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Air quality in the Phare countries 1997

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Summary

The objective of this report is to provide an overview of the state of air quality in 13 central and east European countries (the Phare countries) involved in the Phare programme of the European Union. The report is based on 1997 air quality data collected from these countries within the framework of Phare topic link on air quality project (PTL/AQ). The contents and structure of the report follow the format of the pilot exchange of information (EoI) reports of the European Topic Centre on Air Quality. However, this report describes not only the data on air quality but also presents these in a broader context embracing consideration of the DPSIR (driving forces, pressure, state, impact and response) assessment framework of the European Environment Agency (EEA).

Through a series of country visits, the PTL/AQ successfully developed links and contacts and facilitated information and expertise exchange with national focal points (NFPs), national reference centres (NRCs) and air quality experts in the Phare countries. This infrastructure created the prerequisites for obtaining the necessary information from the Phare countries on air quality monitoring stations and air quality data for the preparation of this report.

Major political changes in central and eastern Europe during the period 1985-90 affected the general social and economic situation in these countries. In comparison with the situation at the beginning of the 1990s, energy and solid fuel consumption has decreased considerably in most of the Phare countries. The decrease in industrial production connected with the economic transformation and restructuring process has led to a decline in energy intensive production and hence a decrease in energy and solid fuel consumption. In addition, there has been a general change to the use of natural gas rather than solid fuel, particularly in Estonia, the Czech Republic, Hungary and Poland.

The decrease in solid fuel consumption, fuel switching (to natural gas), economic restructuring, renewal of power plants and finally, abatement measures on large point sources (flue gas desulphurisation) are the main reasons for the remarkable decrease in SO_2 emissions in the Phare countries in the last 10 years.

In spite of the considerable decrease in sulphur dioxide emissions, these emissions, calculated per capita, are still much higher in the Phare countries than the average for EU-15 countries. In contrast, NOx emissions per capita are, on average, higher in EU-15 countries.

By 2000, 11 Phare countries had made the selection of monitoring stations for the Europe-wide air quality monitoring network Euroairnet (Bulgaria, the Czech Republic, Estonia, Former Yugoslav Republic of Macedonia (FYROM), Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia). The main emphasis has been on monitoring in urban areas; in total, 231 stations have been selected in larger cities. In rural areas, the spatial coverage is not well represented and needs further improvement. Partial improvement is expected by incorporation of all the EMEP stations and inclusion of additional rural stations. The selection includes 43 monitoring stations selected in 31 rural areas of seven Phare countries.

The Phare countries submitted meta-information about their air quality networks and stations as well as air quality data to the European Environment Agency air quality database — Airbase, with the assistance of the PTL/AQ. Air quality data for the year 1997 from at least one station are available from all Phare countries except Bosnia and Herzegovina and Romania.

Summary statistics for the Phare region as a whole show that the highest concentrations of SO_2 are associated with industrial and urban background sites. The 98th percentile of daily average SO_2 concentrations is in the range from 139 $\mu g.m^{-3}$ at industrial stations to 84 $\mu g.m^{-3}$ at rural stations. The median of SO_2 daily concentrations ranges from 22 $\mu g.m^{-3}$ at traffic sites

to 8 $\mu g.m^{-3}$ at rural sites. The 98th percentile of daily average PM_{10} is in the range from 187 $\mu g.m^{-3}$ at traffic stations to 85 µg.m-3 at rural stations. The median of PM_{10} daily concentrations ranges from 48 $\mu g.m^{-3}$ at traffic to 20 $\mu g.m^{-3}$ at rural sites. The 98th percentile of daily average SPM is in the range from 149 $\mu g.m^{-3}$ at traffic stations to 139 $\mu g.m^{-3}$ at urban background stations. The median of SPM daily concentrations ranges from 46 $\mu g.m^{-3}$ at traffic and urban stations to 36 $\mu g.m^{-3}$ at industrial sites. The highest concentrations of NO_2 are associated with traffic and urban background sites. The 98th percentile of daily average NO_2 concentrations is in the range 91 $\mu g.m^{-3}$ at traffic sites to 42 $\mu g.m^{-3}$ at rural stations. The median of NO_2 daily concentrations ranges from 43 $\mu g.m^{-3}$ at traffic to 10 $\mu g.m^{-3}$ at rural sites.

In parallel with the reduction of coal and lignite based pollution sources and the significant decrease in sulphur and dust emissions, the ambient air concentration of sulphur dioxide and particulate matter decreased in most of the largest cities of the Phare region. In Budapest, for example, an intensive campaign and technological investment programme has been undertaken to reduce the sulphur content of diesel oil consumed by public buses, which are the major users of that type of fuel. In addition, individual coal-based heaters are being replaced by centralised natural gas heating systems in several Phare cities. The trend in annual average nitrogen dioxide concentration in large cities in the Phare region in the last few years is consistent with the development that, in general, the dominant source of air pollution in most Phare cities is now traffic.

The assessment of the frequency of exceedance of WHO guidelines and EU limit values indicates that the limit values for the PM_{10} fraction of particulate matter are likely to cause the greatest problem for air quality management. The population affected by air pollution concentrations exceeding limit values represents almost 14 % of total population of those Phare countries, which delivered data in 1997.

The concluding chapter of this report deals with air pollution impacts on the environment together with information on responses and pollution reduction measures taken in the Phare countries.

1. Introduction

1.1. General

This report has been prepared under the Phare topic link on air quality project (PTL/AQ) based on a contract with DG 1A of European Commission (Contract Number 97-0373.00). The goal of this report is to provide an overview of the state of air quality in 13 central and east European countries (the Phare countries) involved in Phare programme of the European Union ([1]).

The report is based on air quality data for 1997, collected within the framework of the PTL/AQ project from these countries. Previous reports reviewing air quality in Europe have been mostly focused on the EU region (Jol, A. and Kielland, G. (eds), 1997; Richter, D. A. U. and Williams, P. W., 1998; Sluyter, R. (ed.), 1995).

This report presents and analyses air quality data for 1997 transmitted by the Phare countries in the first reporting cycle following the procedures of the exchange of information (EoI) decision 97/101/EEC. The EoI decision establishes a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within EU Member States. Data reporting, based on EU decisions and directives is obligatory for EU Member States. However, the Phare countries agreed to participate voluntarily in the exchange of air quality data through their involvement in the work programme of the European Environment Agency (EEA).

The contents and structure of this report follow the format of the pilot EoI reports of the European Topic Centre on Air Quality (ETC/AQ). However, the report describes not only the data on air quality but also presents these in a broader context of the entire general framework of the DPSIR (driving forces, pressures, state, impact and responses) assessment framework.

Chapter 2 of the report presents the main socioeconomic activities (driving forces) in the Phare countries, which release pollutant emissions (pressures) into the atmosphere. Chapter 3 of the report describes the air quality monitoring networks, with particular regard to the implementation of the European air quality monitoring network (Euroairnet) in the Phare countries (Chapter 4). The report presents not only the state of air quality based on the 1997 data from the Phare countries but also recent trends in air quality and emissions in major cities in the Phare countries. The concluding chapter deals with the impact of air pollution on the environment and on responses and measures taken in the Phare countries.

1.2. Institutional background for data collection and exchange of information

The overall objective of the EEA is to provide the Community and the Member States with objective, reliable and comparable information at European level, enabling them to take the requisite measures to protect the environment, to assess the results of such measures and to ensure that the public is properly informed about the state of the environment.

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(1) Phare (Phare programme) is the financial instrument of the European Union's pre-accession strategy which will lead the partner countries of central and eastern Europe (CEECs), which have signed Europe agreements, to full EU membership. Set up in 1989 to support economic and political transition, Phare had by 1996 been extended to include 13 partner countries from the region: Albania, Bosnia and Herzegovina, Bulgaria, the Czech Republic, Estonia, the former Yugoslavic Republic of Macedonia (FYROM), Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia. Phare provides financial support to the partner countries from the process of economic transformation and strengthening of democracy to the stage where they are ready to perform the obligations of membership of the European Union. The main priorities for Phare funding are common to all countries, and include restructuring of State enterprises including agriculture, private sector development, reform of institutions, legislation and public administration, reform of social services, employment, education and health, development of energy, transport and telecommunications infrastructure, nuclear safety and environment.

To achieve these objectives, the EEA has developed the European environmental information and observation network (EIONET). This consists of the EEA, national focal points (NFPs), European topic centres (ETCs), national reference centres (NRCs) and main component elements (MCEs). To extend the work to the Phare countries, Phare topic links (PTLs) have been set up to work with the ETCs to form extended European topic centres. In close coordination with the European Topic Centre on Air Quality (ETC/AQ), the main objective of the PTL/AQ is to assist the EEA in extending its activities to the Phare countries.

One of the main tasks of the PTL/AQ is to develop and maintain air quality related technical contacts and links and facilitate information and expertise exchange with NFPs, NRCs and air quality experts in the Phare countries. The successful development of these links and contacts, promoted through the country visits, created the prerequisites for providing information from the Phare countries on air quality monitoring stations and air quality data collection as a necessary basis for the preparation of this report. The PTL/AQ established links with NFPs and NRCs in practically all Phare countries. With the exception of some countries, in which technical obstacles were identified, the PTL/AQ succeeded in collecting information on stations and air quality data from most of the Phare countries for inclusion in the European air quality database, Airbase.

The PTL/AQ would particularly like to express its appreciation to the many willing and receptive colleagues in the Phare countries — NFPs, NRCs and particularly, AQ experts who delivered both the necessary data on air quality and the supplementary data on stations and further information used in this report.

2. Driving forces and pressures

2.1. Socioeconomic background in the Phare countries

The activities of a human society — exploitation of resources, production of goods, transportation and consumption — all affect the environment. All these various activities contribute directly or indirectly to air pollution. In the Phare countries, the range of socioeconomical activities which can cause environmental change is extremely wide. There are, however, certain similarities among the different economies in relation to air quality.

Basic statistical socioeconomic data for individual Phare countries are given in Table 2.1 (Statistical compendium, 1996).

Basic geographical and socioeconomic statistics in the Phare countries Table 2.1

Country	Total area (km^2)	Agriculture land (km^2)	Forested area (km^2)	Population (1 000)	Population density (per km^2)	GDP 1994 (Mio USD)	GDP 1994 per capita (USD)
Albania	28 750	11 260	10 960	3 369	117	1 689	700
Bosnia and Herzego-vina	51 130	20 000	20 000	3 628	71	7 768	1 307
Bulgaria	110 910	60 180	39 130	8 549	77	16 985	1 106
Czech Republic	78 840	42 760	26 290	10 275	130	25 777	3 498
Estonia	45 100	14 540	20 170	1 507	33	2 317	1 510
FYROM	25 713	12 910	10 200	1 946	76	3 470	1 552
Hungary	93 030	61 220	17 190	10 162	109	31 155	4 072
Latvia	64 600	25 400	28 700	2 572	40	9 370	1 173
Lithuania	65 300	35 130	19 634	3 744	57	7 596	1 132
Poland	322 580	187 070	87 320	38 499	119	61 360	2 503
Romania	238 390	147 980	66 800	22 830	96	30 023	1 274
Slovak Republic	49 040	24 460	19 890	5 325	109	11 190	2 331
Slovenia	20 250	7 880	10 664	1 925	95	15 789	7 206

Political changes in central and eastern Europe during the period 1985–90 affected the general social and economic situation in these countries. The decline in economic growth during this period resulted in a general decline in production in the region, which also continued after 1990. In comparison to the situation in the beginning of the 1990s, energy and solid fuel consumption has decreased in most of the Phare countries (Table 2.2). In addition, the decrease in production connected with economic transformation in the Phare countries and, the direct restructuring processes that resulted in a decline in energy intensive production, led to a decrease in energy and solid fuel consumption. In Estonia, the Czech Republic, Hungary and Poland, the structure of fuel consumption has also changed, with an increase in natural gas consumption.

On the other hand, the intensity of traffic (number of cars) has increased considerably in the Phare Countries since the beginning of the 1990s (Table 2.2) and has now become an important contributor to environmental stress.

The intensity of human activity as a decisive environmental stress factor is closely related to the population density. The land cover map (Figure 2.1) shows the areas with highest population density in the Phare region to be the capital cities and industrial regions such as Silesia in southern Poland and northern Moravia, north-western Bohemia region (part of Black Triangle region), the region of Györ and Tatabanya in north-eastern Hungary, Dimitrovgrad and Marica in south-eastern Bulgaria and Baia Mare in Romania. These regions are amongst the most industrialised in Phare area and contain a high proportion of the region's heavy industry (coal mining, coke, iron and steal production, etc.).

Areas with high population density are also characterised by a high density of transport. Transit traffic by heavy trucks and private cars increases significantly the number of cars inside the cities. During the last few years a start has been made (e.g. in Budapest and Prague) to build orbital motorways around the cities so as to enable vehicles to avoid entering the cities unnecessarily.

Table 2.2 **Air quality related economical statistics in the Phare countries, 1990 and 1995 (Statistical compendium,1996)**

Country	Gross inland energy consumption 1 000 toe		Solid fuel consumption (1 000 toe)		Gas consumption (1 000 toe)		Passenger cars (per 100 inhabitants)	
	1990	1995	1990	1995	1990	1995	1990	1996
Albania	2 204	1 020	630	38	204	23	—	—
Bosnia and Herzego-vina	753	1 595	—	348	490	211	—	—
Bulgaria	26 770	20 568	8 782	7 213	5 394	4 583	15	19*
Czech Republic	46 785	39 013	29 697	20 855	5 264	6 547	23	33
Estonia	10 208	5 126	6 415	3 610	1 785	3 121	15	28
FYROM	2 993	2 572	1 562	—	279	—	11	12*
Hungary	28 427	25 103	6 201	4 184	8 911	9 163	19	21
Latvia	3 274	3 702	435	215	2 144	1 010	11	15
Lithuania	16 883	8 510	809	184	4 672	2 041	13	21
Poland	97 880	94 472	75 379	70 330	8 850	8 902	14	19
Romania	60 518	44 026	11 683	10 094	28 830	19 316	—	—
Slovak Republic	21 197	17 447	7 395	5 232	5 344	5 268	17	19
Slovenia	5 226	5 583	1 416	1 224	686	671	30	38

Note: * = 1994 data; - = no data.

2.2. Atmospheric emissions

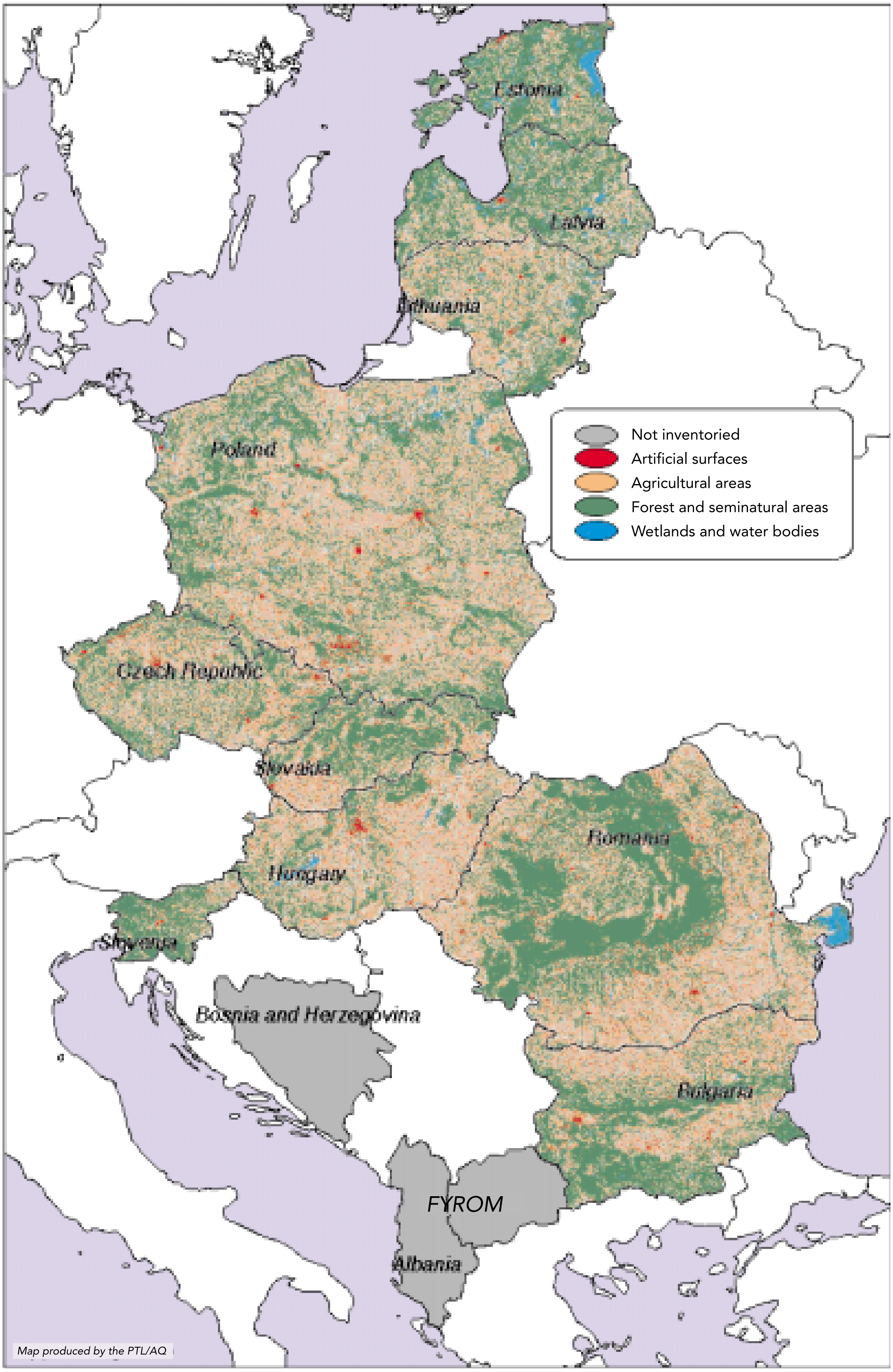
At the beginning of the 1990s, about 38 % of sulphur dioxide and 16 % of NMVOC emitted throughout Europe were produced in the Phare countries. Approximately 90 % of SO_2 emissions in the Phare area were produced by electricity and heat generation. More than 50 % of SO_2 in each Phare country was emitted from large point sources. More than 90 % of CO_2 in this part of Europe arose from the combustion of fossil fuels. The proportion of traffic-related emissions varied between 25 % (Slovenia) to 5 % (Romania). In 1990, the percentage of cars equipped with catalytic converters was negligible. According to Corinair90, NMVOC and NO_x emission from road transport in 1990 accounted for approximately 50 % of the national total emissions in Slovenia, Estonia and Hungary, about 35 % in Lithuania and approximately 20 % in Bulgaria, the Czech Republic, the Slovak Republic and Poland. The proportion of CO emission from traffic was more than 60 % in Hungary, Estonia, Slovenia and Lithuania (Marecková, private communication). The increased proportion of road transport emission in national totals is indicated by 1996 estimates (in Bulgaria: for NO_x 32 %, for CO 48 % and for NMVOC 19 %; in the Czech Republic: for NO_x 52.2 %, for CO 32.8 % and for NMVOC 23.2 %).

The extraction and distribution of fossil fuels are important sources of CH4, particularly coal mining and the natural gas distribution network (9 % in Lithuania — 56 % in Romania). For NMVOC emissions, extraction, distribution, and storage of crude oil and crude oil products are the most important processes.

NMVOC emissions occur within all main source sectors. However, the proportion attributed to the different groups varies from country to country. Combustion of fossil fuels is the main cause of SO_2, CO and CO_2 emissions in all countries. The proportion varies among the countries due to the national differences. However, it should be noted that differences in emission contributions are also — at least in part — due to differences in the national approach and methodology used to compile the emission inventory.

The decrease in solid fuel consumption, as documented in Table 2.2, fuel switching with an increasing share of natural gas compared to coal, restructuring of the economies, renewal of power plants and finally, abatement measures on large point sources (flue gas desulphurisation) are the main reasons for the remarkable decrease of SO_2 emissions in the Phare countries in the last 10 years (Figure 2.2). Trends in annual emissions of nitrogen dioxide, NMVOC and carbon monoxide are presented in Figures 2.3–2.5 (emission data see EMEP, 1999). For those countries where an emission inventory of particulate matter has been compiled, similar decreasing trends were observed (Table 2.3).

Figure 2.1 **Land cover in the Phare countries**



Trend of sulphur dioxide emissions in the Phare countries, 1988–97 (1000 t SO_2) Figure 2.2

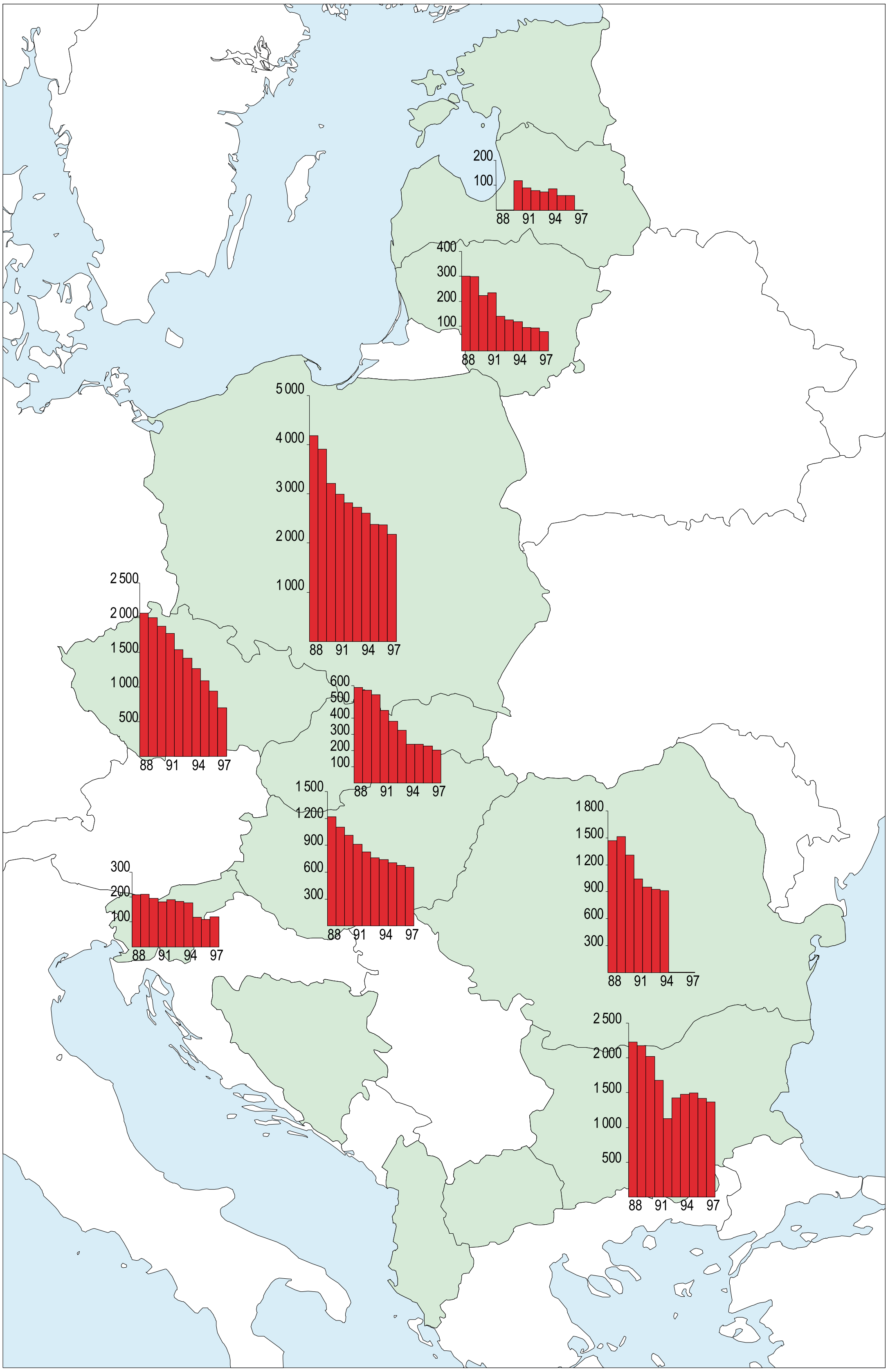
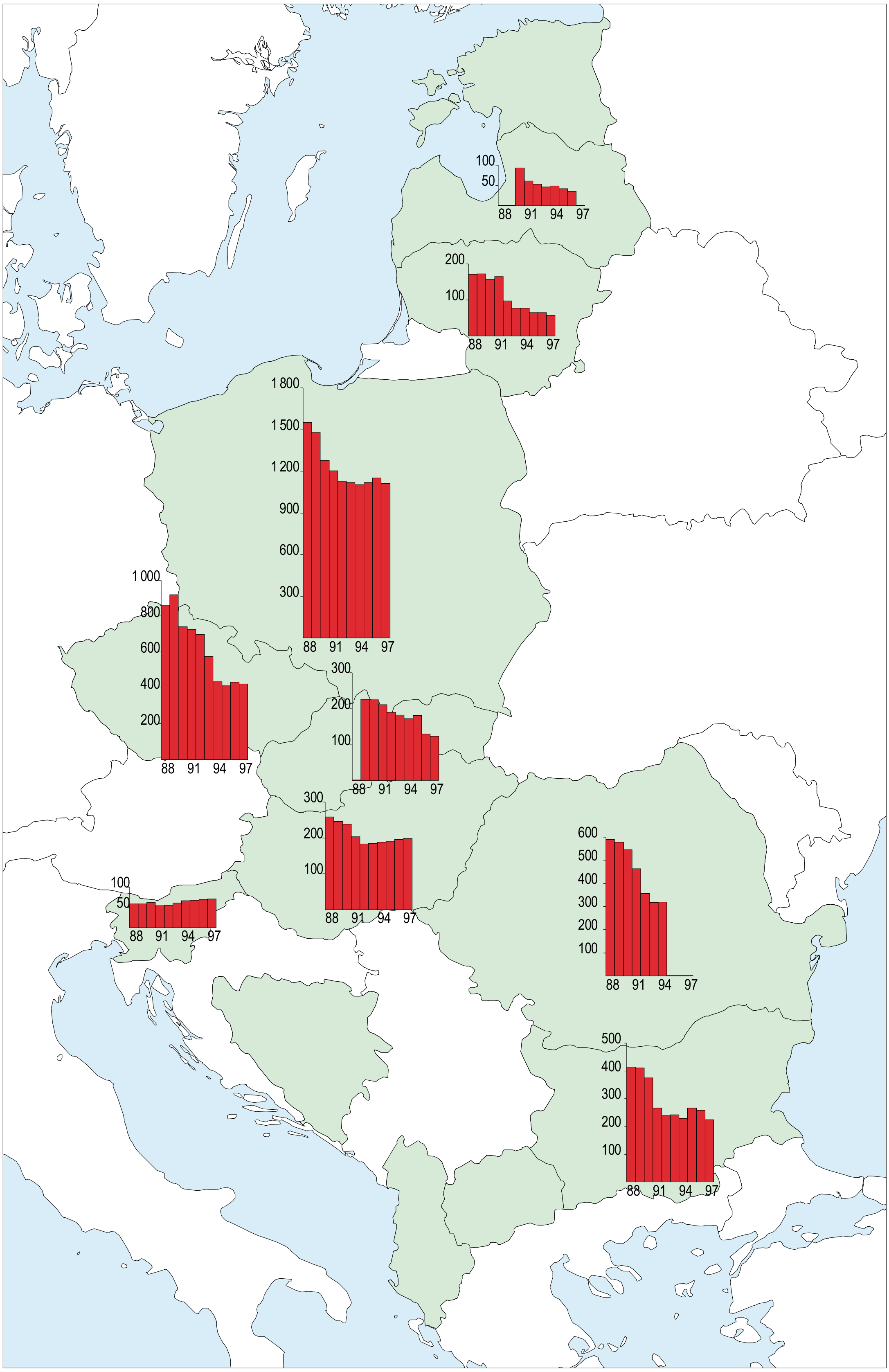


Figure 2.3 **Trend of nitrogen oxides emissions in the Phare countries, 1988–97 (1000 t NOx)**



Trend of carbon monoxide emissions in the Phare countries, 1988–97 (1 000 t CO) Figure. 2.4

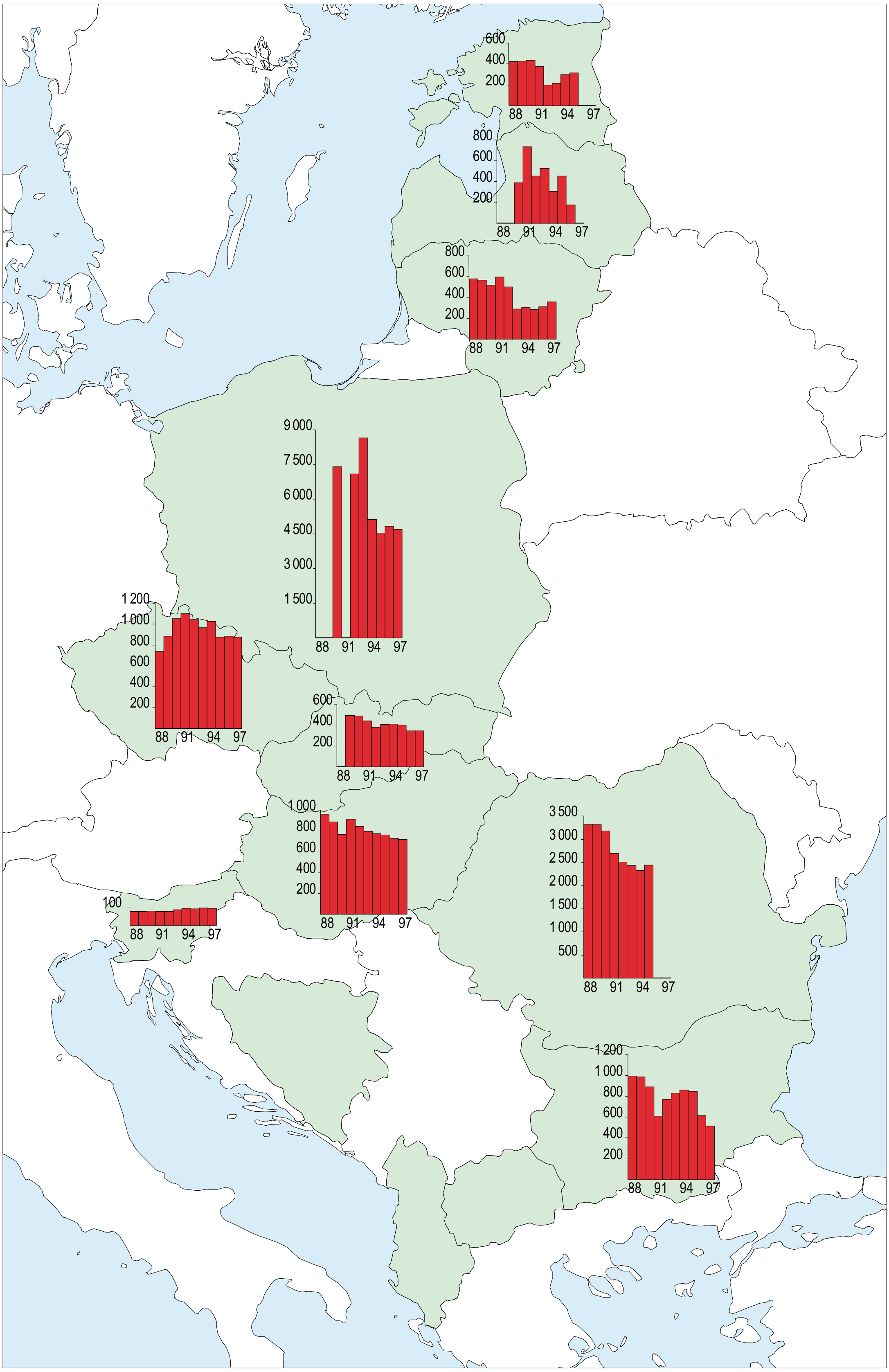
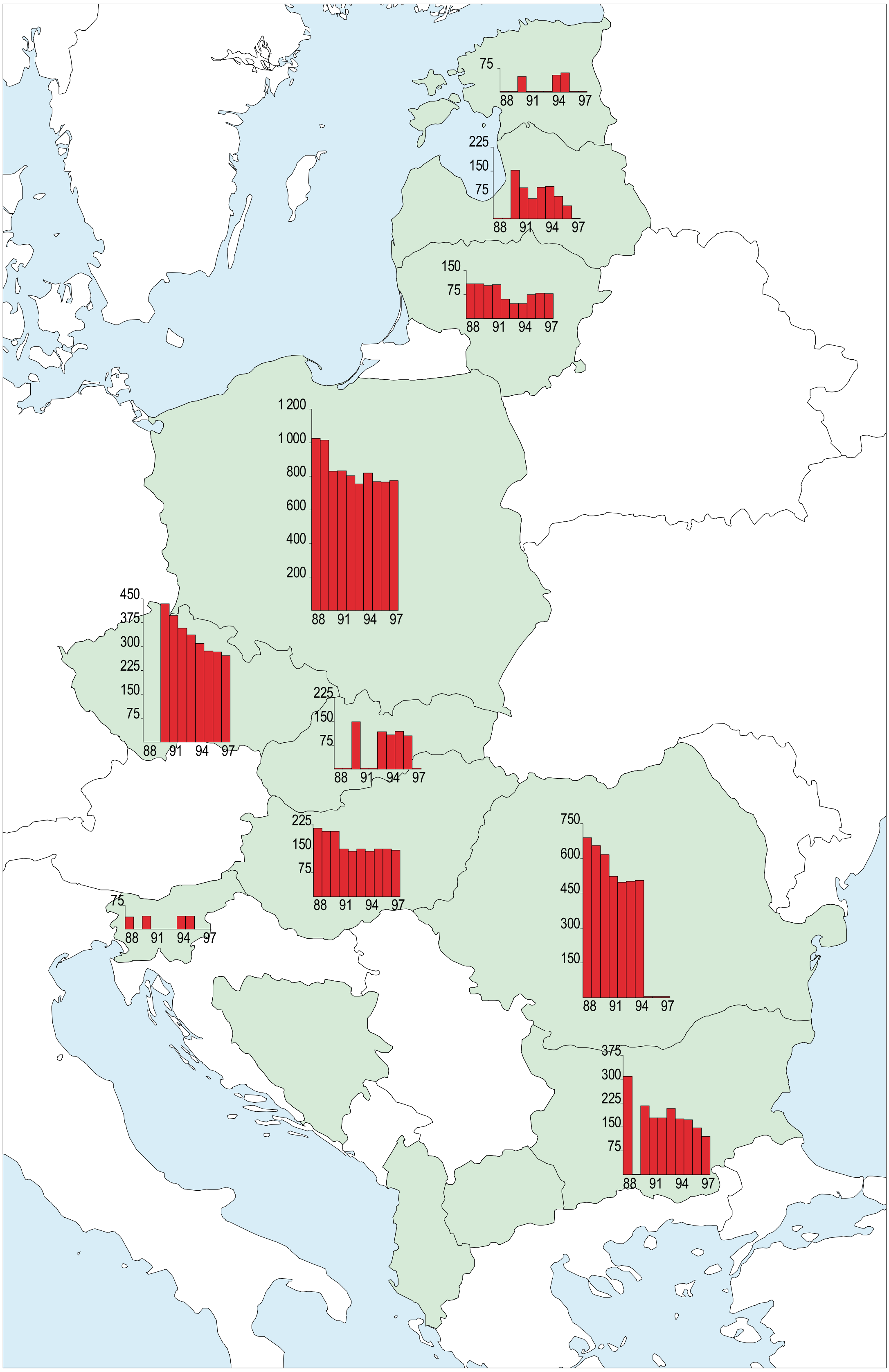


Figure. 2.5 **Trend of non-methane VOC emissions in the Phare countries, 1988–97 (1 000 t NMVOC)**



Annual atmospheric emissions of particulate matter (1 000 t) Table. 2.3

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Czech Republic	840	673	631	529	501	441	344	201	179	128
Poland		2 400	1 950	1 680	1 580	1 495	1 395	1 308	1 250	1 130
Slovak Republic	308	321	304	234	181	147	91	93	70	63

In spite of the considerable decrease in sulphur dioxide emission, these emissions, calculated per capita, are still much higher in the Phare countries compared to the average for EU-15 countries, as illustrated in Table 2.4. In contrast, NO_x emissions per capita are, on average, higher in EU-15 countries.

Atmospheric emissions per capita Table. 2.4

Country	NO_x			SO_2			CO_2	
	1990	1995	1997	1990	1995	1997	1990	1995
	(kg/capita)			(kg/capita)			(t/capita)	
Albania	7.1	7.1	7.1	28.2	9.5	21.4	0.3	0.1
Bosnia and Herzegovina	22.1	4.4	22.1	132.3	151.6	132.3	:	:
Bulgaria	44.0	31.1	26.3	236.3	175.1	159.7	10.6	8.6
Czech Republic	72.2	40.1	41.2	182.6	106.2	68.2	16.1	12.6
Estonia	45.1	31.2	29.9	158.6	73.0	79.0	26.3	13.1
FYROM	18.2	18.2	2.8	49.6	49.6	8.1	:	:
Hungary	23.4	18.7	19.5	99.4	69.4	64.7	7.3	6.3
Latvia	36.2	16.3	13.6	46.3	22.9	22.9	9.0	4.4
Lithuania	42.2	17.4	15.2	59.3	25.1	20.6	11.2	6.4
Poland	33.2	29.1	30.1	83.4	61.7	56.7	10.0	8.6
Romania	23.9	18.4	14.1	57.4	57.4	39.9	7.5	5.6
Slovak Republic	42.3	34.0	23.1	102.0	44.9	37.9	11.3	8.4
Slovenia	32.2	34.8	36.9	100.8	61.8	62.3	6.8	7.3
Phare countries	34.3	25.2	24.8	99.8	72.4	62.0	9.8	7.5
EU 15	36.2	31.2	29.6	44.6	29.0	25.1	9.0	8.6

During the 1990s, mobile sources (mainly passenger cars, buses and lorries) have become an increasingly important emission source in the Phare countries. Hence, the type, quality and age of car fleets in the Phare countries now have a strong influence on the emission characteristics in Phare cities. It is also likely that differences in car fleet characteristics are contributing significantly to differences in urban ambient air quality within the Phare region.

3. Air quality in the Phare countries

So far, an overview of air quality information from central and east European countries has been difficult to get, partly due to poor availability of data and sometimes low reliability and comparability. Nevertheless, various European and national reports or other information sources highlight the variability in air quality in this area. This corresponds with the large variation in emission density, orography, climate, meteorological conditions and land-use through the territory of the Phare countries. Industrial areas, overloaded with obsolete heavy industry still provide air pollution hot spots. On the other hand, there are large areas of forest and other areas with a very low population — particularly in the northern part of the Phare area. These belong to some of the cleanest areas in Europe.

This chapter focuses on the presentation of the 1997 air quality data transmitted by the Phare countries — predominately from Euroairnet sites — in the first reporting cycle in accordance with the EoI decision (97/101/EC). Implementation of the Euroairnet in the Phare countries will lead to unification of air quality monitoring procedures, which will ensure more objective, reliable and comparable information on air quality across Europe. The extent and completeness of air quality data transmitted has been described in the previous chapter.

Air quality trends in urban areas of the Phare countries are presented in the following subchapter. In order to identify areas and pollutants for which future problems of compliance with the European air quality directives might be expected, the frequency of exceedance of health-related air quality limit values, as defined in the new daughter Directive 99/30/EC, has been evaluated.

The last part of this chapter offers an approach for modelling the spatial pollutant concentration distribution within the Phare countries based upon the relationships between the measured pollutant concentrations and surrogate data (e.g. emissions estimates per unit area or land cover statistics).

3.1. Air quality monitoring results in 1997

Tables 3.1–3.5 summarise air quality in the Phare countries in 1997 on a country-by-country basis and by station type for SO_2, PM, NO_2, CO and ozone respectively. For each country and station type, the arithmetic average concentration from the number of sites given in brackets is presented followed by the range of concentration statistics. Statistics, as described in Decision 97/101/EC are calculated and presented in these tables for sulphur dioxide, particulate matter (BS — black smoke, TSP and PM_{10}), nitrogen dioxide, carbon monoxide and ozone.

For all pollutants, air quality data are also presented in maps (Figures 3.1–3.5) as spots varying in size and colour on a station-by-station basis (rural, urban background, traffic and other stations).

Table 3.6 shows summary statistics for the Phare region as a whole — maximum, 98th percentile, 95th percentile, 90th percentile, 75th percentile, median, 25th percentile, 10th percentile and minimum value are presented. These statistics have been calculated from annual sets of daily concentrations for each type of station in the whole Phare area for sulphur dioxide, particulate matter (PM_{10}, SPM and black smoke), nitrogen dioxide and ozone. As expected, with exception of ozone, the lowest concentrations for all components were measured on rural stations. The highest concentrations of SO_2 are associated with industrial and urban background sites. The 98th percentile of SO_2 is in range from 139 $\mu g.m^{-3}$ at industrial stations to 84 $\mu g.m^{-3}$ at rural stations. Median of SO_2 daily concentrations ranges from 22 $\mu g.m^{-3}$ at traffic to 8 $\mu g.m^{-3}$ at rural sites. The 98th percentile of PM_{10} is in range from 187 $\mu g.m^{-3}$ at industrial stations to 85 $\mu g.m^{-3}$ at rural stations. The median of PM_{10} daily concentrations ranges from 48 $\mu g.m^{-3}$ at traffic to 20 $\mu g.m^{-3}$ at rural sites. The 98th percentile of SPM is in range from 149 µg.m^{-3} at traffic stations to 139 µg.m^{-3} at urban background stations. The median of SPM daily concentrations ranges from 46 µg.m^{-3} at traffic and urban stations to 36 µg.m^{-3} at industrial sites. There were no measurements of SPM at rural type sites. The highest concentrations of NO_2 are associated with traffic and urban background sites according to this analysis. The 98th percentile of NO_2 is in the range 91 µg.m^{-3} at traffic type to 42 µg.m^{-3} at rural stations. The median of NO_2 daily concentrations ranges from 43 µg.m^{-3} at traffic to 10 µg.m^{-3} at rural sites. Although this analysis indicates that the classification of stations is generally correct, the presence of zero concentrations as minimum value, instead of half of measurement method detection limit, indicates that it may be necessary to check QA/QC procedures and improve data verification procedures

SO_2 concentrations by country and by station type Table. 3.1

Annual average: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		65(6). 26–94		
Czech Republic	18(19). 5–37	28(34). 16–43	26(2). 25–28	26(1)
Estonia			5(1)	8(2). 7–9
Hungary	10(4). 5–17	42(3). 38–45	49(4). 46–51	35(1)
Latvia	2(2). 2–2			
Lithuania			8(1)	
FYROM		25(12). 6–83	39(8). 13–69	32(4). 9–70
Poland		25(12). 10–51		
Slovak Republic		29(13). 15–63	24(8). 15–31	31(9). 6–64
Slovenia		39(2). 35–43	23(1)	
Phare	15(25). 1–37	(3 182). 6–94	32(25). 5–69	29(17). 6–70
98th percentile: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		187(1)		
Czech Republic	80(19). 27–164	129(33). 67–220	124(2). 112–135	117(1)
Estonia	1(1)		13(1)	26(2). 24–28
Hungary	49(4). 27–83	100(3). 98–102	100(4). 97–103	86(1)
Latvia	7(2). 6–8			
Lithuania			27(1)	
FYROM		90(11). 17–208	137(7). 46–282	111(4). 30–246
Poland		94(10). 44–170		
Slovak Republic		124(9). 47–263	82(6). 56–137	135(7). 49–292
Slovenia		109(1)	66(1)	
Phare	66(26). 1–164	116(68). 17–263	100(22). 13–282	(10 915). 24–292
24-h maximum: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		242(1)		
Czech Republic	183(19). 64–548	286(33). 128–752	187(2). 158–216	161(1)
Estonia	2(1)		17(1)	54(2). 42–65
Hungary	109(4). 39–204	151(3). 143–158	132(4). 120–146	124(1)
Latvia	8(2). 6–10			
Lithuania			45(1)	
FYROM		245(11). 33–678	346(7). 120–604	209(4). 52–457
Poland		181(10). 92–326		
Slovak Republic		340(9). 75–1 029	149(6). 74–291	410(7) 80–1 159
Slovenia		190(1)	83(1)	
Phare	(26). 2–548	(68). 33–1 029	(22). 17–604	(15). 42–1 159

NB: Figure between brackets = number of stations.

Table 3.2 **PM concentrations by country and by station type**

Annual average: average and range ($\mu g.m^{-3}$)					
Country	**Rural**	**Urban**	**Traffic**	**Industrial**	**Note**
Estonia			36(1)		TSP
Hungary		55(3). 50–59	53(4) 43–64	68(1)	TSP
Slovak Republic		51(8). 36–74	49(6). 21–65	44(9). 31–90	TSP
Czech Republic	25(19). 13–51	38(34). 24–60	51(2). 50–52	38(1)	PM_{10}
Poland		50(6). 34–59	77(1)	73(1)	PM_{10}
FYROM		23(15). 5–42	29(8). 11–48	25(4). 12–36	BS
Poland		23(6). 10–35			BS
98th percentile: average and range ($\mu g.m^{-3}$)					
Country	**Rural**	**Urban**	**Traffic**	**Industrial**	**Note**
Estonia			332(1)		TSP
Hungary		127(3). 124–130	120(3). 106–138	162(1)	TSP
Slovak Republic		121(5). 66–162	127(3). 97–153	110(8). 73–221	TSP
Czech Republic	73(19). 34–174	119(33). 67–168	148(2). 146–150	116(1)	PM_{10}
Poland		145(4). 102–188	210(1)	187(1)	PM_{10}
FYROM		90(14). 19–194	107(7). 32–162	107(4). 62–139	BS
Poland		88(6). 42–143			BS
24-h maximum: average and range ($\mu g.m^{-3}$)					
Country	**Rural**	**Urban**	**Traffic**	**Industrial**	**Note**
Estonia			492(1)		TSP
Hungary		191(3). 181–210	173(3). 165–186	233(1)	TSP
Slovak Republic		188(5). 90–334	173(3). 122–231	164(8). 109–285	TSP
Czech Republic	139(19). 55–330	232(33). 101–502	285(2). 266–303	268(1)	PM_{10}
Poland		208(4). 138–294	279(1)	399(1)	PM_{10}
FYROM		161(14). 31–454	241(7). 106–338	224(4). 100–427	BS
Poland		203(6). 91–326			BS

NO_2 concentrations by country and by station type Table 3.3

Annual average: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		13(4). 3–24		
Czech Republic	14(16). 5–23	33(25). 23–48	46(1)	
Estonia			37(1)	6(2). 5–7
Hungary	8(4). 3–14	53(3). 39–66	50(4). 31–61	25(1)
Latvia	2(2). 2–2			
Lithuania			35(1)	
Poland	21(1)	31(13). 20–46	68(2). 68–68	23(1)
Slovak Republic		27(12). 10–41	38(8). 28–53	23(9). 18–29
Slovenia		17(1)	51(1)	
Phare	12(23). 1–23	31(58). 3–66	45(18). 28–68	21(13). 5–29
98th percentile: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Czech Republic	40(16). 18–66	70(25). 57–85	89(1)	
Estonia			67(1)	31(2). 28–34
Hungary	18(4). 10–26	94(3). 82–104	85(4)67–97	60(1)
Latvia	5(2). 4–6			
Lithuania			59(1)	
Poland	50(1)	61(10). 46–78	112(2). 112–112	
Slovak Republic		79(7). 60–126	74(6). 57–101	53(8). 40–81
Slovenia		47(1)		
Phare	33(23). 2–66	70(46). 47–126	81(15). 57–112	50(11). 2881
24-h maximum: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Czech Republic	72(16). 34–111	114(25). 79–181	142(1)	
Estonia			77(1)	48(2). 47–49
Hungary	27(4). 16–40	120(3). 98–141	103(4). 75–126	73(1)
Latvia	7(2). 6–8			
Lithuania			64(1)	
Poland	85(1)	85(10). 63–123	155(2). 155–155	
Slovak Republic		98(7). 69–152	99(6). 76–137	71(8). 55–104
Slovenia		69(1)		
Phare	59(23). 3–111	105(46). 63–181	106(15). 64–142	67(11). 47–104

Note: Figure between brackets = number of stations.

Table 3.4 **CO concentrations by country and by station type**

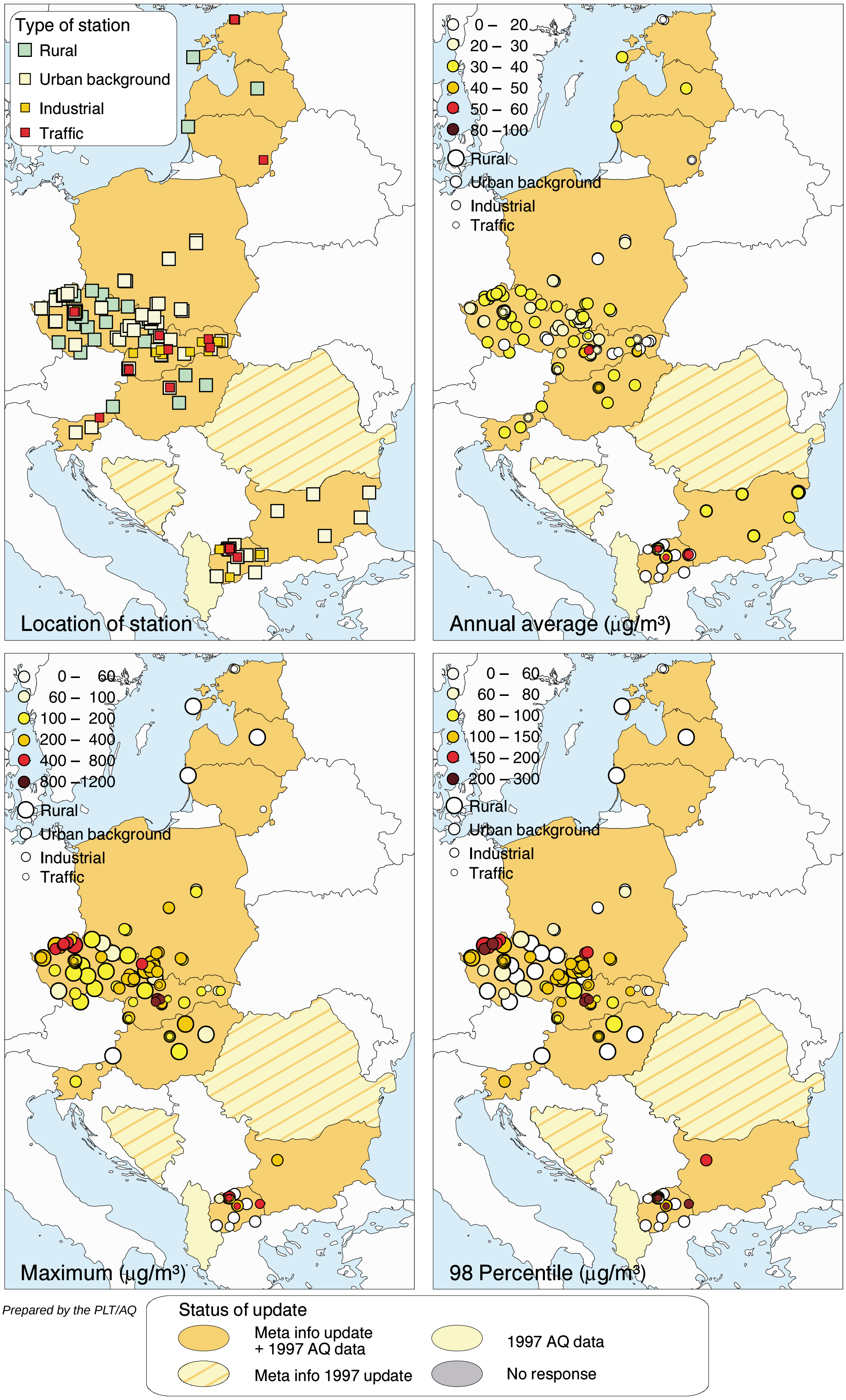
Annual average: average and range ($\mu g.m^{-3}$)				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		1 336(6). 395–2 542		
Czech Republic	352(2). 308–396	669(21). 368–914	1 174(1)	906(1)
Estonia			1158(1)	
Hungary		2 158(3). 2 116–2 202	2 744(4). 2 494–2 902	2 435(1)
Lithuania			2 230(1)	
Poland		983(1)	2 860(1)	
Slovak Republic			1 100(5). 769–1 462	221(1)
Phare	352(2). 308–396	952(31). 368–2 542	1 838(13). 769–2 902	1 187(3). 221–2 435
98th percentile: average and range (8-hourly moving average) ($\mu g.m^{-3}$)				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		2 013(1)		
Czech Republic	807(2). 739–876	1 984(17). 1 381–2 823	3 042(1)	2 275(1)
Estonia			3 185(1)	
Hungary		3 915(2). 3 445–4 385	5 232(4)4 278–5 889	
Lithuania			5 208(1)	
Poland			6 256(1)	
Slovak Republic			3 470(3). 2 359–4 773	
Phare	807(2). 739–876	2 178(20). 1 381–4 385	4 456(11). 2 359–6 256	2 275(1)
8-h maximum: average and range ($\mu g.m^{-3}$)				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		3 950(1)		
Czech Republic	1 094(2). 1 036–1 151	3 836(17) 2 031–7 402	4 783(1)	5 531(1)
Estonia			6 137(1)	
Hungary		5 716(2). 5 321–6 110	8 626(4). 6 880–10 894	
Lithuania			11 161(1)	
Poland			11 506(1)	
Slovak Republic			5 354(3). 3 273–7 871	
Phare	1 094(2). 1 036–1 151	4 030(20). 2 031–7 402	7 650(11). 3 273–11 506–	5 531(1)

Note: Figure between brackets = number of stations.

Ozone concentrations by country and by station type Table 3.5

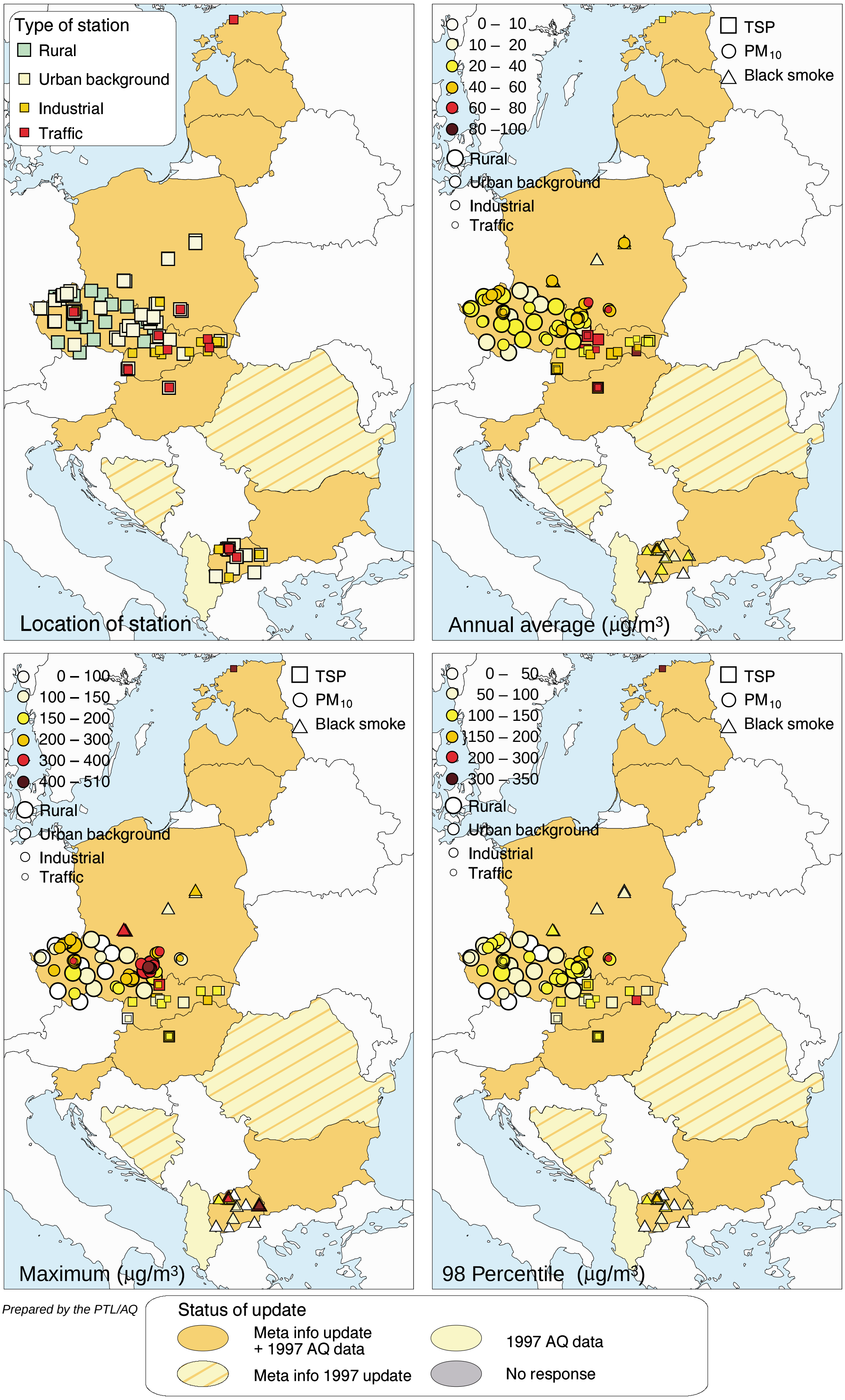
Max. 1-hour: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Czech Republic	167(13).135–200	169(16). 127–200		147(1)
Estonia	166(1)		122(1)	
Hungary	184(4). 165–199	157(1)		
Lithuania		130(3). 122–143	180(1)	
Poland	155(7). 136–175	176(7). 141–222		
Slovak Republic	174(3). 130–232	147(5). 126–172	142(2). 124–159	148(3). 135–166
Slovenia	198(2). 193–203	248(2). 210–285		
Phare	169(30). 130–232	168(34). 126–285	146(4). 122–180	148(4). 135–166
Max. 8-hour (moving average): average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Czech Republic	149(13). 121–163	148(16). 107–187		131(1)
Estonia	152(1)		107(1)	
Hungary	165(4). 146–177	136(1)		
Lithuania		120(3).113–127	157(1)	
Poland	146(7). 130–167	148(7). 125–175		
Slovak Republic	123(3). 104–149	128(5). 112–145	116(2). 97–135	132(3). 124–145
Slovenia	174(2). 161–187	179(2). 162–195		
Phare	(30). 104–187	(34). 107–195	(4). 97–157	(4). 131–145
Average: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		53(5). 16–122		
Czech Republic	66(13). 44—81	44(17). 29–57		35(1)
Estonia	65(2). 59–72		34(1)	
Hungary	69(4). 55–77	50(1)		
Latvia	50(1)			
Lithuania		51(4). 48–55	38(1)	
Poland	56(8). 35–81	39(8). 27–51		
Slovak Republic	54(3). 31–80	49(9). 38–80	33(2). 30–36	47(3). 42–51
Slovenia	78(2). 57–99	38(2). 36–39	36(1)	
Phare	(33). 31–81	(46). 16–122	(5). 30–36	(4). 35–51
98th percentile: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Czech Republic	118(13). 93–134	110(16).74–130		99(1)
Estonia	121(1)		72(1)	
Hungary	128(4). 112–143	106(1)		
Lithuania		93(3). 90–97	98(1)	
Poland	109(7). 94–124	101(7).81–116		
Slovak Republic	92(3). 67–118	98(5). 82–109	84(2). 69–99	104(3). 97–108
Slovenia	140(2). 130–151	118(2). 112–123		
Phare	(30). 67–151	(34). 74–130	(4). 69–99	(4). 97–108
24-h maximum: average and range (µg.m^{-3})				
Country	**Rural**	**Urban**	**Traffic**	**Industrial**
Bulgaria		67(1)		
Czech Republic	130(13). 89–156	105(16). 73–141		88(1)
Estonia	134(1)		82(1)	
Hungary	132(4). 115–142	92(1)		
Lithuania		97(3). 90–107		
Poland	113(7). 95–141	95(7). 74–128		
Slovak Republic	99(3). 67–131	98(5). 84–106	83(2). 68–97	99(3). 93–107
Slovenia	160(2). 148–172	143(2). 138–148	87(1)	
Phare	(30). 67–172	(35). 67–148	(4). 68–97	(4). 88–107

Figure 3.1 **Location of stations, annual average, maxima and 98th percentiles in given classes, sulphur dioxide, 1997**



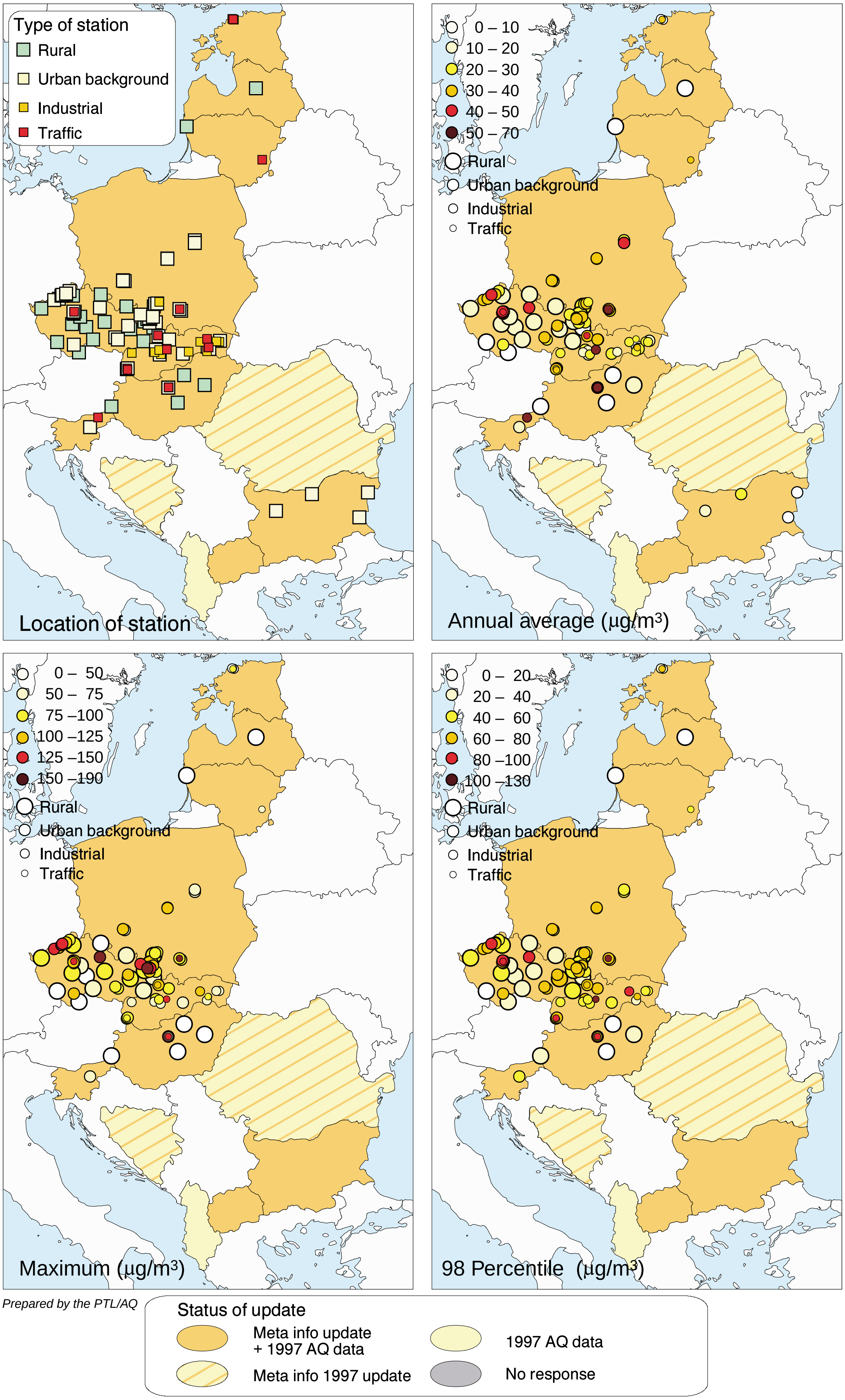
Prepared by the PLT/AQ

Location of stations, annual average, maxima and 98th percentiles in given classes, particulate matter, 1997 Figure 3.2



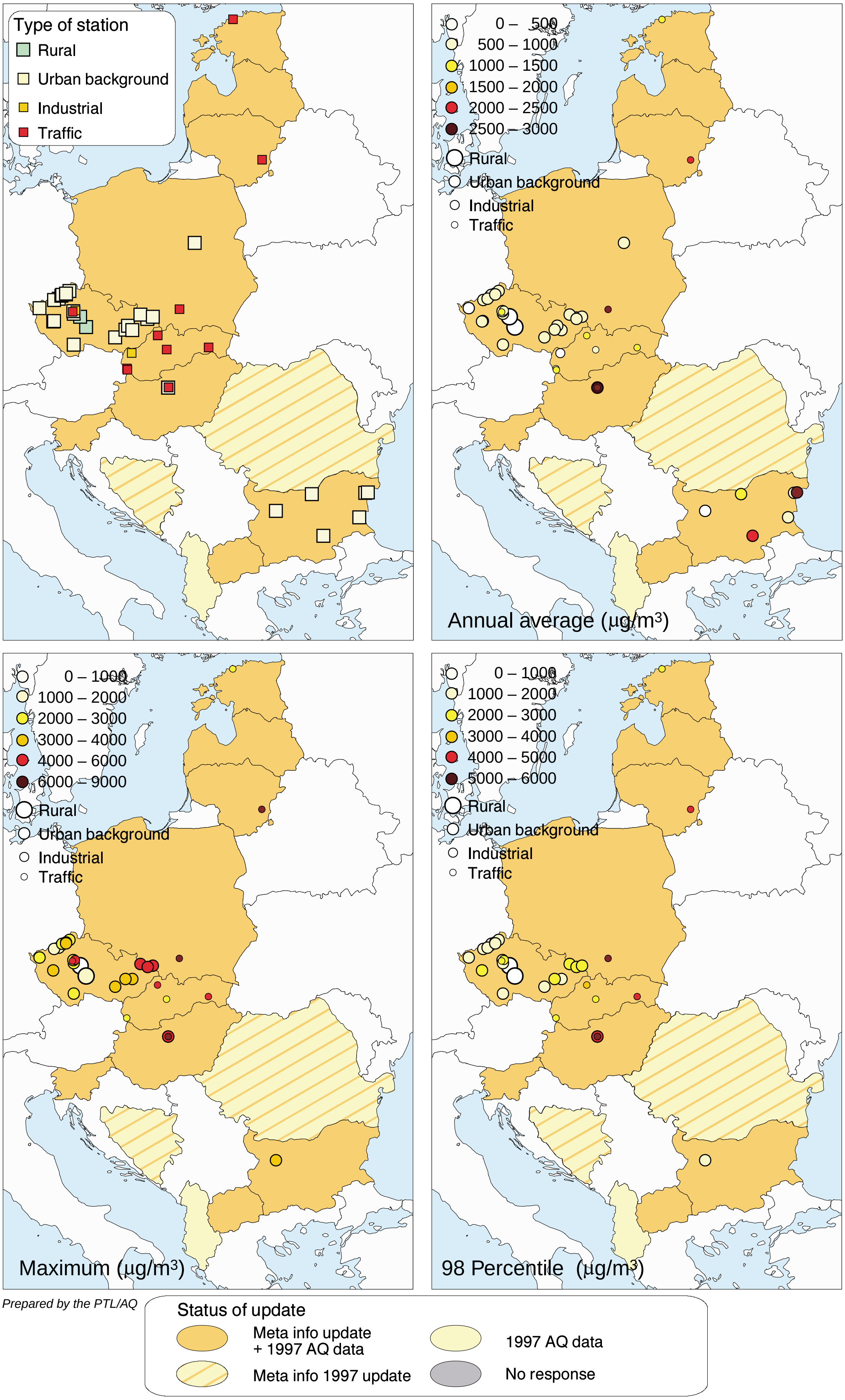
Prepared by the PTL/AQ

Figure 3.3 **Location of stations, annual average, maxima and 98th percentiles in given classes, nitrogen dioxide, 1997**



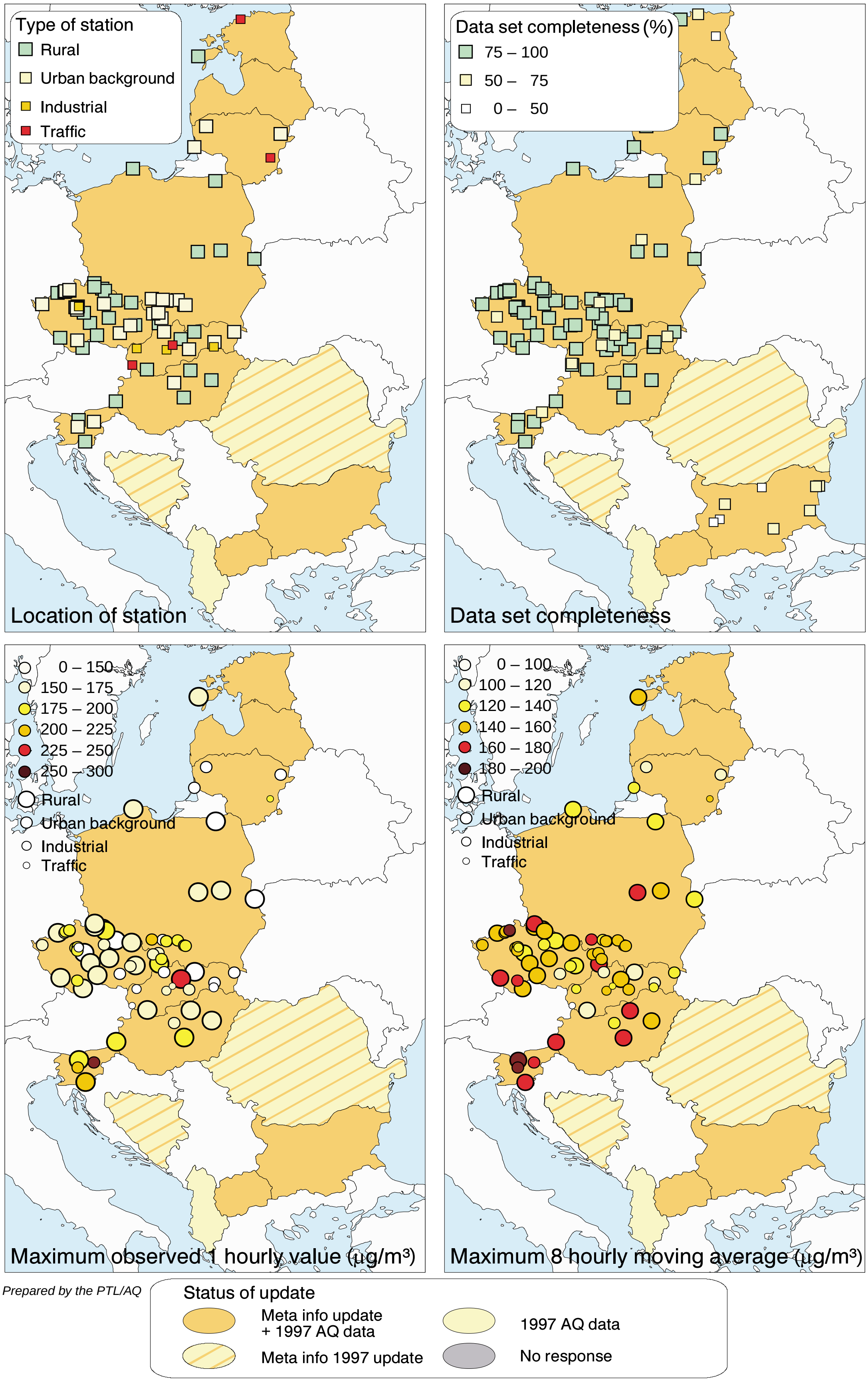
Prepared by the PTL/AQ

Location of stations, annual average, maxima and 98th percentiles in given classes, carbon monoxide, 1997 Figure 3.4



Prepared by the PTL/AQ

Figure 3.5 **Location of stations, data set completeness, maximum 1-hourly value, maximum 8-hourly moving averages in given classes, ozone, 1997**



Prepared by the PTL/AQ

Statistics of daily average concentrations (µg.m-3) of main pollutants per type of station in the Phare region, 1997

Table 3.6

Type of station	Pollutant	Max.	98th percentile	95th percentile	90th percentile	75th percentile	50th percentile	25th percentile	10th percentile	Min.
Urban background	SO_2	1 029	133	93	64	35	18	9	5	0
Traffic		604	122	83	60	41	22	11	5	0
Industrial		1159	139	92	61	33	17	9	5	0
Rural		548	84	50	34	17	8	3	1	0
All		1 159	125	85	58	33	16	8	4	0
Urban background	PM_{10}	502	130	96	73	47	30	20	14	2
Traffic		303	187	147	110	73	48	33	23	7
Industrial		399	170	130	104	68	45	28	18	6
Rural		330	85	60	46	31	20	12	8	1
All		502	128	93	70	44	28	18	12	1
Urban background	SPM	334	139	117	97	67	46	31	21	5
Traffic		492	149	119	95	68	46	30	0	0
Industrials		285	146	110	88	59	36	24	16	0
All		492	146	115	94	64	43	28	17	0
Urban background	BS	454	110	80	56	27	13	7	4	0
Traffic		338	135	102	72	35	16	7	3	0
Industrial		427	121	85	61	29	14	7	3	0
All		454	119	86	60	29	14	7	3	0
Urban background	NO_2	181	80	66	56	42	29	20	14	0
Traffic		155	91	79	70	56	43	31	22	0
Industrial		104	54	45	38	28	19	11	3	0
Rural		111	42	32	24	16	10	5	2	0
All		181	78	65	54	39	24	14	7	0
Urban background	O_3	148	92	82	74	60	43	25	11	0
Traffic		97	68	63	58	47	33	20	11	0
Industrial		107	84	78	70	60	46	27	13	2
Rural		172	119	107	98	82	64	46	29	2
All		172	109	97	86	69	51	32	16	0

3.2. Air quality in cities in the Phare countries

The number of inhabitants in the Phare region is more than 115 million people of which approximately 17 million live in urban areas with more than 500 thousand inhabitants. About 8 million people live in cities with a population in the range 250-500 thousand and 19 million in cities with a population in the range 50-250 thousand. The highest population areas are generally the capital cities (see Table 3.7).

Until the end of the 1980s, the air quality situation in cities in the Phare region was characterised by increasing sulphur dioxide and particulate pollution. At that time, Phare cities were affected by high soot and sulphur dioxide concentrations (London type smog) in the winter season, as was the case in many other cities throughout Europe. Later, due to the reduction of coal- and lignite-based pollution sources, sulphur and soot emissions decreased significantly (see Figure. 2.1). In parallel, the ambient air concentration of sulphur dioxide and particulate matter decreased in most large cities of Phare region (Figures. 3.6 and 3.7). In Budapest, for example, an intensive campaign and technological investment programme has been undertaken to reduce the sulphur content of diesel oil consumed by the public buses, which are the major users of that type of fuel. In addition, individual coal-based heaters are being replaced by central natural gas heating systems in several Phare cities.

Table 3.7 **Population in capitals and other large cities (> = 500 thousand)**

City	Country	Population/1 000
Tirana	Albania	500
Sofia	Bulgaria	1 300
Sarajevo	Bosnia and Herzegovina	341
Prague	Czech Republic	1 220
Tallinn	Estonia	900
Skopje	FYROM	550
Budapest	Hungary	2 100
Riga	Latvia	900
Vilnius	Lithuania	570
Warsaw	Poland	1 500
Silesia conurbation	Poland	2 100
Krakow	Poland	800
Lodz	Poland	850
Poznan	Poland	590
Bucharest	Romania	2 400
Bratislava	Slovak Republic	500
Ljubljana	Slovenia	273
Total		**17 444**

However, the number of vehicles increased rapidly, releasing increasing amounts of nitrogen oxides, hydrocarbons and carbon monoxide; these pollutants lead to photochemical oxidant formation (ozone, PAN, etc.). The trends in nitrogen dioxide annual concentration in large cities of the Phare region in the period 1988–97 (Figure 3.8) suggest that, generally, the dominant source of this pollutant is now traffic in most of the cities of the region. There are no trends evident in the time series of annual average ozone concentrations (Figure 3.9).

The annual time series of 24-hour concentrations of the basic pollutants at selected urban background stations (Figure 3.10) show the seasonal variation of these pollutants and occurrences of episodes of extremely high concentrations of some pollutants. Figure 3.11 and Figure 3.12 depict the annual time series of 24-hour concentrations of the main pollutants at selected traffic and industrial sites. Urban background stations reflect representative levels of air pollution for assessment of population exposure in cities, whereas traffic and industrial sites represent higher exposure levels which can prevail in the central area of the city with dense traffic, or in industrialised zones.

Graphs of ordered 98th percentiles and annual mean concentration of SO_2, PM (TSP or PM_{10}), NO_2 and, for O_3 maximum 8-hour and 1-hour average, show the highest pollutant concentrations and their range at urban background (Figure 3.13) and traffic and industrial sites (Figure 3.14). Figure 3.13 shows that the exceptionally high annual average urban background concentrations of sulphur dioxide, 83 and 80 µg.m^{-3}, were detected in Titov Veles (FYROM) and Vratsa (Bulgaria) respectively. Other urban background stations with annual average concentrations of sulphur dioxide higher than 40 µg.m^{-3} are located in Zabrze (Poland), Prievidza (the Slovak Republic), Gliwice (Poland), Budapest (Hungary), Usti n. L. and Teplice (the Czech Republic). Most of annual average urban background concentrations of sulphur dioxide lie in range of 40–15 µg.m^{-3}.

The highest 98th percentiles of 24-hour SO_2 concentrations were detected in the range 220–185 µg.m^{-3} in Teplice and Chomutov (the Czech Republic), Skopje (FYROM), Vratsa (Bulgaria) and Prievidza (the Slovak Republic). Other urban background stations with 98th percentile of 24-hour SO_2 concentrations higher than 160 µg.m^{-3} are situated in Zabrze and Gliwice (Poland) and Usti n. L. and Most (the Czech Republic).

As regards the nitrogen dioxide concentrations, the levels on urban background stations are only slightly lower then at the traffic sites (Figure 3.14). The highest annual average concentrations of nitrogen dioxide at urban background sites in Budapest (Köbánya and Laborc utca) were 66 and 54 µg.m^{-3} respectively, whereas the highest annual average concentration of nitrogen dioxide at traffic sites were detected in Krakow (Poland), 68 µg.m^{-3}. On the contrary, at traffic sites in Budapest (Baross tér, Kosztolányi tér and Széna tér) the 24-hour average NO_2 concentrations were in the range of 61–51 µg.m^{-3}. The highest 98th percentile of 24-hour NO_2 concentrations at urban sites was detected in Budapest, 103 µg.m^{-3}, whereas the highest 98th percentile of 24-hour NO_2 concentrations at traffic site in Krakow (Poland) was 112 µg.m^{-3}.

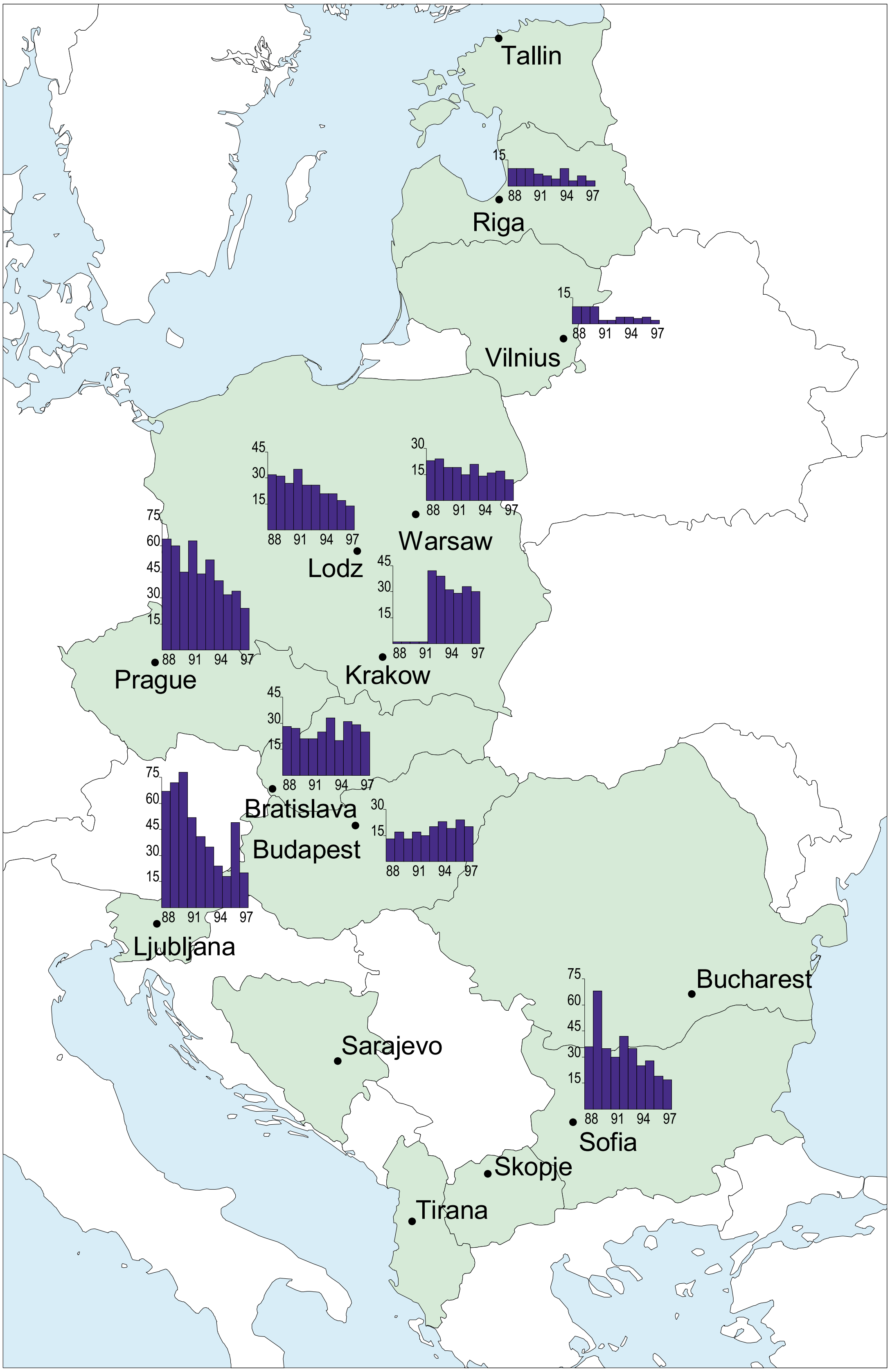
The wide size range distribution of aerosol particles found in the atmosphere makes the sampling difficult. Some countries report TSP or black smoke (BS) while others PM_{10}. For this reason, the comparison of particulate concentration levels is difficult.

Cities in this part of Europe are still coping with the problem of atmospheric lead (Pb) arising mostly from vehicles using leaded gasoline. Older cars can only use leaded gasoline due to their engine construction. However, the number of modern cars equipped with catalytic converters is increasing and hence, an increasing fraction of gasoline consumed in the region is unleaded. During the past decade, the use of unleaded gasoline has become increasingly widespread in the Phare region (Bozó, 1998). In general, it can be stated that although air quality in the Phare region has improved in recent decades, air pollution still represents one of the major environmental issues that authorities at all levels have to cope with. In contrast to the decreasing SO_2, Pb and PM ambient concentrations, pollutants associated with road transport such as NO_x, CO, VOC and indirectly O_3 have increased during the last decades. In this sense, cities in Phare region replicate, to some extent, the development of air pollution in cities of the EU countries.

To identify areas and pollutants for which problems of compliance with new European air quality standards (Directive 99/30/EC) could be expected, the number of days exceeding health-related air quality limit values was evaluated for Phare urban areas. The frequency of exceedance of given limit values are presented in Table 3.8 and depicted on a map (Figure 3.15), which shows sites exceeding limit values. This assessment indicates that the limit values for PM_{10} are likely to cause the greatest problem.

The number of people affected by air pollutant concentrations exceeding limit values is almost 14 % of the total population of the Phare countries which delivered data in 1997.

Figure 3.6 **Annual concentration trends in large cities, sulphur dioxide, 1988–97 (µg/m³)**



Annual concentration trends in large cities, particulate matter, 1988–97 (µg/m³) Figure 3.7

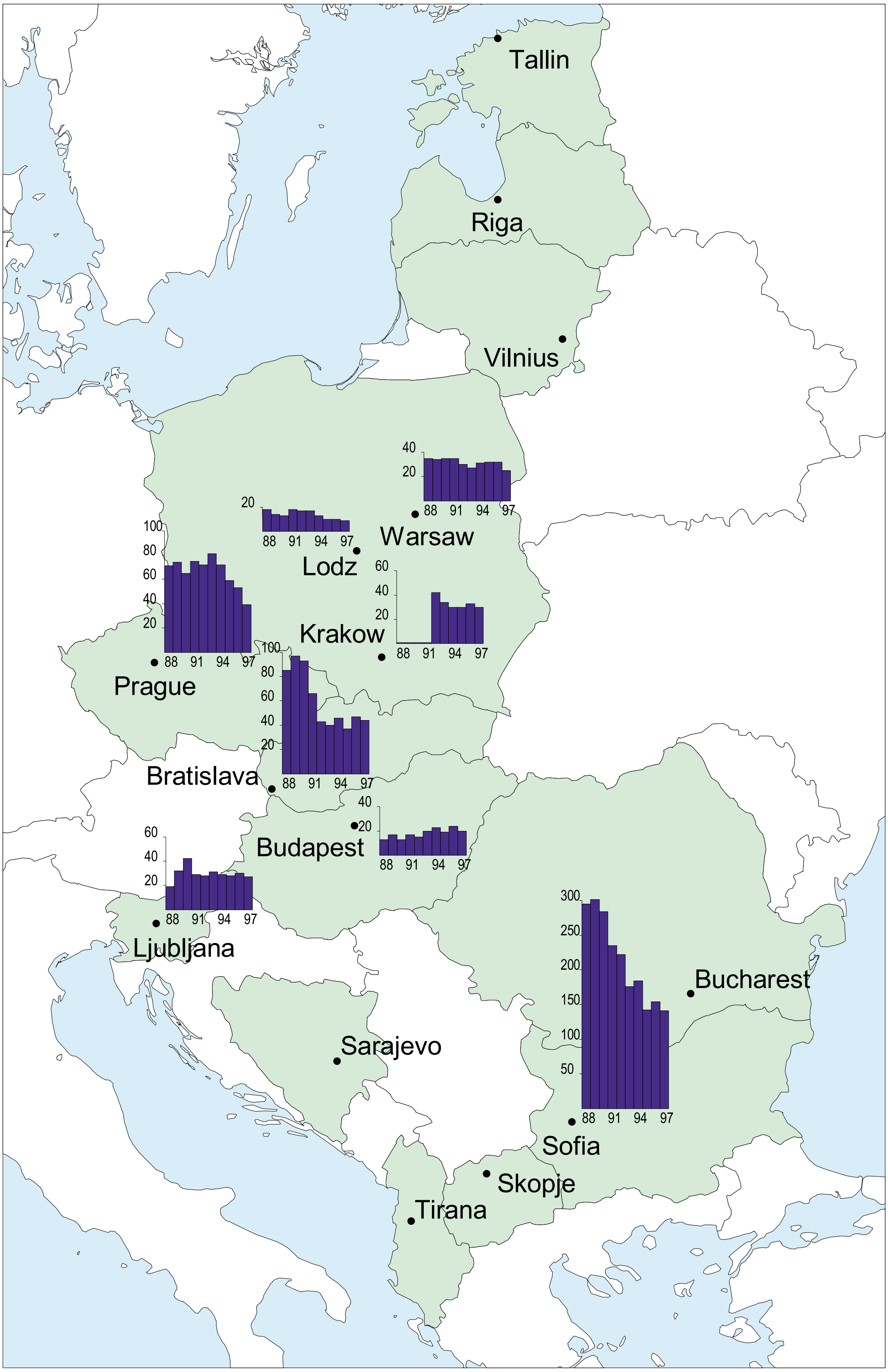
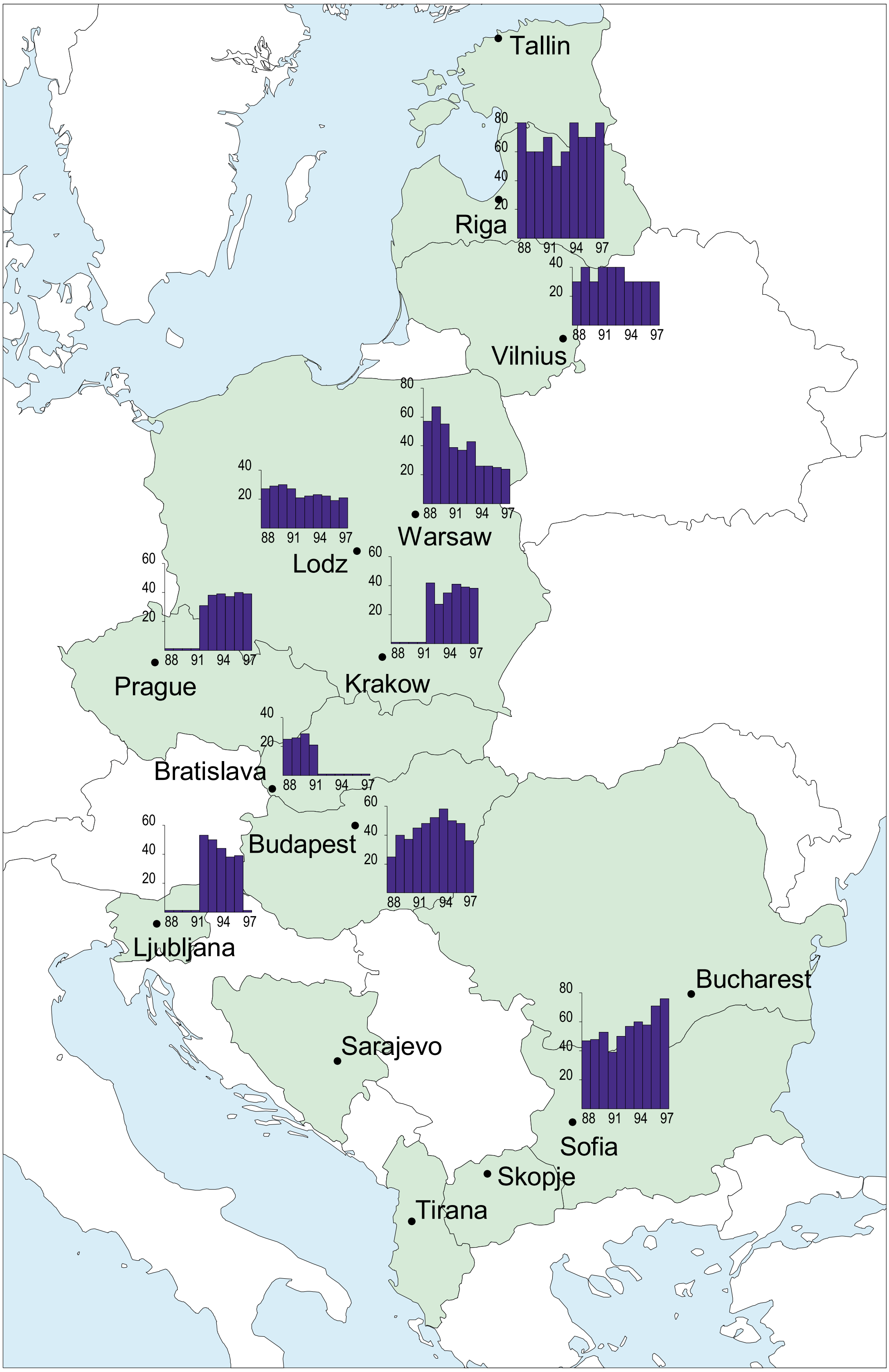


Figure 3.8 **Annual concentration trends in large cities, nitrogen dioxide, 1988–97 (µg/m³)**



Maximum hourly concentration trends in large cities, ozone, 1992–97 (µg/m³) Figure 3.9

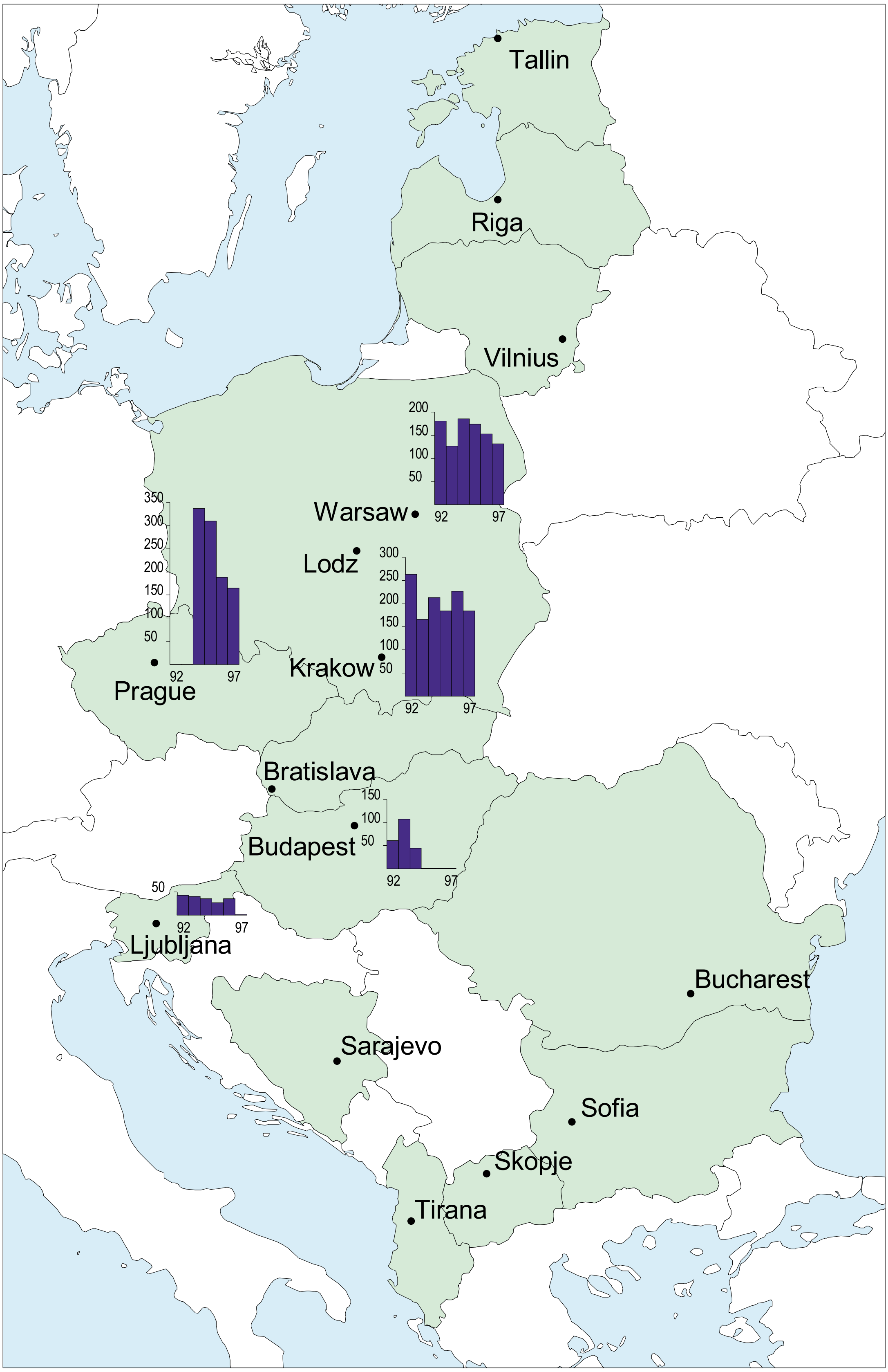
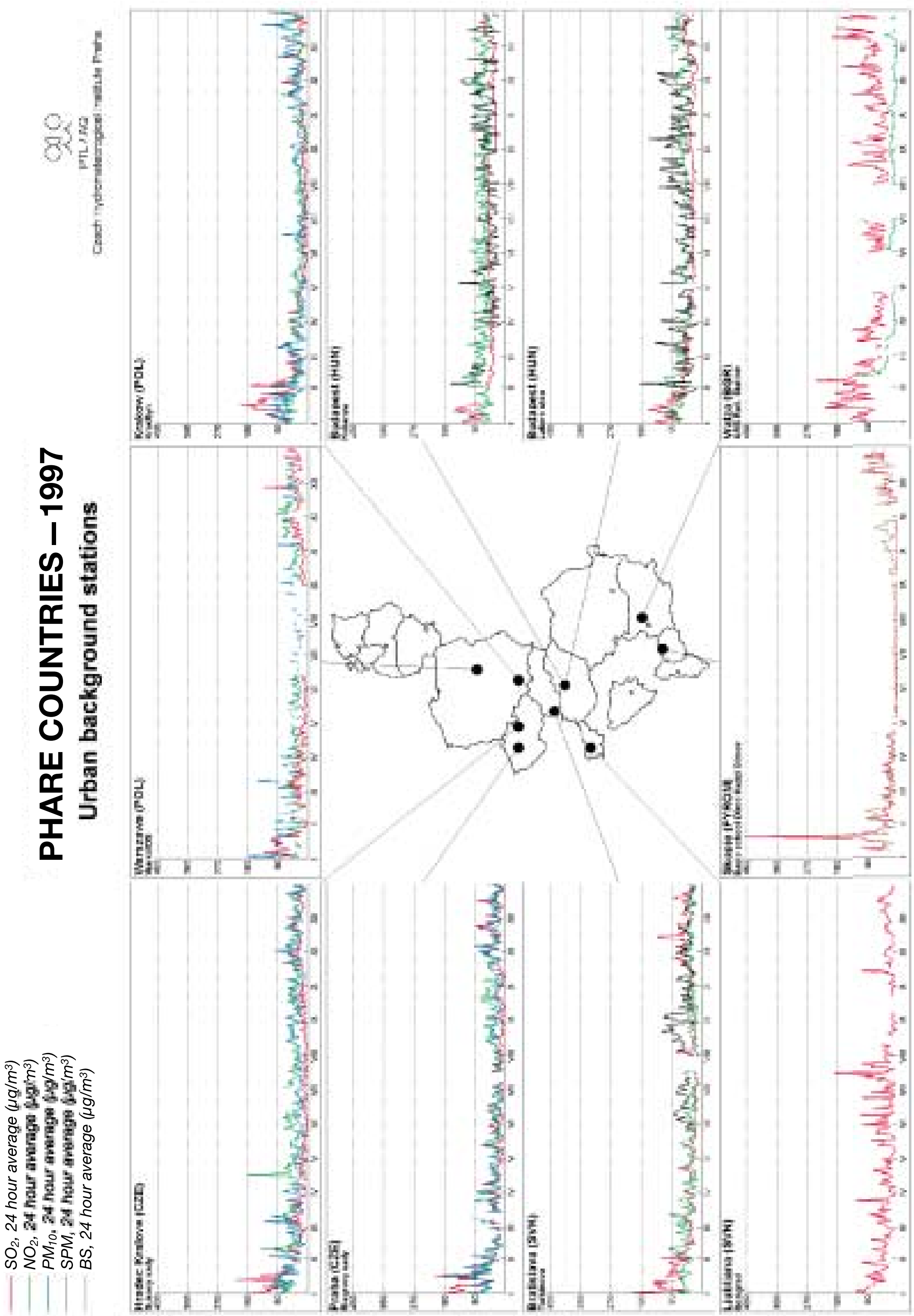


Figure 3.10 **Urban background stations, the Phare countries, 1997**



Traffic stations, the Phare countries, 1997 | Figure 3.11

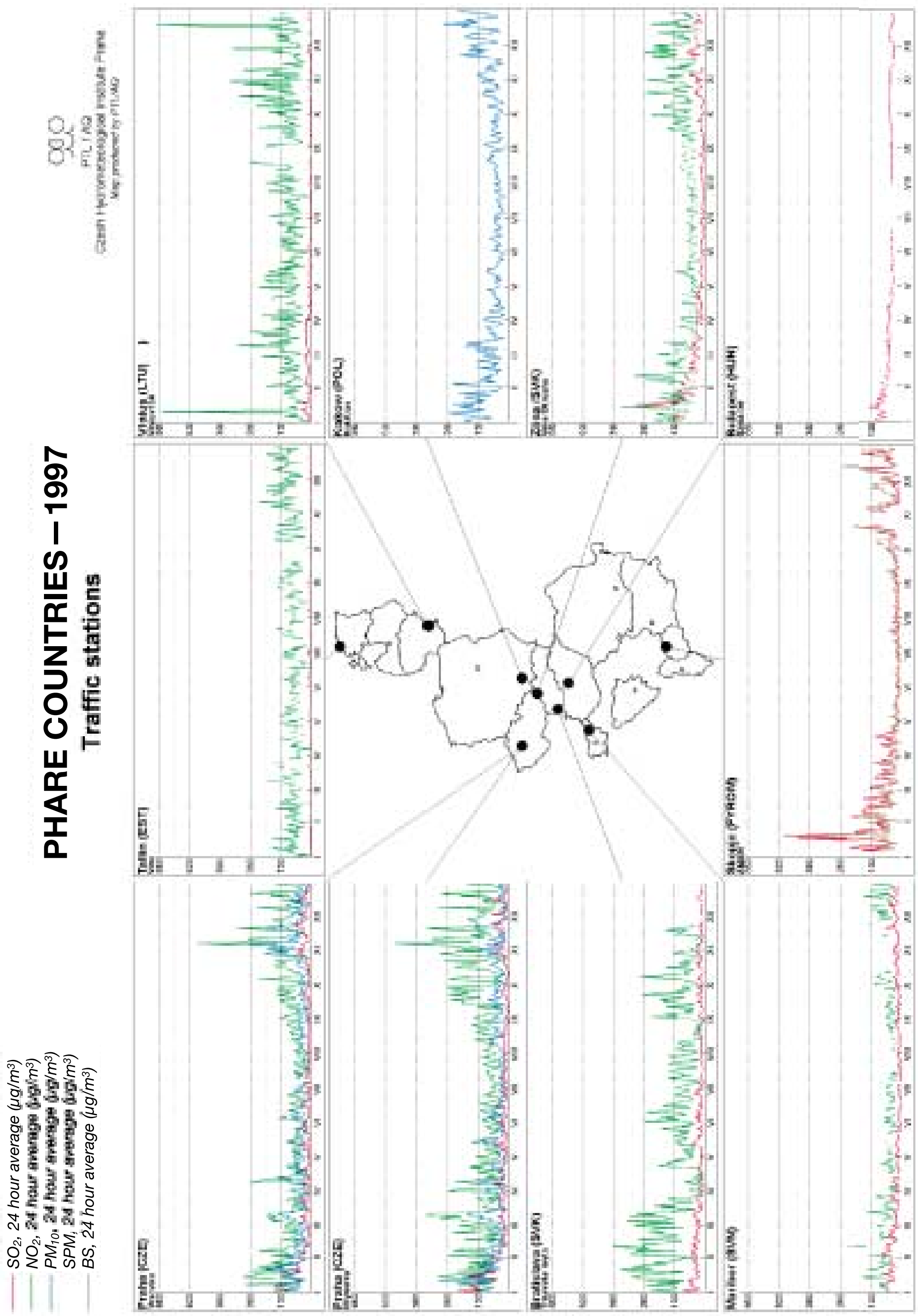
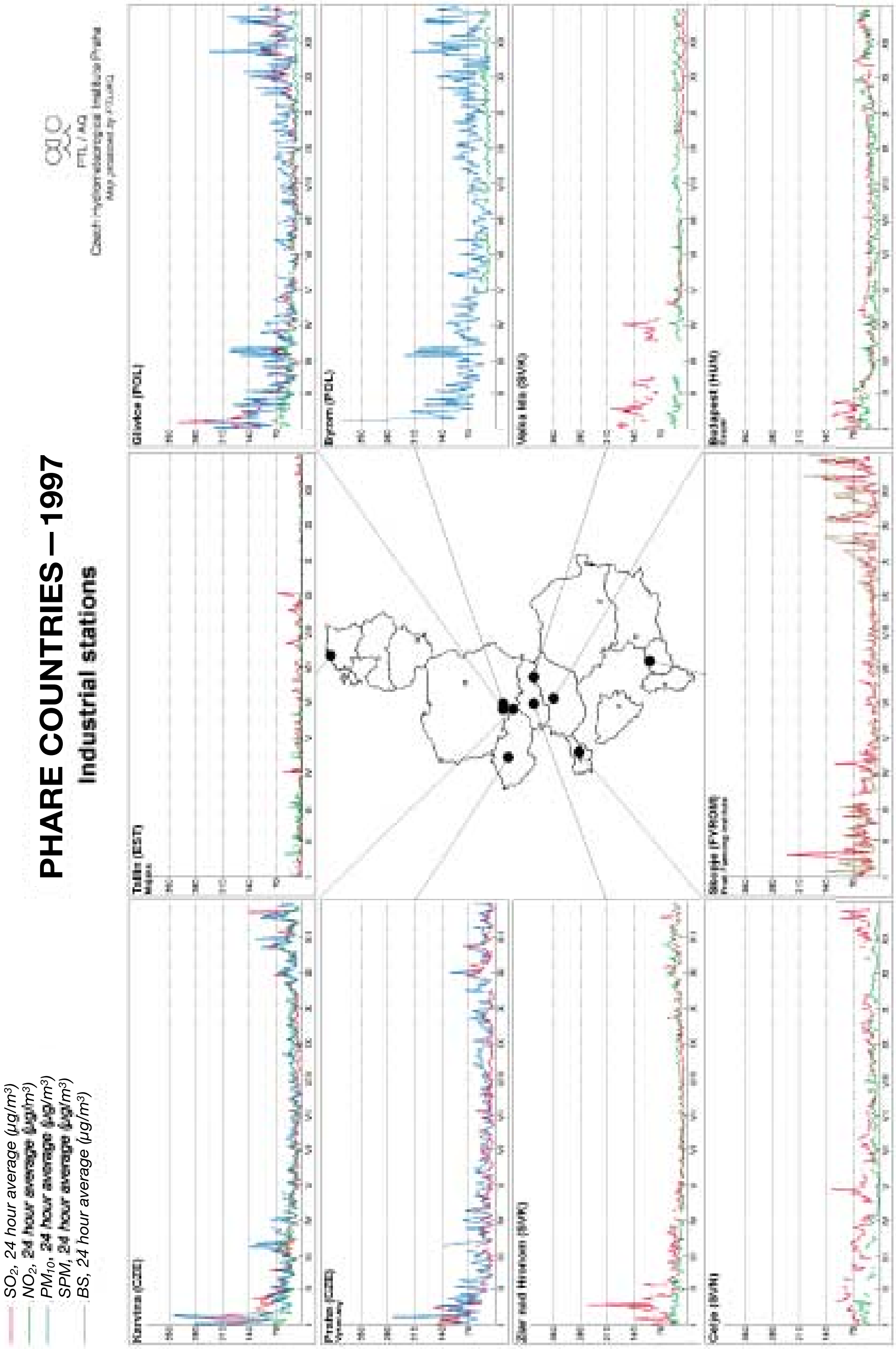


Figure 3.12 **Industrial stations, the Phare countries, 1997**



Annual average and 98th percentile pollutant concentrations at urban background sites 1997

Figure 3.13

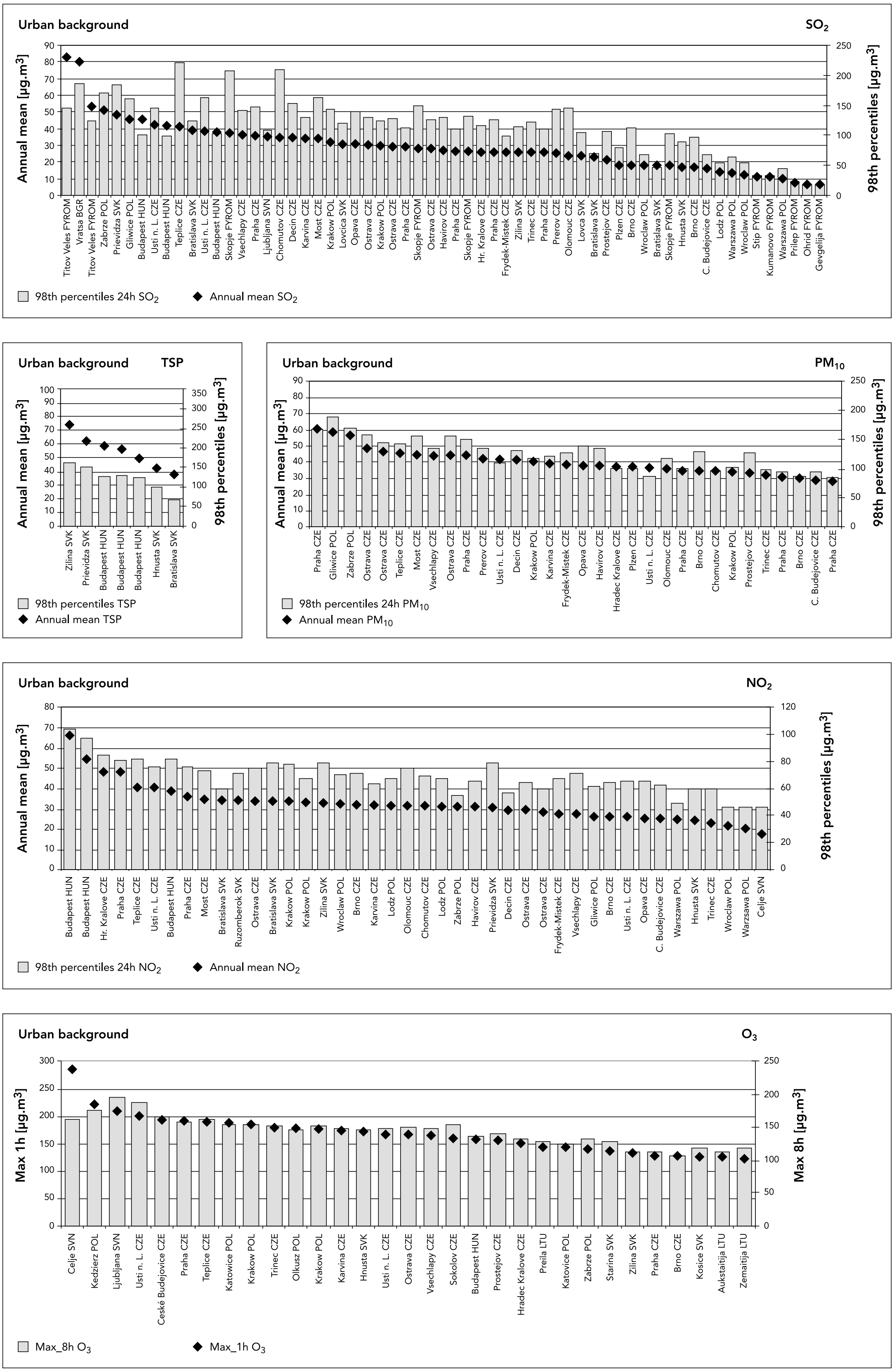
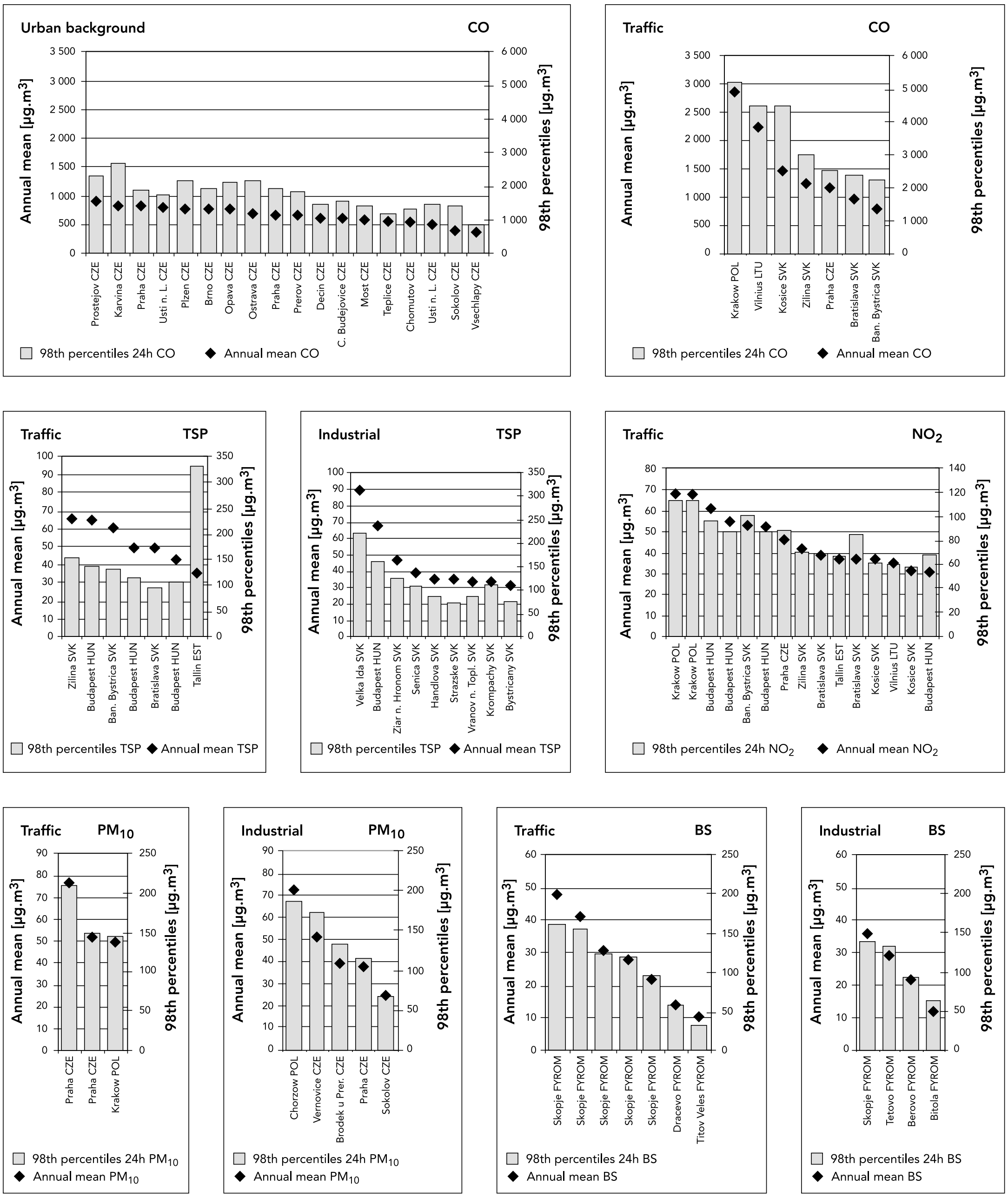


Figure 3.14 **Annual average and 98th percentile pollutant concentrations at urban, traffic and industrial sites, 1997**



Exceedances of limit values Figure 3.15

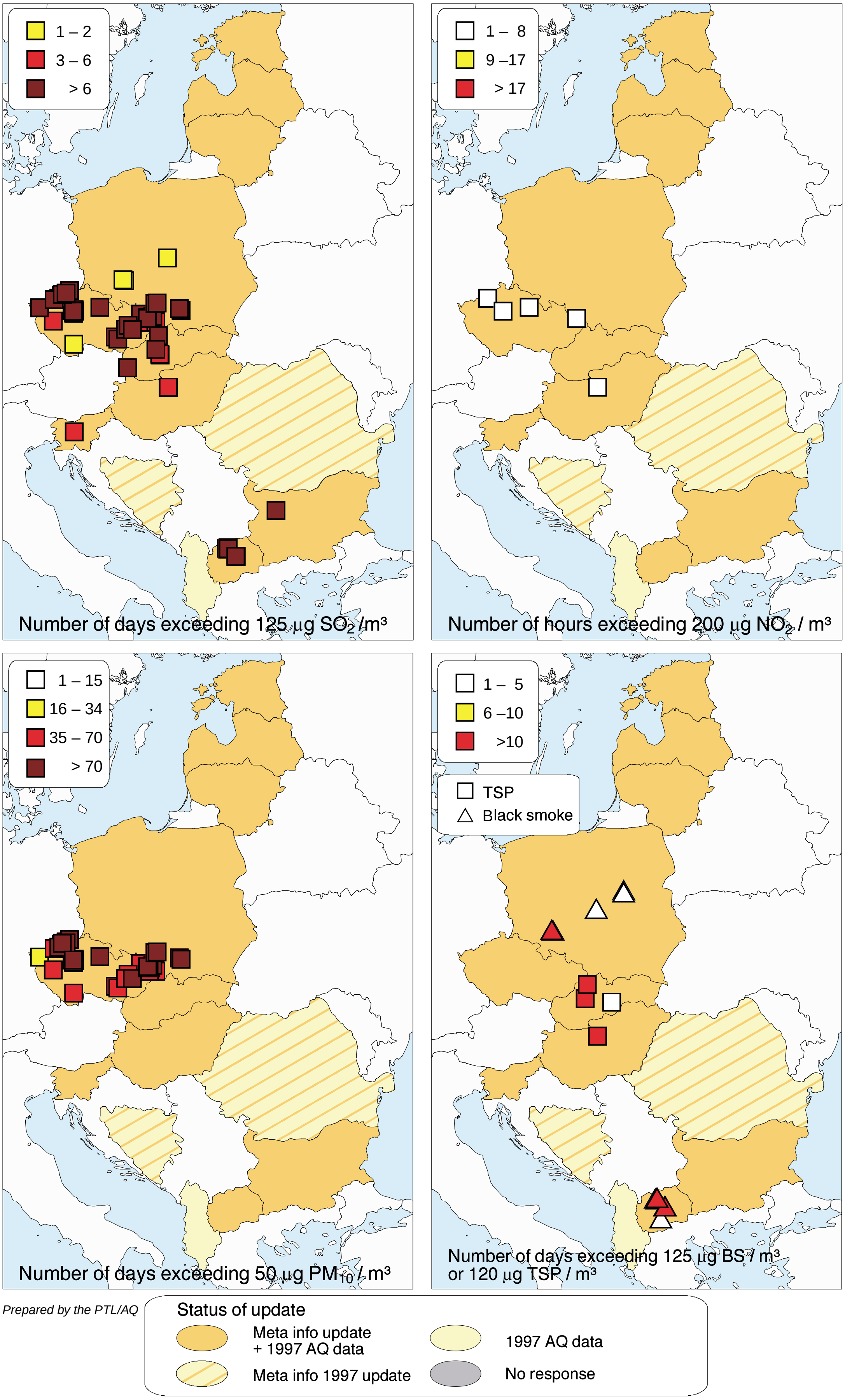


Table 3.8 **Exceedance of WHO (WHO, 1997) and EU limit values (Directive 99/30/EC)**

Country	City	No of days with SO_2 24-hour conc. >=125 µg.m^{-3}	No of days with NO_2 1-hour conc. >=200 µg.m^{-3}	No of days with PM_{10} 24-hour conc. >=50 µg.m^{-3}	No of days with TSP. BS* 24-hour conc. >=125(120*) µg.m^{-3}	Population
Bulgaria	Vratza	36				82 000
Czech Republic	Brno	4–8 (2)		42–47(2)		388 296
	C. Budejovice	1		35		97 243
	Decin	14		85		54 341
	Frydek-Mistek	6		66		63 808
	Havirov	8		59		86 297
	Hradec Kralove	7	6	73		99 917
	Chomutov	13		69		53 107
	Karvina	9		71		68 405
	Most	12	1	110		70 670
	Olomouc	8		54		102 786
	Opava	8		54		62 815
	Ostrava	8–9 (3)	3	87–95 (3)		327 371
	Plzen	3		60		173 008
	Praha	2–12 (9)	1	38–173 (9)		1 214 174
	Prerov	10		81		51 300
	Prostejov	8		56		50 074
	Sokolov	8		25		25 210
	Teplice	15		118		53 004
	Trinec	6		40		41 620
	Usti n.L.	12–16 (2)		67–99 (2)		98 178
Hungaria	Budapest	2–4 (3)			8–13 (3)	1 909 000
FYROM	Prilep				1*	71 899
	Skopje	2–12 (4)			2–24 (7)*	550 000
	Titov Veles	7–33 (2)			1–13 (2)*	50 000
Poland	Krakow	8–13 (2)		66–81 (2)		741 100
	Lodz	1			1*	833 700
	Warszawa				1–2 (2)*	1 642 700
	Wroclaw	1–2 (2)			4–12 (2)*	642 300
	Silesia conurbation	20–30 (2)		152–153 (2)		2 100 000
Slovak Republic	Bratislava	7				445 000
	Prievidza	18			29	53 393
	Ruzomberok					29 403
	Zilina	7			43	98 000
Slovenia	Celje					50 648
	Ljubljana	3				264 200
Total						**12 744 967**

3.3. Air quality in rural areas

Air quality data for 1997 were delivered from more than 30 rural sites in the Phare countries. The main objective of rural stations is to monitor air pollution for population and ecosystem exposure assessment. As mentioned in the previous chapter, in rural areas the spatial coverage is not well represented and needs further improvement. Some improvement is expected by incorporating all of the EMEP stations and inclusion of further rural stations. The present selection includes 43 monitoring stations selected in 31 rural areas of seven Phare countries.

The annual average time series of 24-hour concentrations of SO_2, NO_2, PM_{10}, SPM, BS and O_3 in selected rural sites are shown in Figure 3.16. Some of the sites (Košetice — the Czech Republic; Stará Lesná — the Slovak Republic; Krvavec — Slovenia; K-puszta — Hungary; Rucava — Latvia; and Zoseni — Latvia) are included in the EMEP programme.

Graphs of ordered 98th percentiles and annual mean concentration of NO_2 SO_2 PM_{10} and for O_3 maximum 8-hour and 1-hour concentrations are shown in (Figure 3.17). This figure shows the highest pollutant concentrations and their range at rural sites.

Decreasing emissions of lead due to the increasing use of unleaded petrol are well reflected in ambient lead concentrations at the K-puszta rural monitoring station (Figure 3.18).

3.4. Estimating pollutant concentrations using empirical models

Empirical models have been developed to estimate annual average pollutant concentrations on national and regional scale (Stedman, 1998). These models have made use of a combination of emissions estimates and measurement data to identify simple relationships between ambient concentrations and pollutant emissions. The application of similar techniques have been investigated for estimating pollutant concentrations in the Phare countries in order to generate territory-covering maps of estimated concentrations.

3.4.1. General approach to modelling

The approach used to model pollutant concentrations within the Phare countries has been based upon the identification of simple relationships between measured pollutant concentrations and surrogate data available over a much larger geographical area than measurements data themselves (e.g. emissions estimates per unit area or land cover statistics).

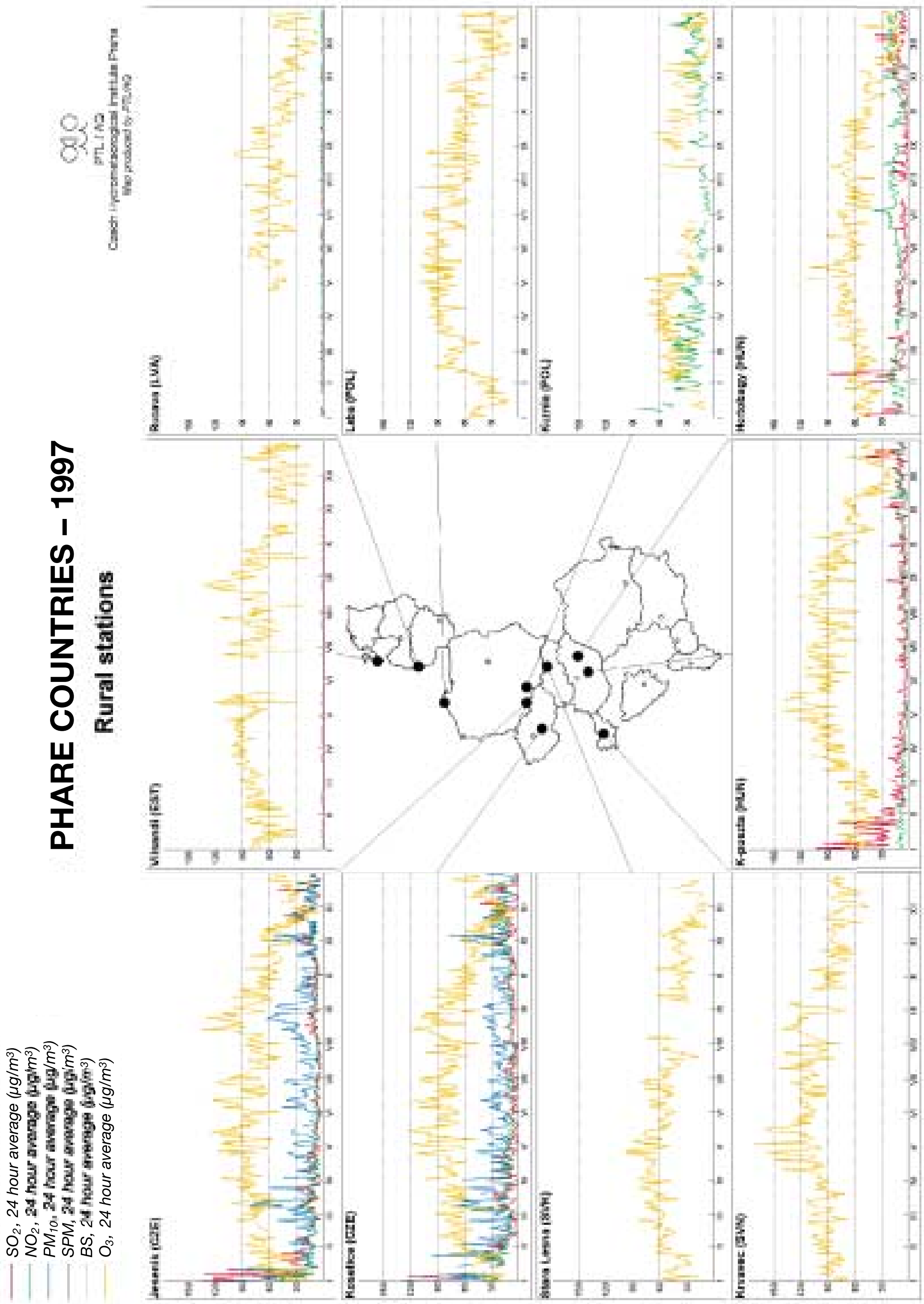
Annual average measurement data for the 1997 calendar year were available within the following countries: Bulgaria, the Czech Republic, FYROM, Hungary, Latvia, Lithuania, Poland, the Slovak Republic and Slovenia. Measurement data for the following pollutants were provided:

- nitrogen dioxide (NO_2)
- sulphur dioxide (SO_2)
- carbon monoxide (CO)
- PM_{10}
- black smoke (BS)
- suspended particulate matter (SPM)

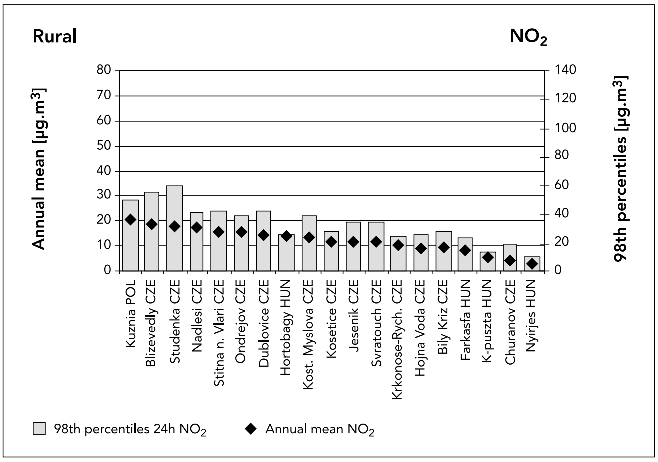
The relationships between measured annual average concentrations for these pollutants at background locations and surrogate information were investigated. The following surrogate information was available for comparison:

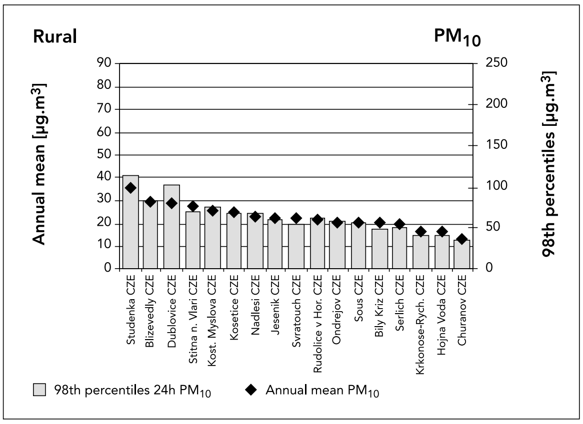
- emissions estimates per unit area (km^2) derived from the NUTS administrative regions database
- population per NUTS administrative region
- population density per NUTS administrative region
- urban/suburban land cover at a 10 × 10 km resolution derived from Corine 250 m resolution land cover data (available for Bulgaria the Czech Republic Hungary Poland Romania and the Slovak Republic).

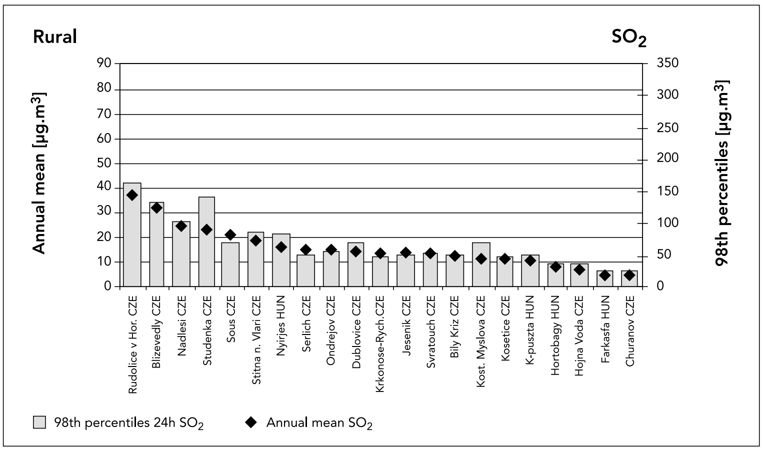
Figure 3.16 **Rural stations, the Phare countries, 1997**



Annual average and 98th percentile pollutant concentrations at rural sites, 1997 Figure 3.17







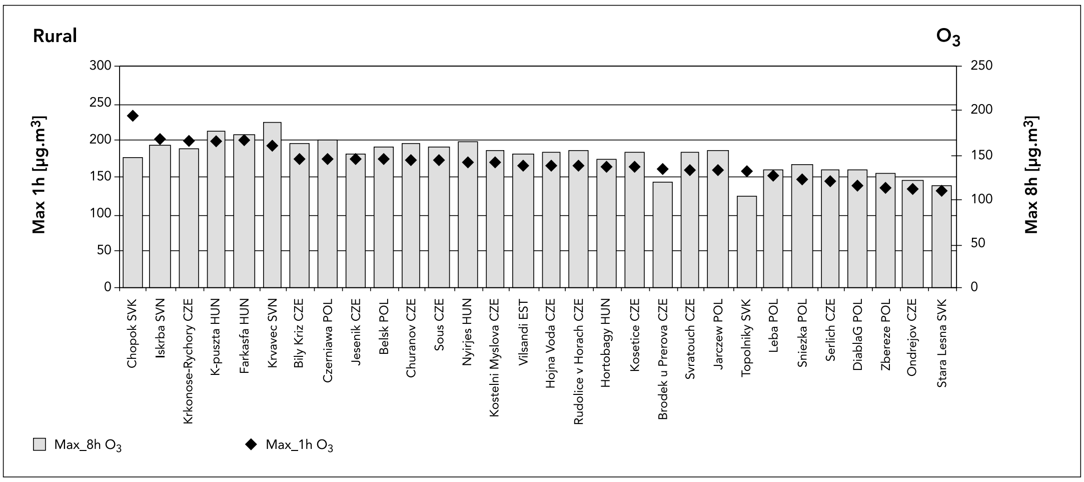
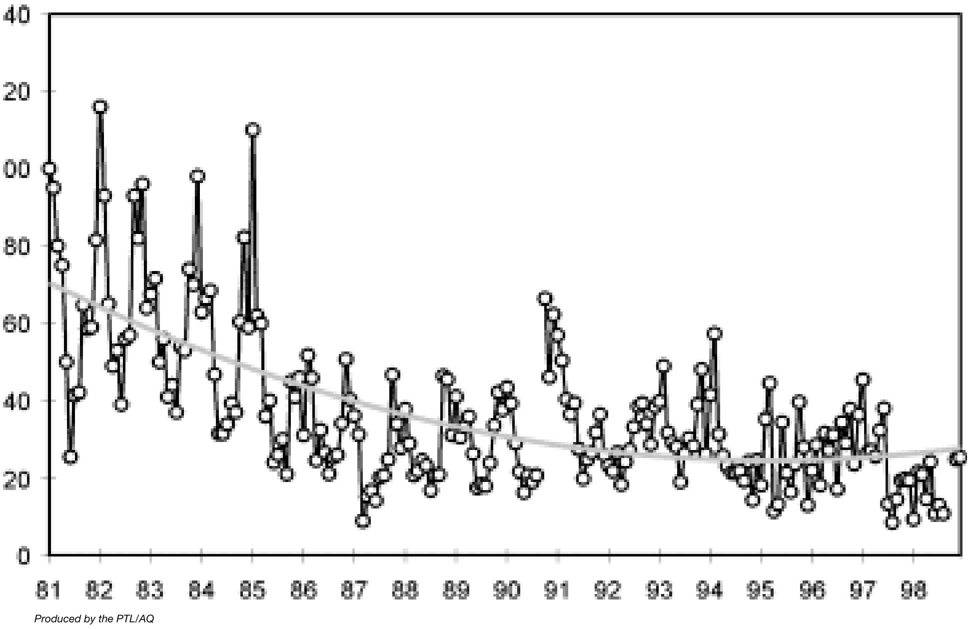


Figure 3.18

Monthly average lead concentrations (ng.m-3) with second order polynomial trendline at K-puszta rural background station in central Hungary

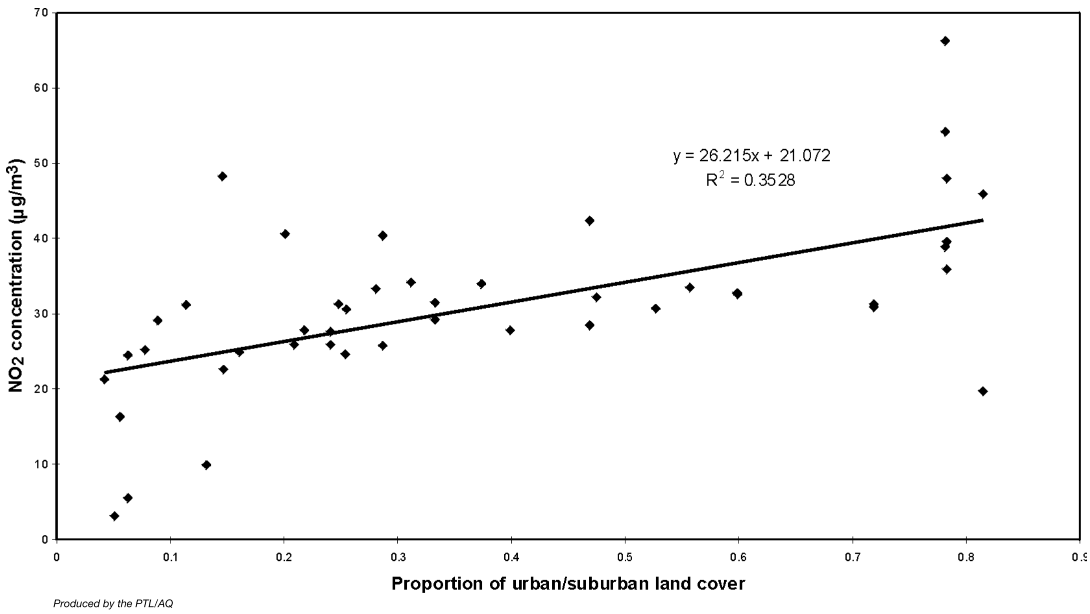


3.4.2. Relationships between measured data and surrogate information

In order to identify robust relationships between pollutant concentrations and the various surrogate statistics, comparisons were only performed at monitoring locations where greater than 50 % data capture (as hourly averages) was achieved. Regression analyses for each pollutant against the surrogate statistics detailed above were performed. It soon became evident that a reasonable correlation was only obtained between NO_2 and land cover; all other pollutants showed very poor correlations with any of the surrogate information available. Figure 3.19 presents the best overall correlation obtained for nitrogen dioxide and the surrogate statistics.

Figure 3.19

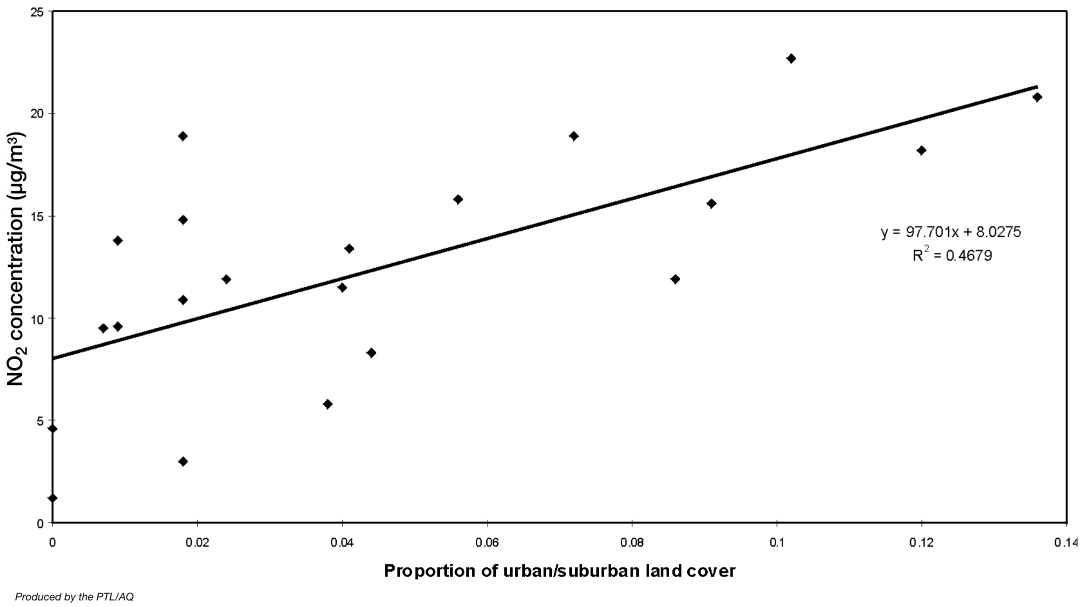
Relationship between annual average nitrogen dioxide concentrations at urban background locations and urban/suburban land cover in the Phare countries, 1997



3.4.3. Further investigation of relationships with nitrogen dioxide

In order to better identify the relationship between annual average NO_2 concentrations and suburban and urban land cover the measurement data and land cover data were scrutinised for outliers. Data points which obviously did not fit the general trend were removed from the data set. In addition, the relationship between measurement data at rural monitoring sites and urban and suburban land cover was investigated using regression analysis and found to be reasonable. Figure 3.20 presents this relationship.

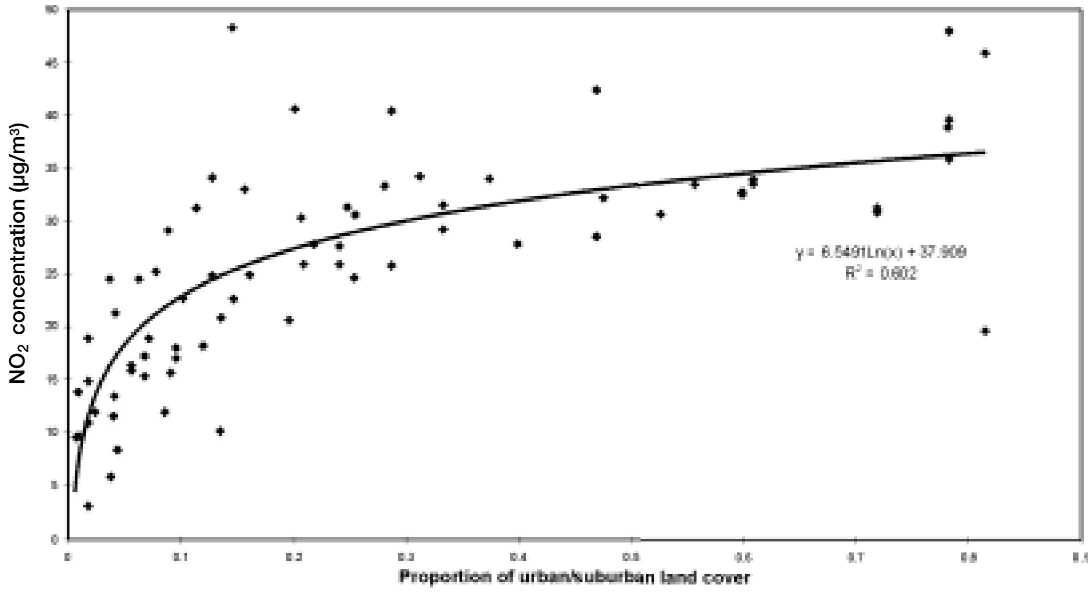
Relationship between annual nitrogen dioxide concentrations at rural background locations and urban/suburban land cover in the Phare countries, 1997 Figure 3.20



The overall relationship between both rural and urban background NO_2 concentrations and urban and suburban land cover were then investigated by plotting both data sets on the same axes against suburban and urban land cover. The data were again scrutinised and data points that were found to be significant outliers were removed.

Figure 3.21 presents these data. A logarithmic regression model has been fitted to indicate the best fit relationship between annual average NO_2 concentrations at rural and urban background monitoring locations and the percentage of urban land cover in the 10 ¥ 10 km gridcell within which these monitoring stations are located. Clearly, the correlation between data using the logarithmic regression model is good and therefore the regression model itself presents an acceptable method for estimating annual average NO_2 concentrations from percentage urban and suburban land cover.

Figure 3.21 **Relationship between annual average nitrogen dioxide concentrations at urban background and rural locations and urban/suburban land cover in the Phare countries, 1997**



Produced by the PTL/AQ

3.4.4. Modelling nitrogen dioxide concentrations in the Phare countries

The relationship identified in Figure 3.21 has been used to map annual average NO_2 concentrations at urban and rural background locations in the Phare countries. Mapping has been performed at a 10 km² resolution using urban and suburban land cover statistics derived from the Corine land cover data set. Therefore:

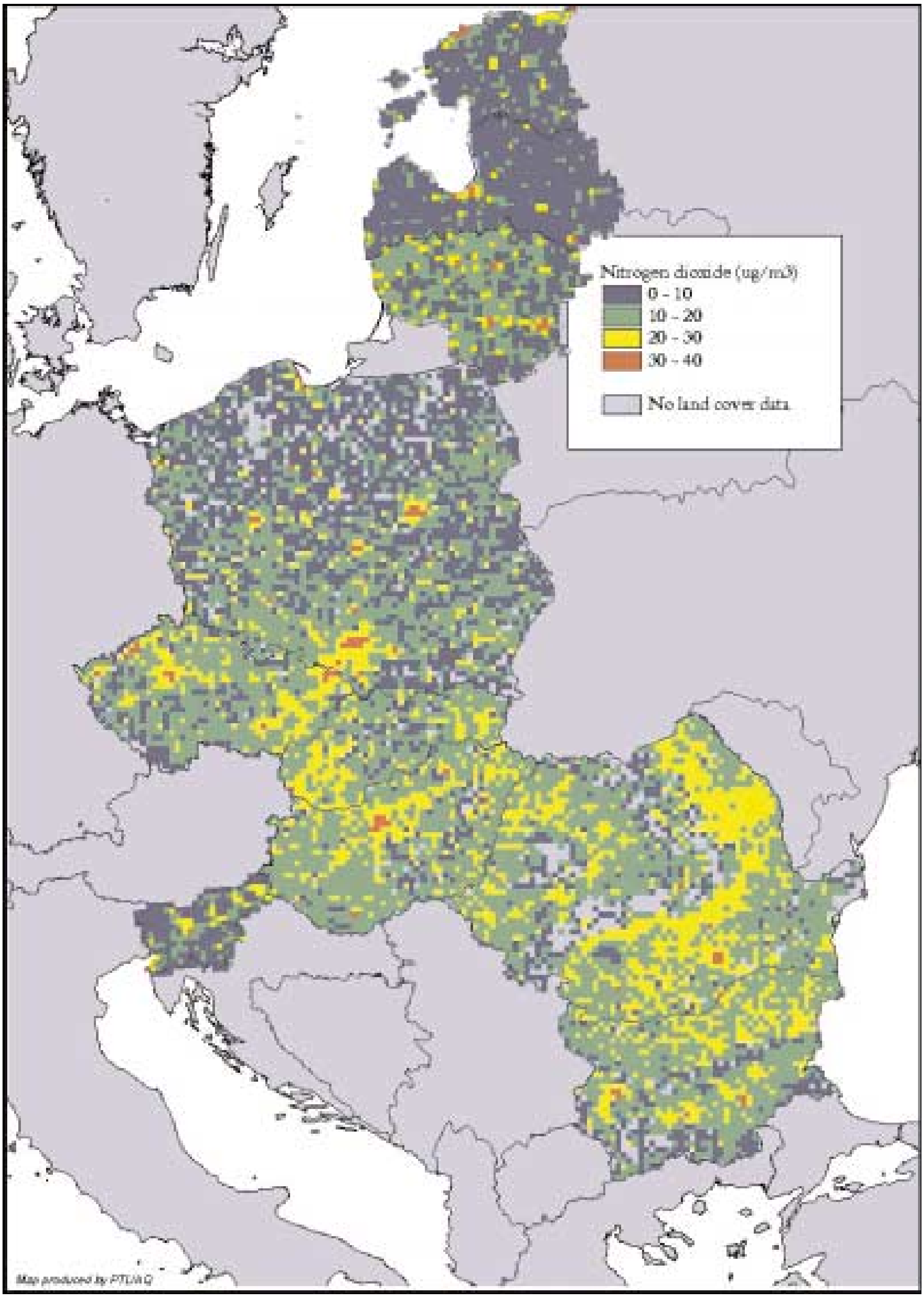
$$\textit{Annual average urban/rural background } NO_2\ (\mu g.m^{-3}) = 6.549 * \mathrm{Ln}(\textit{usublcov}) + 37.9$$

where:

usublcov is the proportion of urban and suburban land cover at a 10 km² resolution.

Figure 3.22 presents the map of estimated annual average background NO_2 concentrations for the Phare countries during 1997.

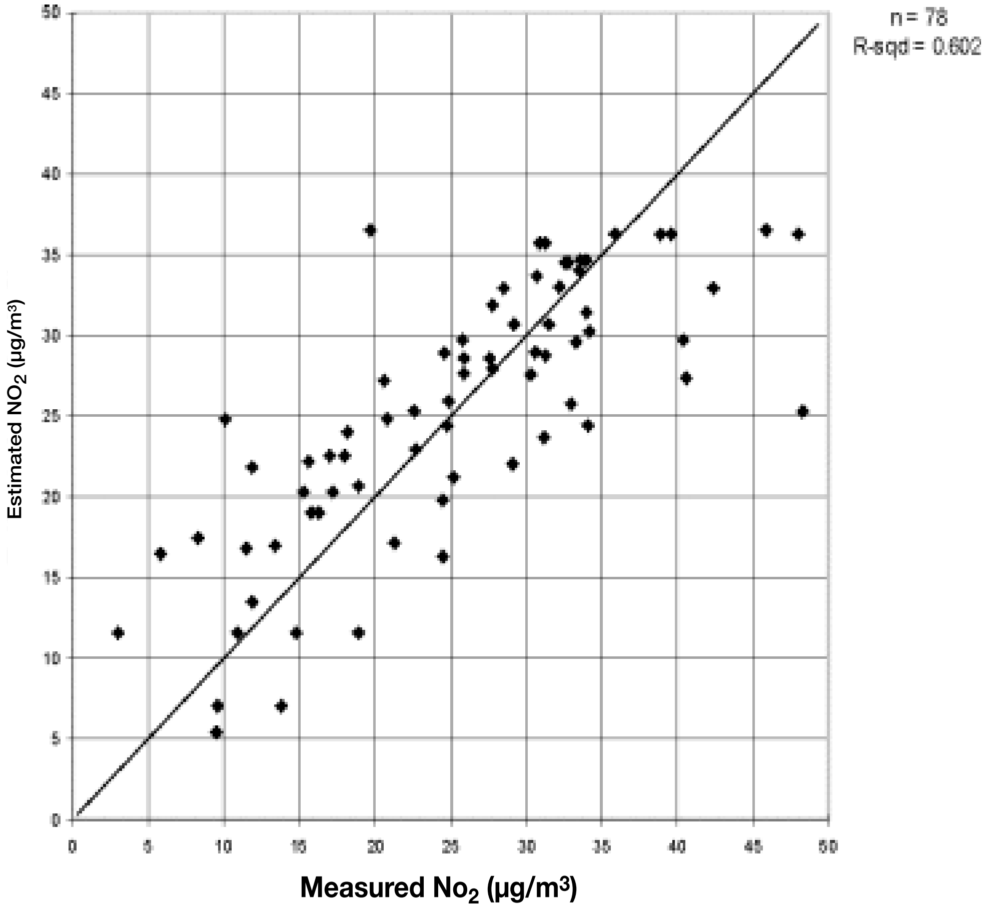
Estimated annual average nitrogen oxide concentrations at background locations in the Phare countries, 1997 — Figure 3.22



3.4.5. Reliability of the model

In order to provide some means of assessing the reliability of the model, estimated NO_2 concentrations have been plotted against measured concentrations. These data are presented in Figure 3.23 and show that relationship between estimated and measured annual average NO_2 is approximately 1:1. Some scatter is evident although 95 % of modelled concentrations are within 14 µg.m^{-3} of the measured value.

Figure 3.23 **Comparison of measured and estimated annual average nitrogen dioxide concentrations in the Phare countries, 1997**



Produced by the PTL/AQ

4. Impact of air pollution and measures taken in the Phare countries

4.1. Impacts of air pollution

The main consequences of exposure to ambient air pollutants are increased morbidity and mortality in humans (particularly the sensitive groups of population), damage to vegetation and ecosystems as a whole, and also building deterioration and damage to materials. The impacts of air pollution on health and population exposure assessment are the most important goals of air pollution assessment. As an example, the effects of long-term exposure to suspended particulate matter are generally considered to be the most important health effect of ambient air pollution causing perhaps 41 to 152 thousand extra cases of respiratory diseases per year in the EU. These effects occur at various concentration levels including concentrations considered as 'low' (Brunekreef, 1997). The higher mortality or morbidity rates create public and private costs that could be avoided in the future by directing the development of society towards cleaner air and lower exposure levels.

As the range of impacts is extensive and information on general aspects can be found in abundant scientific literature, this report will not consider these general effects in detail but will focus on specific examples from the Phare countries. Though data and information of this type are rather difficult to collect for the Phare countries the following information tables are presented as an illustration of possible impacts on human health and vegetation in the region.

World Health Organisation (WHO) health statistics (http://www.ch/) for the Phare countries — mortality rates (probability of dying) life expectancy at birth and health expenditures — reveal that the life expectancy varies widely within the Phare countries for males — from 62 years in Latvia to 71 years in Bulgaria FYROM and Slovenia. For females the range is narrower — from 74 years in Romania to 78 years in Slovenia. In comparison with EU countries, the life expectancy both for males and females in the Phare countries is shorter. The population health status is influenced by many factors. Although the dominating risk factors of the most frequent severe diseases are related to various host characteristics (e.g. genetic predisposition, individual susceptibility) and behavioural and lifestyle factors a number of environmental factors may and probably do adversely influence the health of population. It is extremely difficult, if not impossible, to estimate the contribution of air pollution among these factors.

With regard to the effects on vegetation and ecosystems data on the impacts on trees are considered. In Table 4.1 and Table 4.2, defoliation of conifer and broadleaf trees (as one of the whole range of the health status parameters recorded to study the impact of air quality on trees) is presented for different Phare countries for single years of the period 1988–96. While the proportion of the worst defoliation represented by class 4 has decreased an increased proportion of classes representing lower defoliation is observed. As a result total defoliation is increased. For Albania, Bosnia and Herzegovina and FYROM, data are not available for the whole period under review.

Table 4.1 **Defoliation of conifers (Statistical compendium, 1996)**

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996
Bulgaria	7.6	32.9	37.4	26.5	25.5	26.9	25.0	41.4	46.5
Czech Republic	37.5	:	46.9	46.3	57.9	51.5	59.0	60.7	74.9
Estonia	9.0	28.5	20.0	28.0	29.5	21.2	16.0	14.2	14.6
Hungary	9.4	13.3	23.3	17.8	20.1	20.1	21.2	18.7	17.8
Latvia	:	:	43.0	:	45.0	41.0	34.0	23.0	24.8
Lithuania	3.0	24.0	22.9	27.8	17.5	29.2	26.3	26.6	12.9
Poland	24.2	34.5	40.7	46.9	50.3	50.8	55.6	54.5	40.5
Romania	:	:	:	6.9	10.9	16.6	15.5	15.2	10.4
Slovak Republic	52.7	59.1	55.5	38.5	44.0	49.9	50.3	52.0	41.0
Slovenia	:	:	34.6	31.3	:	27.0	19.0	33.6	26.0

Note: % of trees in defoliation classes 2–4.

Table 4.2 **Defoliation of broadleaf trees**

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996
Albania	:	:	:	:	:	:	:	:	:
Bosnia and Herzegovina	:	:	:	:	:	:	:	:	:
Bulgaria	8.8	16.2	17.3	15.3	18.0	16.6	34.4	32.7	33.0
Czech Republic				37.6	29.2	54.4	48.0	30.6	34.0
Estonia						1.1	2.0	1.1	5.3
FYROM	:	:	:	:	:	:	:	:	:
Hungary	7.0	12.5	21.5	19.9	21.8	21.2	21.8	20.2	19.5
Latvia	:	:	27.0	:	19.0	17.8	15.0	10.0	11.4
Lithuania	1.0	16.0	15.8	14.9	17.6	23.8	23.3	20.8	12.2
Poland	7.1	17.7	25.6	34.8	40.4	49.9	51.5	46.7	37.4
Romania	:	:	:	10.4	18.4	21.4	22.9	23.1	18.7
Slovak Republic	28.5	41.8	31.3	21.1	30.0	29.1	35.6	35.8	28.0
Slovenia	:	:	4.4	5.8	:	11.0	13.0	19.3	15.0

Note: % of trees in defoliation classes 2–4.

The condition of the tree crown reacts to various stress factors and therefore shows a great variety of developments depending on site conditions and species. Symptoms are often not specific — in particular chronic air pollution does not result in specific symptoms — but careful synoptic studies in connection with other monitoring data contribute to the assessment of air pollution and other stress factors.

The highest defoliation scores were reported in parts of central and eastern Europe. In particular conifers pine and spruce (*Pinus silvestris, Picea abies)* and beach *(Fagus sylvatica*) had the highest defoliation scores in the Czech Republic southern Poland northern Slovakia and Romania. In view of the coincidence of these areas with regions of highest levels of air pollution, the damage in these areas has largely been attributed to higher air pollution deposition fluxes. A recent improvement in the crown condition of conifers, *Pinus silvestris* and *Fagus sylvatica* in northern Poland and parts of the Czech Republic, is attributed to a decrease in air pollution and favourable weather conditions. This may also be the case in Romania where tree crown condition is also improving ('Forest Condition in Europe', 1998).

4.2. Measures taken in the Phare countries

As mentioned in Chapter 1, environment-related actions taken in different Phare countries during the 1990s vary considerably. Policies were formulated and action plans developed but their realisation was very much dependent on the socioeconomic conditions in the given country. In most of the countries, new institutions have been created both in the form of organisations and legal arrangements. In relation to general environmental issues, a short overview is given below on a country-by-country basis. Where explicitly available some specific air quality related measures are also listed.

Albania
The primary body responsible for environmental issues is the Albanian Committee for Environmental Protection established in 1992. New environmental legislation, the Law on Environmental Protection was passed in 1993. A national environmental action plan was also developed in 1992–93 based on a study of environmental strategy carried out by the World Bank and the Committee for Environmental Protection. Financial support from a Phare project, ‘Environment Albania, 1997’, is expected to facilitate a study which will develop a future strategy for air pollution monitoring all over the country.

Bulgaria
National programmes for the reduction of emissions of greenhouse gases and sulphur oxides are under development. In cooperation with the World Bank, Bulgaria is finalising a pollution abatement programme which includes implementation of several projects involving technological reconstruction and innovations aimed at phasing out leaded gasoline, heavy metal pollution from copper smelters and conversion of central heating from coal/oil to gas.

The Czech Republic
Between 1990 and 1994, the production of energy shifted from the use of fossil to renewable fuels, although coal and lignite are still the most important sources of energy in the Czech Republic (59 % in 1992). Consequently, the relative output of emissions from the energy industry has fallen. Air pollution is still considered to be the number one environmental problem in the country. Therefore, an air recovery programme was adopted and measures to reduce emissions are being implemented in most large coal-burning power stations. Some units have been shut down. Gasification projects in municipalities are also proceeding rapidly.

The restructuring of the industrial sector has also resulted in a reduction of emissions. Since 1986, the consumption of ozone-depleting substances has decreased by 88 %. Current legislation stimulates industry to take remedial measures and to invest in environmental improvements. Emission limits have also been established by law and the 1998 deadline for compliance with prescribed emission limits is projected to be met by approximately 75 % of polluters. However, the provisions concerning air pollution are inadequate for providing sufficient incentives for some industries to reduce emissions and/or introduce pollution control techniques. In addition, the national economy continues to demand more energy. Coal and all kinds of energy sources are subject to a reduced level of value-added tax and the price of energy and energy carriers is very low. Incentives to encourage energy saving and to apply modern energy efficiency technology are also inadequate.

Estonia
In 1995, the Estonian Parliament adopted the Act on Sustainable Development to guide the country into the next century. In accordance with this act, the national environmental strategy was developed in 1996 and the elaboration of a national environmental action plan has begun. In 1996, a National Commission on Sustainable Development lead by the Prime Minister was also established.

Hungary
A national environmental programme reflecting all the major recommendations of Agenda 21 was approved by Parliament in September 1996. With respect to air pollution, a national initiative called the cross-sectoral air pollution control programme was launched in 1993. In Hungary, all ozone-depleting substances (ODS) are imported as the country has no facilities for their production. The national programme for ODS phase-out was prepared by the Ministry of the Environment and Regional Policy.

Emissions from traffic are now the major source of air pollution, while those from industry have decreased over the last two years, mainly due to the economic recession. The Hungarian Government has urged local governments to prepare traffic control measures which contribute to emission reduction. A city bus greening programme has been introduced to focus on the replacement of old bus engines with environmentally sound ones which meet

EU emission standards. Protection of the atmosphere improving air quality and promoting the reduction of harmful atmospheric emissions are high-priority areas of the new national environmental programme. This programme lists key sectoral policies and indicates the most essential regulatory tasks.

Latvia
The Environmental Protection Committee was established in June 1990. The fundamental law on environmental protection is the Environmental Protection Act which was passed in 1991. Latvia completed its national environmental protection plan in 1994.

Lithuania
In 1996, the Lithuanian Parliament adopted its first national environmental strategy.

An Environmental Protection Department was established in 1990 and a new framework law on environmental protection was adopted in January 1991.

Poland
In Poland, the national environmental policy was adopted by Parliament in 1991 and the national environmental policy implementation programme to the year 2000 passed in 1995. Medium-term priorities set by the national environmental policy include: (a) reduction of sulphur dioxide emissions nitrogen oxide (NO_x) particulate matter and increase of the average efficiency of particulate removal; (b) reduction of volatile organic compounds hydrocarbons heavy metals and other pollutants; and (c) initiation of activities aimed at counteracting global climate change in step with international community efforts. Long-term priorities include: (a) full elimination of individual coal furnaces in urban areas and health resorts; (b) introduction of catalytic converters in all cars produced and used; (c) reduction of SO_2 and NO_x emissions; (d) elimination of freons and halons from use; (e) reduction of carbon dioxide (CO_2) emissions to the level agreed upon at the international forum. However, it will be difficult to reduce greenhouse gas emissions in the long-term because of the fast growth in the Polish economy during the transformation period and the fact that national power production will be based on coal for a long time. This is in spite of improvements in energy efficiency in power production and industry and changes in the structure of fuel use towards increased use of gas.

Romania
After the transition period started as a first step an environmental strategy paper was prepared. Its long-term objective is the creation of a framework which will foster a long-term economically sustainable acceptable environment. In addition, a national environmental action plan was launched in 1996 as part of the Sofia process. To address issues of environmental protection in 1990 — for the first time — the Ministry of Water Forests and Environmental Protection was established.

The Slovak Republic
By 1997, over 15 laws and 700 regulations had been introduced in the Slovak Republic. The strategy of environmental policy approved in 1993 is the cornerstone of the Slovak Government's environmental policy. It is based on the principles of the 1992 Rio and the 1993 Luzerne conferences incorporating elements of sustainable development. The Slovak Republic participates in the environmental action planning process.

In 1993, the Slovak Republic initiated the national climatic programme and the national programme for reducing emissions of greenhouse gases. The consumption of ozone-depleting substances has decreased during the mid-1990s. An additional decrease in their consumption will require the gradual replacement of compressors in cooling equipment and the substitution of some technologies. The government's short-term objectives for pollution control include the introduction of a ban on halon use effective from 1994 and a ban on partially halogenated hydrocarbons carbon tetrachloride and partially halogenated bromo hydrocarbons effective in 1996.

Slovenia

The 1993 Environmental Protection Act is the legislative base for implementing the principles of sustainability. The government promotes policies and programmes in the field of environmentally sound and efficient transportation. In order to have a less polluting and safer transport system transportation technologies impacts on the environment and safety have been addressed comprehensively. The relative cost-effectiveness of alternative systems and the establishment of mass transit systems have also been partly addressed. Since 1992, 50 regulations related to environment have been adopted by the Ministry of Transport.

5. Conclusions and recommendations

- One of the main tasks of the PTL/AQ was to establish air-quality-related technical links and contacts with the Phare countries through NFPs and NRCs. The successful development of these contacts promoted through country visits was a prerequisite for providing information on network stations and air quality data collection. This major mission of the PTL/AQ was completed and the respective infrastructure has been established in the majority of the Phare countries. With the exception of some countries which identified technical obstacles, the PTL/AQ succeeded in collecting information on stations and air quality data from most of the Phare countries. These data have been input into the European air quality database — Airbase.
- Monitoring of both air quality and emissions has progressed considerably in most of the Phare countries during the last years. However, improvements in harmonisation and evaluation of these data are still required. The important issue of their interconnection to exposure and health effects is still at an unsatisfactory level.
- The measured concentrations of main pollutants give a good overview of the air quality situation but the picture is far from complete. Pollutants such as PM_{10}, $PM_{2.5}$ and VOCs including carcinogenic benzene and the polycyclic aromatic hydrocarbons (PAHs) for which EU limit or guide values are in preparation may exceed WHO guidelines and EU air quality objectives. Monitoring of such pollutants needs to be increased in the Phare countries.
- Further development of Euroairnet is needed, particularly an increase in monitoring sites in rural areas and incorporation of other compounds. To improve the assessment of material and ecosystem impacts chemical compounds in precipitation and meteorological parameters need to be included. The need for the selection of monitoring stations in industrial areas should also be re-evaluated.
- Further information on QA/QC procedures needs to be collected to ensure that data will at least satisfy Euroairnet data quality objectives.
- In general, although air quality in the Phare region has improved in recent decades, air pollution still represents one of the major environmental issues that authorities at all levels have to cope with. In contrast to the decreasing SO_2, Pb and PM ambient concentrations pollutants associated with road transport such as NO_x, CO, VOC and, indirectly, O_3 have increased during the last decades.
- The aim of future activities will be to further develop the information infrastructure in the Phare countries to collect information on network stations and air quality data to produce more extensive pan-European assessment reports.

Annex A. Air quality networks and data flow

A.1. Framework for air quality data exchange

European Union countries have a long tradition for exchanging air quality data. The reciprocal exchange between countries and the European Commission (EC) is based on several Council decisions. The latest decision (97/101/EC establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States — the exchange of information (EoI) decision) was adopted by the Council of Ministers in 1997. The EoI decision obliges Member States to transmit meta-information on networks, stations and measurement configurations. The reporting cycle covering 1997 data was the first cycle of obligatory reporting in the framework of the new decision. A further data exchange cycle is based on the ozone directive and provides data on ambient ozone and its precursor concentrations.

In cooperation with the PTL/AQ, the European Topic Centre on Air Quality (ETC/AQ) has been developing, in close interaction with the countries a European wide air quality monitoring network (Euroairnet) which will consist of a selection of monitoring stations from networks that are already in operation in the European countries. Thus, Euroairnet will not, in general, require the establishment of new monitoring stations. However, if important shortcomings are found, new stations may be recommended. The purpose of Euroairnet is to provide objective, reliable and comparable information on air quality relevant to framing and implementing policy at the European level.

The reporting cycles based on the above-mentioned decision and directive are obligatory for EU Member States. The Phare countries, which also work closely with the European Environment Agency (EEA), agreed to voluntarily participate in the exchange of data from Euroairnet stations.

A.2. Extension of Euroairnet to the Phare countries

A primary task of the PTL/AQ in the field of air quality monitoring is to assist in the extension of Euroairnet into the Phare countries, in order to provide timely, reliable and representative air quality information on European scale. During the initial two-year contract period, representatives of the PTL cooperated intensively with NFPs, NRCs, and national air quality experts in the Phare countries. The Euroairnet sites selected by individual countries were evaluated with regard to the Euroairnet criteria and any shortcomings were addressed to the individual countries for completion. This cooperation culminated with country visits (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia) by PTL/AQ experts where the Euroairnet criteria were elucidated and site selection further discussed. In August 1999, 11 Phare countries had made the selection of monitoring stations for Euroairnet (Bulgaria, the Czech Republic, Estonia, FYROM, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia) (see Table A.1).

All of the above-mentioned countries have selected monitoring stations in cities and agglomerations. A total of 73 cities in the three major Euroairnet population classes have been selected together with 9 towns with a population of 25–50 000 (Class 4). In general, site selection meets the criteria well in most countries but some countries have been asked to extend the number of selected cities and check if all relevant stations have been included.

The total number of stations selected in industrial areas comprises 16 stations located in small towns with population less than 25 000 and six stations located in industrial areas. There are specific reasons why Bulgaria, FYROM and Poland selected stations in small cities. Except for the Czech Republic, none of the countries has provided information on monitoring in industrial areas. The need for monitoring in industrial areas in other countries should be re-evaluated.

In rural areas, the spatial coverage is not well represented, some improvement is expected by incorporation of all EMEP stations and the inclusion of further rural stations. The present selection includes 43 monitoring stations selected in 31 rural areas in seven Phare countries. All Phare countries have been asked to confirm if the site selection meets the criteria for population and ecosystem exposure.

Table A.1 **Overview of Euroairnet selected areas and stations per country**

Country			**Bulgaria**	**Czech Republic**	**Estonia**	**FYROM**	**Hungary**	**Latvia**	**Lithuania**	**Poland**	**Romania**	**Slovak Republic**	**Slovenia**	**Total cities/stations**	
Number of cities in each population class (1)		**1**	1	1	1	1	1	1	1	5 (3)	1			**13**	**82**
		2	2	2						1	4	1	1	**11**	
		3	15	15		3	5			1	4	4	2	**49**	
		4	3			5				1				**9**	
Local pollution stations	Urban areas (2)	**T**		2	1	4	8		2	1		6	1	**25**	**230**
		I		1	1	5	1			2	23			**33**	
		U	60	31	1	21	6	2	1	14	31(4)	3	2	**172**	
	Near city stations									2 (5)				**2**	**2**
Ind. areas and small towns	Ind. areas			6										**6**	**22**
	Small towns (6)		14			1				1				**16**	
Rural areas				18	3			2	1	10		7	2	**43**	**43**
Total stations			**74**	**58**	**6**	**31**	**15**	**4**	**4**	**30**	**54**	**16**	**5**		**297**

(1) Class 1: >0.5 mill., Class 2: 0.25 — 0.5 mill., Class 3: 0.05 — 0.25 mill., Class 4: 0.025 — 0.05 mill.
(2) Type of station: T — Traffic, U — Urban, I — Industrial.
(3) Including Silesia agglomeration.
(4) At 7 stations the classification is missing.
(5) Classified as B/S stations.
(6) Small towns with population of < 25 000.spa

To date, the emphasis has been on monitoring in urban areas, in total there are 230 stations selected in larger cities. According to the general site classification, there is a dominance of urban background stations, approximately 75 % of the total number of stations. The proportion of traffic stations is about 10 % and industrial stations about 15 %. The site selection in cities differs from country to country. While in Bulgaria, all stations are located in urban background areas, approximately 50 % of stations in Romania are affected by industrial sources. In neither of these two countries have traffic stations been selected. On the other hand, more than 50 % of the total number of stations in the Slovak Republic and Hungary are local traffic stations. To a certain extent, this reflects the differing philosophy of air quality monitoring at the national level. There are also differences between countries in the number of cities selected for each particular class.

However, the present state of site selection and compound coverage provides a good basis for assessment of population exposure, especially in urban areas. As documented in Table A.2, most of the Priority 1 compounds ('Criteria for Euroairnet', 1998) are measured throughout the Phare region. The main pollutants, such as sulphur dioxide, nitrogen dioxide, nitrogen oxides and ozone, are monitored to a considerable extent, while the measurement of lead and PM_{10} needs to be extended in some countries. Pollutants, such as hydrogen sulphide, phenol, sulphuric acid and some others contribute to the deterioration of air quality, mainly in Bulgaria and Romania and hence, stations monitoring these pollutants are included in the Euroairnet selection for these countries.

In the process of integration, quality assurance of measurements at monitoring stations included in Euroairnet is of vital importance. Additional information on the level of the QA/QC is still required because not all the countries provided information on QA/QC procedures. Current information on the QA/QC level is summarised in Table A.2, which indicates that high data quality is considered as an important part of most national air quality monitoring system, especially in the Czech Republic, Bulgaria, Estonia and Latvia. In other countries, the data quality may be lower, but at least a minimum documented QA/QC plan is implemented.

Data are available for incorporation into Airbase from most of the countries within six months after the end of the calendar year.

More detailed information on the implementation of Euroairnet in the Phare countries is presented in the 'Euroairnet in the Phare status report'.

More detailed information about Euroairnet is presented in 'Criteria for Euroairnet, the EEA air quality monitoring and information network' (EEA Technical Report No 12) and 'Euroairnet site selection', 1998 (EEA Technical Report No 16).

Table A.2 **Pollutant coverage (population exposure), level of QA/QC and data availability by country**

Country		Bulgaria	Czech Republic	Estonia	FYROM	Hungary	Latvia	Lithuania	Poland	Romania	Slovak Republic	Slovenia
Priority 1 (1)	SO_2	73	45	2	31	15	4	4	13	44	14	3
	NO_2	70	46	2	4	15	4	4	15	36	14	2
	NO_x	9	46	2	4	15		3	8		9	2
	O_3	7	19	1	2	7	3	4	9	1	8	5
	PM_{10}	7	45			5		1	9		3	
	Pb	45	3				2				10	
Priority 2 (2)	CO	8	24	1	4	14		3	2	1	5	
	TSP	60	1	1	4	8				26	8	
	BS				27				7			
	Benzene						2					
	PAH											
	Cd		3				2				10	
	As	2	3									
	Ni		3								5	
	Hg											
	HM (3)									5		
Other pollutants (4)	H_2S	62								3		
	Phenol	13								6		
	NH_3	15					2			46		
	HCl	2								9		
	THC	7										
	H_2SO_4	3								7		
	HCHO									2		
	Toluen						2					
QA/QC (5)		2a	2a	1	4	—	1, 2a	4	3, 4	—	4	—
Data availability in months (6)		6	6/12	6	3	4/6	6/10	4/6	6	6	6	—

(1) Number of stations which measure particular pollutants listed in Priority 1 group.
(2) Number of stations which measure particular pollutants listed in Priority 2 group.
(3) Heavy metals.
(4) Number of stations which measure various pollutants not listed in any of Priority groups.
(5) QA/QC level codes:
level 1:
Stations belonging to a national air quality monitoring network, operating a QC plan implemented on a national level, operated by a central accredited laboratory, providing comparability on a national level.
level 2a:
Stations belonging to national air quality monitoring network, operating a QC plan implemented on a national level, operated by a central laboratory (no accredited), but still providing comparability on a national level.
level 3:
Stations belonging to local air quality monitoring network, operating a QC plan implemented on a local level, not operated by an accredited laboratory.
level 4:
Individually operated networks or stations implementing a minimum QC plan.
— = No information available.
(6) Number of month into the new year when quality controlled data files are available to transfer to Airbase.

A.3. Air quality network meta-information

The European Commission has asked the EEA to facilitate the operation and practical implementation of a Europe-wide air quality information system. The ETC/AQ, under contract to EEA, is managing the European air quality database system, Airbase, in which the information submitted by collaborating countries is stored and also made available to the public by world wide web access. A special software tool — data exchange module (DEM) — was made available to all data suppliers by ETC/AQ, to improve the process of data collection, management and information exchange.

The main task of the PTL/AQ in the field of exchange of information was to facilitate data flow from the Phare countries. PTL/AQ experts worked with national air quality data experts to prepare the information and air quality data requested. The Phare countries submitted meta-information about their air quality networks and stations and air quality data to Airbase, with the assistance of the PTL/AQ.

The DEM software was transmitted to the Phare AQ data experts at the end of summer 1998. A training session on air quality data exchange and use of the DEM software, for Phare data suppliers, was organised by the PTL/AQ in Prague, the Czech Republic, on 16 and 17 November 1998. Experts from all Phare countries participated in this training. The DEM was then used for both meta-information and air quality data transmission to Airbase. Some of the Phare countries had used the Airbadm software to submit meta-information previously (1997, Bulgaria, the Czech Republic, Poland). These countries changed to DEM for meta-information update and completion. A large number of questions concerning the use of DEM and data preparation were discussed between PTL/AQ experts and Phare air quality data experts, by e-mail and also during country visits.

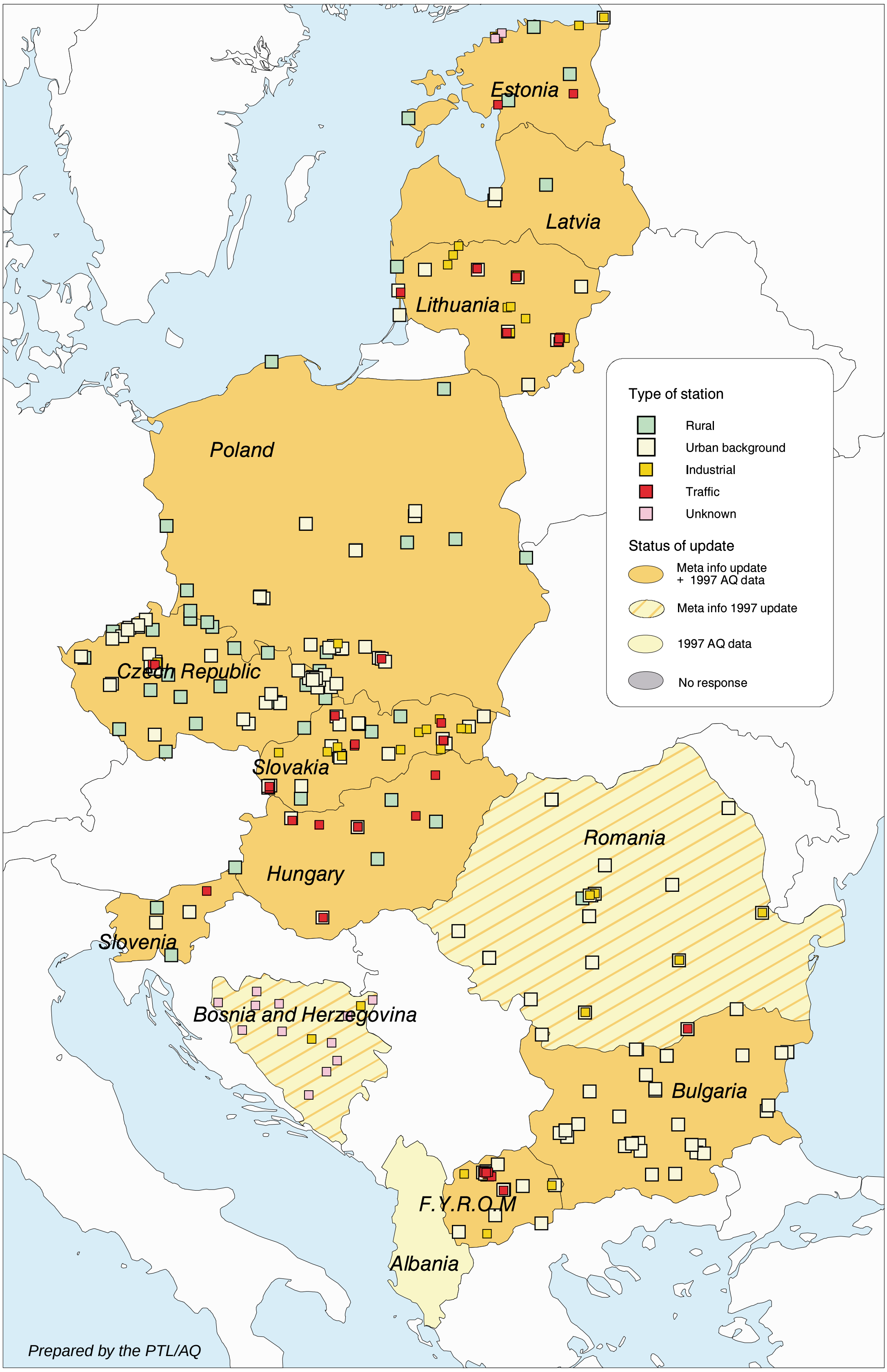
All Phare countries, except for Albania, transmitted meta-information about networks and stations (Table A.3). A summary of the available information is shown in Table A.4 and Figure A.1, including the division of stations by type. Some of the countries reported many local networks with a small number of stations, while others reported all stations in one countrywide network. Most stations were classified as background (sub)urban.

Phare data transmission of meta-information and 1997 air quality data status (31.8.1999) Table A.3

Country	Ozone data 1997 based on the ozone directive (1)	Meta-information	Air quality 1997 data based on the EoI decision
Albania	—	—	1.2.1999 (2)
Bosnia and Herzegovina	—	25.3.1999	—
Bulgaria	—	17.2.1999	Yes (3)
Czech Republic	Yes	18.1.1999	Yes
Estonia	—	16.6.1999	Yes (4)
FYROM	—	29.1.1999	Yes
Hungary	—	1.2.1999	Yes
Latvia	Yes	25.1.1999	Yes
Lithuania	—	10.1.1999	Yes
Poland	Yes	15.6.1999 (5)	Yes (5)
Romania	—	2.4.1999	—
Slovak Republic	Yes	19.1.1999	Yes
Slovenia	—	23.12.1998	Yes

(1) In EEA Topic Report No 3/1999, 'Air pollution by ozone in Europe in 1997 and summer 1998'.
(2) Only raw air quality data in text format without meta-information was transmitted therefore no data were incorporated into Airbase and air quality data were used only for purposes of this report.
(3) Only for automatic stations.
(4) Only raw air quality data in text format were transmitted. Therefore these data were not incorporated into Airbase but was used only for purposes of this report.
(5) Only for part of final planned number of stations.

Figure A.1 **Euroairnet and other AQ monitoring stations involved in AQ data exchange in the Phare countries**



A.4. Air quality data collection overview

Air quality data for the year 1997 from at least one station are available from all Phare countries, except Bosnia and Herzegovina and Romania (Tables A.3–A.6).

Table A.5 presents the number of stations per pollutant for which data were transmitted and the averaging time of the raw data. Data were mainly transmitted for the basic pollutants such as SO_2, NO_X/NO_2 and particles, although O_3 and CO were included in many cases. However, few data were submitted for other pollutants. The data averaging times mostly followed the EoI decision requirements.

Table A.6 presents the average percentage of valid 1997 data including range (minimum — maximum) per pollutant, which is good for most pollutants and countries. The measurements with a low average of valid data were not included in the evaluation of air quality concentrations in the next chapter. Data set completeness is shown, per pollutant, in Figure A.2. Data set completeness for ozone is presented in Figure 4.5. The Czech Republic, Latvia, Poland and the Slovak Republic also participated in the 1997 ozone data exchange based on the ozone directive. These data were included in EEA Topic Report No 3/1999 'Air pollution by ozone in Europe in 1997 and summer 1998'.

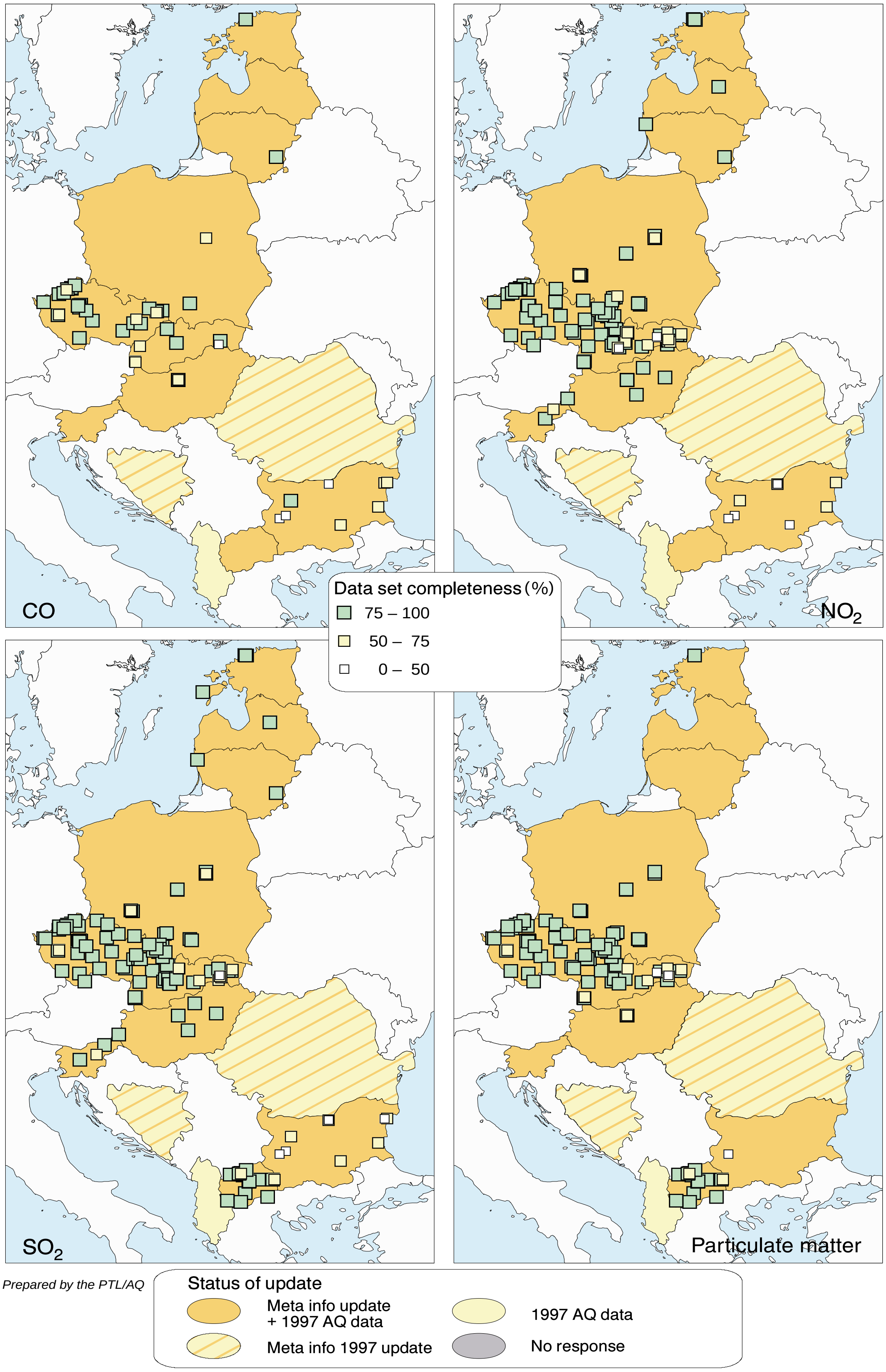
Data, which were incorporated into Airbase, will be included in report 'European air quality and monitoring information in 1997' which is being prepared by the ETC/AQ.

Available meta-information from the Phare countries before 31 July 1999 Table A.4

Country	Number of networks defined in DEM	Number of stations defined in DEM	Manual stations	Automatic stations	Number of traffic stations	Number of industrial stations	Number of background (sub)urban stations	Number of background rural stations	Number of unknown stations
Albania	1	1	—	Yes	—	—	—	—	1
Bosnia and Herzegovina	13	14 (1 x 2. 12 x 1)	Yes	—	—	2	—	—	12
Bulgaria	1	52	Yes	Yes	—	—	52	—	—
Czech Republic	1	63	—	Yes	2	1	38	22	—
Estonia	5	17 (4. 2. 7. 3. 1)	Yes	Yes	3	8	1	4	—
FYROM	3	27 (7. 2. 18)	Yes	—	8	4	15		—
Hungary	3	19 (8. 7. 4)	—	Yes	9	1	5	4	—
Latvia	2	4 (2. 2)	Yes	Yes	—	—	2	2	—
Lithuania	2	28 (24. 4)	Yes	Yes	8	11	5	4	—
Poland	1	31	Yes	Yes	1	1	19	10	—
Romania	13	56 (3. 8. 11. 2 x 1.2.4. 4 x 5)	Yes	—	1	7	46	2	—
Slovak Republic	1	39	—	Yes	8	11	16	3	—
Slovenia	1	5	—	Yes	1	—	2	2	—

Note: Type of station as filled in Airbase data exchange module (DEM), only for stations active in 1997.

Figure A.2 **Data set completeness**



Number of stations and averaging time per pollutant for which the Phare countries transmitted 1997 air quality data Table A.5

Country	SO_2	Black smoke	TSP	PM_{10}	NO	NO_2	NO_x	O_3	CO	Other
Albania	1	—	—	—	1	1	—	1	1	—
Bosnia and Herzegovina	—	—	—	—	—	—	—	—	—	—
Bulgaria	9 1/3h	—	1	—	—	8 1/3h	—	8	8	H_2S: 6. 1/ 3h NH_3: 5
Czech Republic	56/day	—	—	56/day	—	42	56	31	25	—
Estonia	4/day	—	1/day	—	—	1 2/day	1	4	1	—
FYROM	24/day	27/day	—	—	—	—	—	—	—	—
Hungary	8 4/day	—	8	—	8	8 4/day	—	5	8	—
Latvia	2/day	—	—	—	—	2/day	—	1	—	—
Lithuania	1	—	—	—	1	1	1	5	1	—
Poland	12/day	6/day	—	8/day	—	2 13/day	—	16	2	—
Romania	—	—	—	—	—	—	—	—	—	—
Slovak Republic	31/day	—	25/day	—	—	31	31	17	7	H_2S: 6/day
Slovenia	3	—	—	—	—	2	2	5	—	—

Note: Number of stations without specification is for 1-h averaging time. Other averaging times are given behind the slash following the number of (additional) stations with this averaging.

Table A.6

Average percentage of valid data including range and averaging time per pollutant for which the Phare countries transmitted 1997 air quality data

Country	SO_2	Black smoke	TSP	PM_{10}	NO	NO_2	NO_x	O_3	CO	Other
Albania	25.8 (–)	—	—	—	25.3 (–)	26.0 (–)	—	26.0 (–)	26.0 (–)	—
Bosnia and Herzegovina	—	—	—	—	—	—	—	—	—	—
Bulgaria	43.4 (8–74) 56.7 (–) /3h	—	46.4 (–)	—	—	37.8 (8–68) 58.8 (–) /3h	—	48.2 (7–74)	55.0 (15–77)	H_2S: 33.8 (0–64). 36.3 (–) /3h NH_3: 43.6 (1–73)
Czech Republic	96.0 (67–100) /day	—	—	94.6 (65–100) /day	—	94.6 (80–100)	94.1 (65–100)	94.0 (66–100)	90.4 (64–99)	—
Estonia	97.7 (91–100) /day	—	94.8 (–) /day	—	—	91.8 (–) 97.1 (97–97) /day	92.6 (–)	59.2 (1–98)	99.7 (–)	—
FYROM	91.6 (59–99) /day	92.2 (63–99) /day	—	—	—	—	—	—	—	—
Hungary	95.4 (87–100) 94.0 (87–98) /day	—	80.6 (59–97)	—	94.2 (83–100)	93.5 (79–99) 91.8 (89–93) /day	—	92.4 (83–97)	87.4 (63–100)	—
Latvia	91.4 (87–96) /day	—	—	—	—	91.6 (88–95) /day	–	64.5 (–)	—	—
Lithuania	92.1 (–)	—	—	—	95.2 (–)	95.1 (–)	95.2 (–)	82.7 (70–93)	95.4 (–)	–
Poland	90.3 (75–100) /day	90.5 (85–99) /day	—	89.2 (61–100) /day	—	75.9 (59–93) 86.7 (58–100) /day	—	89.6 (63–99)	85.5 (74–97)	—
Romania	—	—	—	—	—	—	—	—	—	—
Slovak Republic	85.1 (45–100) /day	—	77.5 (5–100) /day	—	—	78.3 (16–99)	78.4 (16–99)	81.2 (56–97)	71.0 (11–96)	H_2S: 78.5 (56–97) /day
Slovenia	81.5 (71–90)	—	—	—	—	69.9 (59–81)	72.8 (65–81)	81.6 (70–92)	—	—

Note: Number without specification is for 1-h averaging time; (—) denotes the cases in which the range is not relevant.

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