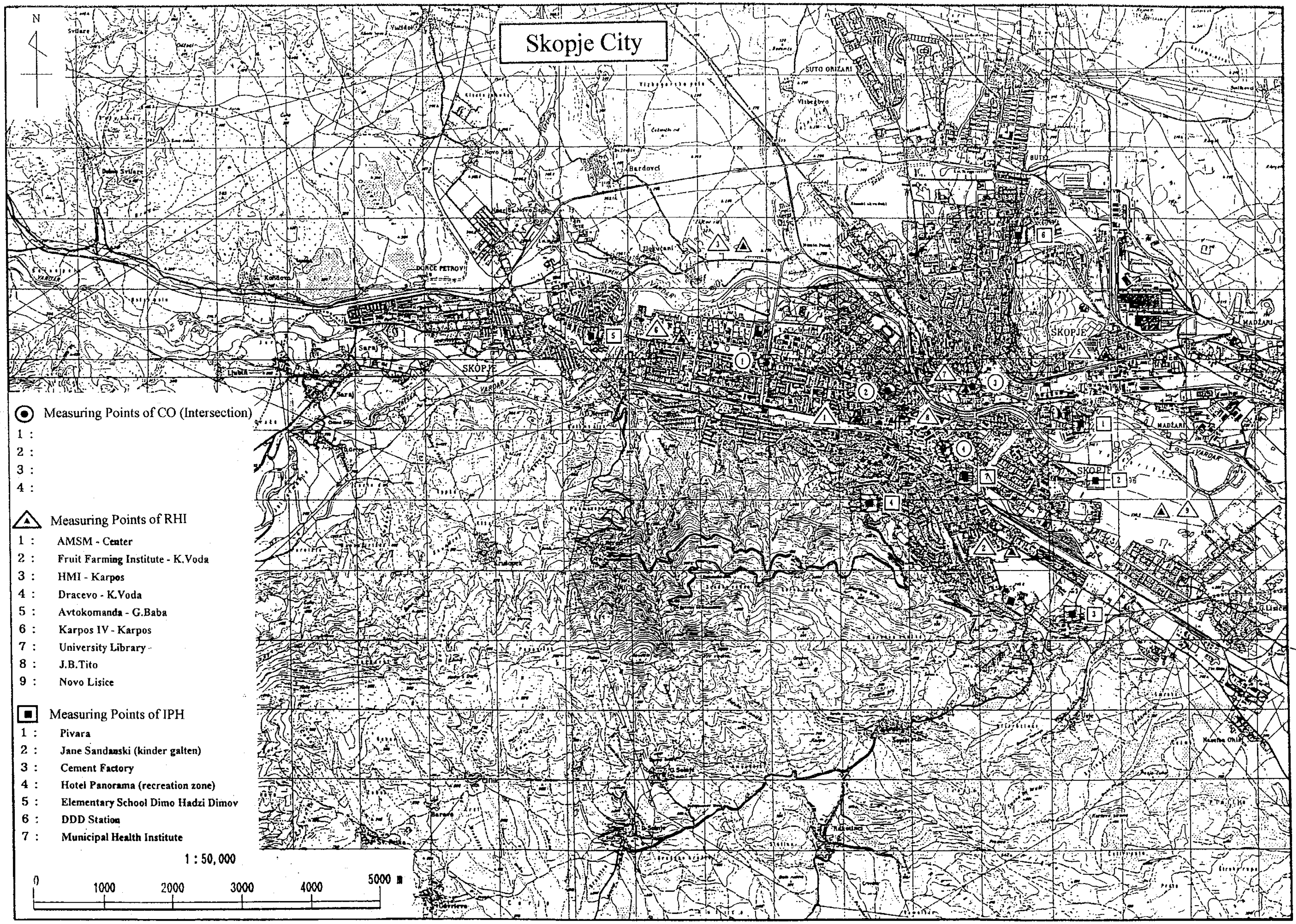


Figure 3.1 The Location Map of Measuring Points in Skopje

(2) Meteorological Observation

The meteorological observation point in Skopje is monitoring surface meteorology, such as wind direction, wind speed, temperature, humidity and rainfall at HMI-Karpos (No.3) measuring point of the RHI.
At the airport, upper meteorology such as vertical distribution of wind direction, wind speed and temperature is additionally monitored every day at 1:00 a. m..
The RHI collects these data and meteorological data from the Landsat and supplies meteorological information to the general public.
Data accumulation and processing of ambient air quality and meteorological data are performed as routine work without any problem. However, data are not adequately utilized or accumulated in accordance with the intended purpose.

(3) Air Emission Sources

Only some large plants monitor emission sources. Those plants and factories that monitor emission sources are cement plants, central heating plants, iron and steel mills and some others.
The monitoring items of these main plants and mills are as follows:

SO_2: Infrared absorption method
NOx: Infrared absorption method
Dust: Light-scattering method
CO: Infrared absorption method, portable equipment
Air emission is monitored every week.
Exhaust gas temperature and flow rate

3.1.2 Present State of Monitoring Equipment in the Major Cities

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

(1) Veles

Two automatic continuous AQM stations owned by "MHK Zletovo" in Veles are installed in two locations in the city. Data acquisition center is located at the plant.
The monitoring results are sent to the center by a radio telemeter system.
The data are collected and processed by a computer. The processed information is displayed on electric light signs in the city through a public information system.

(2) Bitola

The Bitola MPGC thermal power plant has installed its own three British samplers for the continuous monitoring of air pollution. However, this monitoring point is located near the plant and does not indicate typical values for the city.

(3) Tetovo

As for AQM equipment, only the sampler is used. Emission source monitoring is not done periodically at metal chemical plant "JUGOHROM".

(4) Kavadarci

There is no automatic continuous monitoring station of air pollution and exhaust gases emitted by factories. Only classical monitoring is done.

3.1.3 Laboratory Facilities of the Related Organization for the Monitoring

Field survey of the RHI, the IHP, and Institute of Environment "Zelezara" (IEZ), as well as civilian laboratories of the cement plant, "MHK Zletovo" metal smelting plant in Veles and "FENIMAK" ferro-alloy factory in Kavadarci, were conducted.

Basic laboratory equipment is installed. However, some of the equipment has become obsolete, has failed or is lacking in parts. In future, the equipment must be repaired and expanded.

3.1.4 Present State of Air Pollution in Macedonia

(1) Assessment of Precision for the Existing Sampler

1) Cross-check of the Existing Sampler

Cross-check by using SO_2 standard gas was performed on existing British sampler to obtain both correlation and reliance of planned continuous monitors.
Cross-check is also important for comparison of yearly and seasonal averages with the results of simulations.

a) Cross-check by SO_2 Standard Gas

i) Test Method

The gas was simultaneously led to a plural number of existing samplers and was measured by SO_2 continuous monitor. The variables likely to affect the reading are adsorption by the sampling tube and the filter holder, gas leakage, flow meter reading error, the analytical method, and the data processing method.

ii) Results

The results were classified with respect to two types of samplers, the IPH and the RHI.
As for comparison between standard gas concentration and actual reading, the results are shown in Figure 3.2. Necessary corrections were made on accumulated flow meter, gas pressures, absorbing liquid evaporation and temperature.

Conclusions:

- The reading values of the RHI were found somewhat higher than standard gas concentrations without correction being made on the effect of evaporation of the adsorption liquid.
- While admitting that the reading value is subject to various conditions, a value nearly identical to standard gas concentration was obtained.
- The results of the sampler improvement examinations after changing materials of tubes and filters to PTFE were not evaluated since other error factors were large.
- Fluctuation factors should continuously be studied to enhance data accuracy.

Cross-check of the existing samplers by SO_2 standard gas has identified some matters to be studied and considered in future. Evaluation of the existing data should be made based on the results of the examination.

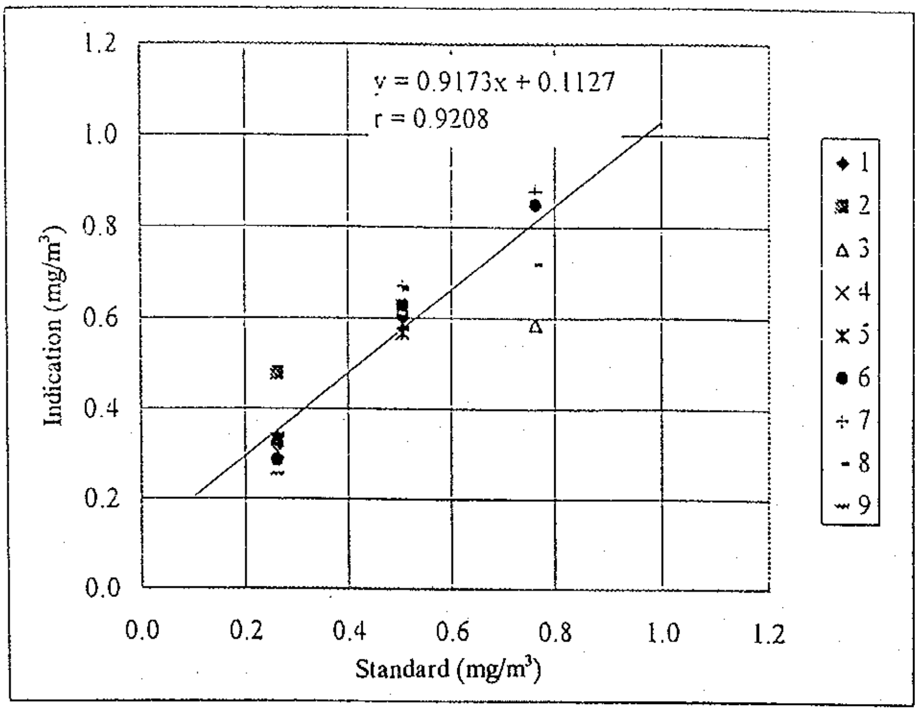


Figure 3.2 (1) Cross-check Result of Existing Samplers by Standard SO_2 Gas Management: RHI

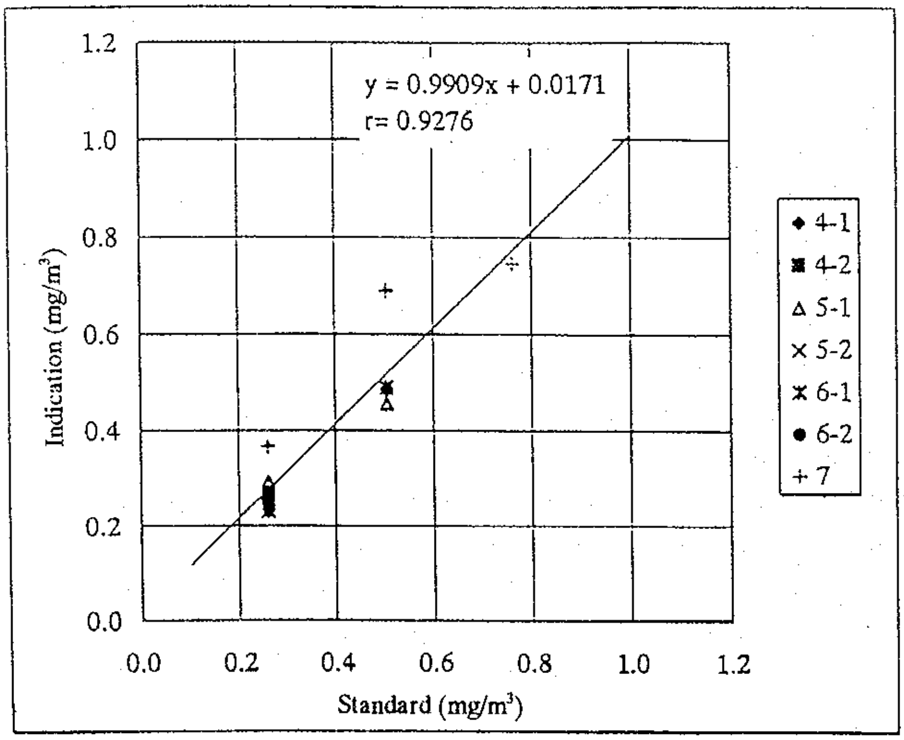


Figure 3.2 (2) Cross-check Result of Existing Samplers by Standard SO_2 Gas Management: IPH

b) Instrumental Error of Dry Gas Meters and its Error Factors

Monitoring and analytical data contain various errors. A study of error factors must be made and efforts must be made to minimize errors in advance to obtain accurate data.
The following error factors can be considered with the British sampler (hereinafter referred to as existing sampler):

- Handling of absorption solution
- Instrumentation errors of dry gas meter
- Evaporation of absorption solution
- Handling such as sample fractionation
- Temperature and pressure loss inside tube
- Titer of standard solution when producing calibration curve
- Equipment to measure absorbance
- Stability, coloring conditions and measuring conditions of reagent blank

<Other Error Factors>
- Consideration of analytical techniques
- Management and handling of reference solutions and absorption liquid
- Flow rate compensation and evaporation compensation of absorption liquid

c) Recommendation for Working of Existing Samplers

The results, which put together causal errors found in existing samplers. Evasion of errors, using standard gases and automatic continuous monitoring instruments, are very important for the engineers of the RHI and the IPH who carried out the examination collaboratively.
The results should be utilized for the forthcoming monitoring by existing sampler in order to get more accurate data.

2) Comparison of Existing Samplers with Simplified Samplers

Figures 3.3, 3.4 and 3.5 show a comparison of daily variations of SO_2 concentration (average values), and a correlation of daily variations excluding lowest two days. Generally, the following observations can be made on the relationship between existing and simplified samplers in the results of SO_2 monitoring.

The average correlation factor between the two types of the samplers was 0.76. Excluding lower concentration, however, the correlation becomes 0.85. As a result, the simplified samplers were effective at comparatively high concentrations.
The comparison test was performed in extremely low concentration compared with the high

concentration of Skopje during winter. The relationship between the two types cannot be evaluated just based on these data. It is desirable that the Macedonian side should make a final evaluation after extending the sampling period or making a comparative study when the concentration is high.

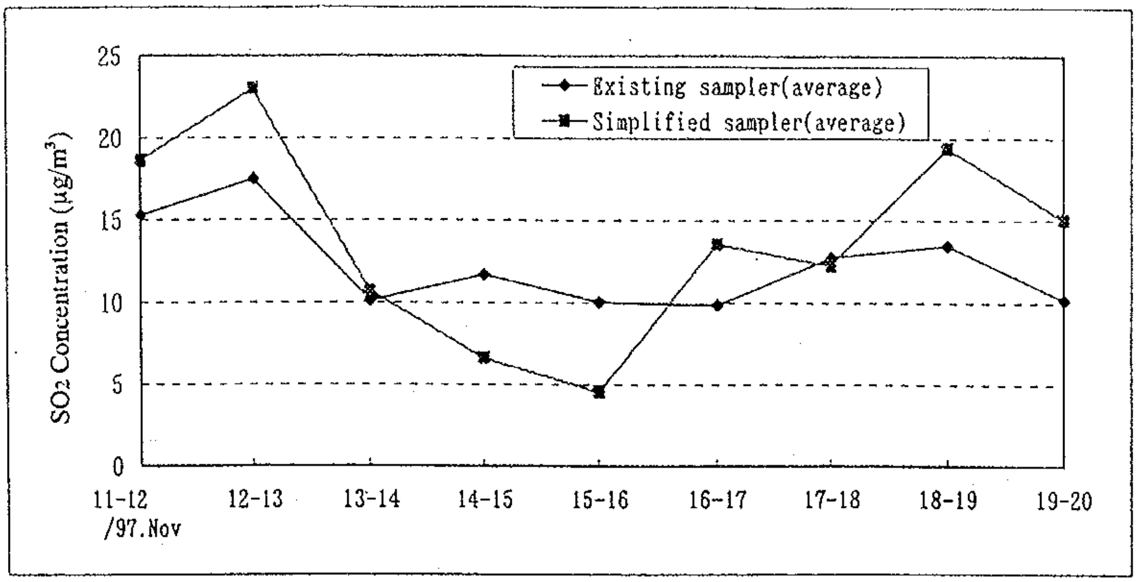


Figure 3.3 Comparison of Daily Variations of SO_2 Concentration (Average values)

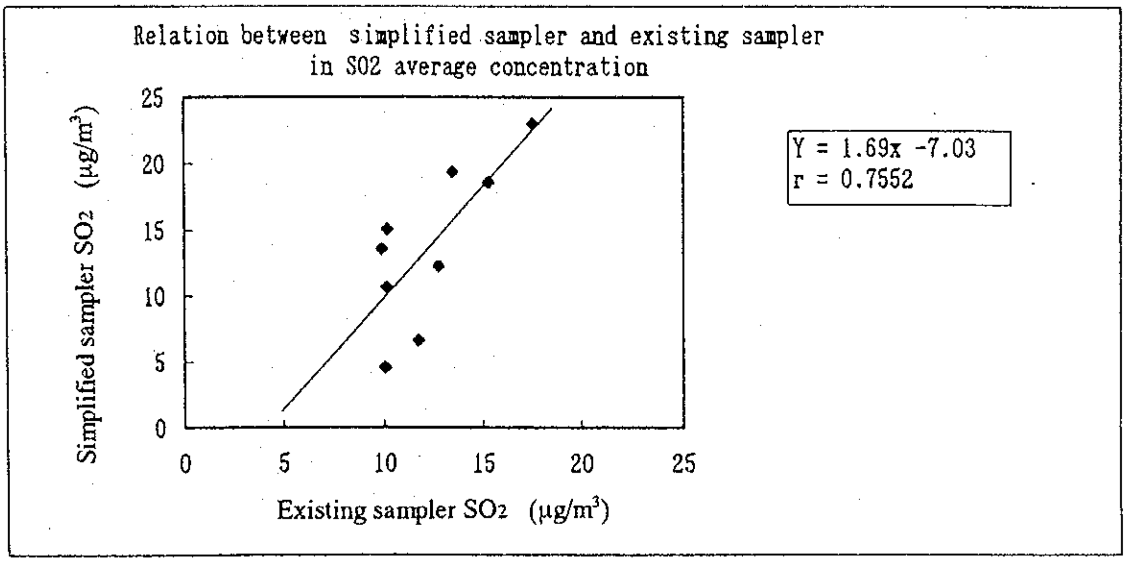


Figure 3.4 Correlation of Daily Variation

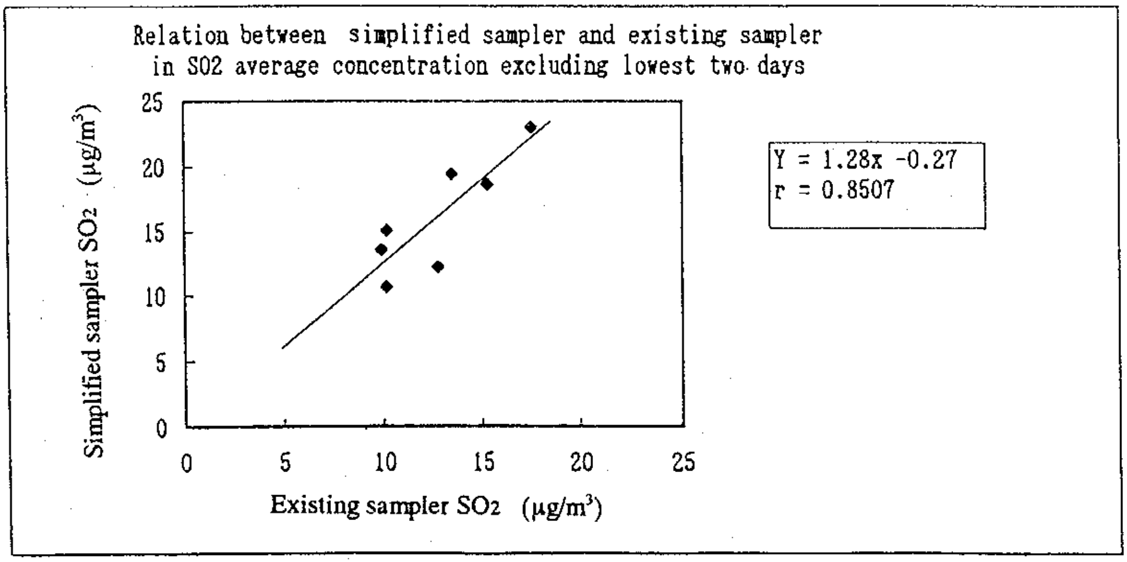


Figure 3.5 Correlation of Daily Variation Excluding Lowest Two Days

3) Comparison of AQM Station with Existing Sampler

SO_2 data obtained by automatic continuous monitoring equipment tend to indicate higher value than that of the existing samplers. There was significant tendency in data obtained in May and June. For BS, the data for automatic continuous monitoring tend to show concentration value twice as high. The relation between SPM and mass is seemed to vary with seasons, since the existing samplers measure the degree of black color of SPM on a filter paper optically. On the other hand, SPM monitor measures particles less than 10 μm in mass directly. There is a basic difference in the equipment.

(2) Meteorological Characteristics of the Major Industrial Cities

Table 3.1 shows the meteorological characteristics of the major industrial cities. Figure 3.6 shows the windrose.
The followings are concluded from the meteorological characteristics of each city:

- They are influenced by the topographical characteristics of the basin or valley in common, and the condition in which the atmosphere remains stagnant, is a factor for serious air pollution in winter.
- Wind blows along the valley and wind speed is generally low.
- Temperature inversion occurs frequently in winter, and also in summer depending on meteorological conditions.
- The precipitation is the smallest and fog appears most frequently in Skopje. This is very unfavorable from the aspect of influence that air pollution has on human body.

Table 3.1 Meteorological Characteristics of the Major Industrial Cities

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

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

* Annual average of minimum temperature

** Annual average of maximum temperature

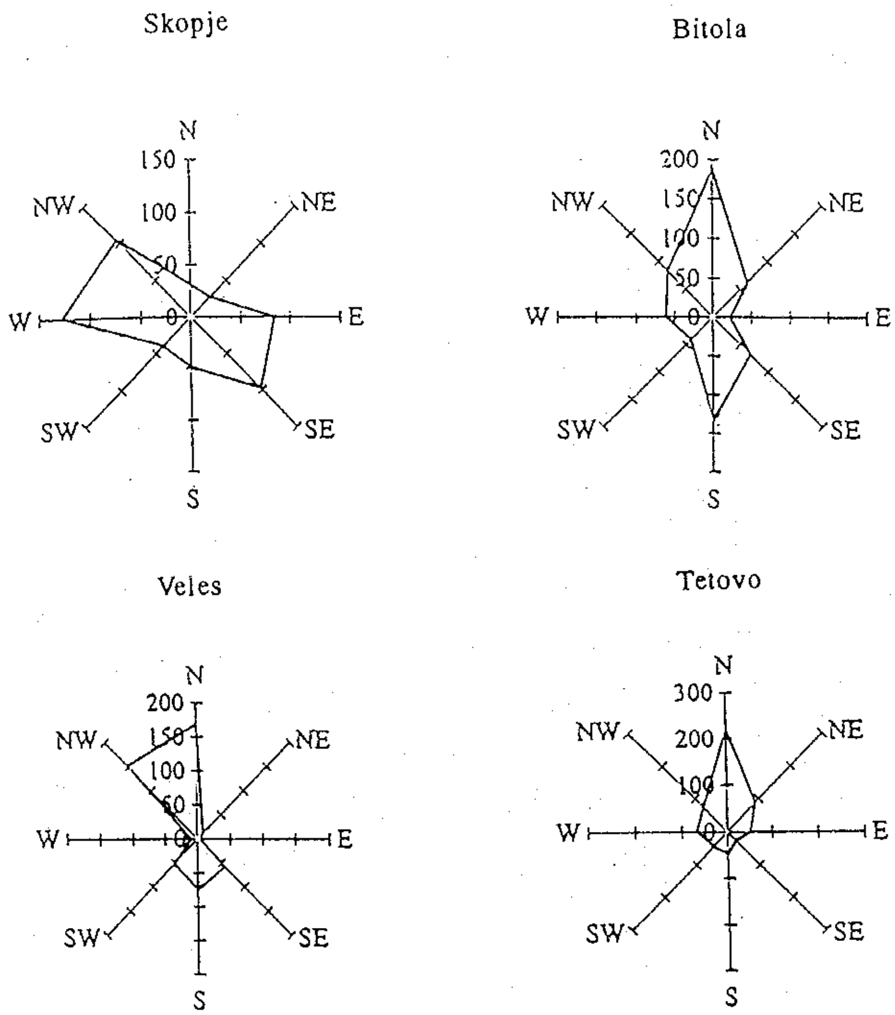


Figure 3.6 Windrose of the Major Industrial Cities

Source: NEAP

(3) Ambient Air Quality Characteristics of the Major Cities

1) Outline of Ambient Air Quality Characteristics

The characteristics of ambient air quality in the major cities are shown Table 3.2

Table 3.2 Characteristics of Ambient Air Quality in the Major Cities

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

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

* Pollution Levels (according to NEAP)

XXX : critical
XX : significant
X : unsatisfactory

* MPC : Environmental Standards (Maximum permitted concentration)

SO_2 : 150 $\mu g/m^3$, BS : 50 $\mu g/m^3$, Dust fall : 300 mg/m^2/month, NO_2 : 85 $\mu g/m^3$
CO : 1 mg/m^3, Ox : 125 $\mu g/m^3$, Pb : 0.7 $\mu g/m^3$

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

2) Comparison of Skopje with Veles on Concentration of SO_2 and BS

The following can be summarized by the data on the annual acquisition charts and the monthly fluctuations of SO_2 and BS from 1990 to 1994.

- The measuring points in Skopje and Veles showed higher concentrations than those from the other points in annual average and annual maximum values of SO_2.
- Skopje showed a high concentration in BS but not similar to Veles. This indicates that Skopje is affected more by automobiles and household heating during the heating season, in addition to emissions by stationary sources.
- The number of days exceeding MPC was several times more with BS than with SO_2.
- Concentrations of SO_2 and BS in Skopje by season, showed prominently high concentration during the heating season. On the other hand, in Veles, BS showed a behavior similar to that of Skopje, but a high concentration of SO_2 was recorded even during the non-heating season. Clearly a difference exists in the conditions of pollution sources.
- In Skopje, dynamic fluctuations also showed that high-concentrations during winter were influenced by meteorological conditions, such as stagnation, in addition to the influence by central heating plants and the heating of individual household.
- One characteristic with Skopje was that its peak value varies from one year to another.

3) Concentration Distribution of Air Quality and High Concentration in Skopje

a) High concentration Pollution and its Causes in January 1993

According to the time variation charts, serious high concentration pollution continued for a long time. This phenomenon can be explained by the continuation of meteorological conditions which caused the formation of an inversion layer and stagnation of pollutants near the surface.

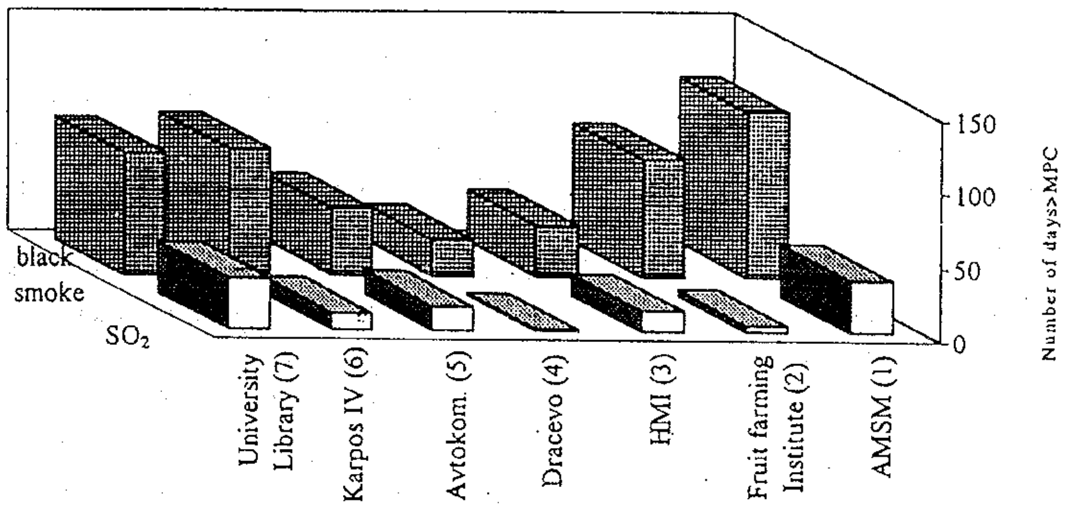
b) SO_2 and BS Concentrations

The RHI and the IPH have monitored SO_2 and BS for a long time.
Figure 3.7 shows the number of days exceeding MPC of SO_2 and BS for the period from 1991 to 1994 by measuring points on which the condition of air pollution in Skopje could be seen. The followings can be concluded from the data which the RHI and the IPH collected:

- As for SO_2, the average annual values change by years for each point.
- The central city area indicates a high SO_2 and BS concentration.
- The average number of days with BS concentration higher than MPC is much bigger than the one for SO_2 concentration, for all the measuring points in the city and for all the years.

- In 1994, when levels of SO_2 and BS concentrations were generally low and the number of days with concentrations higher than MPC was small, the winter was mild.
- The SO_2 and BS concentration values vary within the years due to the meteorological conditions.

These results indicate that in addition to large impacts by meteorological conditions, pointary sources influence SO_2 greatly. As for BS, stationary sources, residential heating (firewood) and vehicles have a greater influence.
The present status of air pollution in Macedonia is comparable to the time when Japan had serious air pollution and the level of BS pollution is higher in Macedonia than in Japan when it suffered from air pollution.



Source: NEAP

Figure 3.7 Number of Days Exceeding MPC for SO_2 and BS for Period from 1991 to 1994 by Measuring Points

c) NO_2 Concentration

At the measuring point of Karpos IV (No.6) in Skopje, the RHI measures NO_2 concentrations, using existing sampler. The number of days that exceed MPC in the period from 1993 to 1994 was six. Observing for each month, the values of January in 1993, in which the temperature inversion continuously occurred, were extremely high.
According to automatic continuous monitoring data, the maximum of hourly value is

approximately three times higher than the value of daily mean. From this fact, it can be said that the number of times that MPC is exceeded based on hourly value are numerous.

d) CO Concentration

The CO concentration survey at four intersections measured by the IHP. Compared with reference values ($3mg/m^3 \fallingdotseq 2.6ppm$ at 20℃), the CO concentration is three times higher than that to the average and is more than ten times higher than that to the average value of 37.39 mg/m^3($\fallingdotseq$32 ppm at 20℃) of maximum concentrations at four points. These values are extremely high and are about three times as high as the environmental standard of Japan (10 ppm). NEAP (Attachment II-14) shows the average concentrations of CO in 1989 to 1993 and CO pollution is noticeable.

e) Oxidant Concentration

According to the NEAP, from the beginning of 1993, concentrations of total oxidant (Ox) and ground ozone have been monitored 24-hour at Karpos IV (No.6) monitoring point. The Ox environmental standard is $125\mu g/m^3$ in maximum individual short-term concentration. The frequency of concentrations exceeding the standard value is high according to this data.

As a future study task, it is recommended to redefine what should be the criteria (total Ox, photochemical Ox and ozone) for a standard and what should be done about the standard methods of monitoring.

Total Ox = Photochemical Ox (O_3 + Peroxides) + Influence of NOx

f) Monitored Value of Heavy Metal in Air at Main Intersections and Sampling Method

i) Pb

The Pb concentration in air at intersections was monitored by two methods (two-hour sampling), namely, filter sampling and by directly absorbing in a solution and sampling it to evaluate the data.

The data by the solution absorption method show that the concentration variances are large depending on the sampling time and monitoring locations. However, generally, the range is 1 to $18\mu g/m^3$ and average value is about $10\mu g/m^3$. Compared with the concentration level of Japan of below $0.1\mu g/m^3$, this concentration level is extremely high and non-leaded gasoline should be promoted.

In comparing the sampling methods, the former method had a far lower value and assuming that problems exist in filter sampling, thus pointing out the necessity of using the solution absorption method as a new criterion and standard method of monitoring. It is clear that the collection efficiency of the cellulose filters which were used, has a problem. The sampling method cannot be evaluated or conclusions from this method cannot be drawn only on the basis of this data.

The sampling time and systems, particulate concentration level, filter type and other factors which influence the collection efficiency will be examined, and final evaluation will be proposed as a recommendation.

The use of the solution absorption method as an official method of monitoring is not denied. However, the standard value is provided by daily average values. Further, the optimum filter type should be examined. It will not be too late to decide on standard method of monitoring after making comparison and evaluation of the 24-hour sampling data.

ii) Cd

The Cd concentration is also extremely high. The Cd concentration in areas in Japan generally noted for high concentration is about 0.003 $\mu g/m^3$.

It should be noted that this is most probably caused by dust flung up by running automobiles because the dust concentration is very high. (The concentration values exceed 120 $\mu g/m^3$, which is WHO standard, at every measuring point.) It is not clear if dust is TSP or PM10.

4) Characteristics of Air Quality in the Other Major Cities

The present status and evaluation of the pollutant concentration in ambient air in major cities are summarized below.

a) Veles

i) SO_2 and BS

During the period from 1984 to 1994, the concentration changes of SO_2 and BS had been surveyed in each year.

The survey results indicate the followings:

- By comparison among the measuring points the concentrations of SO_2 depend on the distance from the smelter and the closer to the smelter. On the other hand, the concentrations of BS are not influenced at such distance from the smelter. As for SO_2, the smelter is dominant and high-concentrations are evidenced through the year.
- Maximum and 98 percentile of SO_2 show high-concentrations at the northern monitoring point (No.4) and the southern point (No.5), which are far from the emission source. Even though the points far and away from the emission source can be influenced by weather conditions such as the atmospheric stability, the wind direction, wind speed and so on.

- The concentrations of SO_2 exceed MPC at every point in many days and those of BS exceed MPC many times at the monitoring point (No.3).

ii) Heavy Metals into the Ambient Air

The concentrations of each heavy metal are highest at MMS (No.1) and there are some cases where the concentrations of Pb are high at TEKE (No.3) and BASINO SELO (No.4). At these three points, the concentrations of Pb exceed MPC ($0.7\mu g/m^3$). Moreover, there is also a case where that of Cd exceeds MPC ($3\ \mu g/m^3$) at TEKE (No.3). It can be seen that these points are broadly influenced by the smelter.
Compared with V. Ivankovci, which is a control area, heavy metal pollution is extreme in the urban area and Veles. The extent of pollution is around 10 to dozens of times as high as the control area.

b) Bitola

Bitola MPGC, the largest coal mine and power station in Macedonia located 12 km northeast of the city. Impacts on human bodies, such as respiratory organ diseases due to coal and coal ash dust, are feared in Bilijanik Village and other places which are located near the coal mine and power station.
The average annual concentrations of SO_2 and BS are low, those of BS exceed MPC 18 to 42 days a year. On the other hand, those of SO_2 rarely exceed MPC. However, it is hard to say that these concentrations stand for Bitola, which is the largest city next to Skopje.

c) Tetovo

The concentrations of BS exceed MPC many times a year, and those of SO_2, on the other hand, rarely exceed MPC in recent years.
The main emission sources are the metal chemical plant "Jugohrom Jegunovce" and pollution from heating facilities or equipment in the winter.

5) Evaluation and Comparison on Air Quality in the Major Cities

The evaluation of air quality in the major cities is prepared for the measurement of 20 places in the Country. Table 3.3 shows the emission amount of the pollutants and the evaluation of air quality indicates in the major cities.
The major cities that are not listed in the table include Kumanovo, which is evaluated as xx-significant, and Berovo, Gevgelija, Resen, Shtip, which are evaluated as x-unsatisfactory.
Regarding these evaluations, heavy metal pollution is also added into the review. The major cities that are evaluated to suffer from a serious impact are Skopje, Bitola and Veles.

Table 3.3 Air Emissions in Municipalities (1993)

(kg/hr)

Municipality	SO_2	NOx	CO	CO_2	Dust	Pollution Level
Skopje	3.692	1.00	1.00	42.678	0.154	xxx
Bitola	9.540	0.01	0.13	562.920	0.500	xxx
Veles	0.757	0.11	0.11	18.355	2.674	xxx
Gostivar	0.040	0.35	0.35	12.338	0.018	x
Delchevo	0.003	-	-	-	-	-
Kavadarci	0.040	0.03	0.03	1.846	-	x
Ohrid	0.001	0.08	0.08	1.631	-	xx
Krushevo	-	-	-	0.078	-	-
Negotino	0.060	0.02	0.02	1.915	-	x
Strumica	0.005	-	-	-	-	x
Kratovo	0.009	0.01	0.01	1.235	-	-
Tetovo	0.281	0.01	0.01	22.055	3.040	xx
Kriva Palanka	-	-	-	-	0.075	x
Prilep	-	-	-	-	0.635	xx
Struga	-	0.39	0.39	1.620	-	-
Kichevo	0.870	0.10	0.10	145.800	0.156	xx
Kochani	-	-	-	-	0.425	x
Sveti Nikole	0.002	-	-	0.220	-	-
Macedonia	15.720	3.00	3.00	812.691	8.666	-

Note) Pollution levels: x- unsatisfactory xx- significant xxx- critical

Source: NEAP

(4) Overview of Emission Sources in the Major Cities

Results of the survey are summarized briefly as follows:

- Most of large-scale factories install dust collector while medium and small scale factories rarely install it. But the toxic gas treatment facility with high efficiency is not installed in most of factories and the pollution prevention measures are therefore insufficient.
- The major fuel in use in Macedonia is heavy oil except thermal power stations and dependence on natural gas and diesel oil is limited. The usage of coal for household heating is less than 10 %.
- Based on the result of the analysis of questionnaire, net operation rate of factories was 30 to 40%, i.e. 153 factories.

1) Overview of Air Emission in Skopje

a) Environmental Protection Measures

Central heating plants, iron and steel mills, cement plants and other plants are installed with dust collecting equipment for flue duct emissions. However, almost all emission source facilities are not installed with dust collecting equipment. Except for those installed in some establishment of iron works, any full-scale toxic gas removal equipment is not installed entirely. Other problems include the low chimneys. This tendency was found true throughout Macedonia.

b) Fuels Used and Operating Ratio

The fuel burnt in various emission source facilities in Skopje is mostly heavy oil. The consumption of coal and gases was found to be little.
For individual household heating, firewood and electric heaters are mainly used. Coal is used less than 10% of the total and natural gas is not used.
The operating ratios of emission source facilities in the plants are 50% or lower. Roughly 20% of all the plants were found operating at below 33% operation ratio.

c) Overview of Major Emission Sources

i) Stationary Sources

- Heating Plant "Toplificacija"

The central heating plant "Toplificacija" was built in 1965, employs about 400 employees and has five plants in the city (one plant is effectively shut down). The plant is a gigantic pollution source with a total heat capacity of 600 MWth equivalent to about eight boilers with evaporation of 100 t/h. The plant supplies heat to 41,000 households in residential districts of 2.6 km^2 and to commercial districts of 1.3 km^2. Heat is supplied mainly to buildings such as apartment buildings (60%) and government and municipal offices (21%). Most of the heat supply for these consumers is provided from two plants in Istok (East) and Zapad (West). The plants have converted heavy oil with a sulfur content of 3 to 3.5% with good quality heavy oil having a nominal sulfur content of about 1% (value actually measured by the Study Team: about 1.4%) to reduce SO_2 emissions. The plants have low stacks. The Istok plant, which is the largest, has a stack about 65m high. A cyclone for exhaust gas is equipped at this plant, but desulfurization equipment is not equipped.
Heat is supplied only during the heating season and the plants are not operated in other seasons. Process steam for factories are not supplied. In 1997 season, the plants consumed 73,000t of fuels.
NEAP proposes the fuel conversion to natural gas in heating plants. As a trial, eight million m^3 of natural gas (10% of the total production) was consumed at the beginning of March 1998. 22% of the total fuel used during the heating season from October 1998 to March 1999 was expected to be natural gas. The fuel conversion to natural gas will be promoted in future.

- Iron & Steel Company

The iron and steel mill "Iron & Steel" was built in 1967 and employs about 3,000 employees. Now, it is being divided into four companies and is undergoing privatization. It uses pig iron and scrap as raw materials. It manufactures plates, medium-thickness plates, sheets and other steel plates and sheets (1,200,000 ton/year in capacity), steel sheets such as color steel sheets as construction materials and coated steel sheets (240,000 ton/year in capacity), ferro-alloys mixed with zinc, manganese (50,000 ton/year in capacity), wires and other products.
Five electric furnaces with 40,000 ton/year capacity are installed, burning heavy oil as an auxiliary fuel. As for environmental protection measures, bag filters are installed as dust collecting equipment.
Moreover, RZ "Topilnica" Co. ferro-manganese and silica-manganese smelting plants and "Balkamstil" low temperature milling plants that conduct deoxidizing process are the only plant that have installed harmful emission gases removal facilities. Such facilities are not installed in other plants.
In the smelting plant, a wet gas removal closed system (made in Poland) is being installed, thus reducing the emission of SO_2, NOx and allowing Mn precipitates to be collected. Moreover, large quantities of the emitted CO gas is being collected and a part of the steam boiler fuel is being used.
The acidic gases from the deoxidizing process can be completely removed by scrubing it with alkali, but special processes are not being employed in pollution source facilities, for example, boilers. At the time of the field survey, the operating ratio of these furnaces was below 30%.

- Leather Factory "Godel"

The leather factory "Godel" was built in 1945 and employs 1,200 employees. It produces 50 ton per day of leather. The factory is installed with three 6-ton boilers and one 12.5-ton boiler for heating and processing. These boilers burn heavy oil. Beside this, the 12.5-ton boiler for gas combustion was built in 1997, but is still standing by with a supply of gas.
In future, heavy oil burners for old boilers will be replaced with gas burners, if gas is provided.

- Chemical Plant "OHIS"

The chemical plant "OHIS" manufactures plastics, polyvinyl chloride, polyacrylic fiber and other plastics in its electrochemical plant. Air pollutant emission was cut down due to fuel conversion from heavy oil to NG at the end of 1998.

- Cement Factory "USJE"

The cement factory "USJE" is the largest cement plant in Macedonia, the production rate of the rotary kiln is 150,000 ton/year. The fuel used is 70% coal and 30% heavy oil. The plant is heading towards privatization and is currently holding talks with foreign enterprises. Dust and NOx are normally monitored in one week and they are kept within the standard emission values. People in charge of the environmental protection work have mentioned that being in touch with foreign enterprises, aids in the learning more about control of emission. However, Skopje admits that "USJE" is a gigantic dust emission source and it bears hopes of introducing new filter technologies. It is extremely important to devise measurement for environmental protection.
In this plant, there are many emission sources such as the rotary kilns and the mills with around 10 stacks.

ii) Area Sources

As area sources, the contribution of firewood and stoves (individual heating) burnt in residential houses to air pollution is large and has become a major focus in monitoring surveys in the past in Eastern Europe. Under the weak-wind stagnant meteorological conditions (stagnation) during winter, these sources may cause great health damage.

iii) Mobile Sources

Among all registered vehicles, there are a wide variety of passenger cars from highly polluting cars manufactured in the former East European block to the latest-model cars manufactured in Western Europe and Japan.
A periodic vehicle inspection system is not enforced in Macedonia and many vehicles have incomplete combustion. Roughly 40% of all vehicles including public transportation vehicles in the country are concentrated in Skopje and the level of air pollution in Skopje caused by mobile emission sources is estimated to be very high.

d) Present State of the Stationary Sources in Skopje

i) Total of Data from Stationary Sources

According to the Register of Polluters in Skopje prepared by Mining Institute from Skopje in 1996, there are 153 objects potential polluters (33% are industrial objects and the rest are not industrial) with 543 treating (35.4% from industry). The volume of exhaust gases and the presence of CO, SO_2, NOx and dust for the territory of the city of Skopje and communities in Skopje are given in Table 3.4.

Table 3.4 Emission of Exhaust Gases in Communities and City of Skopje for 24 h (1996)

Community	Vol. Flow, in $Nm^3/24h$	Emission of CO, in kg/24h	Emission of SO_2, in kg/24h	Emission of NOx, in kg/24h	Emission of Dust, in kg/24h
Cair	1,873,059	10,001.0	106.4	639.8	-
Karpos	1,384,391	597.9	1,446.3	645.3	-
Center	605,683	106.9	346.2	214.9	-
Gazi Baba	4,881,887	283.9	5,962.0	2,449.0	-
Kisela Voda	23,584,431	425.0	3,534.0	999.0	2,042.0
Skopje	32,329,451	11,414.7	11,394.9	4,948.0	2,042.0

ii) Types of Companies - Emitters of Pollution

Emitters of pollution in each area were classified by types, numbers, working years and consumption of fuels.
Putting the information together, the general findings are listed below:

- Industry occupied one third of the total number of facilities of stationary source.
- Gazi Baba and Cair areas have many facilities of stationary source and emitters.
- There are many old combustion facilities. Close to 80% facilities of the whole have been working over ten years.
- Small combustion facilities can be seen to be a lot. Approximately half of emitters are less than 1MW and more than 80% are from 1 to 50 MW.
- Most of the fuels used are liquid.
- Almost 200 emission facilities have working capacities from 33 to 50% and almost 90 facilities have those of less than 33%.
- The amount of emitted CO is largest in industry, and that of SO_2 and NOx is largest in Energetic.

c) Central Heating Plants in Skopje

Distribution network is 170 km long from the central heating plants in Skopje.
According to the existing data and data obtained during the visit of the direction of central heating plants in Skopje, following facts are found.
There is the central heating system comprising of five heating plants in Skopje.
Table 3.5 shows the emission of central heating plant which is now under operation.
A scheme of the city central heating network is given in Figure 3.8.

The periodical measurements of air emission are performed by own department or by the institutions working on emission measurements (RHI, Mining Institute, IEZ). There are some data of air emission that performed in March 1995 for different emitters of heating plant East, West and 11 Oktomvri.

Table 3.5 Emission from the Central Heating Plants

Heating Plant	Vol. Flow Waste Gases (Nm^3/h)	Vol. Flow Waste Gases ($Nm^3/24h$)	CO (kg/24h)	SO_2 (kg/24h)	NOx (kg/24h)
EAST	304,597	2,456,522	108.56	2,790.39	1,390.12
WEST	137,367	1,102,640	34.54	1,277.17	594.53
11 Oktomvri	26,748	208,978	1.96	226.76	96.54
Park	5,031	44,256	0.71	52.82	26.36
Total	473,743	3,812,396	145.77	4,347.12	2,107.55

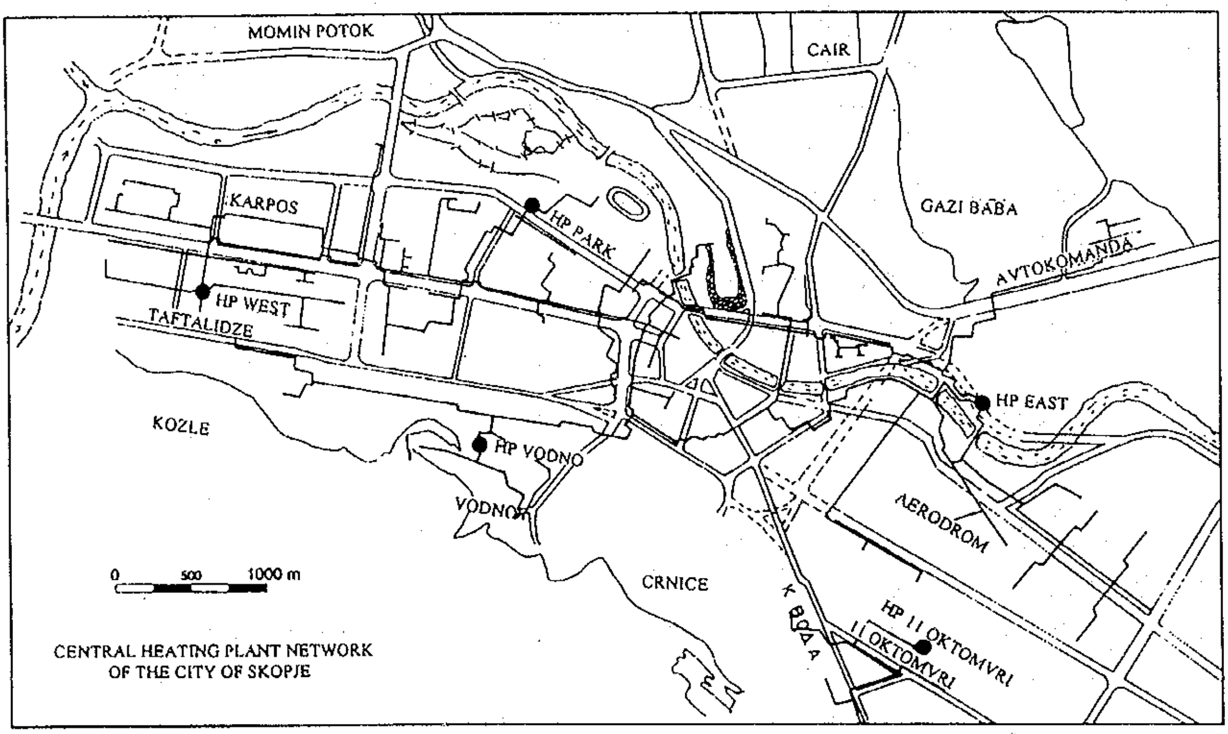


Figure 3.8 Central Heating Plant Network

2) Overview of Air Emission in the Major Cities

a) Veles

Veles is located in a basin. Even though the northern side of it is open, the city is in a topographically poor location for metal smelting and other industries.

The MHK "Zletovo" metal smelting plant as the center of the stationary emission source is located about 1km northwest from the center of the city in the same basin and is smelting zinc and lead. As byproducts, cadmium, chromium and sulfuric acid are produced. The plant was built in 1964 and employs 1,600 employees. The plant was producing 67,000 ton of zinc and 33,000 ton of lead per year. However, in recent years, due to the obsolescence of production equipment, production fell to 42,000 ton of zinc and 19,000 ton of lead per year in 1995, 30 to 40% decrease compared with full-production time.

Coke, imported from Poland, Ukrine and other countries, is used as the fuel (55,000 to 65,000 ton per year). For emission control, electric precipitators, bag filters, cyclones, wet flue gas desulfurization facilities and other facilities and systems are used. However, removal efficiency is poor and soil contamination, farm produce pollution and livestock contamination caused by this smelting plant have become serious problems.

Coke which is stacked in an open coal yard and slag storage places have become an emission source of dust. Much dust is generated when a strong wind blows.

b) Tetovo

Stationary emission sources include a textile factory at one end of the city and a metal chemical plant "JUGOHROM" emitting chromium in Jegunovce Village which is located in the northern part of the valley, more than 10 km distant from the city.

Exhaust gases are emitted from its stacks without any prior treatment. Particles containing heavy metals precipitate in the neighborhoods of the metal chemical factory. Under peculiar meteorological conditions, NO_2, SO_2 and other gaseous substances affect not only the entire region of Tetovo, but also regions as far as valleys in the northwestern part of Skopje.

Exhaust gases from the metal chemical factory are emitted not only from low stacks, but also from the entire factory buildings themselves. The residents living in adjoining residential districts are exposed directly to exhaust gases emitted by this factory. The factory widely affects not only the adjoining residential districts, but also down the valleys.

c) Bitola

Stationary emission sources include the "Bitola MPGC" coal mining and thermal power station (225 MW x 3 units, two 250 m stacks) which is the largest coal mining and power station in Macedonia located 12 km northeast of the city. There are 2,500 staff working in the coal mines and thermal power station.

In the summer, almost all electric power is supplied by hydraulic power generation, thus, this plant has a minimum load.

At present, desulfurization and denitration facility are not installed in the plant. The emissions from this plant affect a wide area. Because of the tall stacks, pollution caused by air emission is considered not to be as great as that widely believed. Nevertheless, the morbidity of respiratory system diseases caused by coal dust is high in Biljanik Village as well as the dispersal of ashes from the coal ash storage piles. The same is true for other places which are located quite near to the coal yard. Damage to health is extensive. The situation is serious.

d) Kavadarci

Kavadarci is located further downstream of the Vardar River than Veles and is similar to Veles in both topography and meteorological conditions.

The ferro-alloy factory "FENIMAK" and its waste disposal yard are located nearby.

The dust removal devices operate poorly. Stacks were emitting reddish brown smoke. The main components of the dust are iron, nickel and silicon. The dust is affecting nearby environments. A solution is needed.

3) Traffic Condition and Emission Volume of Toxic Compound

Traffic is the main source of air pollution. Automobiles are the only means of transport. Old and superannuated buses are used for public transport. Most of passenger cars also are old and superannuated. This in turn aggravates air pollution due to NOx, CO, VOC and TSP. Table 3.6 shows the registered numbers for each type of vehicle.

Table 3.6 Registered Numbers Based on Type of Vehicles (1993)

	Types of Vehicle						
	Motor-cycles	Cars	Buses	Commercial Vehicles	Special Vehicles	Tractors and Working Vehicles	Trailers
In the R. Macedonia (total)	3003	289979	2921	20104	6563	6648	7624
Private Sector (No.)	2893	275339	366	10402	1357	5019	2541
Percents (%)	96.3	94.9	12.5	51.7	20.7	75.5	33.3
In Skopje	709	110332	1242	7457	1888	383	1327
% from Total Vehicles	23.6	38.0	42.5	37.0	28.7	5.7	17.4

Source: NEAP