AIR QUALITY IN MAJOR EUROPEAN CITIES

Part II: City Report Forms

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research for
man and environment

NILU

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Part II: City Report Forms

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This report was written at the request of the European environment ministers attending the Ministerial Conference held at Dobris Castle, Czechoslovakia, June 1991 and on behalf of the Dutch Directorate-General Environment (DGM/LE) and the European Union, Directorate-General XI. The research was carried out within the framework of project No. 722411 (Urban air quality).

The '*Europe's Environment*' project was co-ordinated by the European Environmental Agency Task Force.

PREFACE

At the "Environment for Europe" conference held at Dobris Castle in the Czech and Slovak Federal Republic in June 1991, environment ministers and the EC Commissioner called for preparation of a pan-European state of the environment report; subsequently all European countries joined this initiative. The Dobris Castle conference agreed that in order to prepare the report, the CEC, in co-operation with the United Nations Economic Commission for Europe (UN-ECE), would set up a Project Group of individual European countries and relevant international organisations. Within the CEC, responsibility has fallen to the Directorate-General XI, and specifically to the Task Force which is making preparations for the European Environment Agency (EEA-TF).

The declaration from the 'Environment for Europe' conference specified that, among others, the pan-European state of the environment report should:

- facilitate the development of an Environmental Programme for Europe, which will "...identify priorities for the repair and restoration of existing environmental damage and the prevention of future problems.";
- be "...a basis for the effective implementation of environmental policies and strategies.";
- act as "...a useful tool to inform the public and raise awareness about environmental problems.".

The Dutch National Institute of Public Health and the Environment (RIVM) and the Norwegian Institute for Air Research (NILU) were requested by the EEA-TF to provide information for the report work package 'Air'. The Main Geophysical Observatory (MGO) of St. Petersburg, provided data for cities in the former Soviet Union.

The research carried out for Section 4.1 on urban and local air pollution of the report '*Europe's environment*' (Stanners & Bordeau, eds., *in press*) is summarised in Sluyter (ed.), 1995 (Air Quality in Major European Cities, Part I: Scientific Background Document to Europe's Environment). In this report, supplementary to the Scientific Background Document, underlying basic data used in the data analysis process are presented per city in so-called City Report Forms.

We would like to thank all the city authorities who responded to our questionnaires; without their data it would have been impossible to write this report. We wish to thank the members of EEA-TF, especially Sylvain Joffre and David Stanners for their contributions and assistance. Kari Nevalainan's (UN-ECE Statistical Division, Geneva) help in obtaining population data and checking urban environmental indicators is greatly appreciated. We are especially grateful to the help we received from Irina Smironova, and Alla Schutskaya (both MGO) in collecting data for the cities in the Former Soviet Union. We thank Frank Vermoesen (Free University Brussels) and Albert Venema (State University Utrecht) for providing us with city maps.

SUMMARY

Within the framework of Europe's Environment programme — commissioned by the EU and co-ordinated by the EEA-Task Force — RIVM, NILU and MGO conducted a study on air quality in a number of cities in Europe. The results of this research were summarised in Sluyter (ed.), 1995 (Air Quality in Major European Cities, Part I: Scientific Background Document to Europe's Environment).

Supplementary to the Scientific Background Document, this report presents the basic data per city in specially designed 'City Report Forms'. The first chapter provides a brief introduction. The second chapter summarises the data collection. The procedures followed in compiling the City Report Forms are described in the third chapter. The City Report Forms are listed in alphabetical order.

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1 INTRODUCTION

In the framework of the Europe's Environment programme, commissioned by the EU and co-ordinated by EEA-Task Force, RIVM[1], NILU[2] and MGO[3] have conducted a study on the air quality situation in a selection of cities in different parts of Europe.

The research was summarised in a scientific background document on air quality in major European cities (Sluyter (ed.), 1995). The scientific background document is the main reference to the *Europe's environment 1993* report (Stanners & Bourdeau (eds.), *in press*), Section 4.1 on urban and local air pollution.

Prime goals of this research were:
1. To define natural and man-made environmental characteristics determining the air quality situation in cities, and to make an inventory of these;
2. To provide a survey of the ambient air pollutant concentrations in cities compared to their WHO-AQGs (World Health Organisation - Air Quality Guidelines);
3. To estimate the number of citizens exposed to exceedances of WHO-AQGs;
4. To estimate the damage to buildings and cultural heritage caused by air pollution;
5. To indicate (industrial) areas with acute local air pollution problems ('hot spots' outside the biggest cities).

Data necessary to make the environmental inventory and to describe the air quality situation per city (goal 1-3) were summarised systematically in specially designed 'City Report Forms' (CRFs). Data collection and procedures followed in compiling the CRFs are described in respectively Chapter 2 and 3. The CRFs are presented in the last part of this report in alphabetical order.

It was impossible to assess the air quality situation in all European cities within the time available for this project. An arbitrary decision was made to describe only cities with more than 500 000 inhabitants. If no such city exists in a participating country, the largest city was chosen. A few small countries like Liechtenstein, Andorra, San Marino, Malta, Cyprus and Monaco are not included in this research. Serbia is excluded from this research because of an UN embargo. Map 1 presents the location and number of inhabitants of the selected cities. Approximately 148 million people live in the 105 selected cities (22% of the total European population).

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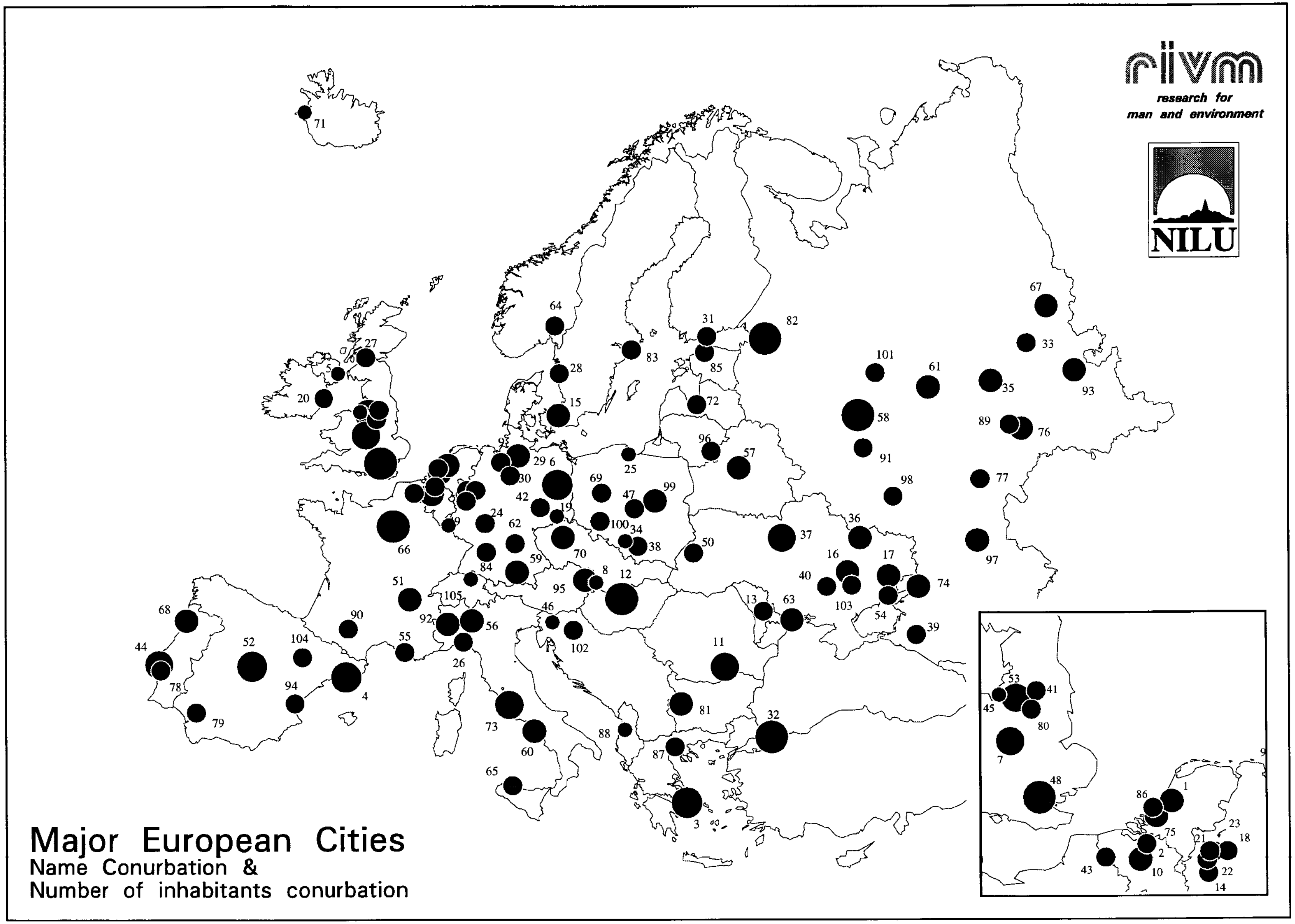
1 National institute of Public Health and the Environment (The Netherlands)
2 Norwegian Institute for Air Research
3 Main Geophysical Observatory (Russian Federation)


Major European Cities
Name Conurbation &
Number of inhabitants conurbation
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Major European Cities

Number of Inhabitants Conurbations

Nr	City	Inh.	Nr	City	Inh.	Nr	City	Inh.
1	Amsterdam	1080	36	Kharkov	1620	71	Reykjavik	110
2	Antwerp	790	37	Kiev	2500	72	Riga	900
3	Athens	3100	38	Krakow	800	73	Rome	2830
4	Barcelona	3100	39	Krasnodar	595	74	Rostov on the Don	1100
5	Belfast	295	40	Krivoy Rog	770	75	Rotterdam	1090
6	Berlin	3430	41	Leeds	710	76	Samara	1240
7	Birmingham	2310	42	Leipzig	510	77	Saratov	910
8	Bratislava	480	43	Lille	950	78	Setubal	800
9	Bremen	550	44	Lisboa	2000	79	Sevilla	780
10	Brussels	1350	45	Liverpool	470	80	Sheffield	530
11	Bucharest	2390	46	Ljubljana	273	81	Sofia	1300
12	Budapest	4434	47	Lodz	850	82	St. Petersburg	4950
13	Chisinau	680	48	London	10570	83	Stockholm	670
14	Cologne	950	49	Luxembourg	80	84	Stuttgart	580
15	Copenhagen	1700	50	Lvov	800	85	Tallin	500
16	Dnepropetrovsk	1220	51	Lyon	1260	86	The Hague	650
17	Donetsk	1120	52	Madrid	3120	87	Thessaloniki	970
18	Dortmund	600	53	Manchester	2580	88	Tirana	450
19	Dresden	480	54	Mariupol	545	89	Togliatti	670
20	Dublin	550	55	Marseille	810	90	Toulouse	610
21	Duisburg	540	56	Milan	1430	91	Tula	540
22	Dusseldorf	580	57	Minsk	1600	92	Turin	1780
23	Essen	630	58	Moscow	9000	93	Ufa	1030
24	Frankfurt	650	59	Munich	1210	94	Valencia	750
25	Gdansk	470	60	Naples	1210	95	Vienna	1560
26	Genoa	700	61	Nizhniy Novgorod	1450	96	Vilnius	570
27	Glasgow	890	62	Nuremberg	500	97	Volgograd	1010
28	Gothenburg	730	63	Odessa	1140	98	Voronezh	960
29	Hamburg	1630	64	Oslo	620	99	Warsaw	1650
30	Hannover	510	65	Palermo	710	100	Wroclaw	660
31	Helsinki	930	66	Paris	8510	101	Yaroslavl	620
32	Istanbul	6890	67	Perm	1120	102	Zagreb	950
33	Izhevsk	640	68	Porto	1315	103	Zaporozhe	900
34	Katowice	360	69	Poznan	590	104	Zaragoza	590
35	Kazan	1100	70	Prague	1220	105	Zurich	360

Key

Nr. of inh. conurbation

- < 500.000
- 500.000 - 1.000.000
- 1.000.000 - 2.000.000
- 2.000.000 - 3.000.000
- 3.000.000 - 4.000.000
- > 4.000.000

Number of Inhabitants Conurbation:

Core municipality (city) together with its morphologically integrated neighbouring cities/towns, or a city and its suburbs. Secondary towns or suburbs separated by more than 2.5 km from the prime city are excluded.

Population data in thousands

Source: RIVM/NILU Cartography: RIVM-LLO

2 DATA COLLECTION

Modelling urban environmental phenomena (e.g. air quality) requires a city definition on the basis of the physical boundary rather than on the administrative boundary, because Europe's large cities often are vast urban areas made up of a prime city coagulated with secondary satellite towns and/or suburbs (e.g. London). The physical city is the three-dimensional space in which pollutants are emitted and the resulting concentration fields are directly influenced by the city's meteorological environment.

To meet this morphological concept the term ***conurbation*** is used:

Conurbation: Core municipality together with its morphologically integrated neighbouring cities/towns, or a city and its suburbs, excluding secondary towns or suburbs separated by more than 2.5 km from the prime city.[4]

Data collection focused on information about *conurbation* and *built-up area* rather than *city* or *total area.* It proved difficult to generate data based on the conurbation concept. Existing (environmental) data are often available on the level of 'administrative units' (municipalities).

Both RIVM and NILU were responsible for a selection of cities as far as data collection and description of the air quality situation were concerned. Annex I lists which institute made each CRF.

In order to describe the cities, available data sources were first reviewed thoroughly and combined whenever possible. The inventory of available data provided a clear picture of data gaps. To cover these gaps persons responsible for air quality were identified in each city through ad hoc questionnaires. Responsible persons were asked to deliver missing and additional information.

2.1 Existing databases and information

This section focuses on the databases and information available within this project. The databases are described in general terms. More detailed information can be found in the scientific background document (Sluyter (ed.), 1995).

The Times Atlas of the World (Times, 1990) was used to make a first list of possible cities/conurbations with more than 500 000 inhabitants. UN-ECE, through their International Environmental Data Service (UN-IEDS), checked and annotated the list and provided the number of inhabitants in the cities and sometimes conurbations. These population statistics were taken from the 1989 UN demographic yearbook (UN, 1991) and made up the preliminary city list. The list was continuously updated during the project with information from ad-hoc questionnaires and UN-IEDS.

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4 No definition was set a priori of 'built-up area', responsible authorities in the cities were asked to draw the boundary between rural and built-up. The only precondition set is on secondary towns or suburbs near the conurbation.

The Faculty of Geographical Sciences (Department of Cartography), State University of Utrecht (Netherlands) supplied some topographical material from the university library's extensive map collection.

The Free University of Brussels (Belgium), *Groupe d'etude pour la valorisation de l'espace rural et urbain*, delivered additional population-density maps for a number of cities.

Climatic data were taken from a database (ODS: Observational Data Set) provided by the European Centre for Medium range Weather Forecasts (ECMWF) (described in Potma, 1993). The ODS database contains 6-hourly meteorological information from 1 January 1980 - 31 December 1989 for approximately 1200 standard WMO stations in Europe.

The Laboratory for Waste Materials and Emissions (RIVM - LAE) provided an approximate estimate of anthropogenic emissions of SO_2, NO_x and VOCs per country, per source category, per inhabitant for the whole of Europe for 1990. The results were used here to compute estimates of cities' emissions when these were not available from the cities themselves.

Procedures for estimating emissions included:
- collection of data on total emissions per country for 1990;
- collection of data on source category allocation of emissions per country for 1990 or for the most recent year possible;
- collection of population data per country for 1990;
- calculation of emissions per source category per inhabitant per country, using the above data.

Source category allocation was based on CORINAIR-1985 definitions (CORINAIR, *in preparation*). Emissions were assigned to one of three categories:
1. Industry (including public power/co-generation/district heating, oil refining, combustion in industry, production processes, industrial solvent use);
2. Transport;
3. Commercial/institutional/residential combustion, and non-industrial solvent use.

The resulting emission estimates (RIVM, 1993) must be interpreted with great care, they are rough estimates. The following points should be taken into consideration:
- emission source category allocation was often based on detailed but not up-to-date emission inventories, such as those from 1985 (CORINAIR-1985, *in preparation*; Veldt, 1991) and 1980 (OECD, 1990);
- as far as non-EU countries are concerned, it is often not clear whether natural VOC emissions and CH_4 emissions have been included in their VOC emission estimates;
- it is not always known if the source category "other transport" (off-road vehicles, air, rail and water transport) was included in the collected total emission figures;
- emission totals used were based as far as possible on data provided by the countries themselves (UN-ECE, 1992; Zierock and Zachariadis, 1991), otherwise data from various other sources were used;
- the CORINAIR-1985 source category classification does not distinguish between industrial and non-industrial solvent use; here, total emissions from solvent use were divided evenly between industrial and non-industrial categories, as expected from Netherlands data;

- EU country VOC emission totals exclude typical CH_4 sources such as mining, agriculture, gas distribution and land-fills, and natural VOC emissions; they include emissions in the category other transport, and CH_4 from other source categories.

GIRAFE is the (French) abbreviation for *Guide d'Information sur les Résaux de qualité de l'Air Fonctionnant en Europe* (Information system on operational European air quality monitoring networks). The inventory was made in 1990 by DGXI of EU (EU, 1994) The database contains information on all operational air quality monitoring networks in the EU. It contains information on the location and environment of all stations, the components monitored, techniques used and on the organisations responsible for the networks. More than 3000 stations are described. GIRAFE was used to identify addresses of responsible organisations for air quality monitoring in cities. The information was also used to assess air quality data provided by the cities and air quality data from the APIS database.

APIS is the abbreviation for Air Pollution Information System (APIS, 1992). It is a software package (database) designed for the exploration of air quality data. These data were submitted by the EC member states in the framework of the Exchange of Information on Air Pollution (Council Decision 82/459/EEC). APIS is capable of performing statistical treatment of data and presentation of data and statistics in graphs and tables.

APIS was used to fill in missing data and to assess long-term trends in concentration levels. APIS was not used more extensively since many stations had been operated for only a few years, or data from stations were transmitted irregularly. This resulted in fragmented time series. APIS data are often difficult to compare because of differences in methods of analysis between member states or because these are not known.

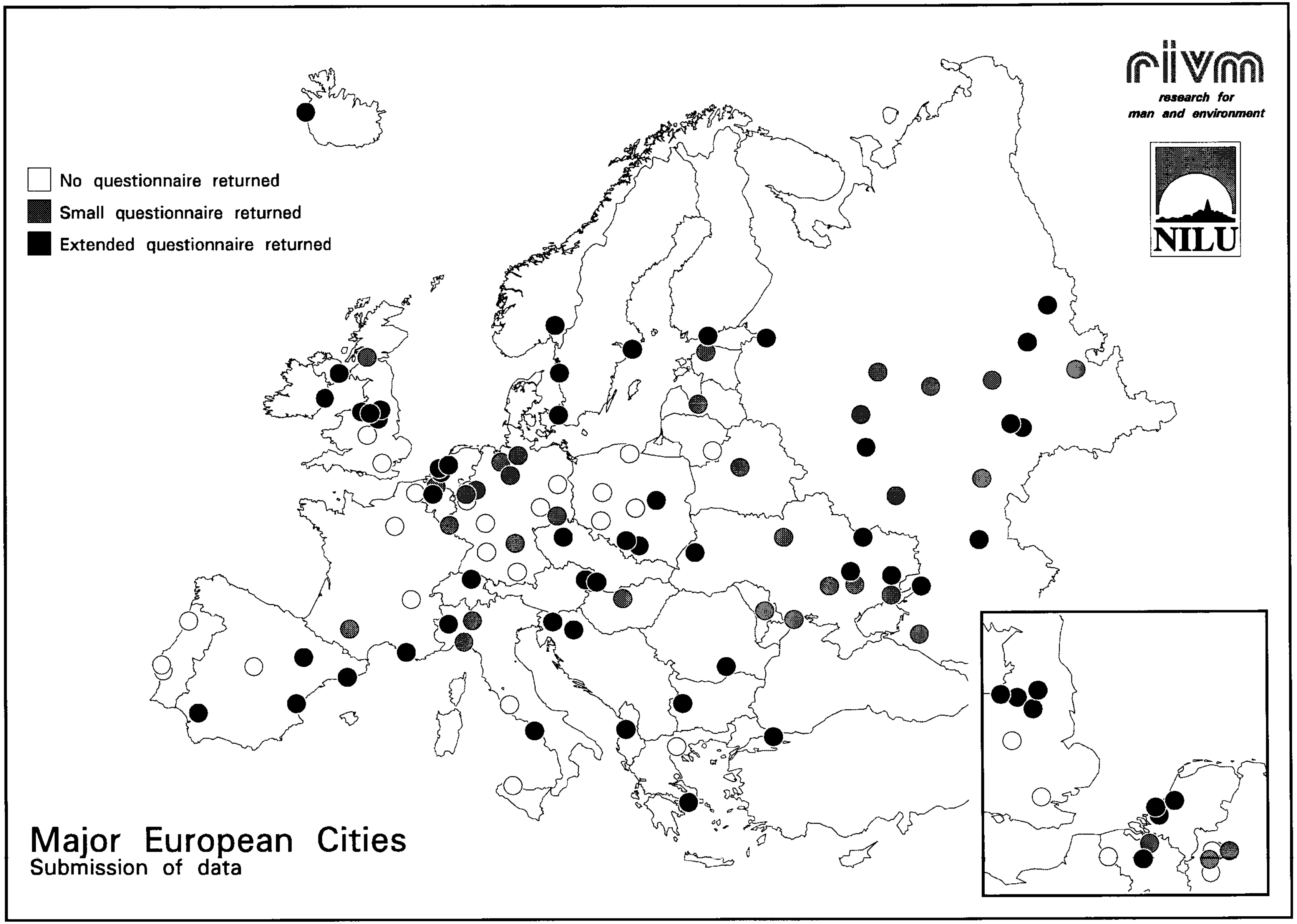
WHO and UNEP (United Nations Environment Programme) carry out an urban air quality monitoring and assessment programme, known as GEMS-AIR, which is a component of the Global Environment Monitoring System. This programme has been operating since 1974 and its activities include collecting, handling and assessing air quality data from over 50 cities in 35 countries. For some cities, GEMS air quality and emission data have been used. Data were gathered through GEMS-AIR publications (WHO/UNEP, 1992; UN, 1992).

The search for articles and reports on local and urban air pollution in European cities was carried out by use of a data base (Base 41 - Pollution abstracts) with the key words: *air* and (*quality* or *monitoring* or *modelling*) and *city name* (major European cities). The search gave as a result 38 references, which were all investigated.

The references contained information on air pollution in the following cities:

Athens	Istanbul	Madrid	Sheffield
Barcelona	Lancaster	Manchester	Venice
Belfast	Leeds	Marseille	Vienna
Budapest	Liverpool	Milan	Zagreb

One reference dealt with the cities of Nordrhein-Westfalen. Another referred to suspended particle concentrations in Amsterdam, Brussels, Frankfurt, London, Madrid, Prague and Zagreb. Two further references provided data on some cities in France and Germany. Most of the references are from the 1980s; a few are older. Some present data and modelling studies from 1988-90.


No questionnaire returned
Small questionnaire returned
Extended questionnaire returned
Major European Cities
Submission of data
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research for man and environment
NILU

2.2 Questionnaires

Two ad hoc questionnaires were sent to the municipal authorities responsible for urban air quality. Map 2 shows which cities responded to either of the two questionnaires. The names and addresses of institutes which collaborated within this project are listed in Annex II. Goal of the first questionnaire was primarily to identify the persons responsible for air pollution information in the cities and to assess in general terms if sufficient data were available in the cities to be able to describe the air quality situation. The first questionnaire was written in English, German, French and Russian; the English version is presented in Annex III. The data themselves were collected in a later stage through a second (more extensive) questionnaire. The second questionnaire was written in English and Russian; Annex IV presents the English version. In some cases cities were visited for additional information. Main Geophysical Observatory of St. Petersburg (Russian Federation) collected information on cities in Belarus, Ukraine and the European part of the Russian Federation.

3 DESCRIPTION OF PROCEDURES APPLIED IN COMPILING THE CITY REPORT FORMS

City Report Forms have been compiled for 105 cities. The amount of information available in the CRFs varies from city to city. Cities which did not respond to either the first or second questionnaire have been described using only information available from international databases and literature. It may not be concluded that the cities which did not return the first questionnaire were unwilling to co-operate. In many cases the tight schedule of the project was to blame. There was simply not enough time to calculate specific statistics which were requested. A number of cities could not provide all the information requested. Information from international databases and literature was used to complete the CRFs. Specific tables were left out when no information on the subject was available.

References to information extracted from international databases or literature are given in endnotes. Data presented in the CRFs of Ukraine, Belarus and the Russian Federation were supplied by MGO except for data printed *in italics*, which was supplied by municipal authorities.

Draft versions of the CRFs were sent back to municipal authorities or national focal points for final checks and annotations. Annex I indicates which CRFs were checked.

The City Report Forms contain information on the following 7 main topics:

I general data (population, area, main activities);
II topography and climatology;
III emissions;
IV traffic data;
V space/domestic heating;
VI air quality data.
VII effects

A number of indices have been defined to relate natural and man-made environmental characteristics to urban air quality, and to be able to find (dis)similarities between environmental characteristics of cities in different parts of Europe. Classification methods are discussed in this chapter. Results of the classification will be presented in the CRFs by topic.

3.1 General data

If the city itself provided a population figure, this was used. Otherwise, information was taken from UN-IEDS or the UN demographic yearbook. Unfortunately the UN gives information on cities rather than conurbations. If the number of inhabitants for the conurbation was in the Times Atlas of the World (Times, 1990) or in the Economist statistical compendium series (The Economist, 1992), this figure was used instead of UN statistics.

The area figures from the cities themselves were used, when available; otherwise, data from the University of Brussels or estimates made by RIVM.

The population and area figures printed **bold** were used to calculate population density. If available, calculations were carried out for the conurbation (population and built-up area). If not, population data for the city and/or total area statistics were used. This causes a substantial problem with comparison of data between cities when population density data are involved. Moreover, it was not always clear if data applied to conurbation or city. Because of this, emission density (per square kilometre and per inhabitant) and population density are difficult to compare between individual cities.

The city co-ordinates were taken from the Times Atlas of the World. Information on major activities and development trends were supplied by the cities themselves.

3.2 Topography and climatology

In the area of investigation, the pan-European territory, differing climatological regimes and meteorological conditions are found superimposed on regions with a variety of cultural and socio-economic backgrounds. Together with differences in access to natural resources, energy and technology, this combination leads to different living conditions and air pollution problems. The European regions as mentioned in the CRFs are listed in Table 3.1.

Table 3.1: European regions

Region	Countries
Northern Europe	Finland, Iceland, Norway, Sweden
Western Europe	Austria, Belgium, Denmark, France, Ireland, Luxembourg, Switzerland, The Netherlands, United Kingdom, former West Germany
Southern Europe	Greece, Italy, Portugal, Spain
Central Europe	Albania, Bulgaria, Czech Republic, former East Germany, Hungary, Poland, Romania, Slovak Republic, former Yugoslavia
Eastern Europe	Belarus, Estonia, Latvia, Lithuania, Moldova, the Russian Federation, Ukraine, European part of Turkey

Information on topography and meteorological conditions were supplied by the cities. Using the available topographical information, cities were classified into 5 site classes (see Table 3.2). Average temperature, total precipitation, average cloud cover and average wind speed were calculated by RIVM using data from meteorological stations selected from the ECMWF-ODS database. A wind rose for a down-town station is included, when supplied by the cities.

Table 3.2: Classification used for topographical siting of cities

class	description	
++	coastal (C), coastal-plain (C,P)	(most favourable)
+	plain (P)	
o	coastal-hills (C,H), plain-river basin (P,RB), plain-hills (P,H)	
-	coastal-valley (C,V), river basin (RB)	
--	valley (V), river basin-hills/valley (RB,H/V)	(most unfavourable)

The climatological regions found in Europe are described in Table 3.3. It should be noted that Central Europe is a climatic transition zone with maritime influence varying from year to year. Moreover the classification does not suffice for cities in countries on the fringe of two climatological regions defined by the Köppen-Geiger system using only temperature and precipitation. If additional climatological parameters had been used, these countries would probably have been classified differently.

Table 3.3: Climatological regions found in Europe (according to Köppen)

Cfa/Cfb/Cfc			**Marine west-coast climate**
C			coldest month > -3 °C but < 18 °C, at least one month has an average temperature above 10 °C
	f		moist, adequate precipitation in all months and no dry season
		a	hot summer, warmest month > 22 °C
		b	warm summer, warmest month < 22 °C
		c	less than four months over 10 °C
Csa/Csb			**Mediterranean climate**
C			coldest month > -3 °C but < 18 °C, at least one month has an average temperature above 10 °C
	s		dry season in summer
		a	hot summer, warmest month > 22 °C
		b	warm summer, warmest month < 22 °C
Dfb			**Humid continental climate**
D			coldest month average temperature < -3 °C, warmest month average temperature > 10 °C
	f		moist, adequate precipitation in all months and no dry season
		b	warm summer, warmest month < 22 °C
Dfc			**Continental sub-arctic climate**
D			coldest month average temperature < -3 °C, warmest month average temperature > 10 °C
	f		moist, adequate precipitation in all months and no dry season
		c	less than four months over 10 °C
BSk/BSh			**Steppe climate**
BS			evaporation exceeds precipitation on the average throughout the year, boundary between steppe (BS) and desert (BK) according to formula
	k		dry-cold, mean annual temperature < 18 °C
	h		dry-hot, mean annual temperature > 18 °C

Certain meteorological conditions are favourable for enhanced concentrations of air pollution or 'smog'. Winter-type smog is a mixture of mainly SO_2 and particulate matter. Summer-type, or photochemical smog, is a complex mixture of ozone, nitrogen oxides and volatile organic compounds. O_3 is used here as an indicator for summer-type smog. In both cases health effects are caused by short-term exposure to high concentrations of air pollution during episodes.

An index called *Meteorological Smog Potential* has been defined for both the winter and summer half-years, to describe the probability of enhanced concentrations on the basis of the local meteorological situation independently of emissions (van Velze *et al.*, 1993). The method used to calculate these indices is described in Annex V.

Climatological statistics were calculated using data from a meteorological station just outside the city, selected from the ECMWF-ODS database (see Section 2.1.). Calculations were performed with data for the period 1980-1989 and for 1985 and 1989 separately. Figures concerning wind speed, winter smog index and summer smog index were ranked in 5 classes, according to Table 3.4.

Table 3.4: Classification of wind speed and Meteorological Potential Winter and Summer Smog indices

class	range			
++	$< M - 1.5\sigma$			(most favourable)
+	$> M - 1.5\sigma$	and	$< M - 0.5\sigma$	
o	$> M - 0.5\sigma$	and	$< M + 0.5\sigma$	
-	$> M + 0.5\sigma$	and	$< M + 1.5\sigma$	
--	$> M + 1.5\sigma$			(most unfavourable)

M = population average; σ = standard deviation

Several cities delivered a thematic map with information about residential areas, industrial areas, city centre/commercial areas, woodlands/parks/green areas, main roads, air quality monitoring sites, major point sources and meteorological (wind) stations. For all FSU cities a map with location of the monitoring stations is included. When no thematic map was available, a population density map provided by the Free University of Brussels (Belgium), *Groupe d'etude pour la valorisation de l'espace rural et urbain*, or a topographical map provided by the Faculty of Geographical Sciences (Department of Cartography), State University of Utrecht (Netherlands) is enclosed.

3.3 Emission and activity data

In the CRFs emission data are provided for three main source categories:
- traffic;
- domestic/space heating;
- industry and power plants.

It is not always clear whether the data in Section III (emissions), Section IV (traffic data) and Section V (space/domestic heating) of the CRFs are for the *city* or for the *conurbation*; if known, this is recorded in the tables.

If it is not known whether emission data refer to *city* or *conurbation*, calculations are done using data for the *conurbation*, when available. Emissions per km^2 are calculated using the *built-up* area figures whenever available, otherwise *total* area figures are used. Emission calculations per capita for the FSU cities in 1990 are based on the average of population figures from 1987 and the most recent figures (mostly 1992).

It is difficult to compare cities as far as emission estimates are concerned:
- only a few cities had emission estimates available for all three source categories;
- for most cities it is unknown if emission data refer to city or conurbation;
- area and population figures used for calculating emission density figures are extracted from several different sources;
- different emission inventory methods were used.

Recent (1990 or another year between 1989-1992) SO_2 and/or PM emission data were used as indicators for *winter-type smog emissions*, VOCs and/or NO_X emission data as indicator for *summer-type smog emissions*. To be able to compare cities, emission density figures (per capita) were used to classify cities according to their emission environment. Emission density figures per square kilometre are preferred but were rated not reliable enough to be used in this classification.

If there were no emission data available for a city, the emission indicators were based on expert judgement. For all cities, a general description of activities was available. This description was compared to descriptions of cities with known emissions and experiencing the same activity patterns. The emission class of the city with known emissions was then extrapolated.

Because emissions are always regarded as negative, classes range from *less unfavourable* to *most unfavourable* conditions (see Table 3.5).

Table 3.5: Classification of Winter and Summer Smog Emissions

class	range			
1	$< M - 1.5\sigma$			(less unfavourable)
2	$> M - 1.5\sigma$	and	$< M - 0.5\sigma$	
3	$> M - 0.5\sigma$	and	$< M + 0.5\sigma$	
4	$> M + 0.5\sigma$	and	$< M + 1.5\sigma$	
5	$> M + 1.5\sigma$			(most unfavourable)

M = population average; σ = standard deviation

3.4 Air quality data

Most concentration data presented in the CRFs were supplied by the cities. APIS provided additional data for cities located in the European Community.

Air quality monitoring stations are grouped in 4 different types of stations according to their location:

- **Regional background stations**: Stations located outside the urban area (at least 3 km and not more than 50 km distant from the conurbation built-up area) and not directly influenced by anthropogenic emission sources; the stations are used to monitor regional background air pollution levels;
- **City background stations**: Stations located within the built-up area of conurbations, but situated away from busy streets and industrial sources (not directly influenced by traffic or industry). Citizens are exposed to at least city background levels when outdoors. City background measurements are used to estimate population exposure;
- **Traffic stations**: Traffic (street/kerbside) stations are located in busy streets and are used to monitor the contribution of traffic to (urban) air pollution levels. Within this project data from these types of stations were requested only for the station measuring the highest concentrations as an indication of possible pollution levels in traffic situations;
- **Industrial stations**: Industrial stations are located near or at industrial sites/estates . In many cases these stations are part of an alarm/alert network. Within this project data from these types of stations were required only from the station measuring the highest concentrations as an indication of possible pollution levels near industrial estates.

Table 3.6 presents a standard air pollution concentration table[5], in this case for SO_2. Tables for the compounds TSP, black smoke, NO_2 and O_3 have the same structure. Statistical data however, vary per compound (e.g. *winter average* for SO_2, *summer average* for O_3). Tables for CO and Pb differ in structure from the SO_2 example since only the station measuring the highest concentration is used. In some CRFs concentrations of formaldehyde, benzo(a)pyrene, phenol and/or NH_3 are included.

If possible, data are presented for 1985 and 1990, otherwise for one or two other recent years.

The World Health Organisation short-term Air Quality Guidelines (WHO, 1987) are displayed under the corresponding tables. For instance '*WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$*' means the WHO-AQG is exceeded when the maximum daily average SO_2 concentration over one year is higher than 125 $\mu g\ m^{-3}$.

[5] In some cases the table structure is adjusted to fit the available information.

Table 3.6: Standard concentration table for SO_2 with numbered cells (no data)

SO_2 concentrations $\mu g\ m^{-3}$	**Mean of stations**				**Highest observed concentrations**					
	Regional background		**City background**		**City background**		**Traffic site**		**Industrial site**	
	1985	**1990**	**1985**	**1990**	**1985**	**1990**	**1985**	**1990**	**1985**	**1990**
Number of stations	cell **1**	cell **8**	cell **15**	cell **22**	cell **29**	cell **36**	cell **43**	cell **50**	cell **57**	cell **64**
Annual average	cell **2**	cell **9**	cell **16**	cell **23**	cell **30**	cell **37**	cell **44**	cell **51**	cell **58**	cell **65**
Winter average	cell **3**	cell **10**	cell **17**	cell **24**	cell **31**	cell **38**	cell **45**	cell **52**	cell **59**	cell **66**
Maximum (24 h)	cell **4**	cell **11**	cell **18**	cell **25**	cell **32**	cell **39**	cell **46**	cell **53**	cell **60**	cell **67**
98 percentile (24 h)	cell **5**	cell **12**	cell **19**	cell **26**	cell **33**	cell **40**	cell **47**	cell **54**	cell **61**	cell **68**
Number of days exceeding the WHO-AQG	cell **6**	cell **13**	cell **20**	cell **27**	cell **34**	cell **41**	cell **48**	cell **55**	cell **62**	cell **69**
Number of days exceeding 2 x WHO-AQG	cell **7**	cell **14**	cell **21**	cell **28**	cell **35**	cell **42**	cell **49**	cell **56**	cell **63**	cell **70**

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

City authorities were requested to select and transmit data for a maximum of 10 city background stations. Data presented in the column "**Mean of stations; City background**" (Table 3.6, cells 15-28) refer to the average of the selected city background stations. The same procedures were applied for "**Mean of stations; Regional background**" (cells 1-14). The number of stations on which the averages were based is given in row "number of stations" (cells 1,8,15,22). In several cases however, the *station number(s)* (e.g. "No. 4,7,8" means 3 stations with the station numbers 4,7 and 8) or *station name* are given. Station numbers are often displayed on the enclosed map.

Since many cities did not have regional background concentration data available, the Langrangian model TREND (van Jaarsveld, *in preparation*) was used to calculate the SO_2 and TSP regional background concentration fields for 1990 over Europe. Modelled concentrations are presented in cell 9. They are printed *in italics* to distinguish them from measured concentrations.

Besides air quality data for city background locations, the city authorities were requested to deliver data from one traffic and one industrial station measuring the highest concentrations. Data from these stations are presented on the right of the table (traffic: cells 43-56; industrial: cells 57-70). The following procedures were applied in selecting the city background station measuring the highest concentrations (cells 29-42):

- SO_2, NO_2, TSP, black smoke and PM_{10}: the station with the highest observed *24 hour maximum*;
- O_3: the station with the highest observed *1 hour maximum*.

Since air quality data for cities in the FSU have not yet been entered in a database, it was impossible, given the time frame of this project, to follow these procedures. For FSU cities the selection was made on the basis of the station reporting the highest *annual average*. For the German cities *all the highest values* were selected, not taking into account whether they were from only one station or from different stations. Following these procedures will in most cases result in the same selections as when the station with the highest observed 24 hour (1 hour for O_3) maximum had been selected.

When information from only one city background station was available, this information is printed in both columns 'mean of stations' (cells 15-28) and 'highest observed concentrations' (cells 29-42).

Figures are <u>underlined</u> when less than 75% of the necessary data was available.

Since for FSU cities only 20-minute values were available instead of 24-hour values, RIVM calculated 24-hour maximum and 98 percentile values for SO_2 (Annex VI). These calculated figures are printed *in italics* in the SO_2 concentration table.

Short term exceedances of WHO-AQGs for SO_2 and/or TSP and O_3 have been taken as indicators for winter-type and summer-type smog respectively. The classification schemes applied (see Table 3.7) are based on highest observed city background concentrations (cells 34-35, 41-42). For FSU cities exceedances are calculated (Annex VI).

Table 3.7: Classification winter and summer smog exceedances

class	range
0.5	< 0.5 WHO - Air Quality Guideline
1	0.5 - 1 WHO - Air Quality Guideline
2	1 - 2 WHO - Air Quality Guideline
3	2 - 3 WHO - Air Quality Guideline
4	3 - 4 WHO - Air Quality Guideline
5	4 - 5 WHO - Air Quality Guideline

Not all cities monitor both SO_2 and PM (TSP/black smoke). Sometimes only SO_2 or TSP data are available. The short term AQGs for SO_2 and TSP are both 125 $\mu g\ m^{-3}$. Effects to be expected above this level are similar for both components. Not many cities monitor O_3 at the moment at background sites. Exceedance classification for O_3 is thus limited to a few cities.

Estimation of winter smog exposure (Annex VII) is performed for SO_2 and particles (TSP or other) separately (i.e. the winter smog indicators); the exposure class (Table 3.8) given to the city is the higher of the two.

Table 3.8: Classification winter smog exposure

class	range
1	0 - 5 % population
2	5 - 33 % population
3	33 - 66 % population
4	> 66 % population

There was not sufficient city data available to calculate the extent of exposure to high ozone concentrations (the indicator for summer smog).

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ABBREVIATIONS

σ	standard deviation (statistical)
APIS	Air Pollution Information System (EU database)
CH_4	Methane
CO	Carbon monoxide
CORINE	Coordination de l'information sur l'Environnement
CORINAIR	Coordination de l'information sur l'Environnement, section Air
CRF	City Report Form
DGXI	Directorate General XI
EC	European Community
ECMWF	European Centre for Medium range Weather Forecasts
EEA-TF	European Environmental Agency-Task Force
EEC	European Economic Community
EU	European Union
FSU	Former Soviet Union
GEMS-AIR	Global Environment Monitoring System (AIR)
GIRAFE	Guide d'Information sur les Résaux de qualité de l'Air Fonctionnant en Europe (catalogue on air quality monitoring networks in Europe)
inh	inhabitant
M	average (statistical)
MGO	Main Geophysical Observatory (St. Petersburg)
NILU	Norwegian Institute for Air Research
NO_x	Nitrogen oxides
NFP	National Focal Point
ODS	Observational Data Set
OECD	Organisation for Economic Co-operation and Development
O_3	Ozone
Pb	Lead
PM	Particulate Matter
PM_{10}	Particulate Matter less than 10 μm aerodynamic diameter
RIVM	National Institute of Public Health and the Environment
RIVM-LAE	National Institute of Public Health and the Environment - Laboratory for Waste Materials and Emissions
SO_2	Sulphur dioxide
TREND	Analytical long-term deposition model for multi-scale applications
TSP	Total Suspended Particulates
UN	United Nations
UN-ECE	United Nations-Economic Commission for Europe
UN-IEDS	United Nations-International Environmental Data Service
UNEP	United Nations Environmental Programme
veh	vehicle
VOC	Volatile Organic Compound
WHO	World Health Organisation
WHO-AQG	World Health Organisation - Air Quality Guideline
WMO	World Meteorological Organisation

ANNEX I: List of City Report Forms

city	response first questionnaire	response second questionnaire	CRF made by:	CRF checked by city, NFP* or MGO
Amsterdam	yes	yes	RIVM	no
Antwerp	yes	no	RIVM	no
Athens	yes	yes	NILU	yes
Barcelona	yes	yes	NILU	no
Belfast	no	yes	NILU	yes
Berlin	no	no	RIVM	no
Birmingham	no	no	RIVM	no
Bratislava	no	yes	NILU	yes
Bremen	yes	no	RIVM	yes
Brussels	yes	yes	RIVM	no
Bucharest	yes	yes	RIVM	yes
Budapest	yes	no	RIVM	yes
Chisinau	yes	no	RIVM	yes
Cologne	no	no	RIVM	no
Copenhagen	yes	yes	NILU	no
Dnepropetrovsk	yes	yes	RIVM	yes
Donetsk	yes	yes	RIVM	yes
Dortmund	yes	no	RIVM	yes
Dresden	yes	no	RIVM	yes
Dublin	no	yes	NILU	no
Duisburg	no	no	RIVM	no
Dusseldorf	yes	no	RIVM	yes
Essen	no	no	RIVM	no
Frankfurt	no	no	RIVM	no
Gdansk	no	no	RIVM	no
Genoa	yes	no	RIVM	no
Glasgow	yes	no	RIVM	no
Gothenburg	yes	yes	NILU	yes
Hamburg	yes	no	RIVM	yes
Hannover	yes	no	RIVM	yes
Helsinki	yes	yes	NILU	yes
Istanbul	no	yes	RIVM	no
Izhevsk	yes	yes	RIVM	yes
Katowice	yes	yes	NILU	yes
Kazan	yes	no	RIVM	yes
Kharkov	yes	yes	RIVM	yes
Kiev	yes	no	RIVM	yes
Krakow	yes	yes	NILU	no
Krasnodar	yes	no	RIVM	yes
Krivoy Rog	yes	no	RIVM	yes
Leeds	no	yes	NILU	yes
Leipzig	no	no	RIVM	no
Lille	no	no	RIVM	no

city	response first questionnaire	response second questionnaire	CRF made by:	CRF checked by city, NFP* or MGO
Lisboa	no	no	RIVM	no
Liverpool	no	yes	NILU	yes
Ljubljana	yes	yes	NILU	no
Lodz	yes	no	RIVM	no
London	no	no	RIVM	yes
Luxembourg	yes	no	RIVM	no
Lvov	yes	yes	RIVM	yes
Lyon	no	no	RIVM	no
Madrid	yes	yes	NILU	no
Manchester	no	yes	NILU	yes
Mariupol	yes	no	RIVM	yes
Marseille	yes	yes	RIVM	yes
Milan	no	no	RIVM	no
Minsk	yes	no	RIVM	yes
Moscow	yes	no	RIVM	yes
Munich	no	no	RIVM	no
Naples	yes	yes	RIVM	no
Nizhniy Novgorod	yes	yes	RIVM	yes
Nurnberg	yes	no	RIVM	yes
Odessa	yes	no	RIVM	yes
Oslo	no	yes	NILU	no
Palermo	no	no	RIVM	no
Paris	no	no	RIVM	no
Perm	yes	yes	RIVM	no
Porto	no	no	RIVM	no
Poznan	yes	no	RIVM	no
Prague	yes	yes	NILU	yes
Reykjavik	yes	yes	NILU	yes
Riga	yes	no	RIVM	no
Rome	no	no	RIVM	no
Rostov at the Don	yes	yes	RIVM	yes
Rotterdam	yes	yes	RIVM	yes
Samara	yes	yes	RIVM	yes
Saratov	yes	no	RIVM	yes
Setubal	no	no	RIVM	no
Sevilla	yes	yes	NILU	no
Sheffield	no	yes	NILU	yes
Sofia	yes	yes	NILU	yes
St. Petersburg	yes	no	RIVM	yes
Stockholm	yes	yes	NILU	yes
Stuttgart	no	no	RIVM	no
Tallin	no	no	RIVM	no
The Hague	yes	yes	RIVM	no
Thessaloniki	no	no	RIVM	no
Tirana	yes	yes	RIVM	no

city	response first questionnaire	response second questionnaire	CRF made by:	CRF checked by city, NFP* or MGO
Togliatti	yes	yes	RIVM	yes
Toulouse	yes	no	RIVM	no
Tula	yes	yes	RIVM	yes
Turin	yes	yes	RIVM	yes
Ufa	yes	no	RIVM	yes
Valencia	yes	yes	NILU	yes
Vienna	yes	yes	NILU	yes
Vilnius	no	no	RIVM	no
Volgograd	yes	yes	RIVM	yes
Voronezh	yes	no	RIVM	yes
Warsaw	yes	yes	NILU	no
Wroclaw	yes	no	RIVM	no
Yaroslavl	yes	no	RIVM	yes
Zagreb	yes	yes	RIVM	yes
Zaporozhe	yes	no	RIVM	yes
Zaragoza	yes	yes	NILU	no
Zurich	yes	yes	RIVM	yes

* NFP = National Focal Point

ANNEX II: List of participants

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ANNEX III: FIRST QUESTIONNAIRE ON URBAN AND LOCAL AIR POLLUTION

QUESTIONNAIRE AIR QUALITY IN EUROPEAN CITIES

'Dobris State of the European Environment programme 1992/93'

NOTE

If not all questions fall under your responsibility, fill out your part and send a copy of the questionnaire to the person who is responsible for the remaining questions. Even if you are not able to fill out all questions for your city, please always send (part of) the questionnaire back before 1 September 1992.

Person who answered this questionnaire:

Name:	....	Country:	....
	....	City:	....
Address:	....	Human population:	....
	....	Built-up area:	...........................km^2
Tel:	....	Coordinates:	....°....' N ....°....' W/E
Telex:	....	Prevailing wind:	....
Fax:	....		

- **Please indicate the geographical siting of your city (e.g. flat plain, valley, plateau, (river) basin, coastal, or combinations of these):**

  ....

- **Are there any meteorological stations in operation in or around your city?**

  Y/N Nr........

City:... Country:...

- **Which air pollutant(s) is (are) regarded a major problem in your city (please list; e.g. SO_2, dust*, VOC*, Heavy metals*, NO_2, CO, etc.):**

  ....

- **Which emission sources cause a major air pollution problem in your city (please underline)?**

  Industry, Traffic, Power plants, Space/domestic heating, Other:...

- **Concentration data**

  Is air quality monitored in/around your city? Y/N

  If air quality is monitored, please fill in the table below:

Component	SO_2*	dust*	VOC*	Heavy metals*	NO_2	CO	Other
Number of stations							

  Can the data be made available or are there any restrictions: ....

- **Emission data**

  Are there pollutant emission estimates for your city? Y/N

  For which pollutants (please list; e.g. SO_2, dust*, VOC*, Heavy metals*, NO_2, CO, etc.):

  ....

  Can the data be made available or are there any restrictions: ....

* **Dust**: soot, particles, PM10, TSP; **OCs**: toxic/carcinogenic hydro-carbons, e.g. Benzene, Benzo(a)pyrene Formaldehyde; **Heavy metals**: especially Pb, Cd, Cr.

City:.. Country:..

■ Traffic data

Are there statistics available about the amount of traffic in your city? Y/N
Are there statistics available about the types and amounts of fuels used by traffic in your city? Y/N
Can the data be made available or are there any restrictions: ....

■ Space/domestic heating

Are there any statistics available about the fuels (coal/gas/oil/otherwise) used for space/domestic heating in your city? Y/N
Can the data be made available or are there any restrictions: ....

■ Reports

If there are any reports or publications published about your city concerning the subjects mentioned above, or other relevant information concerning air pollution problems (e.g. exposure/effect studies, modelling activities), please give us a list of the reports, the subjects covered and the way they can be obtained.

Reports: ....
....
....
....
....
....
....
....
....
....
....

City:.. Country:..

■ Other responsible persons

When part of the required information (air quality measurements, emission data, activity data, exposure/effect studies, etc.) fall under the resposibility of, or have been filled in by other persons than you, please give their names and addresses also:

Name: ....
Responsibility: ....
Address: ....
....
Tel: ....
Telex: ....
Fax: ....

Name: ....
Responsibility: ....
Address: ....
....
Tel: ....
Telex: ....
Fax: ....

If you are interested in more information about the Dobris project, please let us know.

Besides the final Dobris report, which will summarize the total ecological situation in Europe, a separate technical background document will be written on the air quality situations in all major European cities. Cities which fill out the questionnaire will receive a copy of this document.

End of questionnaire

ANNEX IV: SECOND QUESTIONNAIRE ON URBAN AIR QUALITY

NOTE

If not all questions fall under your responsibility, fill out your part and send a copy of the questionnaire to the person who is responsible for the remaining questions. Even if you are not able to fill in all questions for your city, please send (part of) the questionnaire back before 20 DECEMBER 1992.

2nd QUESTIONNAIRE

AIR QUALITY IN EUROPEAN CITIES

CITY REPORT:

city________________________ **country**________________________

31 May 1995

Person to whom this questionnaire was sent	
Name:	
Institute:	
Address:	
Postcode:	
City:	
Telephone:	
Fax:	
Person who filled in this questionnaire	
Name:	
Institute:	
Address:	
Postcode:	
City:	
Telephone:	
Fax:	

CITY .... COUNTRY ....

A. GENERAL INFORMATION

		City[1]	Conurbation[2]
Population[3]	(number)		
Total area[4]	(km x km)		
Built-up area[5]	(km x km)		
Coordinates[6]	(lat-/longitude)	° 'N ° '__	

Municipalities in conurbation

Major activities[7]

Development trends (1980-1990, 1990-2000)[8]

CITY .... COUNTRY ....

TOPOGRAPHY AND METEOROLOGY
Location[9]
Topography (siting)[10]
Meteorology[11]

LOCAL WIND DISTRIBUTION (WIND ROSE)[12]

Direction (30° sectors)		N 345-15	NNE 15-45	ENE 45-75	E 75-105	ESE 105-135	SSE 135-165	S 165-195
Average windrose	Freq. %							
1985	Wind speed m/s							
Direction (30° sectors)		SSW 195-225	WSW 225-255	W 255-285	WNW 285-325	NNW 315-345	Wind still	
	Freq. %							
	Wind speed m/s							

LOCAL WIND DISTRIBUTION (WIND ROSE)[12]

Direction (30° sectors)		N 345-15	NNE 15-45	ENE 45-75	E 75-105	ESE 105-135	SSE 135-165	S 165-195
Average windrose	Freq. %							
1990	Wind speed m/s							
Direction (30° sectors)		SSW 195-225	WSW 225-255	W 255-285	WNW 285-325	NNW 315-345	Wind still	
	Freq. %							
	Wind speed m/s							

Map of _______________________________________
Main topography, city morphology, industrial sources and monitoring network[13]

Λ
N

City centre /commercial area	Scale 1 : ____________
Residential area	╬ City coordinate (see page 2)
Industrial area	♦ Major point sources (+I, II, ..X)
Woodlands/parks/ 'green' areas	x Air quality monitoring station (1,2,..10)
Other:	Meteorological (wind) station
	Main road

CITY .... COUNTRY ....

B. EMISSION AND ACTIVITY DATA

Vehicle statistics and traffic activity CONURBATION/CITY[14]			
	Number of vehicles registered[15]	entering from outside[16]	Total traffic activity[17]
Total[18] of which: · passenger cars · busses · freight traffic[19] >3.5 t			veh.km.a^{-1} veh.km.a^{-1} veh.km.a^{-1} veh.km.a^{-1}

Main roads			
	Class[20]	Km of street/road[21]	Traffic activity[22]
Main city roads	10 - 50.000 veh/day		veh.km.a^{-1}
Motorway network	> 50.000 veh/day		veh.km.a^{-1}

TOTAL ANNUAL CONSUMPTION OF FUEL USED BY TRAFFIC CONURBATION/CITY[23]				
	Annual consumption (t.a^{-1})[24]		Average Sulphur content (%)	
	1985	19__[25]	1985	19__[25]
Diesel oil Petrol/Gasoline LPG				

Public transport systems[26]	
CONURBATION/CITY[27]	Total public transport activity
non-electric-powered public transport (busses, diesel trains) electric-powered public transport (tramways, underground railways, trolley-busses)	passenger.km.a^{-1} passenger.km.a^{-1}

ROAD TRAFFIC[28]

CITY .... COUNTRY ....

MAJOR INDUSTRY[29]

DOMESTIC/SPACE HEATING[30]

TOTAL ANNUAL CONSUMPTION OF FUEL USED BY SPACE/DOMESTIC HEATING CONURBATION/CITY[31]

	Annual consumption 1985	Annual consumption 19__[32]	Average Sulphur content 1985	Average Sulphur content 19__[32]
Fuel oil low sulphur ($t.a^{-1}$)	...	...	... %	...%
Fuel oil high sulphur ($t.a^{-1}$)	...	...	... %	...%
Coal ($t.a^{-1}$)	...	...	... %	...%
Wood ($t.a^{-1}$)	...	...		...%
Natural/city gas ($10^6 m^3.a^{-1}$)	...	...		

CITY .... COUNTRY ....

ANNUAL EMISSIONS PER SOURCE AND TOTALS IN 1985 (kton.a^{-1})
CONURBATION/CITY[33]

	SO_2	NO_x	CO	VOC	Particulate matter			Pb
					process emissions	of which percent PM_{10}	combus-tion	
Traffic . road traffic . ships and trains . other traffic								
Domestic/space heating								
Industry and power plants · stack height < 50 m · stack height > 50 m								
Total								
Per capita Per km^2								

ANNUAL EMISSIONS PER SOURCE AND TOTALS IN 1990 (OR IN THE MOST RECENT YEAR: 19__)
(kton.a^{-1})[33]
CONURBATION/CITY[34]

	SO_2	NO_x	CO	VOC	Particulate matter			Pb
					process emissions	of which percent PM_{10}	combus-tion	
Traffic . road traffic . ships and trains . other traffic								
Domestic/space heating								
Industry and power plants · stack height < 50 m · stack height > 50 m								
Total								
Per capita Per km^2								

CITY .... COUNTRY ....

LOCAL POLICIES ON AIR POLLUTION[35] (measures introduced and planned)
Traffic: **Domestic/space heating:**   **Industry and power plants:**

CITY .... COUNTRY ....

C. AIR QUALITY DATA

MONITORING NETWORK[36]

AIR QUALITY MONITORING EQUIPMENT				
Component[37]	Analytical principle[38]	Manual or Automatic[39]	Integration period[40]	Quality assurance[41]
				1 2 ...

QUALITY ASSURANCE[41]	
Note	Explanation
1 2 ...	

.... Reports enclosed[42]

CITY .... COUNTRY ....

NUMBER OF MONITORING NETWORK STATIONS IN 1985 AND 1990 (OR IN THE MOST RECENT YEAR: 19__ [43])				
Stations	Component			
	SO_2 1985 19__	NO_2 1985 19__	CO 1985 19__	O_3 1985 19__
Regional background[44] City background[45] Traffic site[46] Industrial site[47]				
Stations	Component			
	Heavy metals 1985 19__	TSP[48] 1985 19__	Black smoke 1985 19__	PM_{10}[49] 1985 19__
Regional background[44] City background[45] Traffic site[46] Industrial site[47]				

CITY .... COUNTRY ....

AIR QUALITY DATA[48]	SO_2 concentrations ($\mu g/m^3$)									
Station identifier[49]										
Station type[50]										
Year[51]	1985	19__	1985	19__	1985	19__	1985	19__	1985	19__
Annual average[52]										
Winter average[53]										
Maximum (24 h)[54]										
98 Percentile (24 h)[55]										
Number of days exceeding the WHO-AQG[56]										
Number of days exceeding 2 x WHO-AQG										
Monitoring period[57]										
First - Last year operation[58]										

CITY .... COUNTRY ....

AIR QUALITY DATA[59]	**NO_2 concentrations** ($\mu g/m^3$)									
Station identifier[60]										
Station type[61]										
Year[62]	1985	19__	1985	19__	1985	19__	1985	19__	1985	19__
Annual average[63]										
Maximum (24 h)[64]										
Maximum (1 h)[65]										
Number of days exceeding the WHO-AQG[66]										
Number of days exceeding 2 x WHO-AQG										
Monitoring period[67]										
First - Last year of operation[68]										

CITY .... COUNTRY ....

AIR QUALITY DATA[69]	CO concentrations (mg/m³)									
Station identifier[70]										
Station type[71]										
Year[72]	1985	19__	1985	19__	1985	19__	1985	19__	1985	19__
Annual average[73]										
Maximum (8 h)[74]										
Number of days exceeding the WHO-AQG[75]										
Number of days exceeding 2 x WHO-AQG										
Monitoring period[76]										
First - Last year of operation[77]										

CITY .... COUNTRY ....

AIR QUALITY DATA[78]	Pb concentrations (μg/m³)									
Station identifier[79]										
Station type[80]										
Year[81]	1985	19__	1985	19__	1985	19__	1985	19__	1985	19__
Annual average[82]										
Maximum monthly average [83]										
Monitoring period[84]										
First - Last year of operation[85]										

➤

CITY .... COUNTRY ....

AIR QUALITY DATA[86]	TSP concentrations ($\mu g/m^3$)									
Station identifier[87]										
Station type[88]										
Year[89]	1985	19__	1985	19__	1985	19__	1985	19__	1985	19__
Annual average[90]										
Winter average[91]										
Maximum (24 h)[92]										
98 Percentile (24 h)[93]										
Number of days exceeding the WHO-AQG[94]										
Number of days exceeding 2 x WHO-AQG										
Monitoring period[95]										
First - Last year of operation[96]										

CITY .... COUNTRY ....

AIR QUALITY DATA[97]	**Black smoke concentrations** ($\mu g/m^3$)									
Station identifier[98]										
Station type[99]										
Year[100]	1985	19__	1985	19__	1985	19__	1985	19__	1985	19__
Annual average[101]										
Winter average[102]										
Maximum (24 h)[103]										
98 Percentile[104]										
Number of days exceeding the WHO-AQG[105]										
Number of days exceeding 2 x WHO-AQG										
Monitoring period[106]										
First - Last year of operation[107]										

CITY .... COUNTRY ....

AIR QUALITY DATA[108]	Other components ____________ ($\mu g/m^3$)									
Station identifier[109]										
Station type[110]										
Year[111]	1985	19__	1985	19__	1985	19__	1985	19__	1985	19__
Annual average[112]										
Winter average[113]										
Maximum (__ h)[114]										
98 Percentile[115]										
Number of days exceeding the WHO-AQG[116]										
Number of days exceeding 2 x WHO-AQG										
Monitoring period[117]										
First - Last year of operation[118]										

CITY .... COUNTRY ....

D. EXPOSURE

EXPOSURE OF CITIZENS[119]

EXPOSURE OF VEGETATION[120]

CITY .... COUNTRY ....

EXPOSURE OF BUILDINGS AND MONUMENTS[121]

DOMINATING BUILDING MATERIALS[122]		
Type of building	Facade	Roof
Historic buildings Apartment buildings Smallhouses Industry		
Sensitive materials used in historic monuments		
Historic buildings **Historic statues and constructions**		

■ *End of the questionnaire*

Explanatory notes to questionnaire

1 **City**: The core municipality of the named conurbation/city.
2 **Conurbation**: Core municipality together with its **morphologically** integrated neighbouring cities/towns, or a city and its suburbs. Secondary towns or suburbs separated by more than 2.5 km from the prime city are excluded.
3 **Population**: Please give the number of inhabitants.
4 **Total area**: Total administrative area.
5 **Built-up area**: Area with permanent man-made structures (e.g. houses, buildings, infrastructure)
6 **Coordinates**: The city centre coordinates have been taken from the *Times Atlas of the World* (1991 edition).
7 **Major activities**: Activities of major economic importance, e.g. harbour and port, heavy industry, business and administration, tourism, etc.
8 **Development trends**: Trends in city growth, changes in major economic activities, etc.
9 **Location**: Macro/meso scale characteristics, e.g. North, South, West or East Europe, distance to a sea, hills/mountains, plains. These characteristics determine climatic features.
10 **Topography (siting)**: Local-scale characteristics especially those leading to potentially adverse dispersion conditions, e.g. enclosed basin/valley (persistent inversions, calms, wind direction), coastal (land-sea breezes, wind direction).
11 **Meteorology**: Adverse dispersion conditions, e.g. inversions in valley systems or sea-land breezes in Mediterranean coastal cities.
12 **Local wind distribution**: For a representative wind station in or near the city centre, please give the distribution (percent of time) the wind blows from the indicated 30° sectors for annual average wind statistics for 1985 and for 1990 or, if not available the most recent year. **Indicate the position of the station on the map**. Frequence of wind still periods: the wind speed below which wind still is defined (or < 0.5 m/s).
13 **Map**: Please provide, if available, a map of your city showing at least the features mentioned above. Please use different gray shades to draw the city centre/commercial areas, residential and industrial areas. Please also indicate the borders of the constituent municipalities using broken lines.
14 **Conurbation/City**: Delete where not applicable. Conurbation data is of most interest.
15 **Registered**: Within the city or conurbation
16 **Entering from outside**: Number of cars entering the city or conurbation on weekdays.
17 **veh.km.a^{-1}**: Vehicle x kilometer per year
18 **Total/of which**: Please give totals and, if available, a breakdown into categories.
19 **Freight traffic**: Heavy-duty traffic with vehicles > 3.5 metric tons
20 **Class**: Annual average daily traffic on main streets and on the motorway network.
21 **Km of street/road**: Total number of kilometers of main streets and motorways in the city or conurbation.
22 **veh.km.a^{-1}**: Vehicle x kilometer per year
23 **Conurbation/City**: Delete where not applicable. Conurbation data is of most interest.
24 **t.a^{-1}**: (Metric) ton per year
25 Please give 1990 data or, if not available, data from the most recent year.
26 **Public transport systems**: Please give the total number of passenger kilometers per year (passenger.km.a^{-1}) divided between the two categories.
27 **Conurbation/City**: Delete where not applicable. Conurbation data is of most interest.
28 **Road traffic**: Please give other relevant information concerning road traffic (if available), e.g. the number of cars equiped with a catalyst, most evident problems (e.g. traffic jams) etc.
29 **Major industry**: Please give information on the most important emitters due to economic activity (except road traffic), for example **type of emitters** e.g. industrial estates causing specific air quality problems, power plants, incinerators and nautic activity, **stack heights** of the main emitters, **energy output** of the stacks (Mega Watt) and **emission compounds and amounts**. Please also draw the location of the main emitters on the map using roman numbers (I, II ..X).
30 **Domestic/space heating**: Please give some general remarks, e.g. on the types of space/domestic heating used.
31 **Conurbation/City**: Delete where not applicable. Conurbation data is of most interest.
32 Please give 1990 data or, if not available, data from the most recent year.
33 **Conurbation/City**: Delete where not applicable. Conurbation data is of most interest.
34 If data for 1990 is not available, please give data for the most recent year.
35 **Local policies**: Measures taken since 1980 to reduce air pollution and measures planned in the next few years. Please indicate intended/expected effects of the measures.
36 **Monitoring network**: Please provide some general information on the air quality monitoring network, e.g. the institute responsible for the network and the main objectives of the network. If (part of) the network is used as an alert network, please give some information on the alert/alarm procedures. Please also give information how information from the network is diffused to the public (e.g. reports in newspapers).

37 **Component**: The pollutant monitored. In those cases where a component is determined using different analytical principles, for example SO_2 by both UV fluorescence and flame photometry (see also *analytical principle*), list them as SO_2(1) and SO_2(2).

38 **Analytical principle**: The method used to determine the ambient concentration, e.g. ultraviolet fluorescence.

39 **Manual/automatic: M** for a manually operated monitor from which samples are collected on a regular basis (e.g. black smoke monitors using filters replaced every day) and **A** for an automatic monitor with continuous output.

40 **Integration period**: For a manually operated monitor please give the sampling period (e.g. 1 week), for an automatic monitor please give the integration period of the monitoring results (e.g. 1 hour).

41 **Quality assurance**: Please indicate how quality of the measurements is assured. In this column you can give a number which responds to explanation given in the Table **Quality assurance**.

42 **Reports enclosed**: The amount of information asked on air quality monitoring stations is limited. We are aware of the fact that it will be difficult to interpret air quality data on the basis of this information alone. The reason for not requesting more detailed information is to avoid overburdening you with work. However, we remain very interested in more detailed information on air quality stations, like siting, longitude and latitude of the station, components monitored, height above sea level etc. If you have this information available, for example in the form of a technical report, we would be very interested in receiving it!

43 If data for 1990 is not available, please give data for the most recent year.

44 **Regional background stations**: stations located outside the urban area (**minimal 3 km distance and maximal distance 50 km of the conurbation built-up area**) and not directly influenced by anthropogenic emission sources: they are used to monitor regional `background' air pollution levels.

45 **City background stations**: stations located within the built-up area of conurbations, but situated away from busy streets and industrial sources (not directly influenced by traffic or industry). For this project, city background stations are of special interest. Air quality data from these stations will be used to calculate the city background air pollution levels to which the city's inhabitants are exposed.

46 **Traffic stations**: Traffic (street/curbside) stations are located in busy streets and are used to monitor the contribution of traffic to (urban) air pollution levels.

47 **Industrial stations**: Industrial stations are located near to or at industrial sites/estates and are used to monitor air pollution levels there. In many cases these stations are part of an alarm/alert network.

48 **TSP**: **T**otal **S**uspended **P**articulate matter.

49 **PM_{10}**: Particulate matter with a aerodynamic diameter of < 10 µm (respiratory fraction).

48 **Air quality data**: Please fill in the table. If there are many stations operational, please choose a maximum of 10 representive stations to describe the city background concentration, 1 station measuring the highest street (traffic-induced) concentrations and 1 station measuring the highest industry-induced concentrations. Please first list the *traffic station*, secondly the *industrial station* and then the *city background stations*. Please draw the identification number/code of the stations on the map.

49 **Station identifier**: Please give each station an identification (name or number) to show the location of the station on the map.

50 **Station type**: Please specify the station type (*regional background, city background, traffic (street) station or industrial station* (see also points 36-39)). As far as street and industrial stations are concerned, only data about the monitoring point measuring the highest concentrations should be given.

51 **Year**: Please give concentration data for two years: 1985 and 1990 or, if not available the most recent year.

52 **Annual average**: Please give the annual average. If an average is based on less than 50% of the possible values, please underline this figure.

53 **Winter average**: Please give the winter average. If an average is based on less than 50% of the possible values, please underline this figure. Winter period is defined from 1 October 1984 - 31 March 1985 and 1 October 1989 - 31 March 1990 (or most recent year).

54 **Maximum (24 h)**: Please give the maximum concentration monitored. If an maximum is based on less than 75% of the possible values, please underline this figure.

55 **98 Percentile**: Please give the 98 percentile. If a 98 percentile is based on less than 75% of the possible values, please underline this figure.

56 **Number of days above WHO-AQG**: WHO-Air Quality Guideline: **SO_2: maximum (24 hour) = 125 µg/m^3**. If the figure is based on less than 75% of the possible values, please underline this figure.

57 **Monitoring period**: Please specify the monitoring period per year, e.g. Jan-Feb.

58 **First - Last year operation**: Please give the year in which monitoring was started at the station and, if closed down, the last year of operation.

59 **Air quality data**: Please fill in the table. If there are many stations operational, please choose a maximum of 10 representive stations to describe the city background concentration, 1 station measuring the highest street (traffic induced) concentrations and 1 station measuring the highest industry-induced concentrations. Please first list the *traffic station*, secondly the *industrial station* and then the *city background stations*. Please draw the identification number/code of the stations on the map.

60 **Station identifier**: Please give each station an identification (name or number) to show the location of the station on the map.

61 **Station type**: Please specify the station type (*regional background, city background, traffic (street) station or industrial station* (see also points 36-39)). As far as street and industrial stations are concerned, only data about the monitoring point measuring the highest concentrations should be given.

62 **Year**: Please give concentration data for two years: 1985 and 1990 or, if not available the most recent year.

63 **Annual average**: Please give the annual average. If an average is based on less than 50% of the possible values, please underline this figure.

64 **Maximum (24 h)**: Please give the maximum concentration monitored. If an maximum is based on less than 75% of the possible values, please underline this figure.

65 **Maximum (8 h)**: Please give the maximum concentration monitored. If an maximum is based on less than 75% of the possible values, please underline this figure.

66 **Number of days above WHO-AQG**: WHO-Air Quality Guideline: **NO_2: maximum (24 hour) = 150 $\mu g/m^3$**. If the figure is based on less than 75% of the possible values, please underline this figure.

67 **Monitoring period**: Please specify the monitoring period per year, e.g. Jan-Feb.

68 **First - Last year operation**: Please give the year in which monitoring was started at the station and, if closed down, the last year of operation.

69 **Air quality data**: Please fill in the table. If there are many stations operational, please choose a maximum of 10 representive stations to describe the city background concentration, 1 station measuring the highest street (traffic induced) concentrations and 1 station measuring the highest industry-induced concentrations. Please first list the *traffic station*, secondly the *industrial station* and then the *city background stations*. Please draw the identification number/code of the stations on the map.

70 **Station identifier**: Please give each station an identification (name or number) to show the location of the station on the map.

71 **Station type**: Please specify the station type (*regional background, city background, traffic (street) station or industrial station* (see also points 36-39)). As far as street and industrial stations are concerned, only data about the monitoring point measuring the highest concentrations should be given.

72 **Year**: Please give concentration data for two years: 1985 and 1990 or, if not available the most recent year.

73 **Annual average**: Please give the annual average. If an average is based on less than 50% of the possible values, please underline this figure.

74 **Maximum (8 h)**: Please give the maximum concentration monitored. If an maximum is based on less than 75% of the possible values, please underline this figure.

75 **Number of days above WHO-AQG**: WHO-Air Quality Guideline: **CO: maximum (8 hour) = 10 mg/m^3**. If the figure is based on less than 75% of the possible values, please underline this figure.

76 **Monitoring period**: Please specify the monitoring period per year, e.g. Jan-Feb.

77 **First - Last year operation**: Please give the year in which monitoring was started at the station and, if closed down, the last year of operation.

78 **Air quality data**: Please fill in the table. If there are many stations operational, please choose a maximum of 10 representive stations to describe the city background concentration, 1 station measuring the highest street (traffic induced) concentrations and 1 station measuring the highest industry-induced concentrations. Please first list the *traffic station*, secondly the *industrial station* and then the *city background stations*. Please draw the identification number/code of the stations on the map.

79 **Station identifier**: Please give each station an identification (name or number) to show the location of the station on the map.

80 **Station type**: Please specify the station type (*regional background, city background, traffic (street) station or industrial station* (see also points 36-39)). As far as street and industrial stations are concerned, only data about the monitoring point measuring the highest concentrations should be given.

81 **Year**: Please give concentration data for two years: 1985 and 1990 or, if not available the most recent year.

82 **Annual average**: Please give the annual average. If an average is based on less than 50% of the possible values, please underline this figure.

83 **Maximum monthly average**: Please give the highest monthly average.

84 **Monitoring period**: Please specify the monitoring period per year, e.g. Jan-Feb.

85 **First - Last year operation**: Please give the year in which monitoring was started at the station and, if closed down, the last year of operation.

86 **Air quality data**: Please fill in the table. If there are many stations operational, please choose a maximum of 10 representive stations to describe the city background concentration, 1 station measuring the highest street (traffic induced) concentrations and 1 station measuring the highest industry-induced concentrations. Please first list the *traffic station*, secondly the *industrial station* and then the *city background stations*. Please draw the identification number/code of the stations on the map.

87 **Station identifier**: Please give each station an identification (name or number) to show the location of the station on the map.

88 **Station type**: Please specify the station type (*regional background, city background, traffic (street) station or industrial station* (see also points 36-39)). As far as street and industrial stations are concerned, only data about the monitoring point measuring the highest concentrations should be given.

89 **Year**: Please give concentration data for two years: 1985 and 1990 or, if not available the most recent year.

90 **Annual average**: Please give the annual average. If an average is based on less than 50% of the possible values, please underline this figure.

91 **Winter average**: Please give the winter average. If an average is based on less than 50% of the possible values, please underline this figure. Winter period is defined from 1 October 1984 - 31 March 1985 and 1 October 1989 - 31 March 1990 (or most recent year).

92 **Maximum (24 h)**: Please give the maximum concentration monitored. If an maximum is based on less than 75% of the possible values, please underline this figure.

93 **98 Percentile**: Please give the 98 percentile. If a 98 percentile is based on less than 75% of the possible values, please underline this figure.

94 **Number of days above WHO-AQG**: WHO-Air Quality Guideline: **TSP : maximum (24 hour) = 120 μg/m³**. If the figure is based on less than 75% of the possible values, please underline this figure.

95 **Monitoring period**: Please specify the monitoring period per year, e.g. Jan-Feb.

96 **First - Last year operation**: Please give the year in which monitoring was started at the station and, if closed down, the last year of operation.

97 **Air quality data**: Please fill in the table. If there are many stations operational, please choose a maximum of 10 representive stations to describe the city background concentration, 1 station measuring the highest street (traffic induced) concentrations and 1 station measuring the highest industry-induced concentrations. Please first list the *traffic station*, secondly the *industrial station* and then the *city background stations*. Please draw the identification number/code of the stations on the map.

98 **Station identifier**: Please give each station an identification (name or number) to show the location of the station on the map.

99 **Station type**: Please specify the station type (*regional background, city background, traffic (street) station or industrial station* (see also points 36-39)). As far as street and industrial stations are concerned, only data about the monitoring point measuring the highest concentrations should be given.

100 **Year**: Please give concentration data for two years: 1985 and 1990 or, if not available the most recent year.

101 **Annual average**: Please give the annual average. If an average is based on less than 50% of the possible values, please underline this figure.

102 **Winter average**: Please give the winter average. If an average is based on less than 50% of the possible values, please underline this figure. Winter period is defined from 1 October 1984 - 31 March 1985 and 1 October 1989 - 31 March 1990 (or most recent year).

103 **Maximum (24 h)**: Please give the maximum concentration monitored. If an maximum is based on less than 75% of the possible values, please underline this figure.

104 **98 Percentile**: Please give the 98 percentile. If a 98 percentile is based on less than 75% of the possible values, please underline this figure.

105 **Number of days above WHO-AQG**: WHO-Air Quality Guideline: **Black smoke: maximum (24 hour) = 125 μg/m³**. If the figure is based on less than 75% of the possible values, please underline this figure.

106 **Monitoring period**: Please specify the monitoring period per year, e.g. Jan-Feb.

107 **First - Last year operation**: Please give the year in which monitoring was started at the station and, if closed down, the last year of operation.

108 **Air quality data**: Please fill in the table. If there are many stations operational, please choose a maximum of 10 representive stations to describe the city background concentration, 1 station measuring the highest street (traffic induced) concentrations and 1 station measuring the highest industry-induced concentrations. Please first list the *traffic station*, secondly the *industrial station* and then the *city background stations*. Please draw the identification number/code of the stations on the map.

109 **Station identifier**: Please give each station an identification (name or number) to show the location of the station on the map.

110 **Station type**: Please specify the station type (*regional background, city background, traffic (street) station or industrial station* (see also points 36-39)). As far as street and industrial stations are concerned, only data about the monitoring point measuring the highest concentrations should be given.

111 **Year**: Please give concentration data for two years: 1985 and 1990 or, if not available the most recent year.

112 **Annual average**: Please give the annual average. If an average is based on less than 50% of the possible values, please underline this figure.

113 **Winter average**: Please give the winter average. If an average is based on less than 50% of the possible values, please underline this figure. Winter period is defined from 1 October 1984 - 31 March 1985 and 1 October 1989 - 31 March 1990 (or most recent year).

114 **Maximum (__ h)**: Please give the maximum concentration monitored. If an maximum is based on less than 75% of the possible values, please underline this figure.

115 **98 Percentile**: Please give the 98 percentile. If a 98 percentile is based on less than 75% of the possible values, please underline this figure.

116 **Number of days excedding the WHO-AQG**: WHO-Air Quality Guideline: ___________: **maximum (__ hour) = __ µg/m³**. If the figure is based on less than 75% of the possible values, please underline this figure.

117 **Monitoring period**: Please specify the monitoring period per year, e.g. Jan-Feb.

118 **First - Last year operation**: Please give the year in which monitoring was started at the station and, if closed down, the last year of operation.

119 Do you have or have there been conducted any studies regarding the air pollution exposure of your city's inhabitants and its effects (e.g. epidemiological studies, health studies)? Y/N
If yes please list or send the reports. If we have already listed reports, please send us those reports.

120 Do you have or have there been conducted any studies regarding the air pollution exposure of your city vegetation and its effects (e.g. certain trees cannot be expected to survive) or on surrounding nature (e.g. downwind effects)? Y/N
If yes please list or send the reports. If we have already listed reports, please send us those reports.

121 Do you have or have there been conducted any studies regarding the air pollution exposure of materials and monuments in the city or its surroundings? Y/N
If yes please list or send the reports. If we have already listed reports, please send us those reports.

122 Please list the most dominating material for facade and roof

ANNEX V: Calculation of Meteorological Potential Winter and Summer Smog Indices

The Meteorological Potential Winter Smog Index MSP-W is defined as the sum of probabilities $f_{w\,n}$ for all days during the winter half-year (31 March - 1 October):

$$\text{MSP-W} = \Sigma\, f_{w\,n} \qquad (0 \leq f_{w\,n} \leq 1)$$

The factor $f_{w\,n}$ is the product of functions of the Monin-Obukhov length (atmospheric stability) f_L, precipitation f_p, temperature f_T and wind velocity f_{wv}:

$$f_{w\,n} = f_L \cdot f_p \cdot f_T \cdot f_{wv} \qquad (0 \leq f_i \leq 1 \text{ with } i = L, p, T, wv)$$

The Monin-Obukhov length (L) is estimated for every 6-hour period per day. The method used for calculating the Monin-Obukhov length is described in Beljaars, *et al.*, 1990. Function f_{wv} is defined as wv^{-1} with wv the wind velocity at a height of 10 m, outside the built-up area. The other functions are equal to 0 for meteorological conditions unfavourable for smog and equal to 1 for meteorological conditions favourable for smog, as mentioned in Table 4. Between those margins the function is considered to be linearly related to the regarded meteorological parameter L^{-1}, p or T_{24h}. The influence of a heat island effect on atmospheric stability is not included. This phenomenon can shift the stability toward unstable conditions. Analyses of results with other boundary values (especially for L^{-1}) have been made. It was found that the margins in Table V.1 lead to the best distinction between cities.

Table V.1: Meteorological conditions for winter-type smog

	Function	Meteorological condition
atmospheric stability	$f_L = 0$	$L^{-1} \leq -0.02$
(L^{-1} in m^{-1})	$f_L = (L^{-1} + 0.02) / 0.07$	$-0.02 < L^{-1} < 0.05$
	$f_L = 1$	$0.05 \leq L^{-1}$
precipitation	$f_p = 1$	$p = 0$
(p in mm)	$f_p = 1 - 0.5 \cdot p$	$0 < p < 2$
	$f_p = 0$	$2 \leq p$
temperature	$f_T = 1$	$T_{24h} \leq 0$
(T_{24h} in °C)	$f_T = 1 - 0.1 \cdot T_{24h}$	$0 < T_{24h} < 10$
	$f_T = 0$	$10 \leq T_{24h}$
wind velocity	$f_{wv} = 1$	$wv \leq 1$
(wv in $m\ s^{-1}$)	$f_{wv} = 1 / wv$	$1 < wv$

The Potential Summer Smog Index MSP-S is the sum of probabilities $f_{s\,n}$ on all days during the summer half-year (1 April - 30 September):

$$\text{MSP-S} = \Sigma f_{s\,n} \qquad (0 \le f_{s\,n} \le 1)$$

The factor $f_{s\,n}$ depends on photo-chemical reactions and wind velocity. The influence of photo-chemical reactions is represented by functions relating to temperature f_T, cloudiness f_{Nt} and the residence time of the air in the city f_{rt}. The residence time takes into account the delay due to the reaction time needed for ozone production.
The residence time (rt, in hours) is the time needed for a parcel of air to traverse the city's canopy (with diameter D in km) at wind velocity (in m s^{-1}):

$$rt = 3.6^{-1}\, D\, wv^{-1}.$$

So $f_{s\,n}$ finally is:

$$f_{s\,n} = f_T \cdot f_{Nt} \cdot f_{rt} \cdot f_{wv} \qquad (0 \le f_i \le 1 \text{ with } i = T, Nt, rt, wv)$$

Function f_{wv} is defined as the inverse wind velocity wv^{-1} with a maximum value of 1. The other functions are equal to 0 for meteorological conditions unfavourable for smog and equal to 1 for meteorological conditions favourable for smog, as mentioned in Table V.2. Between those margins the function is considered to be linear with the concerned meteorological parameters, except for f_{Nt}. Which is assumed to be equal to $1 - Nt^{3.4}$ as described by Kasten *et al.* and slightly modified.

Table V.2: Meteorological conditions for summer-type smog

	Function	Meteorological condition
temperature	$f_T = 0$	$T_{max} \le 25$
(T_{max} in °C)	$f_T = (T_{max} - 25) / 5$	$25 < T_{max} < 30$
	$f_T = 1$	$30 \le T_{max}$
cloudiness	$f_{Nt} = 1$	$Nt = 0/8$
(Nt in 1/8)	$f_{Nt} = 1 - Nt^{3.4}$	$0/8 < Nt < 8/8$
	$f_{Nt} = 0$	$Nt = 8/8$
residence time	$f_{rt} = 0$	$rt \le 2$
(rt in hours)	$f_{rt} = 2 - rt$	$0 < rt < 3$
	$f_{rt} = 1$	$3 \le rt$
wind velocity	$f_{wv} = 1$	$wv \le 1$
(wv in m s^{-1})	$f_{wv} = 1 / wv$	$1 < wv$

References:

Beljaars, A.C.M.; A.A.M. Holtslag (1990); A Software library for the calculation of surface fluxes over land and sea. Environmental Software, Vol. 5, No. 2.

Kasten, F.; G. Czeplak (1980); Solar and terrestrial radiation dependent on the amount and type of cloud. Solar Energy 24, 177-189.

ANNEX VI: Calculation of 24h values and exceedances for FSU cities

It is well established that SO_2 concentration fluctuations in the atmosphere can be described by a log-normal distribution. Given a log-normal distribution and the value of two percentiles, all other percentiles can be calculated.

According to Curran et al. (1991) the 98 percentile of the 20-minute values, sampled three times a day in the FSU, can be used as an estimate for the 98 percentile of daily values.

From the yearly average concentration and the 98 percentile value, as collected from the FSU cities, the number of days above the WHO guideline (125 $\mu g\ m^{-3}$ as 24h average) and the maximum daily concentration can be calculated:

$$\ln C_{px} = \ln C_{p50} + Z_{px} \ln S_g \qquad (1)$$

Where C_{px} is the measured concentration of the x percentile,
Z_{px} is the eccentricity for the x percentile,
S_g is the geometric standard deviation

$$\ln C_{am} = \ln C_{p50} + 0.5 \ \ln S_g \qquad (2)$$

Where C_{am} is the arithmetic mean

Combining equations 1 and 2:

$$\ln S_g = [1/(Z_{px} - 0.5) \ln (C_{px}/C_{am})] \qquad (3)$$

The eccentricity for 125 $\mu g\ m^{-3}$ can be calculated, using equations 1 and 3:

$$Z_{125} = [\ln(125/C_{am})/\ln S_g] + 0.5 \qquad (4)$$

The maximum daily value ($P_{99.7}$) can also be calculated using equation 1:

$$C_{Pa} = C_{Pb}.\ (S_g)^{(Zpa-Zpb)}$$

$$C_{P99.7} = C_{P98}.(S_g)^{0.70} \qquad (5)$$

For 47 cities in this study the number of days above 125 $\mu g\ m^{-3}$ and maximum daily values were available. In Figures VI.1 and VI.2 the calculated values are plotted against the measured values. Especially in the lower concentration/exceedance area (98 percentile 66-300 $\mu g\ m^{-3}$, days above 125 $\mu g\ m^{-3}$ less than 20) a good linear regression estimate was found (Y = 0.97 + 0.96X), with correlation coefficients of 0.95 and 0.87. Over the whole concentration area (98 percentile 66-500 $\mu g\ m^{-3}$, days above 125 $\mu g\ m^{-3}$ up to 60) the linear regression estimates were Y = 2 + 0.74X, Y = -5 + 1.08X with correlation coefficients of 0.93 and 0.94, respectively. For the FSU cities, with 98 percentile concentrations ranging from 12 to 160, the above-mentioned approach seems to be feasible.

The calculated maximum daily values and exceedances of 125 $\mu g\ m^{-3}$ for the FSU cities are listed in Table VI.1 (for average city background stations and the highest city background station).

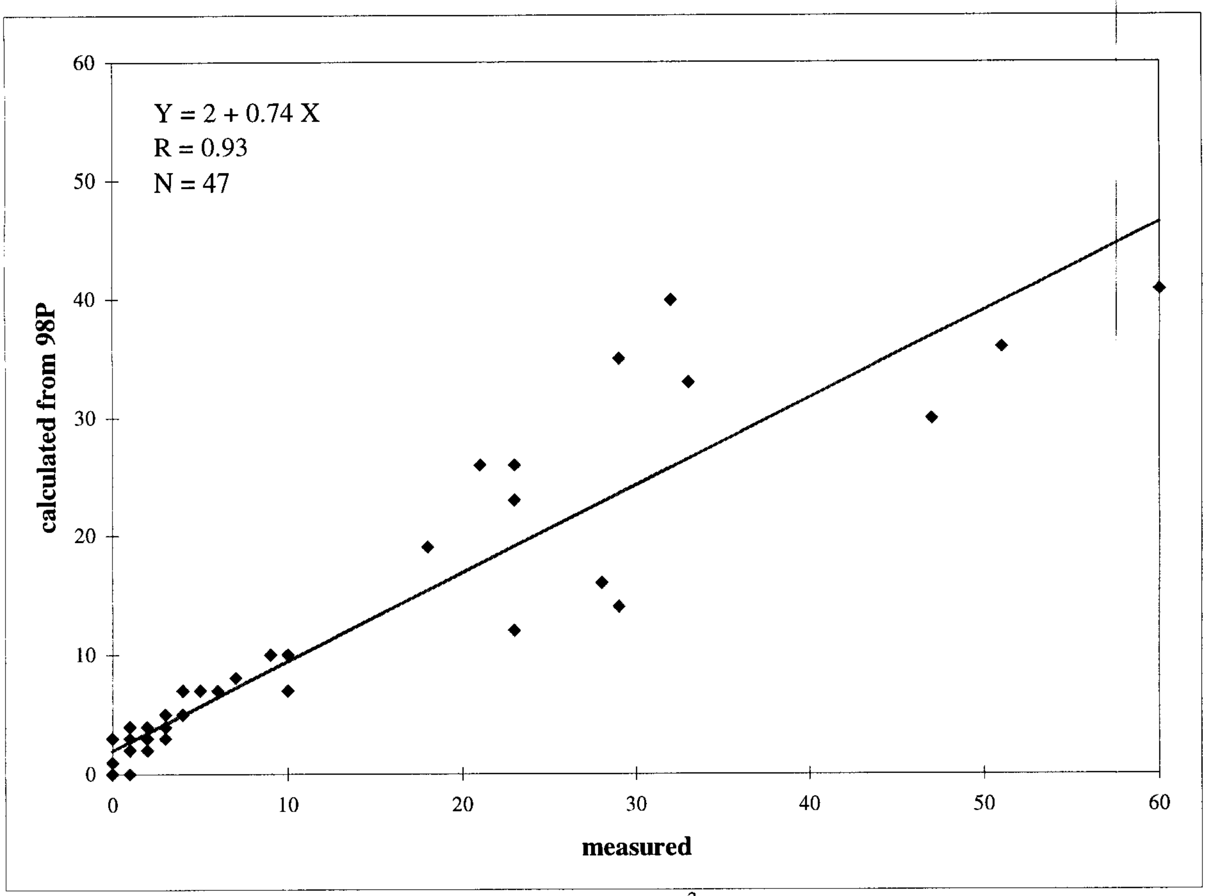


Figure VI.1: Number of days with $SO_2 > 125\ \mu g/m^3$; measured against calculated.

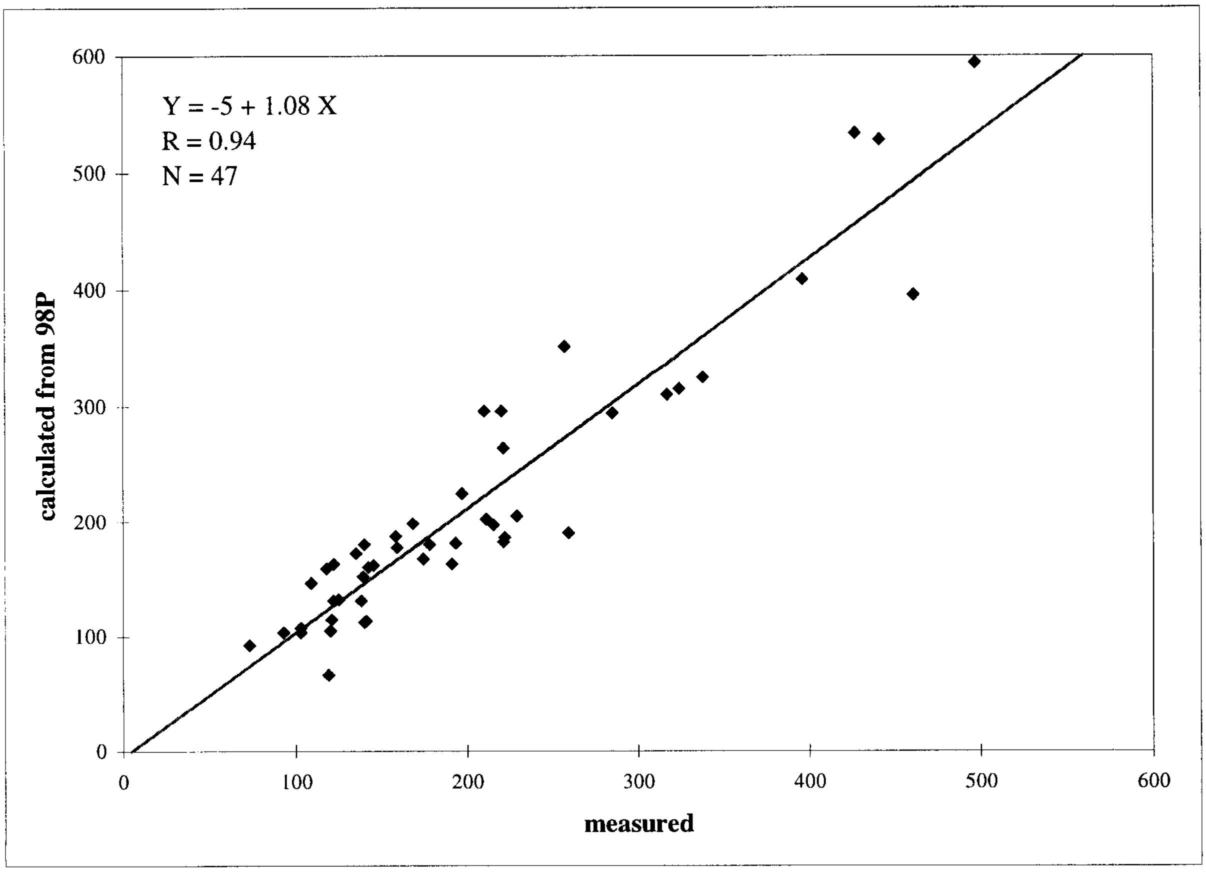


Figure VI.2: Daily maximum SO_2; measured against calculated.

Table VI.1: Calculated maximum daily values and WHO exceedances for cities in the FSU (WHO - Air Quality Guideline SO_2: 125 µg m^{-3})

FSU City	annual average		98P (20 min)		max(24h) calculated		days exceeded calculated	
	average station	max station	average station	max station	average station	max station	average station	max station
Donetsk	28	32	118	160	230	330	6	13
Dnepropetrovsk	9	14	37	50	70	89	0	0
Krivoy Rog	28	29	130	140	260	290	8	10
Kharkov	7	8	30	35	58	68	0	0
Kiev	13	16	70	90	150	200	2	4
Lvov	45		70		85		0	
Mariupol	21	22	50	50	74	72	0	0
Minsk	20	20	75	50	140	76	2	0
Nizhny Novgorod	3	4	17	22	37	48	0	0
Odessa	44	48	98	105	140	150	2	3
Perm	14	18	70	90	150	190	2	3
Rostov at the Don	6	11	34	70	74	160	0	2
St. Petersburg	5	7	28	44	61	100	0	0
Tula	2		12		27		0	
Ufa	15	20	80	100	170	210	3	4
Volgograd	12	25	70	130	160	270	2	8
Voronezh	5	6	23	28	46	56	0	0
Yaroslavl	2		14		34		0	
Zaporozhe	22	24	80	80	140	140	2	2

References:

Curran, T.C; B.A. Beard, E.Yu.Bezuglaya (1991); Application of the USSR Sampling Methodology to US Air Quality Data. Measurement of Toxic and Related Air Pollutants. Vol.1 Air and Waste Management Association. Pittsburgh, Pennsylvania.

ANNEX VII: Population exposure estimates

The term 'population exposure' is here defined as follows:

> The number (or fraction) of inhabitants experiencing concentrations of air pollution compounds within given concentration ranges.

The cumulative population exposure distribution gives the percentage of the total population exposed to concentrations above given values.

The second questionnaire to the cities included a section on the exposure of the population to air pollution concentrations above air quality guidelines. No cities provided such information.

People are exposed to air pollutants at home, during commuting on roads, at work and other places. The correct mapping of pollution exposure requires data on:

- Spatial concentration distribution, and its variation with time
  - city background
  - along main road network
  - near other hot spots, such as near industrial areas.
- Population distribution (residences and workplace), and the number of commuters, and time-dependent travel habits.

The data bases for population exposure calculations are often not complete. A methodology has to be developed for each specific study, dependent upon its scope.

It was decided in this study to put the main emphasis on residential population exposure. The basis for estimating this was measurement data from city background measurement sites. For quite a few cities, measurements from 'hot spot' sites (traffic-exposed sites, industrial area sites) were also available. However, such sites do not as a rule provide a representative picture of the 'hot spot' concentration levels in the city, and it would not be possible within the scope of this study to estimate the fraction of the population exposed to 'hot spot' concentrations.

Regarding the residential population exposure, a rough estimation method had to be developed, bearing in mind that an estimate had to be made for each of the 88 cities for which concentration data were available. There were no data on the spatial distribution of the population in the cities, and only sparse information on the actual location of the city background measurement sites.

The method which was developed to estimate the fraction of the population in a city exposed to concentrations above air quality guidelines was based on these assumptions:

- The city background sites are located in the part of the city with the generally poorest air quality for the compound in question.
- The higher the maximum concentrations are above the guidelines, the larger the fraction of the population above the guideline.
- The larger the number of measurement sites, the better the exposure situation can be described.

The rough method which was developed is illustrated in Figure VII.1 with some examples. The example figure concerns exposure above the 24h air quality guideline of SO_2.

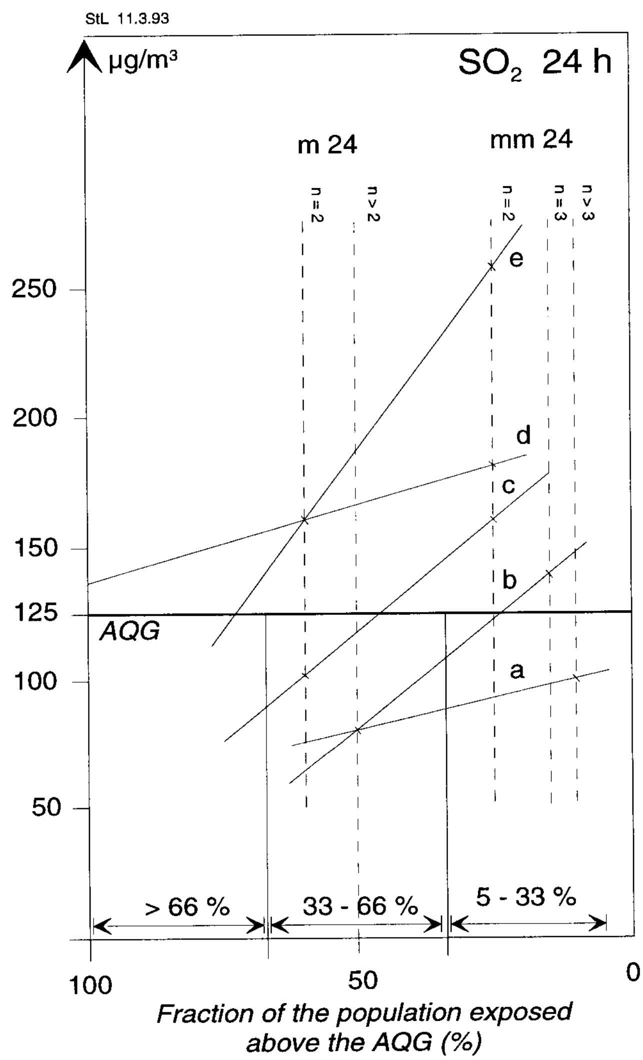


Figure VII.1: Visualisation of the method to estimate the fraction of the population exposed to air pollution concentrations above the air quality guideline (AQG). Example: 24h SO_2 concentrations. The example calculations included in the figure are described in Table VII.2.

Explanation of Figure VII.1:

m24 : Maximum 24h concentration, averaged over all city background stations.
mm24 : The maximum 24h concentration measured at any of the city background stations.
n : Number of city background stations.

The m24 and mm24 values are plotted on the vertical lines, according to the number of stations (n). Where the line drawn between the points crosses the horizontal line for the AQG, the estimated fraction of the population exposed above the AQG can be read from the x-axis.

Considering the limited accuracy of the method, the exposed fraction is then classified within the classes 0-5%, 5-33%, 33-66%, >66%. Finally, to calculate the number of people exposed, the estimated fraction ranges were translated to class values (Table VII.1).

Table VII.1: Exposure class values

Estimated exposed fraction range	Class value	
0 - 5 %	0 %	if hot-spot < AQG
0 - 5 %	5 %	if hot-spot > AQG
5 - 33 %	25 %	
33 - 66 %	50 %	
> 66 %	75 %	

When n=1, the fraction is estimated based on the mm24 at the one station, relative to the AQG.

The position of the vertical lines on the horizontal axis is determined based on the following considerations:

- For 3 or more stations (n>2), if m24=AQG, it is considered that 50% of the population is potentially exposed to the exceedance of the AQG, irrespectively of the value of mm24.
- For n=2, and m24=AQG, it is considered that more than 50% is potentially exposed to the exceedance of the AQG. The value of 60% has been chosen.
- For two stations (n=2), if mm24=AQG, it is considered that 25% of the population is potentially exposed to the exceedance of the AQG, irrespectively of the value of m24.
- For n>2 and mm24=AQG, it is considered that less than 25% of the population is potentially exposed to the exceedance of the AQG. 15% and 10% have been chosen for n=3 and n>3, respectively.

This is a rough method suited to the limited amount of monitoring data available; it may, however, provide a first level of comparison between cities. The method should be tested for cities with extensive monitoring and modelling data, where exposure estimates have been made by more accurate methods.

Table VII.2: Description of the examples

Line a	n = 4 m24 = 80 µg/cm3 mm24 = 100 µg/cm3	All stations are below the AQG. Exposed fractions = 0% → 0-5% → 0%.
Line b	n = 3 m24 = 80 µg/cm3 mm24 = 140 µg/cm3	The average m24 is well below the AQG, but the highest station is above AQG. Estimated exposed fraction: 23% → 5-33% → 25%.
Line c	n = 2 m24 = 100 µg/cm3 mm24 = 160 µg/cm3	The average m24 is below the AQG, while the highest of the two stations is well above the AQG. Estimated exposed fraction: 45% → 33-66% → 50%.
Line d	n = 2 m24 = 160 µg/cm3 mm24 = 180 µg/cm3	The average m24 is well above the AQG, and the two stations are fairly equal in concentration level. This indicates a rather flat spatial concentration distribution. Estimated exposed fraction: 100% → ≥66% → 75%.
Line e	n = 2 m24 = 160 µg/cm3 mm24 = 260 µg/cm3	The average m24 is well above the AQG, and the highest of the two stations is more than double the AQG. This indicates a steep gradient in the spatial concentration distribution. Estimated exposed fraction: 70% → ≥66% → 75%.

CITY REPORT FORMS

DISCLAIMER:

While every effort was made to check and double-check data and other information from the individual cities (see Section 3), background details in text form, concerning e.g. developments, measures, etc., remain largely in the form submitted by our city respondents.

City: Amsterdam	*Country*: Netherlands

I. GENERAL DATA

	City	Conurbation
Population (number)	702 000 (1992)	***1 077 000***
Total area (km^2)	162 (1992)	***583***
Built-up area (km^2)		
Coordinates (lat-/longitude)	52° 21' N 4°52' E	

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and administrative centre. Major industrial activities are concentrated in and around the harbours, west of the centre, and the airport in the southwest (yearly 191 500 LTO-cycli). Most activities consist of storage and dispatch. Petrochemical and chemical industries are present in the harbour area, in the north food industry.

The number of inhabitants in Amsterdam decreased slightly from 716 919 in 1980 to 694 680 in 1990. The number in the agglomeration increased by about 10% between 1980 and 1990. A stabilisation of the number in Amsterdam and a slight growth in the agglomeration is expected up to the year 2000.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: western Europe, western part of the Netherlands.
Topography: plain (coastal). (+)

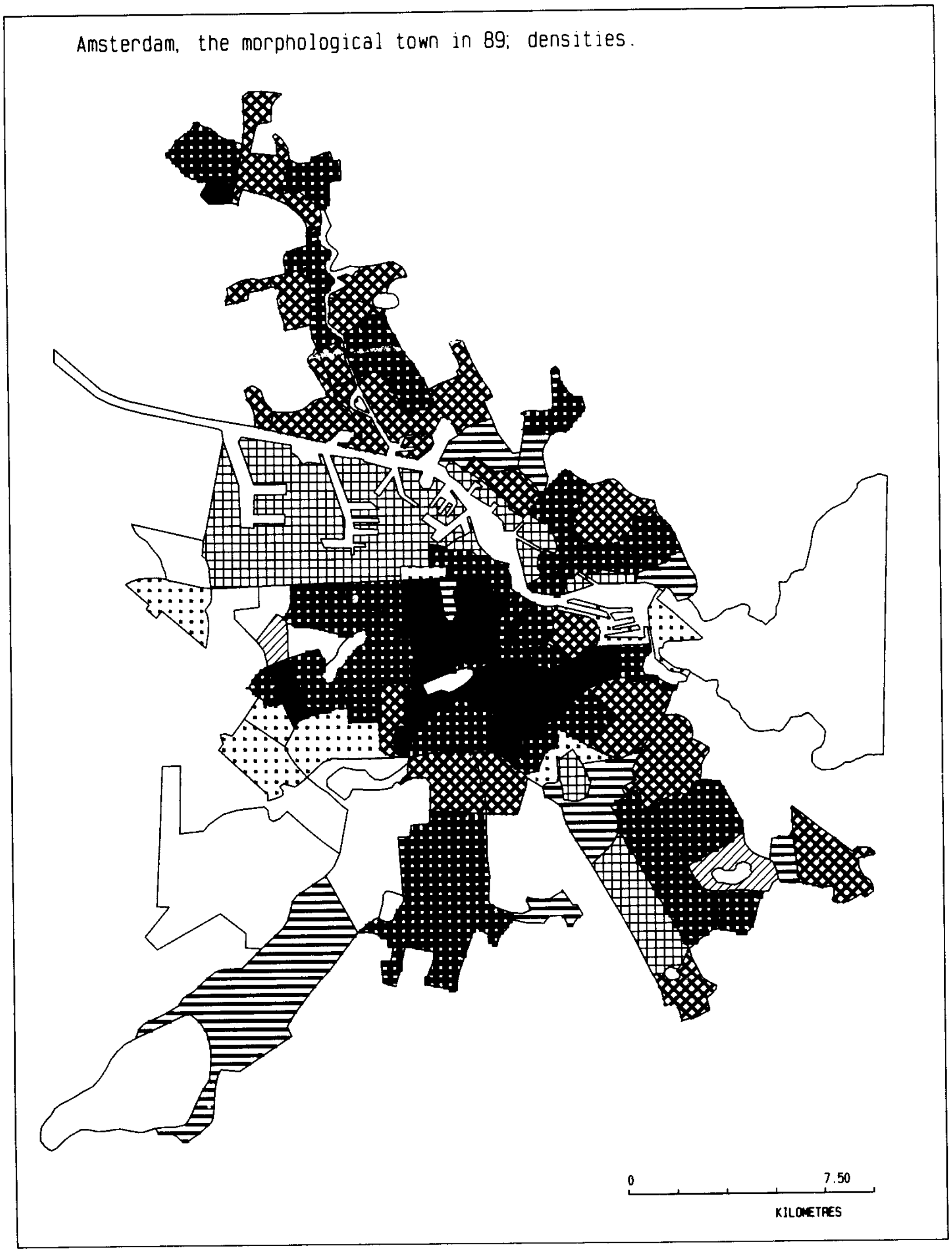
Climate: moderate coastal climate with precipitation during all seasons (Cfb).
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.5	8.4	10.8
precipitation (mm)	625	769	673
wind speed ($m\ s^{-1}$)	***4.8 (+)***	***4.8 (+)***	***4.8 (+)***
winter smog index	***7.2 (+)***	***8.0 (+)***	***6.0 (+)***
summer smog index	***4.3 (+)***	***2.4 (+)***	***4.9 (+)***

Station: 6240 52° 18' N 4° 46' E

Main topography, city morphology, industrial sources and monitoring network

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1986 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic		15.9	36	8		
Domestic/space heating						
Industry and power plants						
Total		15.9	36	8		
Per capita (**kg**)		14.8	33.4	7.4		
Per km^2 (**t**)		27.3	61.7	13.7		

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic		9	24	4		
Domestic/space heating						
Industry and power plants						
Total		9	24	4		
Per capita (**kg**)		8.4	22.3	3.7		
Per km^2 (**t**)		15.4	41.2	6.9		

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***3***

Major (industrial) point sources

No major industries.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity x 10^9 veh km a^{-1}
Total		
of which:		
· passenger cars	225 000	
· buses		
· freight traffic >3.5 t	27 000	

Traffic

Public transport primary by tramway and underground (584 x 10^6 km a^{-1}) in comparison with buses (251 x 10^6 km a^{-1}).

VI. AIR QUALITY DATA

Monitoring network

The municipal monitoring network (OMEGAM) includes 15 stations (1992). The national monitoring network includes 2 stations in the city and 1 station in the regional background.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations		1		8		No. 10		No. 12		
Annual average		9 *(9)*		9		8		18		
Winter average		11								
Maximum (24 h)		36		43		63		84		
98 percentile (24 h)		24		29		35		47		
Number of days exceeding the WHO-AQG		0		0		0		0		
Number of days exceeding 2 x WHO-AQG		0		0		0		0		

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: TSP $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			3	5		AN				
Annual average		*21*	62	36.7		48.4				
Winter average										
Maximum (24 h)			203	102.5		129.2				
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				0						
Number of days exceeding 2 x WHO-AQG			0	0		0				

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Winter smog classification	1990
Exceedance class	***0.5***
Exposure class	***2***

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations		1	1	4	No. 520	No. 520		No. 12		
Annual average		30	48	51	48	51		80		
Maximum (24 h)		82	105	68	105	122		124		
Maximum (1 h)		93	172		172	225				
Number of days exceeding the WHO-AQG		0	0	0	0	0		0		
Number of days exceeding 2 x WHO-AQG		0	0	0	0	0		0		

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations		1		3		No. 520		No. 8		
Annual average		45		29		37		22		
Summer average		60				51				
Maximum (1 h)		274				243				
Maximum (8 h)										
98 percentile (1 h)		136				128				
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG		0				0				
Exceedance class				2						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		No. 8
Annual average		1.35
Maximum (8 h)		8.42
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	AN	AN
Annual average	0.3	0.10
Maximum monthly average		0.45
Number of days exceeding the WHO-AQG	1	3
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data

City: Antwerp	*Country*: Belgium

I. GENERAL DATA

		City		Conurbation
Population	(number)	468 000 (1992)		***785 000***
Total area	(km^2)			370 (1992)
Built-up area	(km^2)			***299 (1992)***
Coordinates	(lat-/longitude)	51° 13' N 4° 25' E		

Major activities and development trends (1980-1990, 1990-2000)
Important harbour and industrial centre. Refineries, (petro)chemical industry.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: West Europe
Topography: plain *(+)*

Climate: Cfb (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	10.1	9.0	11.2
precipitation (mm)	692	759	651
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.5 (0)***	***3.3 (0)***	***3.0 (-)***
winter smog index	***8 (+)***	***11 (0)***	***7 (+)***
summer smog index	***9 (0)***	***5 (+)***	***18 (0)***

Station: Antwerpen Deurne 51° 12' N 4° 28' E

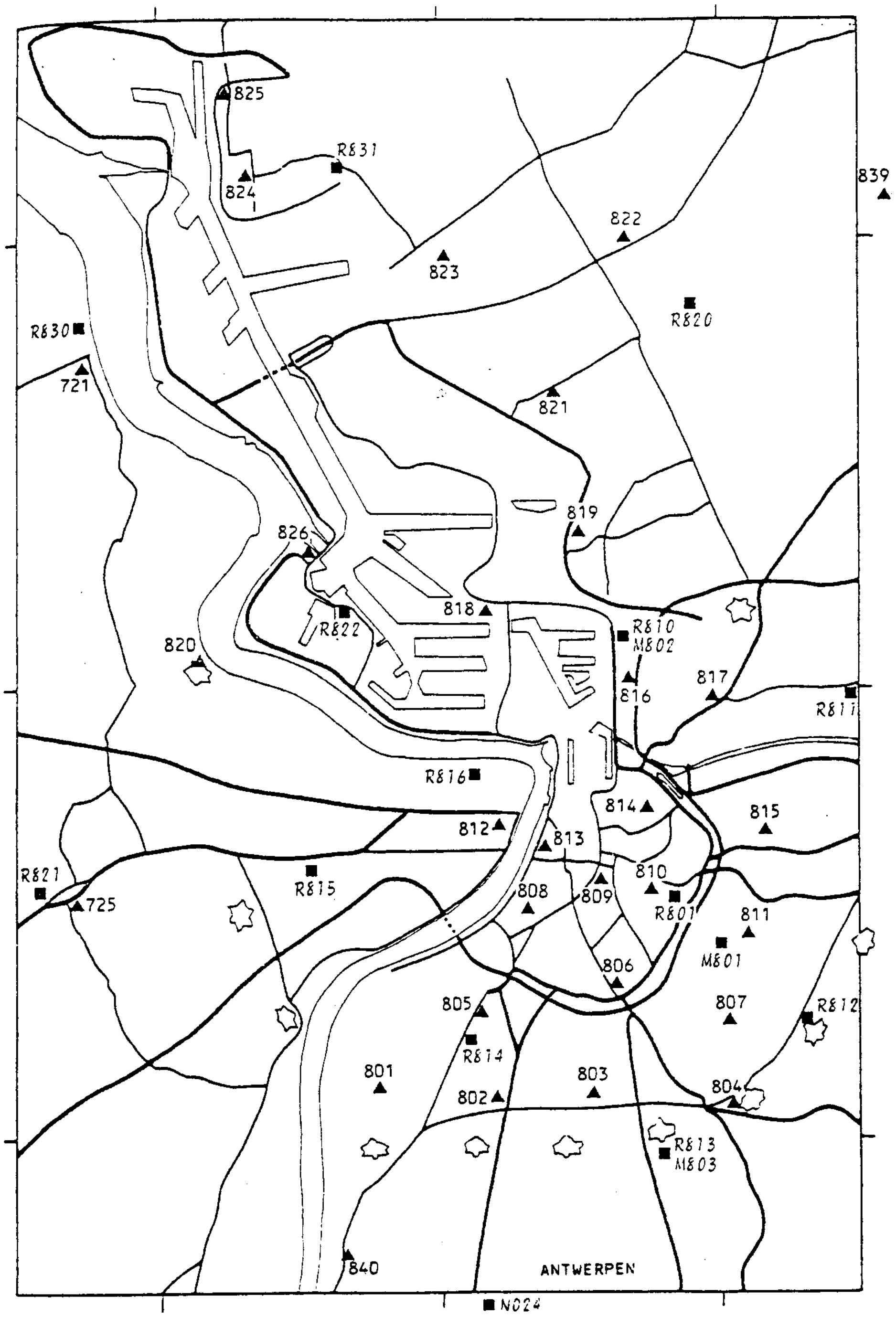
III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***3***
Summer smog emissions[1]	***3***

Local policies to reduce air pollution

Industry: Clean-up programme for harbour is underway: emission inventory, evaluation of emissions, technological measurements to reduce emissions (goals reach EC limit values).

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA

Monitoring network

The Belgian institute for Hygiene and Epidemiology operates a semi-automatic (24h samples) `sulphur-smoke' network, a automatic network for continuous monitoring and a network to monitor heavy metal concentrations.

SO_2 concentrations[2] acidimetric µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			2	2	R813	R813	R809	R809	R826	R826
Annual average			61	47	72	43	77	45	115	76
Winter average			72	50	78	52	87	53	141	92
Maximum (24 h)			338	138	324	145	332	149	629	482
98 percentile (24 h)			193	95	199	107	224	121	369	284
Number of days exceeding the WHO-AQG			23	2	33	2	40	5	98	51
Number of days exceeding 2 x WHO-AQG			3	0	3	0	4	0	27	10

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

SO_2 concentrations[3] fluorescence/photometric µg m^{-3}	Observed concentrations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	89/90	1985	89/90	1985	89/90	1985	89/90	1985	89/90
Number of stations		N014		3		R801		R814		R822
Annual average		17 *(15)*		25		25		38		61
Winter average		18		29		29		52		61
Maximum (24 h)		169		196		276		317		334
98 percentile (24 h)		104		93		112		142		203
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG		0		0		.		.		.

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

Concentrations show a marked downward trend. The WHO-AQG however is still exceeded on a few days per year, on some locations even by a factor two.

Particulate matter[2]: Black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			2	2	R813	R813	R809	R809	R826	R826
Annual average			18.5	16.5	17	18	36	33	16	15
Winter average			25.5	21.5	26	25	42	39	13	19
Maximum (24 h)			107.5	87	94	87	133	117	126	79
98 percentile (24 h)			64.5	52	63	62	85	92	64	45
Number of days exceeding the WHO-AQG			0	0	0	0	1	0	1	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Suspended particulate concentrations[3]			
TSP (nepho, tropical year 1989/90)			
station	**annual average**	**p 98**	**max**
R801 (centre)	74	207	233
R832 (traffic)	76	229	322
Regional background	27		

Black smoke concentrations showed a downward trend, there is a small chance that the WHO-AQG is exceeded. TSP concentrations are higher, the WHO-AQG is likely to be exceeded, even by a factor 2.

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989/90
Exceedance class	*1*
Exposure class[1]	*3*

NO_2 concentrations[3] µg m^{-3}	Mean of stations				(Highest) observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	19__	1985	19__	1985	1990	1985	19__
Number of stations							Rijks	Rijks		
Annual average							64	54		
Maximum (24 h)							156	136		
Maximum (1 h)							294	264		
Number of days exceeding the WHO-AQG							2	0		
Number of days exceeding 2 x WHO-AQG							0	0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations[3]

Concentrations do not show a clear trend over a longer period. The WHO-AQG can be exceeded on a few days per year.

Ozone concentrations[3]

Observed concentrations (based on 1/2 hourly values) at station R831 (industrial, harbour).
1990:
annual average **31**, summer average **49**, maximum 1/2 h. value **197**, 98 p. (1/2 h.) **133** µg m^{-3}.
Number of hours above 150 µg m^{-3}: 71.

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Lead concentrations[4]

Annual average concentration at a traffic site (Hospital):
1985: 0.97 µg m^{-3}
1990: 0.263 µg m^{-3}

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data.

2. Zwavel-rook meetnet. IHE, Brussels: annual reports.

3. Automatisch meetnet voor de luchtverontreiniging. IHE, Brussels: annual reports.

4. Evaluation de la teneur en meteaux lourd dans l'air en Belgique. IHE, Brussels: annual reports.

City: Athens | **Country:** Greece

I. GENERAL DATA

		City	Conurbation
Population	(number)	886 000 (1991)	***3 021 000 (1991)***
Total area	(km²)	427 (1991)	427 (1991)
Built-up area	(km²)	***350 (1991)***	350 (1991)
Co-ordinates	(lat-/longitude)	38° 00' N 23° 44' E	

Major activities and development trends (1980-1990, 1990-2000)
Business and administration activities, tourism (monuments), harbour and airport, light industries.

The greater Athens area consists of 36 communities.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: South eastern Europe. Attic peninsula, central Greece.
Topography: In a basin surrounded by mountains (500-1100 m) and the sea to the south *(-)*.

Climate: Adverse dispersion conditions. (Csa).
Meteorology: Sea-land breezes and mountains prevent dispersion.

Averages	1980-1989	1985	1989
temperature (°C)	17.6	17.9	17.9
precipitation (mm)	431.1	375.3	184.2
cloud cover (8^{-1})			
wind speed (m s⁻¹)	***3.4 (0)***	***3.4 (0)***	***3.8 (0)***
winter smog index	***2.0 (++)***	***1.6 (++)***	***1.0 (++)***
summer smog index	***67.9 (-)***	***69.4 (-)***	***52.0 (-)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	10.5	11.3	5.6	2.8	0.85	1.7	8.9
1985	Wind speed m s⁻¹	2.65	4.28	3.90	2.47	1.60	2.10	3.27
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	8.3	1.3	3.5	2.1	1.2	1.8	
	Wind speed m s⁻¹	3.50	2.90	2.84	3.14	2.61		

LOCAL WIND DISTRIBUTION (WIND ROSE)

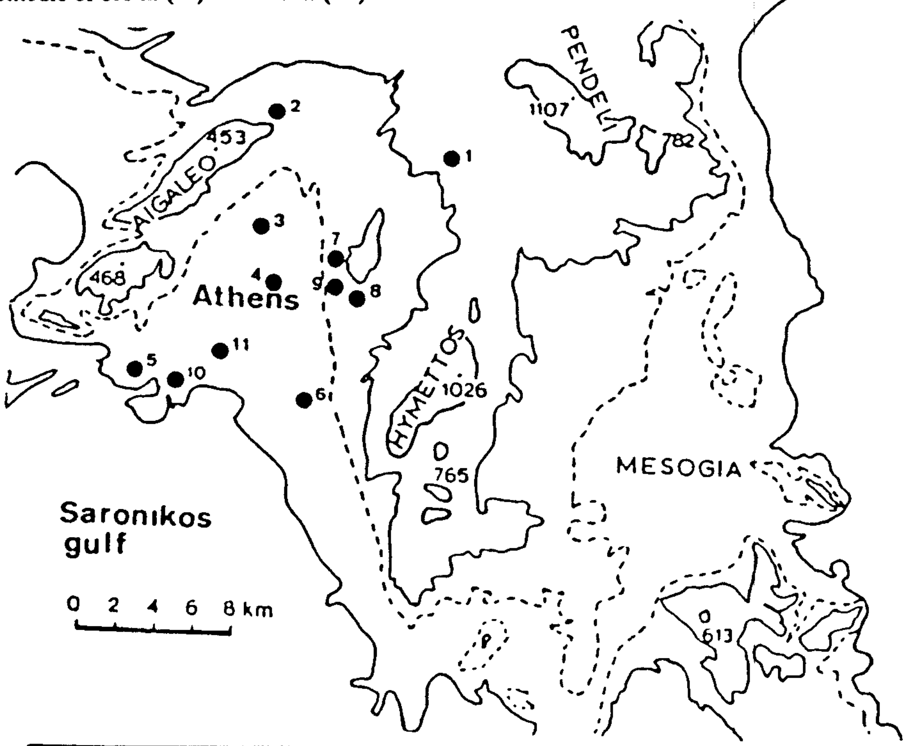
Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	4.8	10.0	7.2	4.9	3.5	0.65	11.7
1990	Wind speed m s⁻¹	1.95	4.23	2.73	1.90	1.73	1.91	2.15
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	11.3	1.8	3.0	1.9	1.6	2.1	
	Wind speed m s⁻¹	2.30	2.81	2.08	1.77	1.37		

City: Athens **Country**: Greece

Main topography, city morphology, industrial sources and monitoring network

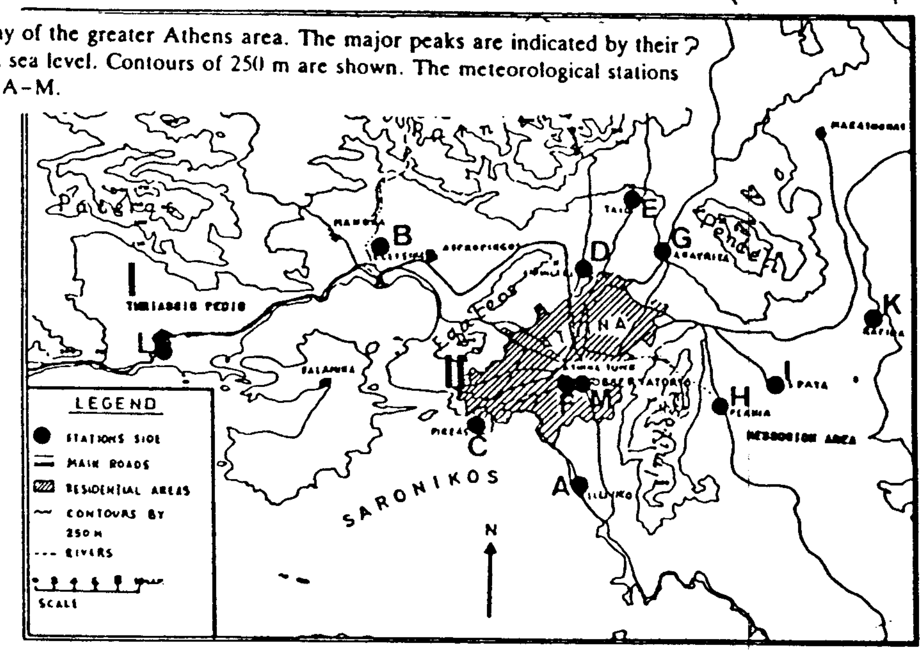
The topography of Athens basin, showing the locations of air pollution monitoring sites, labeled 1 to 11. Contours of 100 m (—) and 200 m (—) are also shown.

N



Code number	Name of the site
1	Marousi
2	Liosia
3	Peristeri
4	Geoponiki
5	Drapetsona
6	Smirni
7	Patission
8	Athinas
9	Ministry
10	Pireous
11	Rentis

The topography of the greater Athens area. The major peaks are indicated by their altitude (m) above mean sea level. Contours of 250 m are shown. The meteorological stations are shown by the letters A–M.



Code letter	Name of the site
A	Ellinlko
B	Elefsis
C	Pireous
D	Filadelfia
E	Tatoi
F	Athens town
G	Anavrita
H	Peania
I	Spata
K	Rafina
L	Magoula
M	Observatory

City: Athens **Country:** Greece

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	1.4	18.5	379	54.7	3.7	
Domestic/space heating	3.7	1.4	0.4	0.2	0.9	
Industry and power plants	12.7	7.2	0.4	21.7	22.0	
Total	17.8	27.1	379.8	76.6	26.6	
Per capita (**kg**)	5.9	8.9	125.7	25.4	8.8	
Per km^2 (**t**)	50.9	77.4	1085.1	218.9	76.0	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	1.4	27.8	538.1	81.1	3.3	
Domestic/space heating	3.7	1.4	0.4	0.2	0.9	
Industry and power plants	12.7	7.0	0.5	21.8	22.2	
Total	17.8	36.2	539.0	103.1	26.4	
Per capita (**kg**)	5.9	12.0	178.4	34.1	8.7	
Per km^2 (**t**)	50.9	103.4	1540.0	294.6	75.4	

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions	***4***

Major (industrial) point sources

(see city map)

The main industrial activities in the area are concentrated in two zones.

1. Thriassio (I on the map). The main industrial installations are oil refineries, metallurgical works and cement plants. The total heavy oil consumption for these industries in 1985 was about 376 000 t, which represents about 52% of the total fuel used in Athens by industry.
2. Drapensona (II on the map). The main industrial installation is a fertiliser plant.

Some industrial activities mainly had processing plants, secondary metallurgical works are scattered throughout the city, mainly in the zone between Athens and Piraeus (see map).

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total of which:	931 000	
· passenger cars	760 000	6 840 x 10^6
· buses	2 000	150 x 10^6
· freight traffic >3.5 t	20 000	480 x 10^6

Total annual consumption of fuel for traffic

	Consumption (t a^{-1}) 1985	Consumption (t a^{-1}) 1991	Average Sulphur content (%) 1985	Average Sulphur content (%) 1991
Diesel oil	983 000	1 347 000	0.3	0.3
Petrol/Gasoline	659 000	892 000	0.1	0.1
LPG				

Traffic

- 20-25% of cars equipped with catalytic converters by end of 1991
- Main problems:
  - narrow streets
  - lack of parking facilities
  - insufficient public transport

City: Athens **Country:** Greece

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption 1985	Annual consumption 1991	Average Sulphur content (t) 1985	Average Sulphur content (t) 1991
Fuel oil low sulphur	($t\ a^{-1}$)	983 000	1 570 000	0,7	0,7
Fuel oil high sulphur	($t\ a^{-1}$)	461 000	223 000	3,5	3,5
Coal	($t\ a^{-1}$)				
Wood	($t\ a^{-1}$)				
Natural/city gas	($10^6\ m^3\ a^{-1}$)				
Total	($t\ a^{-1}$)				

Space/domestic heating: general remarks

District heating systems in Athens use mostly diesel oil, heating period from about 15 November to 15 April.

Local policies to reduce air pollution

Industry:
- Establishment of industrial estates, use of environmental impact assessment and promotion of new clean technologies and recycling.
- Inspection of industrial emissions.
- Installation of emission control filters in power plants.

Traffic:

Incentives were offered for the replacement of old cars by new ones equipped with catalytic converters (this programme was ended December 1992).
- Introduction of the emission control card for private cars
- Technical Control Centres were established for checking the emissions of passenger cars and taxis. This service will be expanded to cover trucks.
- Gradual renewal of the urban buses.
- Promotion of public transport
- Extension of the underground.

Domestic/space heating:

Central heating
- Improvement of fuel quality.
- Inspection of boilers.

VI. AIR QUALITY DATA

Monitoring network

The Network is part of an alert system in combination with the weather forecasting by Meteorological Service. Each day a special bulletin is issued containing information about the air quality of that day and a forecast for the next day.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1991	1985	1991	1985	1991	1985	1991	1985	19__
Number of stations	1	1	1	1	1	1	1	1		
Annual average	12	27(*6*)	20	36	20	36	48	67		
Winter average	19	30	10	18	10	18	60	91		
Maximum (24 h)	61	100	43	264	43	264	172	359		
98 percentile (24 h)	40	67	34	147	34	147	118	187		
Number of days exceeding the WHO-AQG	0	0	0	7	0	7	6	33		
Number of days exceeding 2 x WHO-AQG	0	0	0	1	0	1	0	2		

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

City: Athens **Country:** Greece

Particulate matter: TSP µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	19__	1985	19__	1985	1991	1985	1991
Number of stations							1	1	1	1
Annual average		*9*					173	150	181	154
Winter average							193	157	200	158
Maximum (24 h)							367	338	388	587
98 percentile (24 h)							325	330	319	321
Number of days exceeding the WHO-AQG							57	28	51	18
Number of days exceeding 2 x WHO-AQG							7	4	13	3

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1991
Exceedance class	*2*
Exposure class[1]	*3*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1991	1985	1991	1985	1991	1985	1993	1985	19__
Number of stations	1	1	1	1	1	1	1	1		
Annual average	14	36	20	38	20	38	113	110		
Maximum (24 h)	89	102	88	96	88	96	294	-		
Maximum (1 h)	192	302	222	264	222	264	508	696		
Number of days exceeding the WHO-AQG	0	0	0	0	0	0	43	-		
Number of days exceeding 2 x WHO-AQG	0	0	0	0	0	0	0	-		

WHO-AQG (24h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name	7	7
Annual average	7.7	6.8
Maximum (8 h)	25.0	35.0
Number of days exceeding the WHO-AQG	189	163
Number of days exceeding 2 x WHO-AQG	10	16

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		9
Annual average		0.45
Maximum monthly average		0.65
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data

City: Barcelona	*Country*: Spain

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 687 000 (1991)	***3 097 000***
Total area	(km^2)	91	***457***
Built-up area	(km^2)		
Co-ordinates	(lat-/longitude)	41° 25' N 2° 10' E	

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and administrative centre. Port activities consist of traffic, storage and dispatch; some industrial activities.

Constituent communities:
Barcelona, Hospitalet, Sant Adrià, Badalona, El Prat, Cornella, Esplugues, Santa Colona de Gramanet, Sant Cugat, Sant Just Disvern, Montcada, Cerdamijola.

The population decreased slightly from 1980 to 1990.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: North-eastern Spain on the Mediterranean coast.
Topography: Between two rivers, a coastline of 4 nautical miles, mountains on the landward side. *(0)*

Climate: Moderate coastal (Csa).
Meteorology: No prevailing wind direction.

Averages	1980-1989	1985	1989
temperature (°C)	15.1	14.9	16.2
precipitation (mm)	597.5	733	539.8
cloud cover (8^{-1})			
wind speed (m s^{-1})	***2.9 (-)***	***2.5 (-)***	***3.2 (0)***
winter smog index[1]	***3.9 (++)***	***4.8 (+)***	***1.0 (++)***
summer smog index	***40.9 (-)***	***49.6 (-)***	***43.6 (-)***

III. EMISSIONS

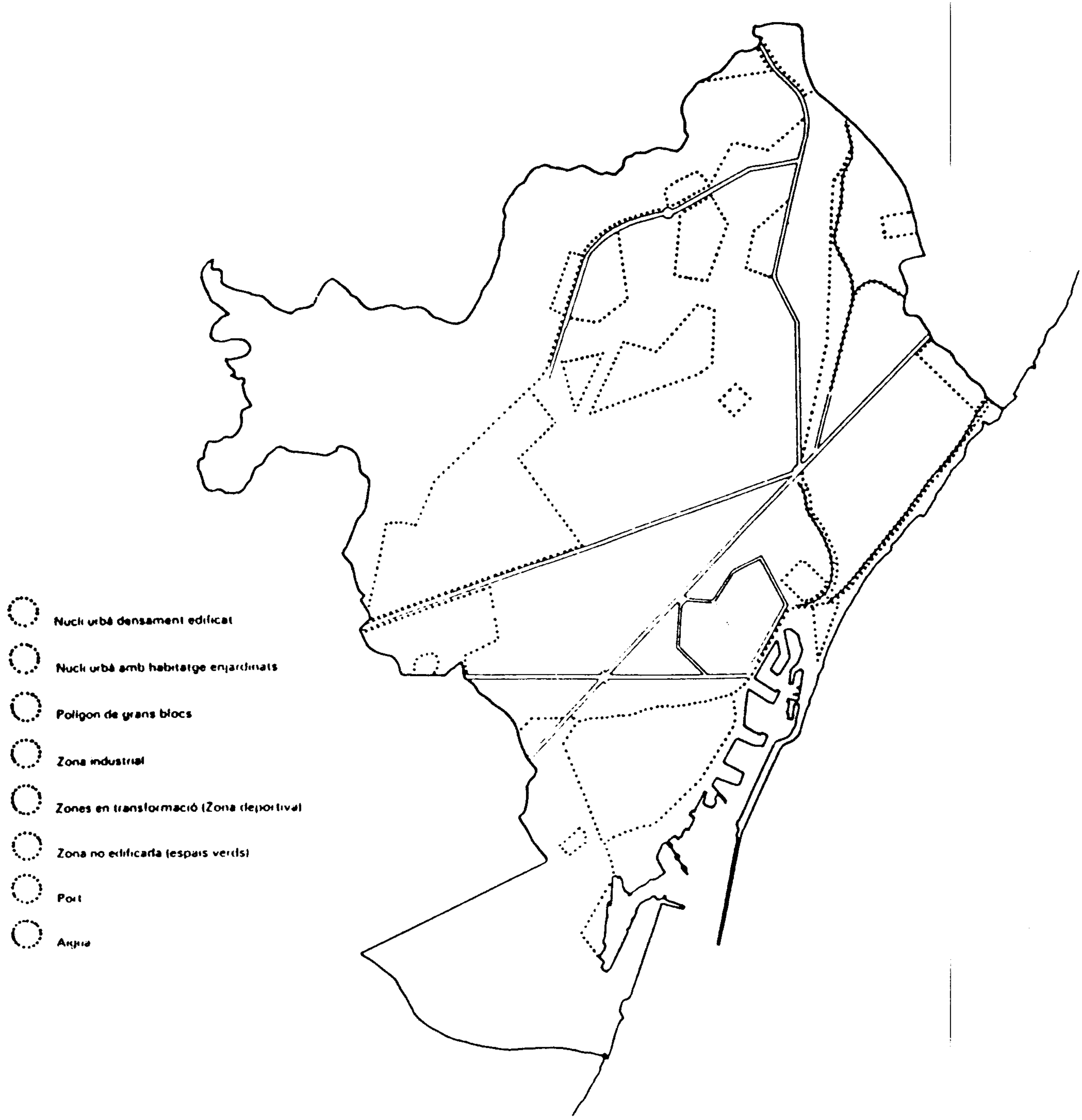
Annual emissions per source and totals in 1985 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.5	3.8	102.4			
Domestic/space heating						
Industry and power plants						
Total	2.7	4.5	102.6			
Per capita (**kg**)	0.9	1.5	33.1			
Per km^2 (**t**)	5.9	9.8	224.5			

Major (industrial) point sources
(see city map)
Municipal incinerator, which burns approximately 1 000 t of garbage daily, has a chimney with a height of 98 m, and an electronic filter system. Two thermal power stations of 1 050 and 300 megawatts burning fuel oil and natural gas, with 3 chimneys of 200 m and two of 82 m; these stations are situated in the municipality of San Adrian del Besós, near Barcelona

City: Barcelona **Country**: Spain

Main topography, city morphology, industrial sources and monitoring network



City: Barcelona **Country**: Spain

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles	Total traffic activity veh km a^{-1}
Total of which: · passenger cars · buses · freight traffic >3.5 t	 950 870	3.4×10^9

Traffic

Public transport:
- Non-electric: Buses, diesel trains
- Electric: Trams, metro, trolleys

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

The commonly used fuels for heating are natural gas and LPG.

Local policies to reduce air pollution

Industry:
In some zones there is no spatial separation of industry and residences.
All new industrial activity seeking a permit to set up in Barcelona is required to present an environmental impact report.
Already-established industrial activities are inspected periodically.

Traffic:
Control of emissions from the cars in the city by the environmental control service.

Domestic/space heating:
With general and specific programmes, the goal was set for inspection of all heating systems which must carry a certificate of yearly inspection.

City: Barcelona **Country**: Spain

VI. AIR QUALITY DATA

Monitoring network

8 manual stations: SO_2 (Thorin); particles (Reflectrometry)
3 automatic stations: particles, SO_2, NO_x, CO, O_3, HC
2 TSP (particles, Pb, Cd, Hg, V)
1 Pollen, spores.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	1991	1985	1991
Number of stations				3				2	3	1
Annual average		*3*		12		13		14		
Winter average										
Maximum (24 h)										
98 percentile (24 h)				19		24		24		
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: TSP $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	1991	1985	1991
Number of stations								2		
Annual average		*9*				117		138		
Winter average										
Maximum (24 h)										
98 percentile (24 h)						300		290		
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Winter smog classification	1991
Exceedance class [1]	*1*
Exposure class [1]	*3*

City: Barcelona **Country:** Spain

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1991	1985	1991	1985	1991	1985	1991
Number of stations				1		1		1		1
Annual average				43		43		65		
Maximum (24 h)				106		106		145		
Maximum (1 h)				200		200		373		
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		1
Annual average		2.5
Maximum (8 h)		13.2
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		2
Annual average		0.44
Maximum monthly average		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g.^{-3}$

1. Uncertain data

City: Belfast	***Country***: United Kingdom

I. GENERAL DATA

		City	Conurbation
Population	(number)	***295 000***	392 000
Total area	(km^2)	***106***	
Built-up area	(km^2)		
Co-ordinates	(lat-/longitude)	54 ° 40 ' N 5 ° 50 ' W	

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and administrative centre. Ship building and aircraft manufacture. Decline in population.

Municipalities in conurbation:
Belfast City Council, Castlereagh Borough Council, Lisburn Borough Council.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Mid east coast of northern Ireland.
Topography: Belfast lies in an enclosed basin; hills on the west act as a barrier to dispersion *(++)*.

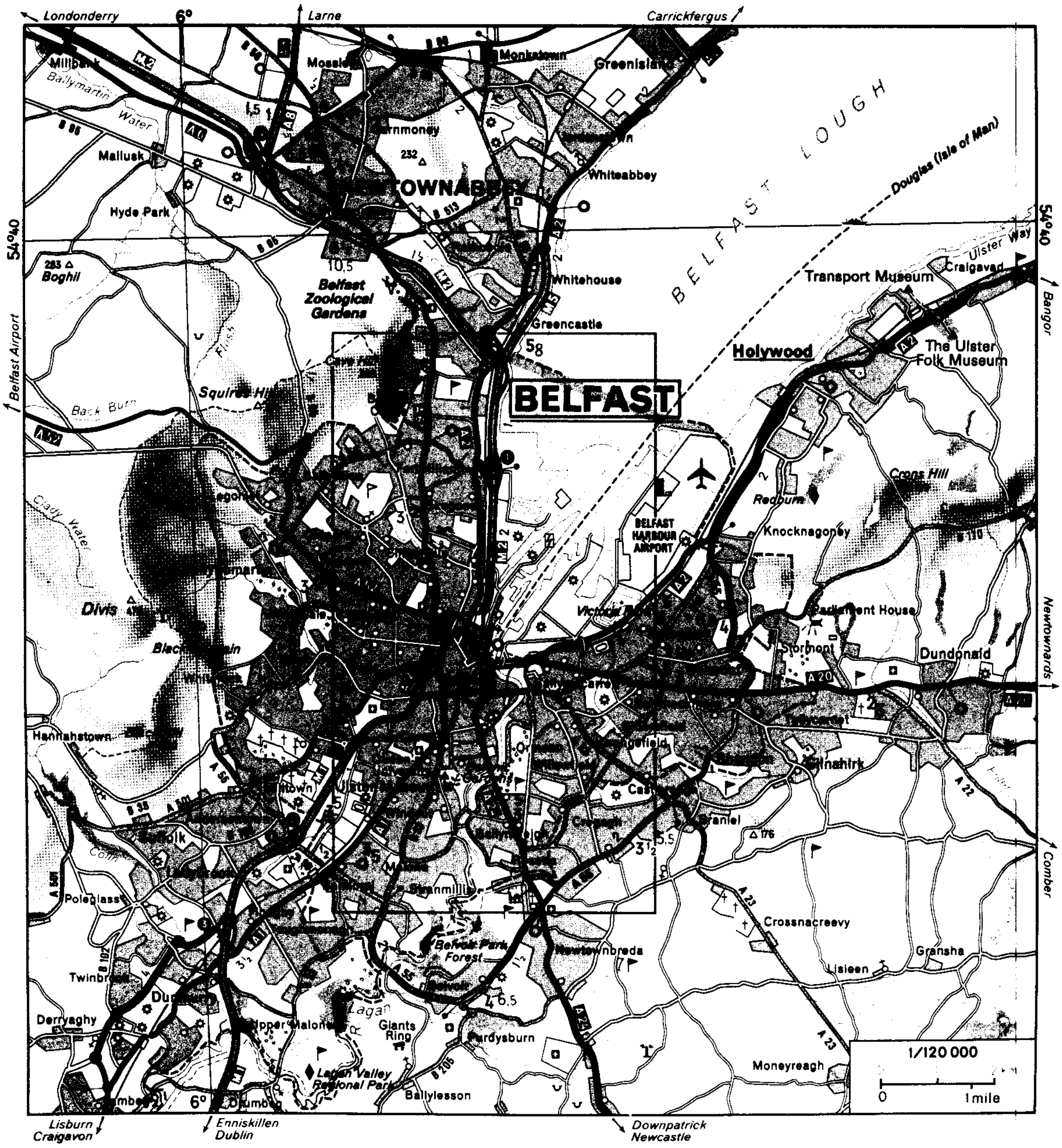
Climate: Moderate climate (Cfb)
Meteorology: Precipitation all seasons; generally stable conditions; occasional temperature inversions.

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	2.30	2.18	4.20	8.40	10.95	7.46	5.56
1990/91	Wind speed $m\ s^{-1}$	2.37	2.23	1.45	1.16	1.78	1.97	1.87
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	9.36	14.75	19.66	10.79	4.39	16.66	
	Wind speed $m\ s^{-1}$	1.82	1.73	1.50	1.38	1.65		

City: Belfast **Country**: United Kingdom

Main topography, city morphology, industrial sources and monitoring network



City: Belfast **Country**: United Kingdom

III. EMISSIONS

Annual emissions per source and totals in 1990 (Kt a^{-1})

Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	4.72				18.65	
Domestic/space heating	45.60				52.6	
Industry and power plants	211.28				36.0	
Total	261.60				107.25	
Per capita (**kg**)	667.3				273.7	
Per km² (**t**)	2467.9				1012.3	

Emission class	1990
Winter smog emissions	***5***
Summer smog emissions [1]	***2***

Major (industrial) point sources

(see city map)
Power Station West: electricity generation plant, located in docks area on north-east foreshore. The plant is fuelled by bituminous coal (annual consumption: 341 305 t a^{-1}, 1990-91). Sulphur content of fuel, average <1.0%, ash 12%. Chimney height 2 at 240 feet (73.15 m). Boiler plant 4 at 130 000 lbs steam/hour and 9 at 220 000 lbs steam/hour. Richardsons Fertilisers Ltd. located in docks area on north east foreshore. NO_2 emission from process, also boiler plant uses heavy oil (sulphur content 3.5%, ash 0.1%, annual consumption 1.8 x 10^6 gallons/year). Chimney height 200 ft (61 m). Boiler plant 2 x 44 000 lbs steam/hour. There are no industries causing special problems at present.

Space/domestic heating: general remarks

Approx. 70 % of all homes use coal for main heating (compared to 12 % in UK).

Local policies to reduce air pollution

Domestic/space heating:
On-going smoke control programme started in 1967 under the Urban Air Act (NI) 1964. The legislation makes it an offence for the occupier to emit smoke from any chimney subject to certain exemptions and limitations. This programme should be completed by 1997. Since 1955 smoke levels have been reduced by around 80%. Sulphur dioxide levels dropped steadily until the early eighties since when there has been a slight increase.

City: Belfast **Country:** United Kingdom

VI. AIR QUALITY DATA

Monitoring network
Part of the UK Department of Environment enhanced urban monitoring network (EUN). NO_X, SO_2, CO, O_3 and particulates are continuously measured at all sites. The Belfast site has been established since March 1992. The D.o.E. operates a UK air quality bulletin system and a local display system has been installed in Belfast city centre. SO_2 and black smoke sites: Belfast 11, Belfast 12, Belfast 13, Belfast 15, Belfast 33

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			5	5	5	5				
Annual average		*8*	65	51	89	71				
Winter average			72	69	105	93				
Maximum (24 h)			234	357	297	515				
98 percentile (24 h)			153	202	201	249				
Number of days exceeding the WHO-AQG			20	26	64	56				
Number of days exceeding 2 x WHO-AQG			0	3	2	6				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: Black smoke ($\mu g\ m^{-3}$)	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			5	5	5	5				
Annual average		*9*	31	32	44	40				
Winter average			44	48	69	61				
Maximum (24 h)			257	450	531	650				
98 percentile (24 h)			127	197	265	251				
Number of days exceeding the WHO-AQG			9	16	29	22				
Number of days exceeding 2 x WHO-AQG			2	5	8	8				

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Winter smog classification	1990
Exceedance class	*3*
Exposure class	*4*

1. Uncertain data

City: Berlin	*Country*: Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	3 300 000	***3 434 000***
Total area	(km^2)	330	***880***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	52° 32' N 13° 25' E	

Major activities and development trends (1980-1990, 1990-2000)
Trading and industrial centre with 3 airports
Major industries: electrotechnics, heavy engineering, food processing, consumer products.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, north eastern part of the country
Topography: plain ***(+)***

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.3	8.5	10.9
precipitation (mm)	435	487	392
wind speed (m s^{-1})	***3.8 (0)***	***3.8 (0)***	***3.6 (0)***
winter smog index	***11 (0)***	***12 (0)***	***9 (+)***
summer smog index	***12 (0)***	***8 (0)***	***18 (0)***

Station: 10384 52° 28' N 13° 24' E

III. EMISSIONS

Emission class	1990
Winter smog emissions	***5***
Summer smog emissions	***5***

Main topography, city morphology, industrial sources and monitoring network

VI. AIR QUALITY DATA [1]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*33*				
Mean of stations in city background	1989	3	68.1	437	279	53	11
Highest observed concentrations	1989		75.5	453	324	73	14

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*38*				
Mean of stations in city background	1989	3	95.6	545	290	80	12
Highest observed concentrations	1989		105.5	619	307	90	14

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class [2]	***4***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	3	39.0	98.3	188	0	0
Highest observed concentrations	1989		45.0	120	239	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	3	39.2	235	143		0	***2***
Highest observed concentrations	1989		46.8	254	159		0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. EC-DGXI/B3 Air Pollution Information System (APIS).

2. Uncertain data.

City: Birmingham	*Country*: United Kingdom

I. GENERAL DATA

		City	Conurbation
Population	(number)	934 000 (1987)	***2 311 000***
Total area	(km^2)		
Built-up area	(km^2)		***150***
Coordinates	(lat-/longitude)	52° 30' N 1° 50' W	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Western Europe
Topography: plain *(+)*

Climate: Cfb (Köppen-Geiger)
Meteorology:

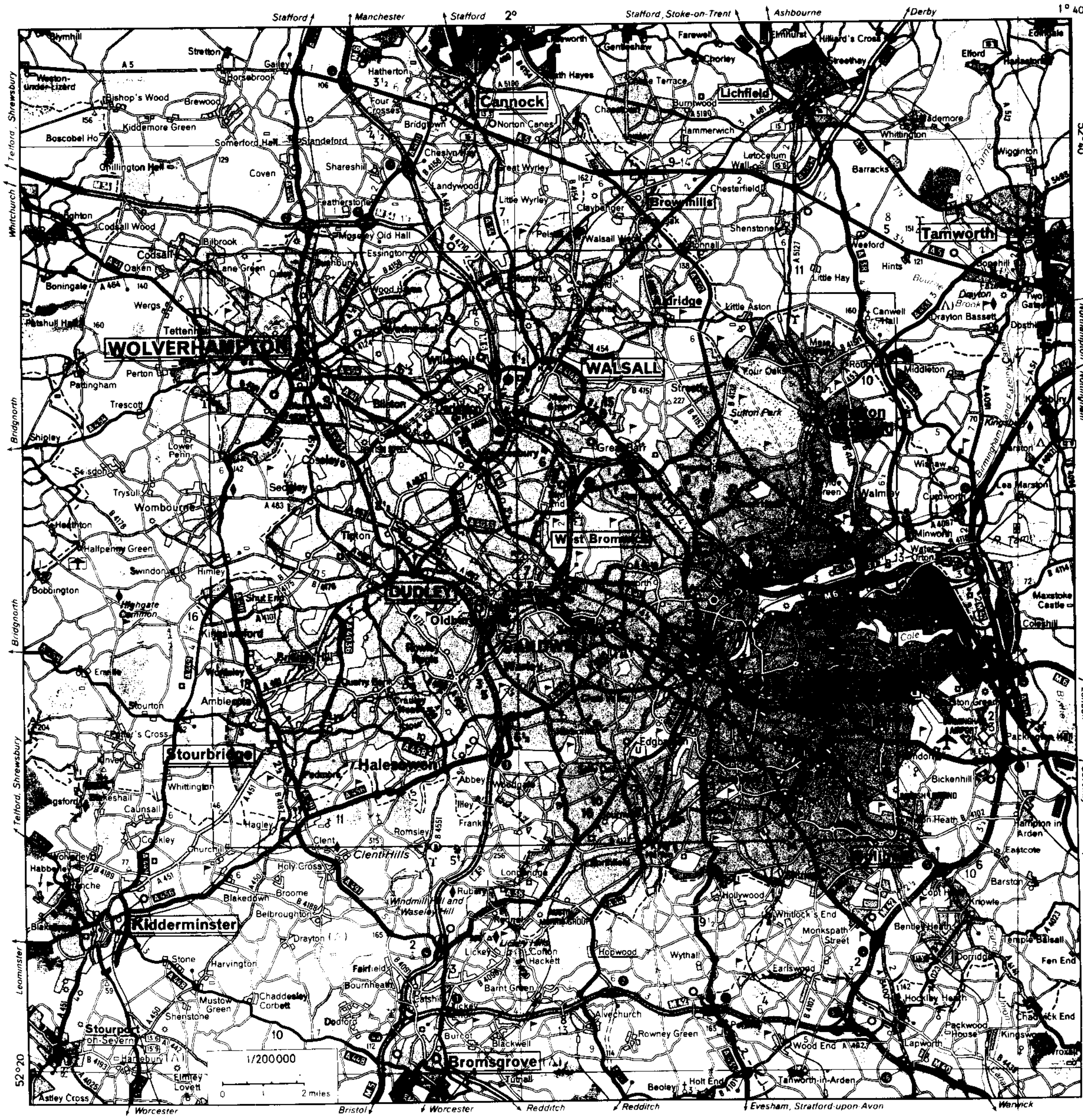
Averages	1980-1989	1985	1989
temperature (°C)	9.3	8.7	10.4
precipitation (mm)	522	652	701
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.7 (0)***	***3.5 (0)***	***3.5 (0)***
winter smog index	***10 (0)***	***13 (0)***	***7 (+)***
summer smog index	***4 (+)***	***0 (++)***	***7 (+)***

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***5***
Summer smog emissions[1]	***5***

1. Uncertain data.

Main topography, city morphology, industrial sources and monitoring network



City: Bratislava	**Country**: Slovak Republic

I. GENERAL DATA

		City	Conurbation
Population	(number)	444 000 (1991)	***475 000***
Total area	(km^2)	368	400
Built-up area	(km^2)	121	***132***
Co-ordinates	(lat-/longitude)	48 ° 12 ' N 17 ° 07 ' E	

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and administrative centre. Major industrial activities are concentrated in the north-east (chemical industries, power plant), south-east (petrochemical industry), and west (automobile industry, glass industry).
The population has increased in the 1980-1990 period, and a slight growth (5 %) of built-up areas and population is expected up to year 2000.

Constituent communities: Stupava, Ivanka pri Dunaji, Rovinka.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Southern Slovakia on both banks of river Danube.
Topography: Danube lowlands, Carpathian foothills (north-west part of the city). *(-)*

Climate: Moderate middle European (Cfb)
Meteorology: Precipitation all seasons, mild winter, hot summer.
Wind: North west.

Averages	1980-1989	1985	1989
temperature (°C)	10	10.1	10.9
precipitation (mm)	184	3.9	21
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)[1]	***5.3 (++)***	***4.8 (+)***	***4.6 (+)***
winter smog index[1]	***18.0 (0)***	***20.3 (0)***	***13.8 (0)***
summer smog index	***49.6 (-)***	***56.0 (-)***	***49.0 (-)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

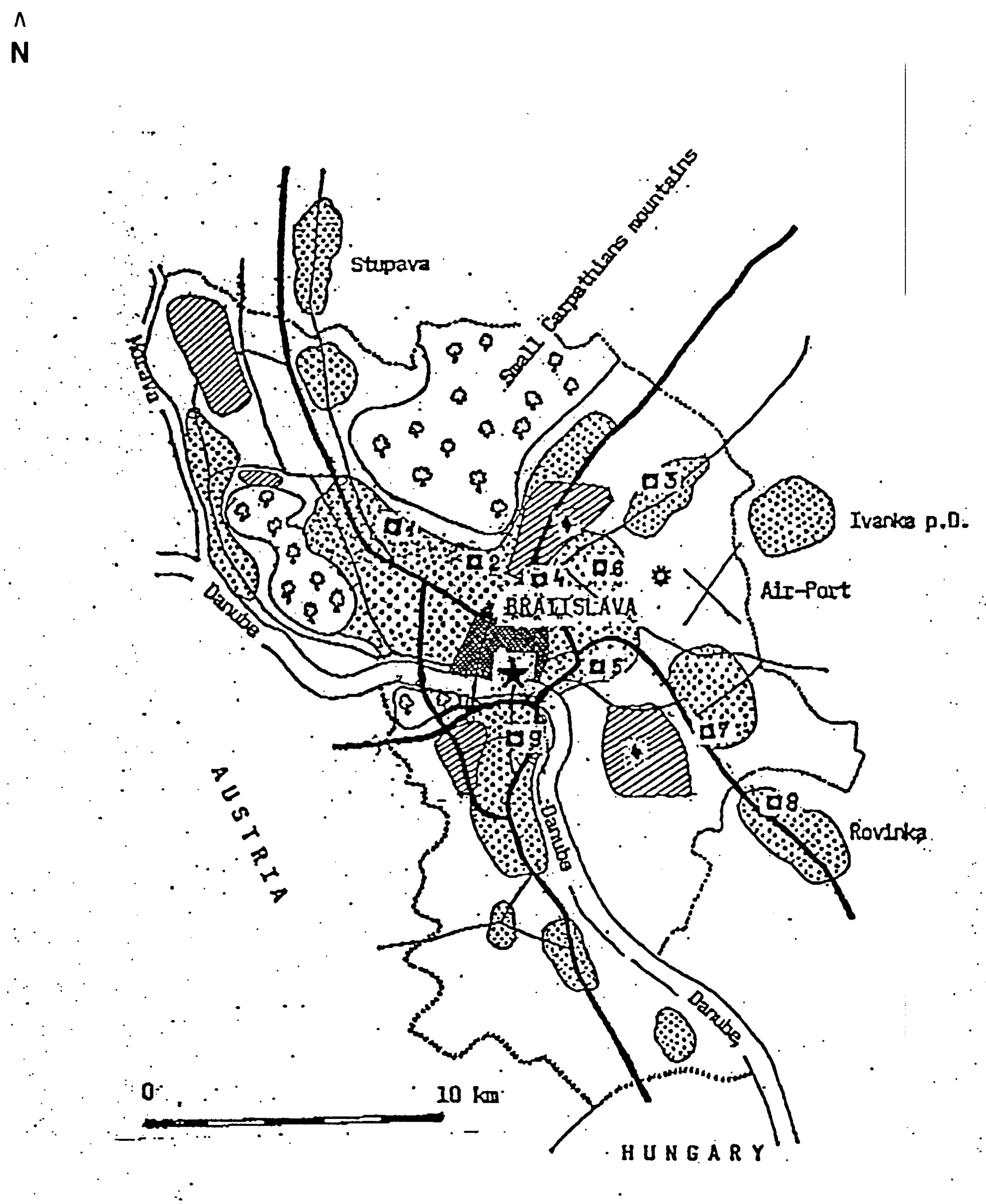
Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose 1985	Freq. %	3.4	7.1	11.3	5.4	7.1	7.2	2.8
	Wind speed $m\ s^{-1}$	3.4	2.0	2.2	2.2	2.9	3.1	3.9
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	3.2	2.7	2.2	18.2	22.7	6.7	
	Wind speed $m\ s^{-1}$	4.2	1.8	2.3	3.8	4.1	-	

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose 1990	Freq. %	5.1	9.6	13.0	3.3	6.2	7.2	4.2
	Wind speed $m\ s^{-1}$	3.3	2.3	2.1	2.1	2.4	3.0	3.1
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	4.2	3.8	3.3	17.3	18.8	4.0	
	Wind speed $m\ s^{-1}$	2.8	2.5	2.6	3.6	3.9	-	

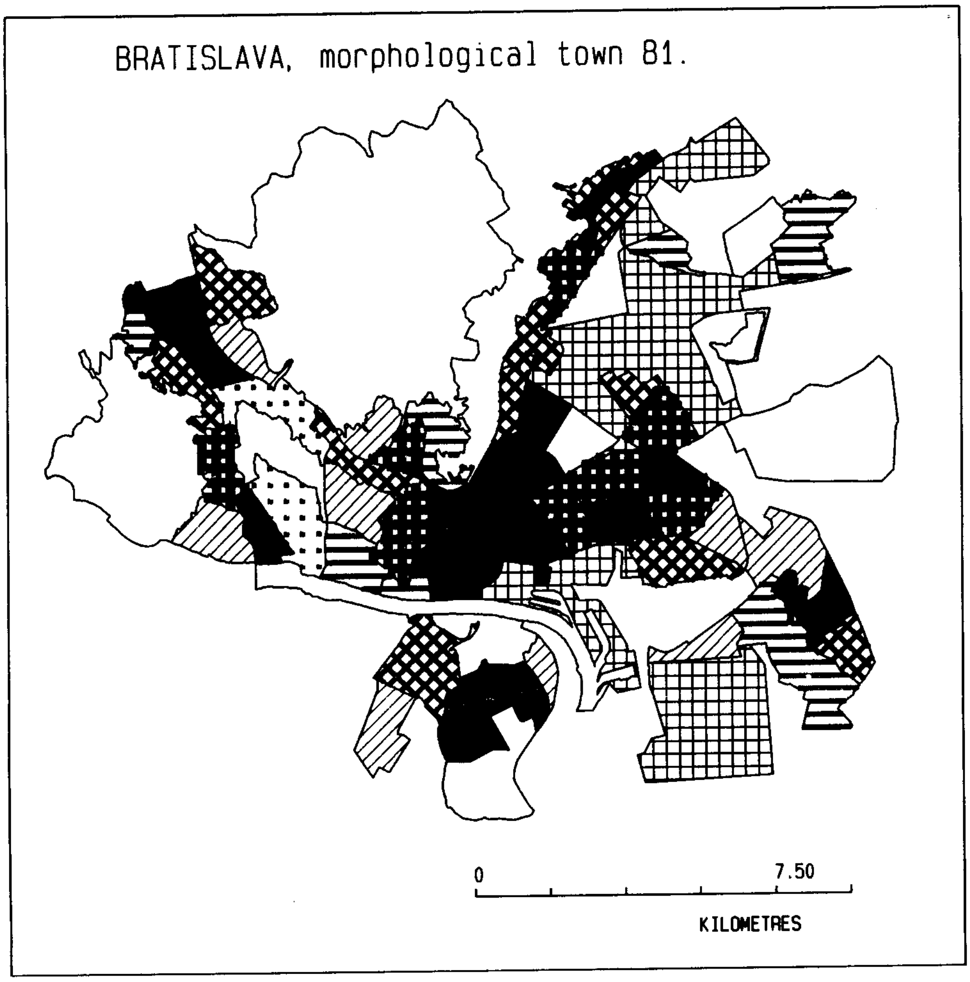
City: Bratislava **Country**: Slovak Republic

Main topography, city morphology, industrial sources and monitoring network



City: Bratislava **Country**: Slovak Republic

Main topography, city morphology, industrial sources and monitoring network



City: Bratislava **Country**: Slovak Republic

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic						
Domestic/space heating	2.6	0.7	3.1	1.4	2.0	
Industry and power plants	42.2	8.7	0.6	26.8	2.9	
Total						
Per capita (**kg**)						
Per km^2 (**t**)						

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.3	11.6	3.6	-	
Domestic/space heating	2.4	0.7	2.7	1.4	1.9	
Industry and power plants	31.6	7.2	0.5	24.4	1.9	
Total	34.0	12.2	14.8	29.4	3.8	
Per capita (**kg**)	76	27	33	66	8	
Per km^2 (**t**)	90	30	40	80	10	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***1***

Major (industrial) point sources

(see city map)
In the north-eastern part of the city: chemicals (viscose, fertilisers, pesticides, explosives, etc.), power plant, polygraphic and agricultural industries.
In the south-eastern part of the city: petrol refinery, petrochemical industry, incinerators, power plants.
In the southern part of the city: rubber industry.
In the western part of the city: automobile industry, glass works, brick works.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity			**Total annual consumption of fuel for traffic**				
	Number of vehicles	Total traffic activity veh km a^{-1}		Consumption (t a^{-1})		Average Sulphur content (%)	
				1985	1990	1985	1990
Total	125 400	1.4×10^9					
of which:							
· passenger cars	98 217		Diesel oil		62 300		0.15
· buses	1 340		Petrol/Gasoline		187 000		0.03
· freight traffic >3.5 t	9 460		LPG				

Traffic

The streets in the town commonly have two lanes.
Less than 1 % of the cars have catalytic converters.
The average occupation of passenger cars is less than 2 persons per car.
Lead content in petrol 0.15 g/l.

City: Bratislava **Country**: Slovak Republic

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption 1985	1990	Average Sulphur content (%) 1985	1990
Fuel oil low sulphur	(t a^{-1})	12 641	9 270	0.5	0.5
Fuel oil high sulphur	(t a^{-1})	684 154	558 460	2-3	2-3
Coal	(t a^{-1})	103 370	95 545	1-3	1-3
Wood	(t a^{-1})		120		
Natural/city gas	(10^6 m^3 a^{-1})	183	193		
Total	(t a^{-1})				

Space/domestic heating: general remarks

More than 75 % of inhabitants live in housing estates, mainly in eastern, southern and western parts of the city. The housing estates are heated via distribution network from the power plants and heating centres. The main fuels are natural gas and heavy oil. Individual houses in the centre and suburbs are heated by natural gas or solid fuels (coal and coke).

Local policies to reduce air pollution

Industry:
Transition period from centrally planned to market economy. Decrease of production. Prognosis for the future uncertain. Lowering of industrial pollutant emissions is expected. New air pollution act was put into force in 1991. Emission standards, based on German 1986 limits as an initial level, were accepted. Market prices for fuels, raw materials and power (without state subsidy) result in much more effective utilisation of all sources.

Traffic:
Since 1980:
Traffic free zones. Some technical improvements to means of transportation. Extension of electric-powered public transport lines. Exclusion of heavy transit transport from the central parts of the town. Reduction of lead content in fuel. Limited number of parking places in the centre.
Since 1990:
Reconstruction of traffic system in Bratislava (motorways). Obligatory application of catalytic converters (new vehicles, since October 1993). Parking charges.

Domestic/space heating:
Heat piping system in housing estates. Increasing consumption of natural gas, as well as decreasing consumption of solid fuels. Lowering of heat losses (thermo-isolation of houses). Economic tools (price increase of fuels).

VI. AIR QUALITY DATA

Monitoring network

The network of Slovak Hydrometeorological Institute: 9 (manual) stations, 24 hours sampling time of SO_2, TSP and heavy metals) in operation since 1975. Other pollutants (NO_x, H_2S, O_3) were measured only sporadically. New real-time air pollution monitoring system of Slovak Hydrometeorological Institute (5 stations - SO_2, NO_x, TSP, CO, O_3, H_2S) was put in operation during 1992. Regular public information in newspapers. Smog warning system will be put into operation in 1993.

City: Bratislava **Country**: Slovak Republic

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			2	2	2	2	1	1	6	6
Annual average		11*(15)*	37	20	41	23	59	29	57	23
Winter average			63	32	73	37	90	49	85	42
Maximum (24 h)			210	135	220	140	310	160	300	180
98 percentile (24 h)			155	88	160	95	220	130	200	100
Number of days exceeding the WHO-AQG			23	2	29	3	57	8	47	5
Number of days exceeding 2 x WHO-AQG			-	-	-	-	4	-	4	-

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: TSP (µg m^{-3})	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			2	2	2	2	1	1	6	5
Annual average		*28*	60	58	71	67	52	99	63	98
Winter average			73	87	79	124	62	182	81	151
Maximum (24 h)			260	310	310	380	250	580	350	610
98 percentile (24 h)			195	200	240	250	175	450	250	300
Number of days exceeding the WHO-AQG			41	30	59	44	32	82	47	92
Number of days exceeding 2 x WHO-AQG			4	4	7	7	2	26	9	16

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1990
Exceedance class	*2*
***Exposure class*[1]**	*4*

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	1	1
Annual average	0.23	0.11
Maximum monthly average	0.51	0.16
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data

City: Bremen	*Country*: Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	***553 000***	
Total area	(km^2)	327	
Built-up area	(km^2)	***100***	
Coordinates	(lat-/longitude)	53° 05' N 8°48' E	

Major activities and development trends (1980-1990, 1990-2000)
Commercial and industrial centre (ship-building, iron and steel industry) with seaport and airport.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, north western part of Germany
Topography: plain (river basin) **(+)**

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	8.6	7.5	9.9
precipitation (mm)	536	706	648
wind speed ($m\ s^{-1}$)	***4.1 (+)***	***4.0 (+)***	***3.9 (0)***
winter smog index	***10 (0)***	***14 (0)***	***8 (+)***
summer smog index	***6 (+)***	***3 (+)***	***7 (+)***

Station: 10224 53° 03' N 8° 48' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

VI. AIR QUALITY DATA

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*8*				
Mean of stations in city background	1990	4	18		85		
Highest observed concentrations	1990		23		94		

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*21*				
Mean of stations in city background	1990	4	32		102		
Highest observed concentrations	1990		29		107		

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class[1]	***1***
Exposure class[1]	***3***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1990	4	38		88		
Highest observed concentrations	1990		37		96		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1990	4	33		107			*1*
Highest observed concentrations	1990		35		115			

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations[2] mg m^{-3}	Highest observed concentrations City background	
	1985	1990
Station number/name		Nord
Annual average		1.2
98 percentile (1/2 h)		2.3
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Brussels	*Country*: Belgium

I. GENERAL DATA

		City	Conurbation[1]
Population	(number)		***1 349 000 (1990)***
Total area	(km^2)		485 (1990)
Built-up area	(km^2)		***402 (1990)***
Coordinates	(lat-/longitude)	50° 50' N 4° 21' E	

Major activities and development trends (1980-1990, 1990-2000)
Capital of Belgium, (European) administrative and commercial centre. National airport.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: West Europe
Topography: plain *(+)*

Climate: Cfb (Köppen-Geiger)
Meteorology: -

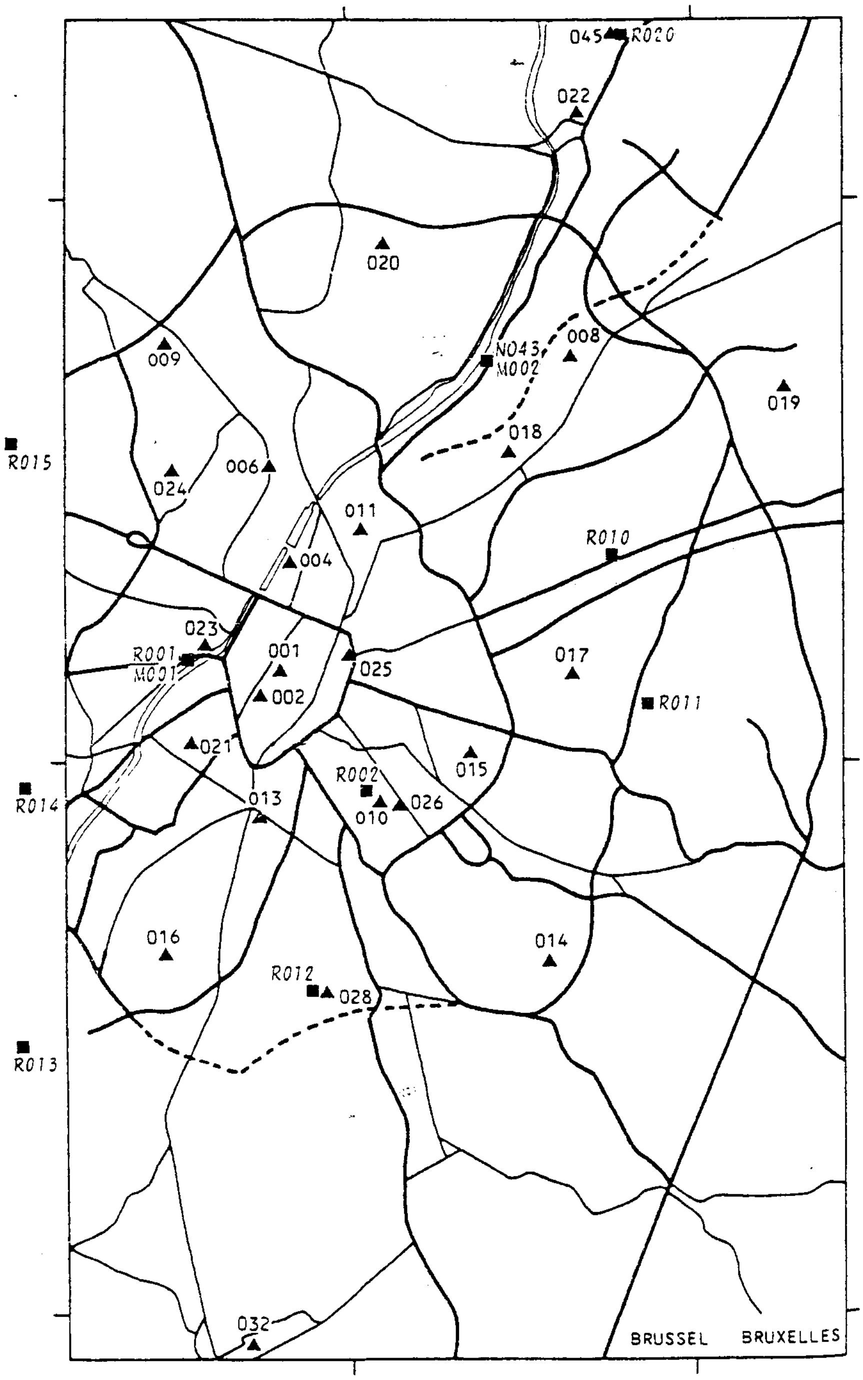
Averages	1980-1989	1985	1989
temperature (°C)	10.1	9.5	11.2
precipitation (mm)	691	795	
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.3 (0)***	***3.1 (0)***	***2.9 (-)***
winter smog index[2]	***9 (+)***	***9 (+)***	***12 (0)***
summer smog index	***10 (0)***	***6 (+)***	***20 (0)***

Station: Ukkel 50° 48' N 4° 21' E

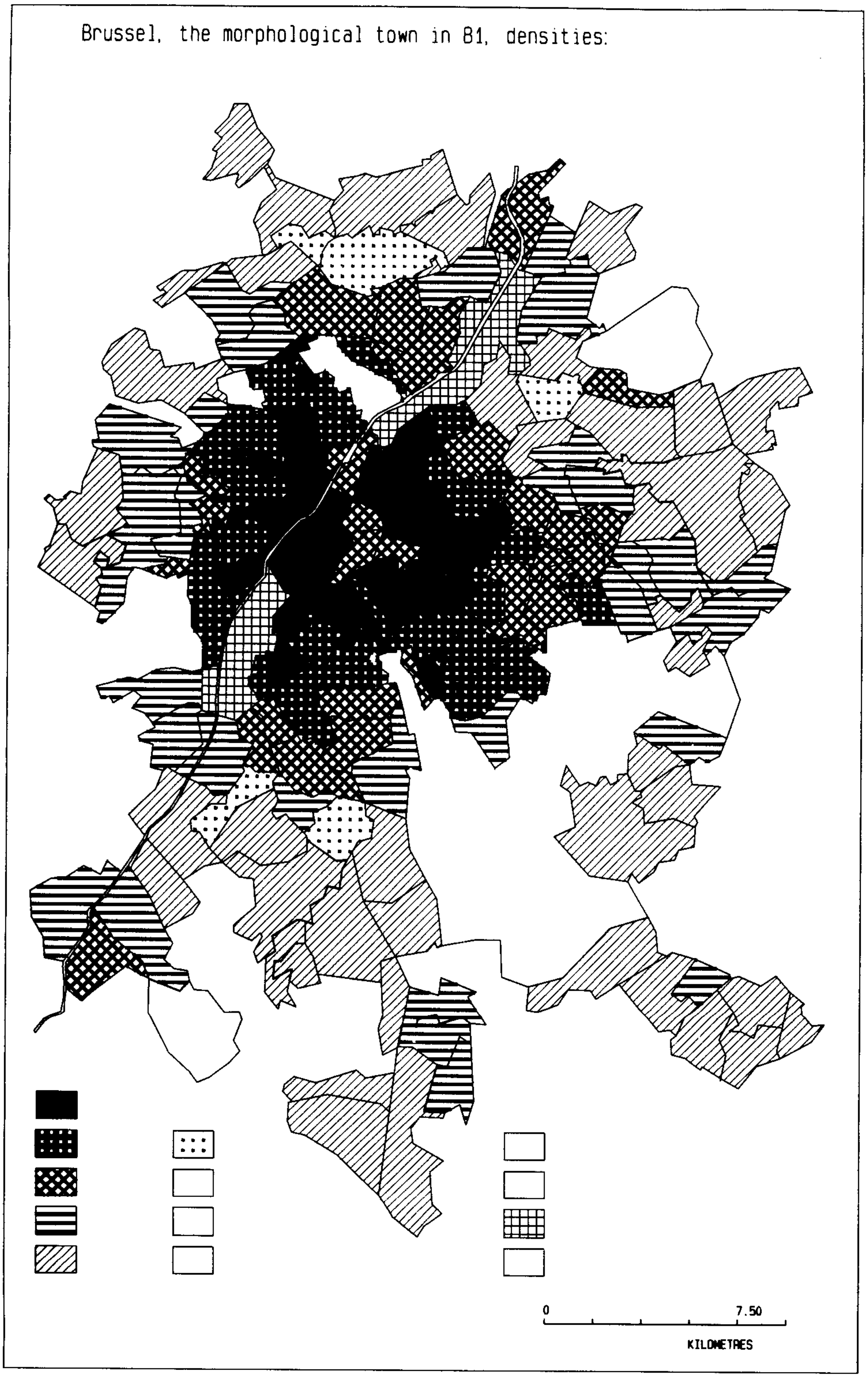
III. EMISSIONS

Emission class	1990
Winter smog emissions[3]	***3***
Summer smog emissions[3]	***4***

Main topography, city morphology, industrial sources and monitoring network[4]



Main topography, city morphology, industrial sources and monitoring network[5]



VI. AIR QUALITY DATA

Monitoring network

The Belgian institute for Hygiene and Epidemiology operates a semi-automatic (24h samples) `sulphur-smoke' network, an automatic network for continuous monitoring and a network to monitor heavy metal concentrations.

SO_2 concentrations[6] µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			3	3	R002	R002	R001	R001	R013	R013
Annual average		*17*	42	27	53	39	64	24	41	19
Winter average			58	28*	80	-	88	37	58	23
Maximum (24 h)			427	73	497	109	611	94	525	106
98 percentile (24 h)			242	63	280	97	290	72	214	60
Number of days exceeding the WHO-AQG			21	0	29	0	42	0	15	0
Number of days exceeding 2 x WHO-AQG			6	0	10	0	11	0	5	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

SO_2 concentrations showed a marked downward trend in the period 1970-1985, in recent years concentrations have remained more or less stable. Emissions dropped almost 50% in the period 1980-1987 as a result of higher chimneys, regulation of sulphur content of fuels and especially the increase in energy production by means of nuclear plants. Exceedance of the WHO-AQG can still be expected during winter smog episodes.
(UV fluorescence) *2 stations

Particulate matter[5]: Black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			3	3	No. 021	No. 021				
Annual average			23	24	25	29				
Winter average			30	31	38	38				
Maximum (24 h)			166	95	190	114				
98 percentile (24 h)			88	67	97	82				
Number of days exceeding the WHO-AQG			3	0	5	0				
Number of days exceeding 2 x WHO-AQG			0	0	0	0				

WHO-AQG (black smoke) = 125 µg m^{-3}

Suspended particulate concentrations

Since 1985 no marked trend in concentrations is visible. Year-to-year variations have mainly meteorological causes. Although no exceedances of the WHO-AQG were observed in 1990, the AQG can still be breached during unfavourable conditions (winter smog episodes).

Winter smog classification	1990
Exceedance class	*1*
Exposure class	*1*

NO_2 concentrations[7] µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations			2	2	R012	R012	R001	R001		
Annual average			47	44	47	41	60	55		
Maximum (24 h)			151	96	151	96	180	132		
Maximum (1 h)			248	194	270	494	298	250		
Number of days exceeding the WHO-AQG			1	0	1	0	2	0		
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
(chemiluminescence) NO_2 concentrations do not show a clear trend.

O_3 concentrations[6] µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	**1988**	1990	**1988**	1990	1985	19__	1985	19__
Number of stations			1(Ukkel)	1(Ukkel)	1(Ukkel)	1(Ukkel)				
Annual average			29.6	37.6	29.6	37.6				
Summer average			42.2	51.6	42.2	51.6				
Maximum (1 h)			150	238	150	238				
Maximum (8 h)										
98 percentile (1 h)			99	<u>150</u>	99	<u>150</u>				
Number of days exceeding the WHO-AQG			1	>12	1	>12				
Number of days exceeding 2 x WHO-AQG			0	0	0	0				
Exceedance class				***2***						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Ozone concentrations
Station Ukkel is located in a residential area (park), moderate traffic intensity in the neighbourhood. No clear trend is visible in concentration levels (period 1986-1991).

Pb concentrations[8] µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	OBRU02	OBRU02
Annual average	1.29	0.38
Maximum monthly average	1.53	0.44
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Lead concentrations
Pb concentrations have dropped considerably since the introduction of lead-free fuel

1. Data provided by Free University of Brussels.
2. Less than 75% of the data available.
3. Uncertain data.
4. Map provided by The Free University of Brussels.
5. Map provided by The Free University of Brussels.
6. Zwavel-rook meetnet. IHE, Brussels: annual reports.
7. Automatisch meetnet voor de luchtverontreiniging. IHE, Brussels: annual reports.
8. Evaluation de la teneur en meteaux lourd dans l'air en Belgique. IHE, Brussels: annual reports.

***City*:** Bucharest	***Country*:** Romania

I. GENERAL DATA

		City	Conurbation
Population	(number)	2 300 000 (1990)	***2 388 000 (1990)***
Total area	(km^2)		228 (1990)
Built-up area	(km^2)		***182 (1990)***
Coordinates	(lat-/longitude)	44° 28' N 26° 07' E	

Major activities and development trends (1980-1990, 1990-2000)
Most important administrative (capital) and commercial centre of Romania (about 13% of total Romanian industrial production). Main industrial sectors present are chemical industry, electronic equipment industry and food industry. Airport north of the city.
The number of inhabitants increased from 1.900.000 in 1980 to 2.388.000 in 1990. The number of inhabitants is expected to increase about 10% in the period 1990-2000.

II. TOPOGRAPHY AND CLIMATOLOGY

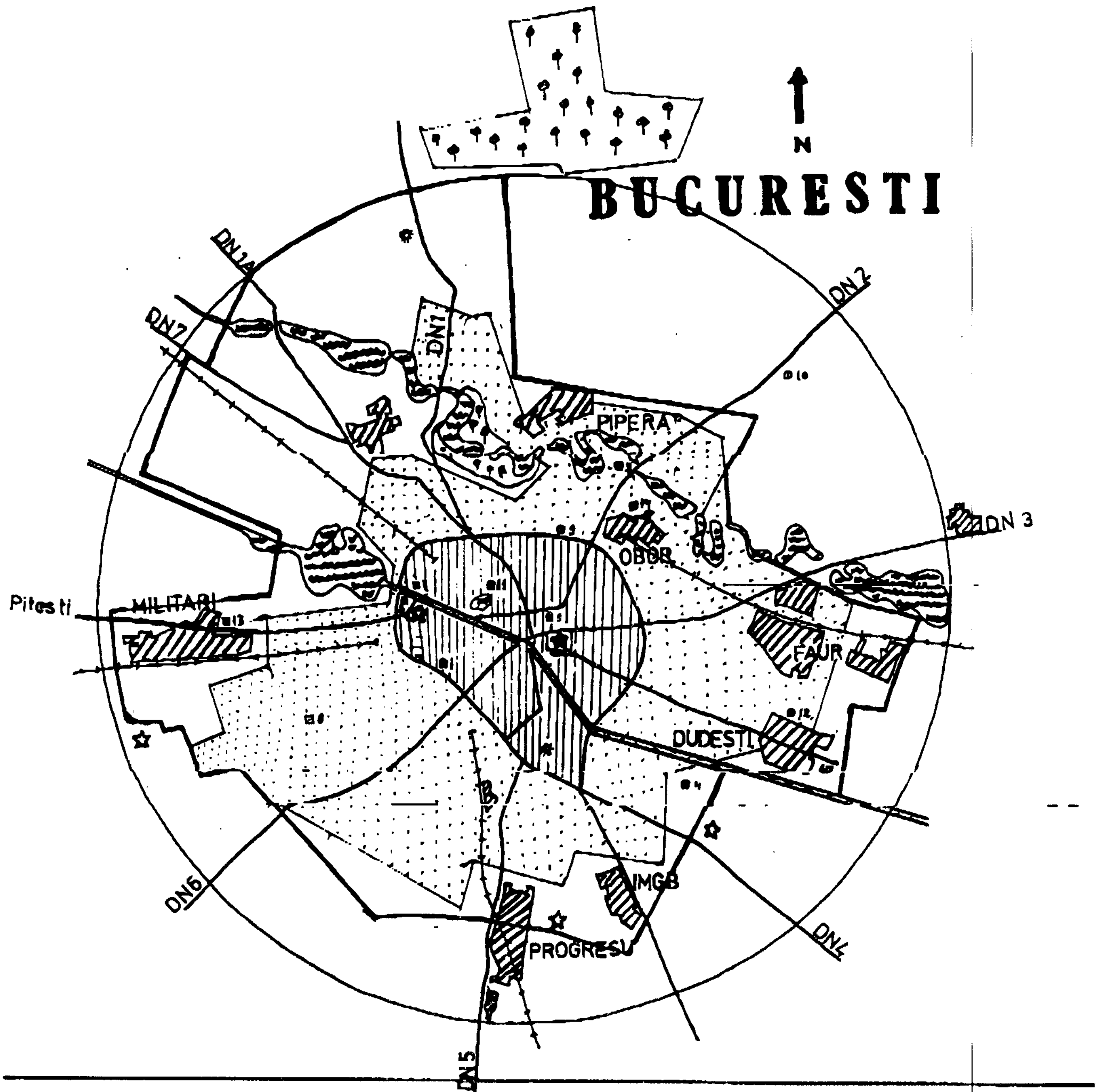
Region: East Europe (225 km from Black Sea, 120 km from Carpathian mountains)
Topography*:** Flat plain along river (55-96 m a.s.l.) ***(+)

Climate: Csa (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	10.6	9.8	11.7
precipitation (mm)	517	718	647
cloud cover (8^{-1})			
wind speed (m s^{-1})	***1.5 (--)***	***1.8 (--)***	***1.3 (--)***
winter smog index	***47 (--)***	***42 (-)***	***45 (-)***
summer smog index	***78 (-)***	***79 (-)***	***67 (-)***

Station: Bucaresti IMH 44° 30' N 26° 08' E

Main topography, city morphology, industrial sources and monitoring network



City centre /commercial area			Scale 1 : ______
		★	City coordinate (see page 2)
Residential area			Major point sources (+I, II, ..X)
Industrial area			Air quality monitoring station (1,2,..10)
Woodlands/parks/ 'green' areas			Meteorological (wind) station
			Main road
Other: power plant	☆		Water

III. EMISSIONS

Annual emissions per source and totals in 1990 (t a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic		3 870	20 030			
Domestic/space heating	3 530	560	210	46 800		
Industry and power plants		17 040				90
Total	45 350	21 470	21 710			
Per capita (**kg**)	19	9	9			
Per km^2 (**t**)	250	118	119			

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***3***

Major (industrial) point sources

(see city map)
Most important industrial sites:

-Chemical industry in eastern part of the city
-Heavy industry in the eastern, southern and north-western parts of the city
-Building material industry in the western part of the city
-Electronic equipment industry in the northern part of the city.

-4 major power plants using fuel oil:

-SE	550 MW
-SW	100 MW
-S	100 MW
-W	250 MW

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	359 332	x 10^9
of which:		
· passenger cars	270 623	
· buses	3 800	
· freight traffic >3.5 t	51 198	

Total annual consumption of fuel for traffic

	Consumption (kt a^{-1})		Average Sulphur content (t)	
	1985	1990	1985	1990
Diesel oil		778		1 166
Petrol/Gasoline		202		182
LPG				

Traffic

There are no cars with catalytic converters. No lead-free petrol is available. The average occupation of passenger cars is 2.3 persons/car. Total non-electric-powered public transport activity (buses) is about 310 300 passenger km a^{-1}. Total electric powered public transport activity is about 1 556 700 passenger km a^{-1}.

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption		Average Sulphur content	
		1985	1990	1985	1990
Fuel oil low sulphur	(t a^{-1})		6 999		0.8%
Fuel oil high sulphur	(t a^{-1})		7 021		4.3%
Coal	(t a^{-1})		79 235		
Wood	(t a^{-1})		147 624		
Natural/city gas	(10^6 m^3 a^{-1})		314		
Total	(t a^{-1})				

Space/domestic heating: general remarks

Around 30% of all households are connected to a district-heating system. In the city centre there are about 33 000 houses with individual heating sources. The most common fuels used are wood, coal, and natural/city gas.

Local policies to reduce air pollution

Industry: A campaign is planned to modernize emission control systems and to stimulate the use of low-sulphur fuels.
Traffic: Access of heavy freight traffic to the city centre is restricted. More restrictions are planned. Car owners are stimulated to use catalytic converters. Lead free petrol will be available before the year 2000.
Domestic/space heating: Further development of central heating system is intended as is the use of natural/city gas instead of wood/coal.

VI. AIR QUALITY DATA

Monitoring network

Air quality is monitored at 14 stations. 5 stations belong to the Bucarest Environmental Protection Agency, 5 to the Ministry of Environment and 4 to the Preventive Health Centre. SO_2, NO_2, dust, heavy metals and NH_3 are sampled on a 24 hour basis.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	19__	1985	19__	1985	19__
Number of stations				14						
Annual average		*11*		40						
Winter average				(10)						
Maximum (24 h)				123						
98 percentile (24 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

(titration) Concentrations are not monitored in December and January. Concentrations show an upward trend till 1989. After 1989 concentrations dropped because of the economic recession.

Particulate matter: TSP µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	19__	1985	19__	1985	19__
Number of stations				14						
Annual average		*20*		130.0						
Winter average				64.5						
Maximum (24 h)				273.0						
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				>1						
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
(gravimetric) Concentrations are not monitored in December and January. Concentrations show an upward trend till 1989. After 1989 concentrations dropped because of the economic recession.

Winter smog classification	1990
Exceedance class[1]	***2***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	19__	1985	19__	1985	19__
Number of stations				14						
Annual average				36.0						
Maximum (24 h)				158.0						
Maximum (1 h)				423.0						
Number of days exceeding the WHO-AQG				>1						
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
(spectrophotometric) Concentrations are not monitored in December and January. Concentrations show an upward trend till 1989. After 1989 concentrations dropped because of the economic recession.

1. Uncertain data.

City: Budapest	*Country*: Hungary

I. GENERAL DATA

		City	Conurbation
Population	(number)	2 109 000 (1989)	***4 434 000 (1991)***
Total area	(km^2)	370 (1989)	***525 (1992)***
Built-up area	(km^2)	200 (1989)	
Coordinates	(lat-/longitude)	47°25 ' N 19° 13 ' E	

Major activities and development trends (1980-1990, 1990-2000)
Capital city of Hungary

II. TOPOGRAPHY AND CLIMATOLOGY

Region: C-Europe
Topography: river basin ***(-)***

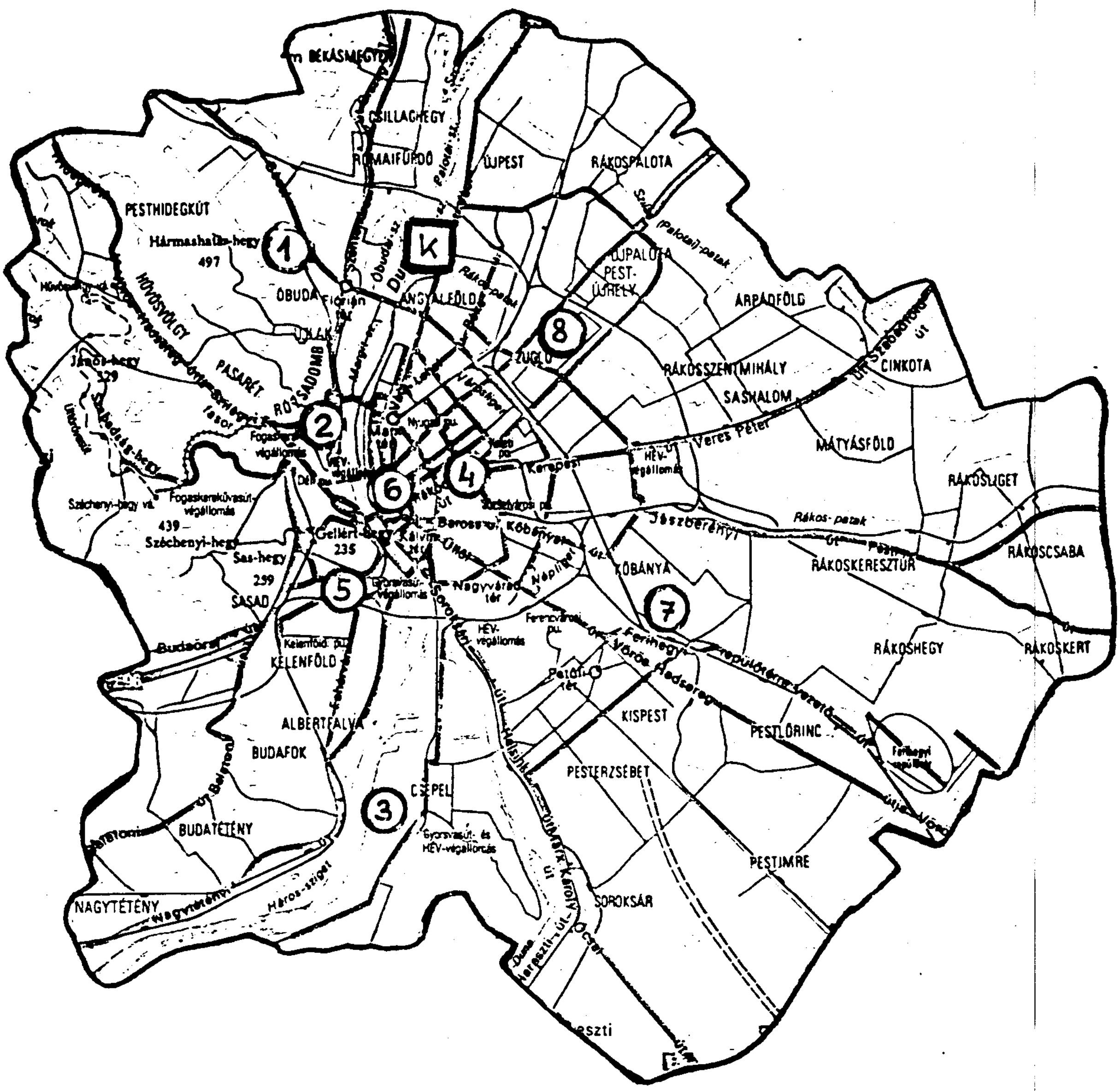
Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	10.3	9.6	11.1
precipitation (mm)	416	521	444
cloud cover (8^{-1})			
wind speed (m s^{-1})	***2.4 (-)***	***3.1 (0)***	***2.2 (-)***
winter smog index	***12 (0)***	***10 (0)***	***10 (0)***
summer smog index	***41 (-)***	***39 (-)***	***36 (-)***

Prolonged cold winter periods, with stagnating air and inversions, favourable conditions for the accumulation of air pollution. In the summer conditions can be favourable for photochemical smog formation.

Station:Budapest (nr 12838), 8 km from city centre 47° 27 ' N 18° 58 ' E

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1991 (kt a^{-1})

City	SO_2	NO_x	CO	Particulate matter (soot)	Pb	CH	CO_2
Traffic	2.25	16.97	150.53	2.1	0.09	16.8	1 022.61
Domestic/space heating							
Industry and power plants							
Total	37.6	27.45	173.7	9.34			
Per capita (**kg**)	18.6	13.6	86.1	4.62			
Per km² (**t**)	71.6	52.3	330.9	17.8			

Emission class	1990
Winter smog emissions[1]	***5***
Summer smog emissions[1]	***4***

Major (industrial) point sources

(see city map)
Main sources of air pollution are: transportation, power generating facilities, industrial facilities and residences (home heating units).

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles 1970	1989
Total	82 000	448 000
of which:		
· passenger cars		
· buses		
· freight traffic >3.5 t		

Traffic

Most of the vehicular transportation between the two parts of Budapest (i.e. Buda situated on the western bank of the Danube and Pest on the eastern side of the Danube) as well as between the western and eastern parts of Hungary is concentrated and ultimately routed through the interior of Budapest. In 1989 one third of the cars had two-stroke engines which emit more hydrocarbons and less nitrogen oxides than four-stroke engines.

Local policies to reduce air pollution

Traffic:
Reduced use of private cars in the inner city; improved public transportation systems as well as the parking network throughout the city. Reduction of emissions from cars by implementing catalytic converters and fuel-based improvement requirements; encourage the use of subways, trains (within the local area) and bicycles; encourage the increased use of boat/barge transport on the Danube.

VI. AIR QUALITY DATA [2]

Monitoring network

Main air pollutants: NO_2-CO-particles-VOC-SO_2

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	19__	1992 *(90)*	19__	1992	19__	1992	19__	1992	19__	1992
Number of stations		1		6						
Annual average		*3 (18)*		44		53		44		68
Winter average										
Maximum (24 h)				124		175		127		196
Maximum (1 h)				310		390		285		338
Number of days exceeding the WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations				6						
Annual average		*29*		62		82		77		89
Winter average										
Maximum (24 h)				199		219		283		287
Maximum (1 h)				883		1006		1020		1012
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

Suspended particulate concentrations

measuring method: FAG kugelfischer beta attenuation particle mass monitor

Winter smog classification	1992
Exceedance class [1]	***2***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	19__	1992	19__	1992	19__	1992	19__	1992	19__	1992
Number of stations		1		6				1		1
Annual average		1.53		44		62		75		78
Maximum (24 h)				110		144		184		150
Maximum (1 h)				310		526		387		331
Number of days exceeding the WHO-AQG				0						
Number of days exceeding 2 x WHO-AQG				0						

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1992	1985	1992	1985	19__	1985	19__	1985	1992
Number of stations		1								1
Annual average		69.3								22
Summer average		91.5								
Maximum (1 h)				250						158
Maximum (24 h)				126						79
98 percentile (1 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										
Exceedance class				***2***						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		1
Annual average		5.1
Maximum (1 h)		23
Maximum (24 h)		10.6
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data.

2. Budapest monthly air quality statistics: Állami népegészégügyi és tisztiorvosi szolgálat.

City: Chisinau	*Country*: Moldova

I. GENERAL DATA

		City	Conurbation
Population	(number)		***675 000 (1992)***
Total area	(km^2)		
Built-up area	(km^2)		***220 (1992)***
Coordinates	(lat-/longitude)	47° 00' N 28° 50' E	

Major activities and development trends (1980-1990, 1990-2000)
Capital of Moldova. Agricultural centre. Food and chemical industry.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: valley ***(--)***

Climate: Bsk (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	4.8	2.6	7.0
precipitation (mm)			
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***2.9 (-)***	***2.8 (-)***	***2.8 (-)***
winter smog index	***31 (-)***	***33 (-)***	***24 (-)***
summer smog index	***16 (0)***	***13 (0)***	***21 (0)***

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***3***
Summer smog emissions[1]	***2***

VI. AIR QUALITY DATA - 1990[2]

sulphur dioxide		**nitrogen dioxide**		**carbon monoxide**		**lead**	
annual average	maximum (20 min.)	annual average	maximum (20 min.)	annual average	maximum (20 min.)	annual average	maximum (20 min.)
2	50	30	390	2	8	0.04	0.08
2	60	20	200	2	19	0.08	0.27
1	30	20	270	2	9		
1	20	10	90	1	4		
2 (mean)	40 (mean)	20 (mean)	238 (mean)				
WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}		**WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}**		**WHO-AQG CO (8h max.) = 10 mg m^{-3}**		**WHO-AQG Lead (annual average) = 0.5 µg m^{-3}**	

1. Uncertain data.

2. Belyland M.E. (ed) 1991. Annual report on the state of air pollution and harmful pollutant emissions to the cities and industrial centres of the Soviet Union. Air pollution, 1990. St. Petersburg, M.G.O.

***City*:** Cologne	***Country*:** Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	***954 000 (1992)***	
Total area	(km^2)	***120***	
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	50°56' N 6°57' E	

Major activities and development trends (1980-1990, 1990-2000)
Administrative centre with mining and metallurgical industry.
National and international junction, inland harbour.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, southern part of Nordrhein-Westfalen
***Topography*:** river basin, valley (-)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.8	8.7	11.0
precipitation (mm)	707.1	812.1	743.2
wind speed ($m\ s^{-1}$)	***3.0 (-)***	***2.7 (-)***	***2.9 (-)***
winter smog index	***10.2 (0)***	***18.3 (0)***	***7.8 (+)***
summer smog index	***15.3 (0)***	***9.3 (0)***	***24.1 (0)***

Station: 10513 50° 52' N 7° 10' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***3***

Main topography, city morphology, industrial sources and monitoring network

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*15*				
Mean of stations in city background	1989	4	23.1	99.5	58.8	0	0
Highest observed concentrations	1989		25.2	99	71	0	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*31*				
Mean of stations in city background	1989	4	56.1	194	114	3	0
Highest observed concentrations	1989		65.0	418	127	4	1

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class[1]	***1***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	4	52.4	132	229	0	0
Highest observed concentrations	1989		56.8	153	274	1	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	2	27.4	227	138		0	***2***
Highest observed concentrations	1989		28.7	215	141		0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

***City*:** Copenhagen	***Country*:** Denmark

I. GENERAL DATA

		City	Conurbation
Population	(number)	470 000 (1990)	***1 700 000 (1990)***
Total area	(km^2)	88 (1990)	2 860 (1990)
Built-up area	(km^2)	80 (1990)	***670 (1990)***
Co-ordinates	(lat-/longitude)	55 ° 41' N 12° 35' E	

Major activities and development trends (1980-1990, 1990-2000)

Business, administration, light industries and tourism.

Constituent municipalities: Copenhagen, Fredriksberg, County of Roskilde, County of Fredriksborg.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: North Europe, east-central Denmark.
Topography*:** Flat plain at sea level. Sea (Øresund) east of the city ***(++)

Climate: Coastal climate (Cfb)
Meteorology: Prevailing wind direction around SW, with continuously passing low pressure areas.

Averages	1980-1989	1985	1989
temperature (°C)	8	6.9	9.6
precipitation (mm)	453.3	702	438.2
cloud cover (8^{-1})			
wind speed (m s^{-1})	***5.1 (++)***	***5.0 (++)***	***5.4 (++)***
winter smog index	***10.0 (0)***	***11.3 (0)***	***8.8 (+)***
summer smog index	***1.7 (++)***	***0.2 (++)***	***4.0 (+)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

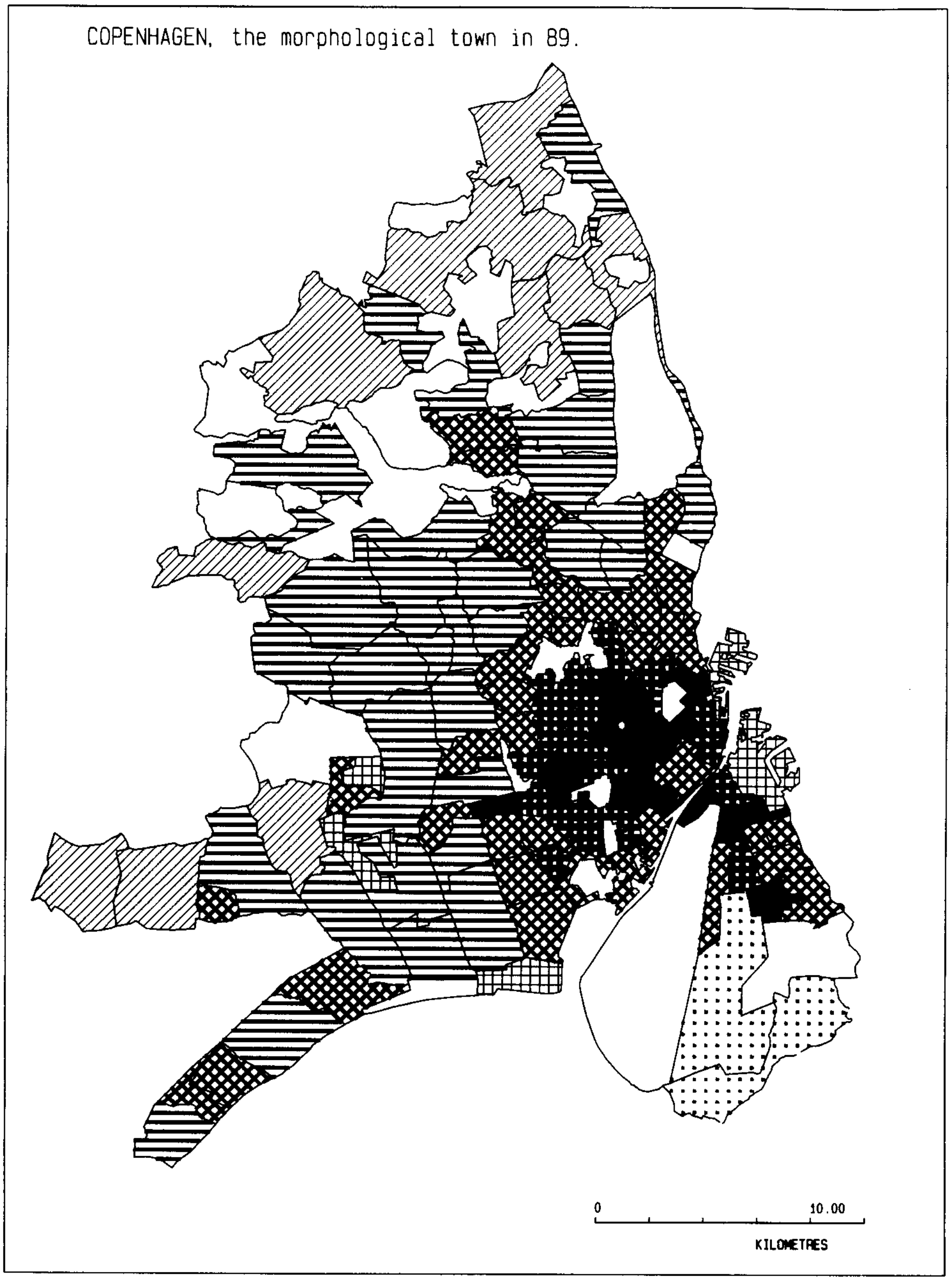
Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	6.2	6.3	6.6	6.3	4.8	6.3	8.2
1985	Wind speed m s^{-1}	5.5	5.1	5.0	5.9	5.2	5.0	5.3
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	10.9	14.1	14.3	10.8	4.1	0.8	
	Wind speed m s^{-1}	5.1	5.9	5.6	6.3	5.7	<1	

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	4.3	4.4	4.5	4.4	3.6	6.2	8.4
1990	Wind speed m s^{-1}	6.0	5.4	5.4	4.8	5.2	5.6	5.9
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	11.9	18.0	17.3	11.0	5.0	0.8	
	Wind speed m s^{-1}	6.1	6.9	6.5	6.2	5.7	<1	

City: Copenhagen **Country**: Denmark

Main topography, city morphology, industrial sources and monitoring network



City: Copenhagen **Country:** Denmark

III. EMISSIONS

Emission class	1990
Winter smog emissions	*3*
Summer smog emissions	*4*

Major (industrial) point sources

(see city map)

VI. AIR QUALITY DATA

Monitoring network

1) Danish Air Quality network (run by National Environmental Research Institute, Ministry of Environment).
2) HLU network (run by Air Pollution Unit of Greater Copenhagen, a co-operation between municipal Authorities in Greater Copenhagen).

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	-	1					1	3	-	-
Annual average		2.5 (*6*)					38	19		
Winter average		4.9					44	24		
Maximum (24 h)		32.1					188	130		
98 percentile (24 h)		26.6					99	57		
Number of days exceeding the WHO-AQG		0					1	1		
Number of days exceeding 2 x WHO-AQG		0					0	0		

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: TSP $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	-	1			-	-	1	3	-	-
Annual average		36 (*14*)					110	82		
Winter average		40					133	80		
Maximum (24 h)		135					335	508		
98 percentile (24 h)		105					233	173		
Number of days exceeding the WHO-AQG		3					112	41		
Number of days exceeding 2 x WHO-AQG		0					3	1		

WHO-AQG TSP (24h max.) =120 $\mu g\ m^{-3}$

City: Copenhagen **Country:** Denmark

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	-	1	-	-	-	-	1	3	-	-
Annual average		14.5					70	67		
Maximum (24 h)		57.7					146	140		
Maximum (1 h)		65.8					293	296		
Number of days exceeding the WHO-AQG		0					0	0		
Number of days exceeding 2 x WHO-AQG		0					0	0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations		1						1		
Annual average		27						11		
Summer average		-						-		
Maximum (1 h)		97						62		
Maximum (8 h)		88						52		
98 percentile (1 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	-	1103
Annual average		2.2
Maximum (8 h)		9.4
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	1103	2
Annual average	0.62	0.25
Maximum monthly average	0.82	0.36
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

City: Dnepropetrovsk[1]	*Country*: Ukraine

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 215 000 (1992)	***1 215 000 (1992)***
Total area	(km^2)	397 (1992)	397 (1992)
Built-up area	(km^2)	222 (1992)	***222 (1992)***
Coordinates	(lat-/longitude)	48° 29' N 35° 00' E	

Major activities and development trends (1980-1990, 1990-2000)
Largest industrial centre of Ukraine, large railway junction, important river port (Dnepr river). Main industry: blast-furnaces, rolling mills. The population number is expected to rise to 1.3 million in 2010, the built-up area is expected to grow 4.55 km^2.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe, Donbass (coal) region
Topography: river basin Dnepr river, plain ***(0)***

Climate: Bsk (Köppen-Geiger)
Meteorology: Calms 25%.In winter inversions (10-250 m) more than 40%.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	8.7	6.8	10.2	8.1
precipitation (mm)	446	684	458	597
cloud cover (8^{-1})				6.0
wind speed[2] ***($m\ s^{-1}$)***	***4.5 (+)***	***4.8 (+)***	***4.5 (+)***	4.2
winter smog index[2]	***21 (-)***	***24 (-)***	***14 (0)***	
summer smog index	***28 (-)***	***28 (-)***	***29 (-)***	

Station: Dnepropetrovsk 48° 22' N 35° 05' E

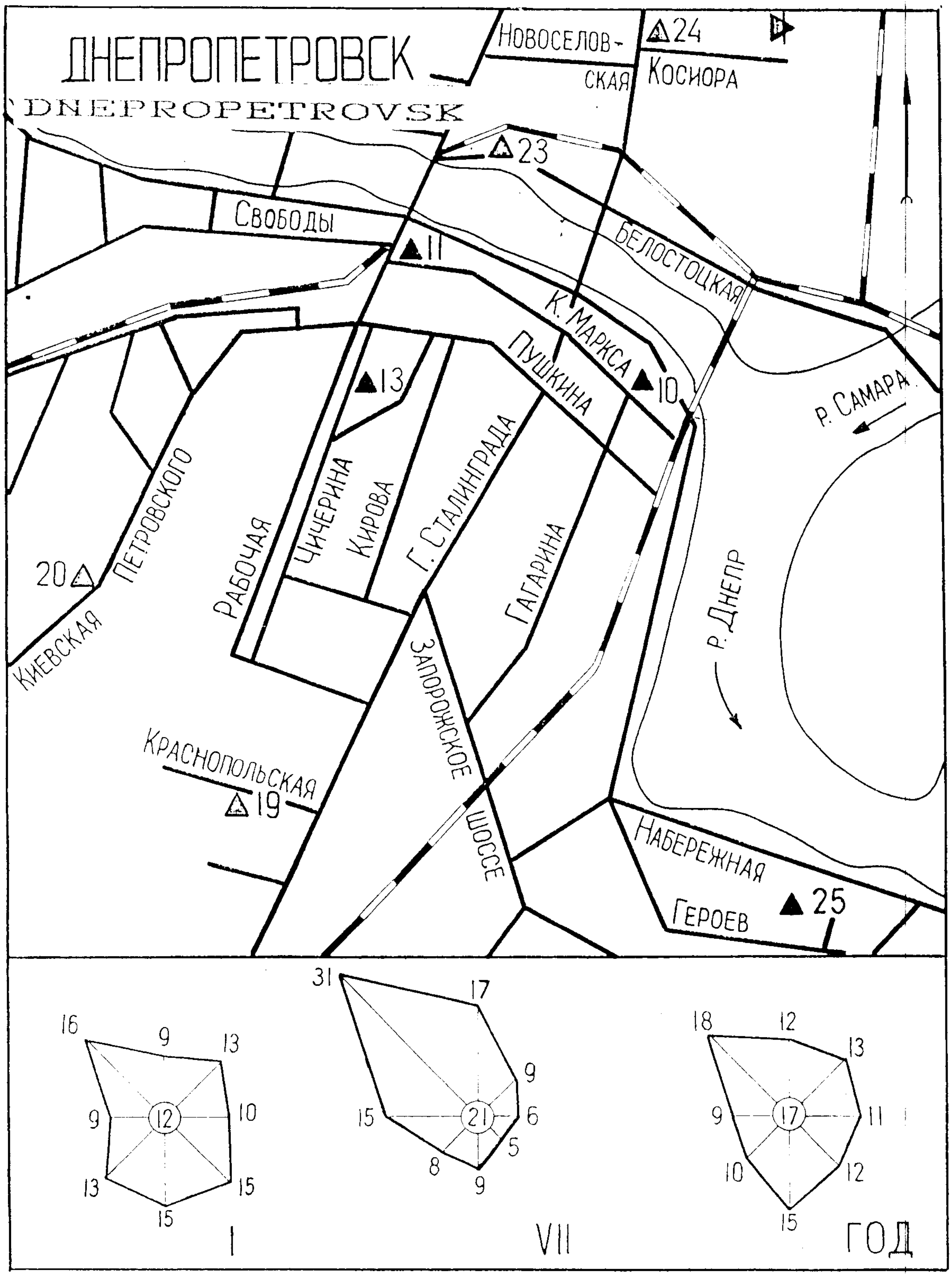
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	8	8	11	8	8	7	5	7	10	13	8	7	13
$m\ s^{-1}$	6.0	5.6	6.0	5.8	5.2	5.2	5.7	5.5	4.9	5.1	5.8	5.8	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	10	9	6	5	6	5	5	8	11	14	9	12	13
$m\ s^{-1}$	4.6	4.7	4.5	4.8	4.4	4.1	4.9	5.6	5.2	5.0	6.0	6.2	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.5	82.8		-	
Domestic/space heating						
Industry and power plants	110.8	41.0	61.0		72.6	
Total	110.8	46.5	143.5		72.6	
Per capita (**kg**)	93.7	39.3	121.4		61.4	
Per km^2 (**t**)	499.1	209.5	646.4		327.0	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.6	65.6	-	-	
Domestic/space heating						
Industry and power plants	89.2	42.3	49.8	8.4	62.7	0.0017
Total	89.2	46.9	115.4	8.4	62.7	
Per capita (**kg**)	71.9	37.8	93	6.5	50.5	
Per km^2 (**t**)	401.8	211.3	519.8	37.8	282.4	

Emission class	1990
Winter smog emissions	***4***
Summer smog emissions	***2***

Major (industrial) point sources

In addition to the emissions given in the Table, 353 t hydrogen sulphide, 206 t ammonia and 85 t phenol are emitted.

Traffic

Traffic is responsible for 24% of total emissions.
Public transport: 851 buses. Non-electrical: buses 1 161 940 passenger km a^{-1}. Electrical: tram/trolley bus: 289.2 x 10^6 passenger km a^{-1}.

Local policies to reduce air pollution

Industry: *Some outdated emission treatment installations have been replaced. Emission standards have been set.*
Traffic: *Diesel buses have been equipped with catalytic converters (financed by municipality).*

VI. AIR QUALITY DATA

Monitoring network

Dnepropetrovsk has 8 stations operated by the state service, which monitors the state of the natural environment in Ukraine. The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the State Committee of the Ukraine for Hydrometeorology is in charge of methodology.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 10, 24, 25		No. 24		No. 11		No. 20
Annual average		*12*		9		14		11		18
Winter average				12		17		13		18
Maximum (24 h) *calculated*				*70*		*89*		*93*		*124*
98 percentile (20 min)*				37		50		48		68
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0(*0*)		0(*0*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

Reported SO_2 concentrations are low, they do not exceed the WHO-AQG.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 10, 24	No. 10, 24	No. 24	No. 24	No. 11	No. 11	No. 20	No. 20
Annual average		*29*	250	100	300	130	700	430	200	220
Winter average			250	110	280	120	520	400	270	180
Maximum (24 h)										
98 percentile (20 min)			680	390	890	450	1860	1410	780	790
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations for 1990 are markedly lower than in 1985, concentrations are still very high and the WHO-AQG is likely to be exceeded on numerous days, especially near roads and at industrial sites. Highest concentrations are observed during the summer when soil particulates add to the dust concentrations.

Winter smog classification	1990
Exceedance class[5]	***2***
Exposure class[5]	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 10, 24	No. 10, 24	No. 24	No. 24	No. 11	No. 11	No. 20	No. 20
Annual average			45	35	60	50	60	60	50	50
Maximum (24 h)										
Maximum (20 min)			150	210	150	210	150	340	200	650
Number of days exceeding the WHO-AQG			0	0	0	0	1	3	0	4
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported NO_2 concentrations near motorways and at the industrial site are likely to exceed the WHO-AQG on a few days per year. Highest city background concentrations are found in the northern part of the city.

Phenol concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	20	20
Annual average	4	4
98 Percentile (20 min)	12	12

NH_3 concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	20	20
Annual average	80	30
98 Percentile (20 min)	310	160

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	11	11
Annual average	5	5
98 Percentile (20 min)	31	26

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		11
Annual average		0.0076
Maximum monthly average		0.0121

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	11	11
Annual average	3	3
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		20
Annual average		0.08
Maximum monthly average		0.16
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station. The location of the station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

***City*:** Donetsk[1]	***Country*:** Ukraine

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 121 000 (1992)	***1 121 000 (1992)***
Total area	(km^2)	366 (1991)	366 (1991)
Built-up area	(km^2)	236 (1992)	***236 (1992)***
Coordinates	(lat-/longitude)	48° 00' N 37° 50' E	

Major activities and development trends (1980-1990, 1990-2000)
Donetsk is an important centre of the Donbass region. The Donetsk conurbation includes the towns Avdeevka, Gorlovka, Donetsk, Enakievo and Yasinonataya. It is an important traffic junction (railway and roads). Main industries: blast-furnaces, rolling mills, chemical industry, heavy engineering.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe, Donbass (coal) region ***Topography*:** Sited along the Kalmius River, plain. *(+)*	Climate: Bsk (Köppen-Geiger) Meteorology: Calms (0-1 m s^{-1}) 30%. Inversions (10-500 m) mean 20%, 40% in winter.

Averages	1980-1989	1985	1989	1990[3]
temperature (°C)	8.0	6.9	9.3	7.5
precipitation (mm)	467	725	366	629.3
cloud cover (8^{-1})				5.7
wind speed (m s^{-1})	***4.4 (+)***	***4.6 (+)***	***4.3 (+)***	4.5
winter smog index [2]	***21 (0)***	***20 (0)***	***13 (0)***	
summer smog index	***23 (0)***	***18 (0)***	***29 (-)***	
Station:			Donetsk 48° 04' N 37° 46' E	

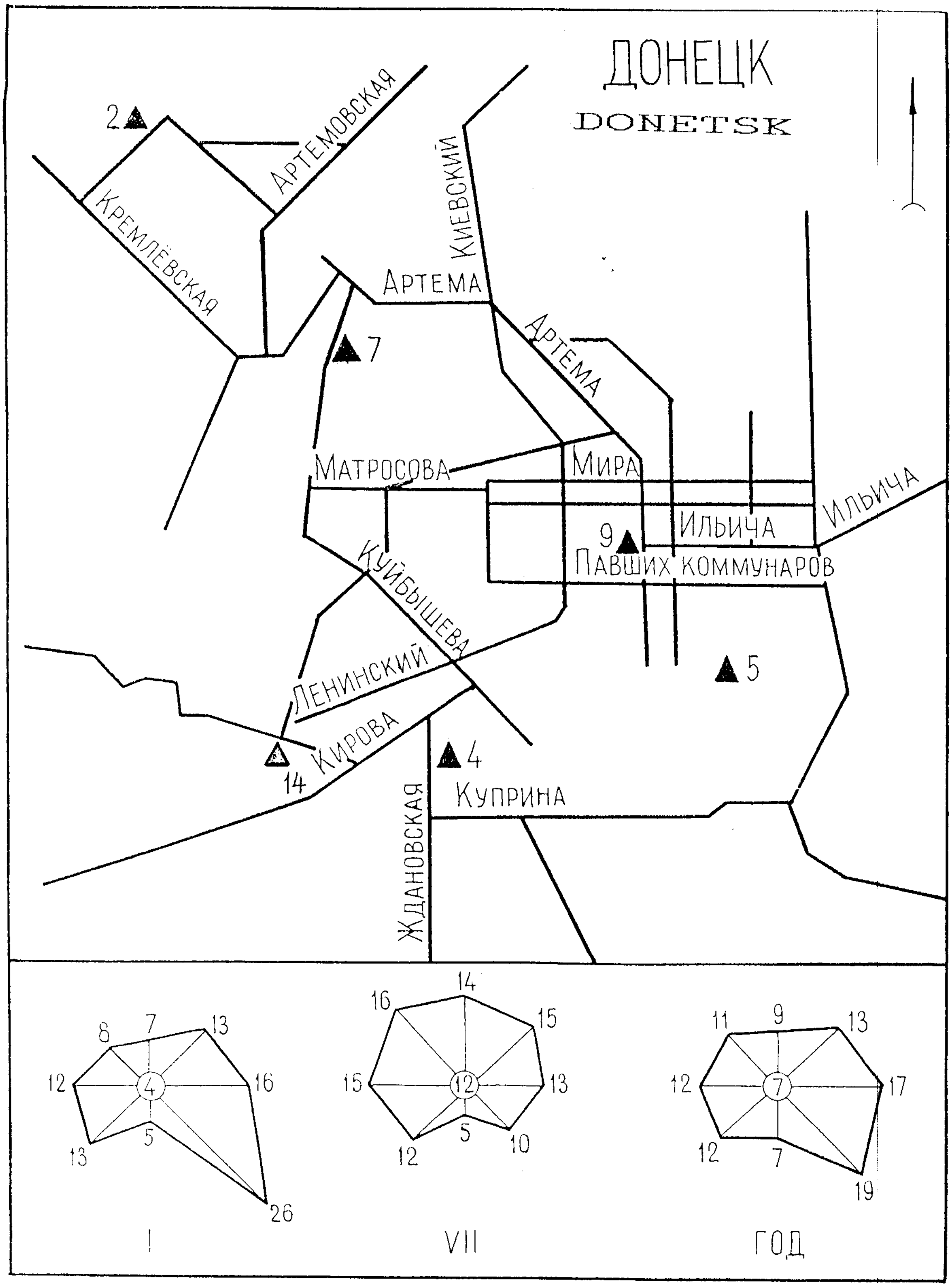
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	2	7	10	10	17	9	6	8	11	11	6	3	9
m s^{-1}	4.2	4.3	4.8	5.6	5.9	5.1	4.4	4.5	4.8	5.2	5.2	5.0	

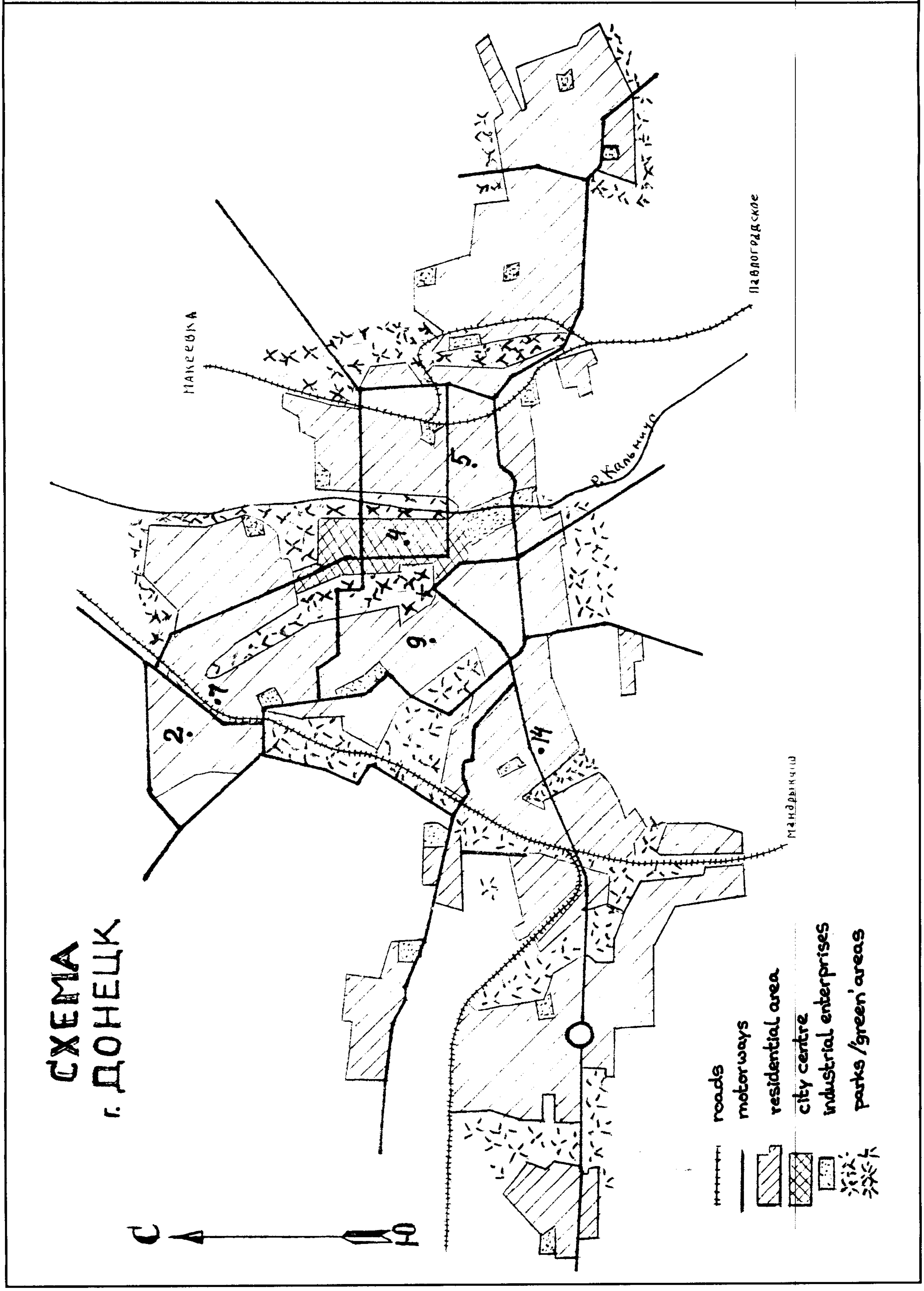
Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	6	8	6	3	10	10	7	11	14	8	10	7	17
m s^{-1}	4.2	3.9	3.8	3.9	5.0	4.6	4.6	4.7	5.0	5.1	4.9	4.6	

Main topography, city morphology, industrial sources and monitoring network



Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	7.1	99.3		-	
Domestic/space heating						
Industry and power plants	31.6	6.9	110.1		21.7	
Total	31.6	14.0	209.4		21.7	
Per capita (**kg**)	29.0	12.8	192.1		19.9	
Per km² (**t**)	133.9	50.3	887.2		91.9	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.3	80.2	-	-	
Domestic/space heating						
Industry and power plants	30.9	6.1	102.2	1.7	23.8	0.001
Total	30.9	11.4	182.4	1.7	23.8	
Per capita (**kg**)	28.0	10.3	165.0	1.5	21.5	
Per km² (**t**)	118.6	48.3	722.9	7.2	100.8	

Emission class	1990
Winter smog emissions	*3*
Summer smog emissions	*1*

Major (industrial) point sources

The main branches of industry are mining (coal) and metallurgy (14% of industrial emissions). Industry is responsible for 59% of total emissions. Also emitted are 3318 t of hydrogen sulphide, 208 t of ammonia and 15 t of acetone per year.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	*78 770*	x 10^9
of which:		
· passenger cars	*53 718*	
· buses	*5 140*	
· freight traffic >3.5 t	*19 915*	

Traffic/space domestic heating

Traffic is responsible for 37% of total emissions.
Annual consumption of fuel by space/domestic heating (2.7% of total emissions): 345 kt coal, 42.7x10⁶ m³ natural gas .

VI. AIR QUALITY DATA

Monitoring network
6 stations are operated by the State Service in Donetsk which monitors the state of the natural environment in Ukraine. The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the State Committee of the Ukraine for Hydrometeorology is in charge of methodology.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 2, 4, 14		No. 14		No. 7		No. 9
Annual average		*31*		28		32		35		88
Winter average				26		27		43		135
Maximum (24 h) *calculated*				*230*		*330*		*276*		*560*
98 percentile (20 min)*				118		160		145		315
Number of days exceeding the WHO-AQG (*+calc.*)				1(*6*)		2(*13*)		0(*10*)		1(*60*)
Number of days exceeding 2 x WHO-AQG				0		0(≥*1*)		0(≥*1*)		0(≥*1*)

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations
SO_2 city background concentrations are likely to exceed WHO-AQGs on a few days per year. At the industrial site concentrations are high; calculations show that the WHO-AQG is likely to be exceeded on over 30 days.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 2, 4	No. 2, 4	No. 2	No. 2	No. 7	No. 7	No. 9	No. 9
Annual average		*56*	900	415	1100	480	800	530	800	600
Winter average			485	415	400	430	680	520	500	530
Maximum (24 h)										
98 percentile (20 min)				1470		1580		1730		1960
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Annual mean TSP concentrations are very high. The WHO-AQG is likely to be breached on numerous days. Highest concentrations are observed during the dry summer when soil particulates add to dust concentrations.

Winter smog classification	1990
Exceedance class[5]	***4***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 2, 4	No. 2, 4	No. 2	No. 2	No. 7	No. 7	No. 9	No. 9
Annual average			70	70	80	70	100	110	90	110
Maximum (24 h)										
Maximum (20 min)			835	350	1310	310	1310	670	460	760
Number of days exceeding the WHO-AQG			31	0	43	0	25	5	7	2
Number of days exceeding 2 x WHO-AQG			9	0	18	0	4	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Nitrogen dioxide concentrations are high. In the industrial area and along motorways (station 7, 9) concentrations are up to 50% higher than in the city background. The WHO-AQG is exceeded in almost all areas of the city.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		4
Annual average		13
98 Percentile (20 min)		56

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		9
Annual average		0.0153
Maximum monthly average		0.0295

Phenol concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		4
Annual average		5
98 Percentile (20 min)		24

NH_3 concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		7
Annual average		130
98 Percentile (20 min)		430

Formaldehyde concentrations/Benzo(a)pyrene concentrations/Phenol concentrations/Ammonia concentrations
The annual mean formaldehyde and ammonia concentrations are 4 times as high as their national standard. The annual mean concentration of phenol is almost 2 times higher than the national standard. The highest B(a)P concentrations are observed during the winter when concentrations exceed the national standard by the factor of almost 30.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	7	7
Annual average	2	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		9
Annual average		0.17
Maximum monthly average		0.34
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO and Pb concentrations do not exceed WHO-AQGs.

VII. Effects

Effects of air pollution on health
The number of cases of respiratory diseases in Donetsk is 74% higher than the average for the cities of the former Soviet Union.

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1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station. The location of the station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Dortmund	*Country*: Germany

I. GENERAL DATA

		City		Conurbation
Population	(number)	***600 000***		
Total area	(km^2)			
Built-up area	(km^2)	***280***		
Coordinates	(lat-/longitude)	51°32' N 7°27' E		

Major activities and development trends (1980-1990, 1990-2000)
Situated in centre of coal basin Westfalen.
Industries: iron and steel industry, heavy engineering, chemical industry.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, centre part of Nordrhein Westfalen.
Topography: plain (+)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.6	8.4	10.9
precipitation (mm)	785.2	921.9	828.6
wind speed ($m\ s^{-1}$)	***3.5 (0)***	***3.7 (0)***	***3.0 (-)***
winter smog index	***7.6 (+)***	***7.8 (+)***	***6.6 (+)***
summer smog index	***8.7 (0)***	***4.4 (+)***	***14.3 (0)***

Station: 10410 — 51° 24' N 6° 58' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***1***
Summer smog emissions[1]	***2***

VI. AIR QUALITY DATA

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*14*				
Mean of stations in city background	1985 1989	1 3	68 24.7	526 93	350 81.3		
Highest observed concentrations	1985 1989		68 27	526 102	350 87		

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*31*				
Mean of stations in city background	1985 1989	1 3	74 71.7	598 222.3	262 174		
Highest observed concentrations	1985 1989		74 84	598 279	262 204		

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class	***1***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1985 1989	1 3	58 46		296 215.7		
Highest observed concentrations	1985 1989		58 49		296 234		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1/2 h)	98 percentile (1/2 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	1	31	236	143			***2***
Highest observed concentrations	1989		31	236	143			

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. Uncertain data.

***City*:** Dresden	***Country*:** Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	***480 000***	
Total area	(km^2)	230	
Built-up area	(km^2)	***226***	
Coordinates	(lat-/longitude)	51° 03' N 13° 45' E	

Major activities and development trends (1980-1990, 1990-2000)
Trading and industrial centre.
Industries: paper, textile, airplanes, metallurgical, chemical and optical industries.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, in the eastern part of the country
***Topography*:** valley (river basin) **(--)**

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.0	8.1	10.3
precipitation (mm)	526.9	596.5	690.4
wind speed ($m\ s^{-1}$)	***2.8 (-)***	***2.7 (-)***	***2.7 (-)***
winter smog index	***13.9 (0)***	***12.6 (0)***	***9.1 (+)***
summer smog index	***18.0 (0)***	***14.1 (0)***	***21.0 (0)***

Station: 9485 — 51° 08 ' N 13° 47' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions	***2***

VI. AIR QUALITY DATA

Monitoring network

SO_2 concentration in 1985: 120 µg m^{-3} annual average with a maximum of 1 112 µg m^{-3}.
SO_2 concentration in 1990: 76 µg m^{-3} annual average with a maximum of 344 µg m^{-3}.

Maximum NO_2 concentration in 1990: 82 µg m^{-3}.

Regional background (1990):
SO_2 concentration: 63 µg m^{-3} annual average
TSP concentration: 60 µg m^{-3} annual average

Winter smog classification	1989
Exceedance class	***2***
Exposure class	***3***

1. Uncertain data.

City: Dublin	*Country*: Ireland

I. GENERAL DATA

		City		Conurbation
Population	(number)	478 000 (1991)		***547 000 (1991)***
Total area	(km^2)	115 (1991)		806 (1991)
Built-up area	(km^2)			***115***
Co-ordinates	(lat-/longitude)	53 ° 20 ' N 6 ° 15 ' W		

Major activities and development trends (1980-1990, 1990-2000)
Large port area and numerous industrial estates both urban and suburban. Airport in the north west. 5 industrial plant licences in city area.

There has been a decrease in the city area, but the total Dublin population increased from 1986 to 1991.

Constituent communities: Dublin-Fingal, Dublin-Belgard, Dun Laoghaire-Rathdown.

II. TOPOGRAPHY AND CLIMATOLOGY

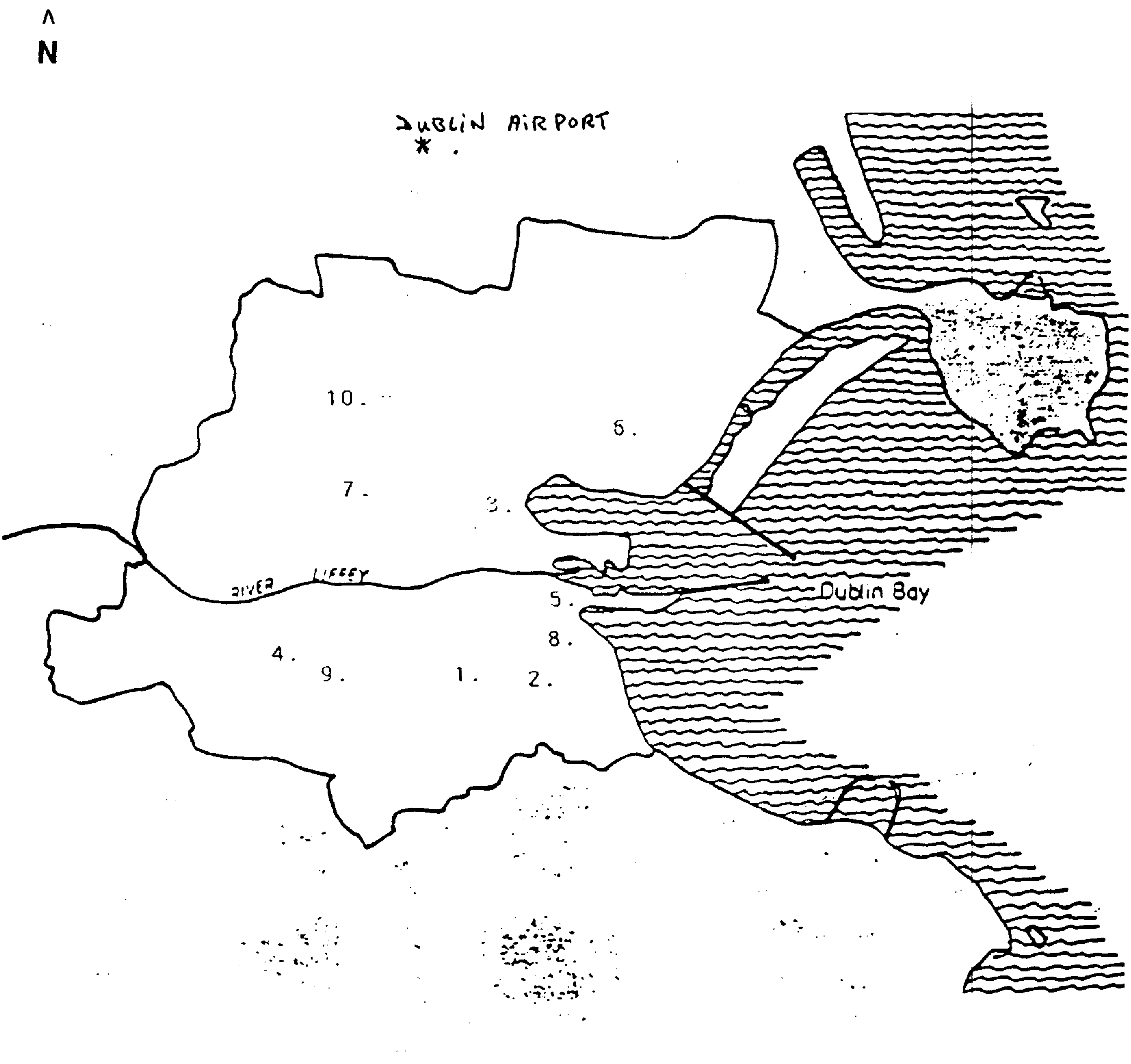
Region: West Europe, eastern part of Ireland.
Topography: Coastal (island). ***(0)***

Climate: (Cfb)
Meteorology: Stability category: class D - neutral.
Main winds: South westerly.

Averages	1980-1989	1985	1989
temperature (°C)	9.7	9.4	10.7
precipitation (mm)	600.9	781.5	564.9
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.7 (+)***	***4.5 (+)***	***4.8 (+)***
winter smog index	***6.3 (+)***	***6.4 (+)***	***6.0 (+)***
summer smog index	***0.3 (++)***	***0.0 (++)***	***0.5 (++)***

City: Dublin **Country**: Ireland

Main topography, city morphology, industrial sources and monitoring network



1.RATHMINES. 2.R D S. 3.MOUNTJOY SQUARE.

4.BALLYFERMOT 5.SOUTH QUAYS. 6.CLONTARF.

7.CABRA. 8.HERBERT ST. 9.BLUEBELL.

10.FINGLAS.

City: Dublin **Country**: Ireland

III. EMISSIONS

Emission class	1990
Winter smog emissions	*2*
Summer smog emissions	*2*

Major (industrial) point sources

(see city map)
1. Power Plant (E.S.B).
2. Incinerators: 2 (+7 hospital incinerators).
3. Industrial plants: 2 (Licensed).

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

Use of natural gas is increasing with central heating systems. Open fires still common, with only "smokeless fuels" permitted by law to be used in city areas.

Local policies to reduce air pollution

Industry:
Licensing of industrial plants that fall within certain categories. Licence conditions mainly based on German T A Luft 1986.

Traffic:
EU Legislation - 1. Lead content in petrol.
2. Catalytic converter in 1993 compulsory.

Bus lanes utilised at peak traffic periods. Limited parking spaces in centre.

Domestic/space heating:
Ban on sale and distribution of bituminous coal in the city area. Ban on high-sulphur (>2%) solid fuel sale and distribution in the city area.

VI. AIR QUALITY DATA

Monitoring network

2 networks in all stations in city (I.E.) smoke + SO_2
(15 stations in city) - 4 inner city
Smog runs in winter for public if required. Otherwise councillor Q's or annual reports
8 leads stations
1 NO_x station

City: Dublin **Country**: Ireland

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	-	-	7	7			1	1	2	2
Annual average		*6*	43	27	58	28	45	25	32	28
Winter average			53	29	64	33	49	27	26	31
Maximum (24 h)			159	140	230	175	177	197	108	144
98 percentile (24 h)			114	72	127	95	115	102	78	96
Number of days exceeding the WHO-AQG			4	1	8	3	4	3	0	2
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: Black smoke $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	19__	1985	19__	1985	19__
Number of stations	-	-	7	7			1	1	2	2
Annual average		*11*	53	41	106	70	77	50	28	37
Winter average			110	72	167	110	123	70	43	32
Maximum (24 h)			471	637	884	1 098	601	926	304	759
98 percentile (24 h)					429	458	400	348	156	315
Number of days exceeding the WHO-AQG			39	20	107	42	61	20	11	18
Number of days exceeding 2 x WHO-AQG			9	7	26	14	22	12	10	1

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Winter smog classification	1990
Exceedance class	*3*
Exposure class	*4*

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	O'Connell Street	O'Connell Street
Annual average	1.32	0.267
Maximum monthly average	2.06	0.450
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

City: Duisburg	*Country*: Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	***535 000***	
Total area	(km^2)	***140***	
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	51°26' N 6°48' E	

Major activities and development trends (1980-1990, 1990-2000)
Centre of steel production, important inland harbour.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, western part of Nordrhein Westfalen
Topography: river basin (-)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.6	8.4	10.9
precipitation (mm)	785.2	921.9	828.6
wind speed (m s^{-1})	***3.5 (0)***	***3.6 (0)***	***3.2 (-)***
winter smog index	***7.6 (+)***	***7.8 (+)***	***6.6 (+)***
summer smog index	***8.7 (0)***	***4.4 (+)***	***14.3 (0)***

Station: 10410 51° 24' N 6° 58' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***1***
Summer smog emissions[1]	***2***

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*14*				
Mean of stations in city background	1985 1989	1 4	80.8 36.3	699 133	367 95.3	53 2	13 0
Highest observed concentrations	1985 1989		80.8 36.7	699 135	367 108	53 4	13 0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*30*				
Mean of stations in city background	1985 1989	1 4	97.3 70.2	448 221	245 167	27 14	3 1
Highest observed concentrations	1985 1989		97.3 80.9	448 266	245 209	27 20	3 2

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class	***2***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	3	48.0	130	273	0	0
Highest observed concentrations	1989		49.0	146	280	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	1	31.5	211	144	..	0	*2*
Highest observed concentrations	1989	1	31.5	211	144	..	0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Dusseldorf	*Country*: Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	***577 000***	
Total area	(km^2)	220	
Built-up area	(km^2)	***95***	
Coordinates	(lat-/longitude)	51°13' N 6°47' E	

Major activities and development trends (1980-1990, 1990-2000)
Administrative centre with trading and marketing function.
Industries: metallurgical industry, chemical products, glass, paper, cars and food processing
Inland harbour and airport.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, western part of Nordrhein Westfalen
Topography: river basin (-)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	10.3	9.3	11.1
precipitation (mm)	647.7	814.7	679.3
wind speed ($m\ s^{-1}$)	***3.7 (0)***	***3.6 (0)***	***3.2 (0)***
winter smog index	***7.5 (+)***	***8.8 (+)***	***9.3 (0)***
summer smog index	***14.3 (0)***	***8.1 (0)***	***23.1 (0)***

Station: 10400 51° 17' N 6° 47' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***1***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*15*				
Mean of stations in city background	1989	3	26.3	81	66	0	0
Highest observed concentrations:							
City background	1989		29.7	85	74	0	0
Traffic site	1989		24.8	98	65	0	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*31*				
Mean of stations in city background	1989	3	57.9	149	120	4	0
Highest observed concentrations:							
City background	1989		60.0	157	130	6	0
Traffic site	1989		68.0	231	154	12	0

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class[1]	*1*
Exposure class	*3*

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	3	43.2	111	180	0	0
Highest observed concentrations:							
City background	1989		46.5	122	198	0	0
Traffic site	1989		58.0	131	202	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	1	29.4	208	146		0	*2*
Highest observed concentrations	1989		29.4	208	146		0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations Traffic site 1985	1989
Station number/name		Reisholz
Annual average		1.65
Maximum (8 h)		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations Traffic site 1985	1989
Station number/name		Reisholz
Annual average		0.26
Maximum monthly average		
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

---

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Essen	*Country*: Germany

I. GENERAL DATA

		City		Conurbation
Population	(number)	***627 000***		
Total area	(km^2)	***300***		
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	51°27' N 6°57' E		

Major activities and development trends (1980-1990, 1990-2000)
Industrial and administrative centre with iron and metallurgical industry, building and cement industries, chemical products, glass and textile industries.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, western part of Nordrhein Westfalen
Topography: river basin (-)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.6	8.4	10.9
precipitation (mm)	785.2	921.9	828.6
wind speed (m s^{-1})	***3.5 (0)***	***3.7 (0)***	***3.0 (-)***
winter smog index	***7.6 (+)***	***7.8 (+)***	***6.6 (+)***
summer smog index	***8.7 (0)***	***4.4 (+)***	***14.3 (0)***

Station: 10410 — 51° 24' N 6° 58' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***1***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network

Essen

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*15*				
Mean of stations in city background	1989	3	31.3	114	87	1	0
Highest observed concentrations:							
City background	1989		32.8	151	110	4	0
Industrial site	1989		47.4	185	351	2	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*31*				
Mean of stations in city background	1989	3	57.2	175	124	5	1
Highest observed concentrations:							
City background	1989		65.1	247	151	11	1
Industrial site	1989		80.7	319	267	21	4

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class	***1***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	3	44.6	115	268	0	0
Highest observed concentrations:							
City background	1989		47.5	130	350	0	0
Industrial site	1989		47.4	185	351	2	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations $\mu g\ m^{-3}$	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	1	26.6	210	123		0	***2***
Highest observed concentrations	1989		26.6	210	123		0	

WHO-AQG Ozone (1h max.) = 150 $\mu g\ m^{-3}$

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Frankfurt	***Country***: Germany

I. GENERAL DATA

		City		Conurbation
Population	(number)	623 000 (1988)		***645 000 (1992)***
Total area	(km^2)			
Built-up area	(km^2)			***50***
Coordinates	(lat-/longitude)	50° 06' N 8° 41' E		

Major activities and development trends (1980-1990, 1990-2000)
Financial centre and traffic junction with airport and inland harbour.
Industries: heavy engineering, chemical and electro-technical industries

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, southern part of Hessen
Topography: river basin, hills **(--)**

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.7	8.8	10.7
precipitation (mm)	515	482	1487
wind speed ($m\ s^{-1}$)	***3.2 (0)***	***3.4 (0)***	***2.7 (-)***
winter smog index	***10 (0)***	***8 (+)***	***10 (0)***
summer smog index	***18 (0)***	***12 (0)***	***21 (0)***

Station: 10637 — 50° 03' N 8° 36' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network

VI. AIR QUALITY DATA [2]

SO_2 concentrations $\mu g\ m^{-3}$	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*11*				
Mean of stations in city background	1989	1	26.7	115	65	0	0
Highest observed concentrations	1989		26.7	115	65	0	0

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

TSP concentrations $\mu g\ m^{-3}$	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*27*				
Mean of stations in city background	1989	1	60.2	147	128	13	0
Highest observed concentrations	1989		60.2	147	128	13	0

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Winter smog classification	1989
Exceedance class[1]	*1*
Exposure class[1]	*2*

NO_2 concentrations $\mu g\ m^{-3}$	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	1	54.3	134	215	0	0
Highest observed concentrations	1989		54.3	134	215	0	0

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

O_3 concentrations $\mu g\ m^{-3}$	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	1	28.6	277	146		0	*2*
Highest observed concentrations	1989		28.6	277	146		0	

WHO-AQG Ozone (1h max.) = 150 $\mu g\ m^{-3}$

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

***City*:** Gdansk	***Country*:** Poland

I. GENERAL DATA

		City		Conurbation
Population	(number)	***467 000 (1992)***		
Total area	(km^2)	***50***		
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	54° 22' N 18° 41' E		

II. TOPOGRAPHY AND CLIMATOLOGY

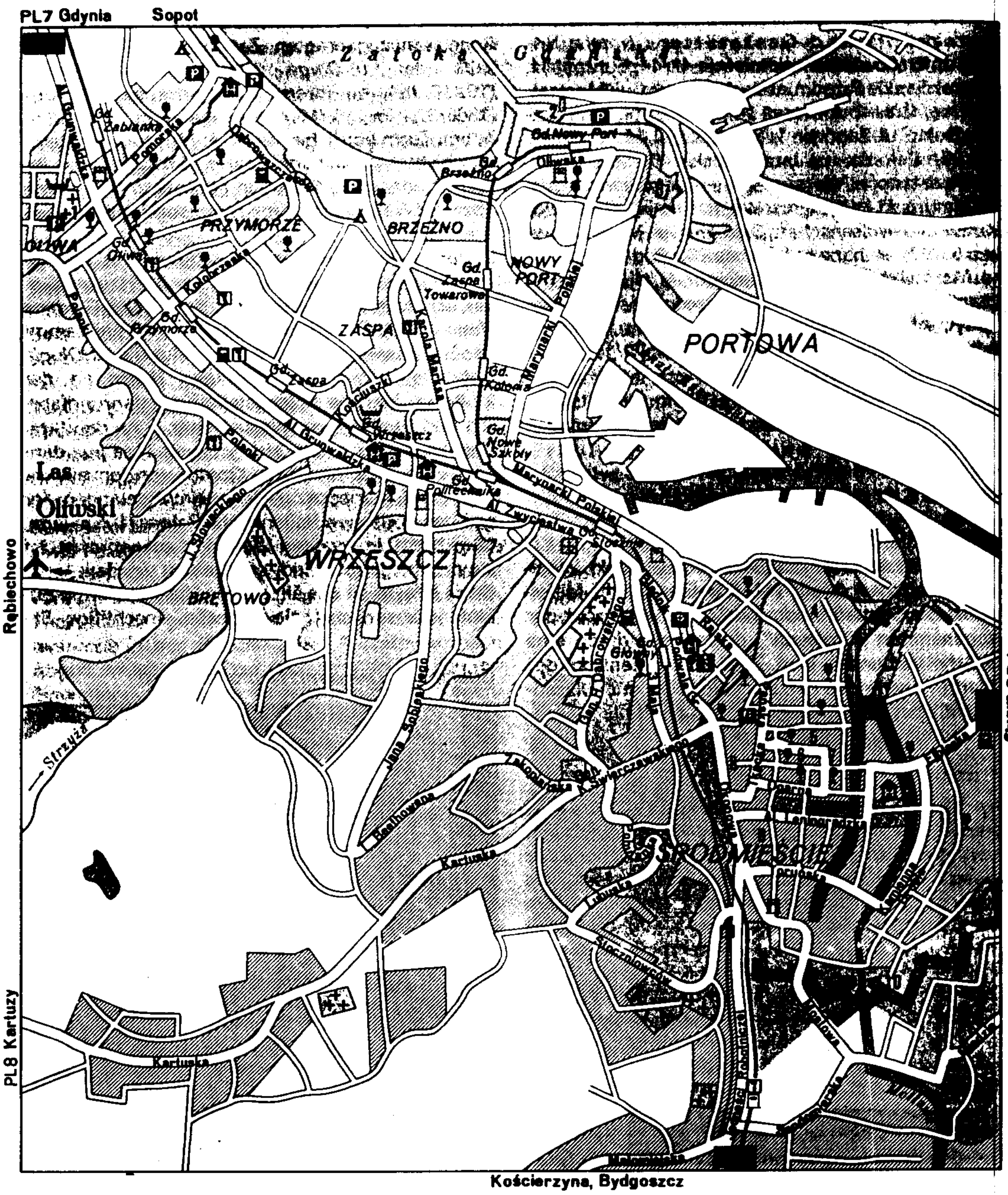
Region: Central Europe ***Topography*:** coastal *(++)*	Climate: Cfb (Köppen-Geiger) Meteorology: -		
Averages	1980-1989	1985	1989
temperature (°C)	8.0	7.8	9.5
precipitation (mm)	352	353	634
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.2 (+)***	***4.0 (+)***	***4.6 (+)***
winter smog index	***14 (0)***	***17 (0)***	***8 (+)***
summer smog index	***2 (++)***	***1 (++)***	***3 (+)***

III. EMISSIONS

Emission class	1990
Winter smog emissions	***4***
Summer smog emissions[1]	***2***

1. Uncertain data.

Main topography, city morphology, industrial sources and monitoring network



City: Genoa	*Country*: Italy

I. GENERAL DATA

		City		Conurbation
Population	(number)			***696 000 (1992)***
Total area	(km^2)			
Built-up area	(km^2)			***240***
Coordinates	(lat-/longitude)	44° 24' N 8° 56' E		

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and industrial centre. Important harbour for Switzerland (oil/coal). Industry: shipyards, car manufacturing, machine building, refineries, chemicals. City has a lot of monuments.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: South Europe (Mediterranean)
Topography: coastal, hills **(0)**

Climate: Csa (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	15.6	15.2	16.5
precipitation (mm)	855	1042	952
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.4 (0)***	***3.4 (0)***	***3.4 (0)***
winter smog index	***2 (++)***	***3 (++)***	***1 (++)***
summer smog index	***40 (-)***	***43 (-)***	***38 (-)***

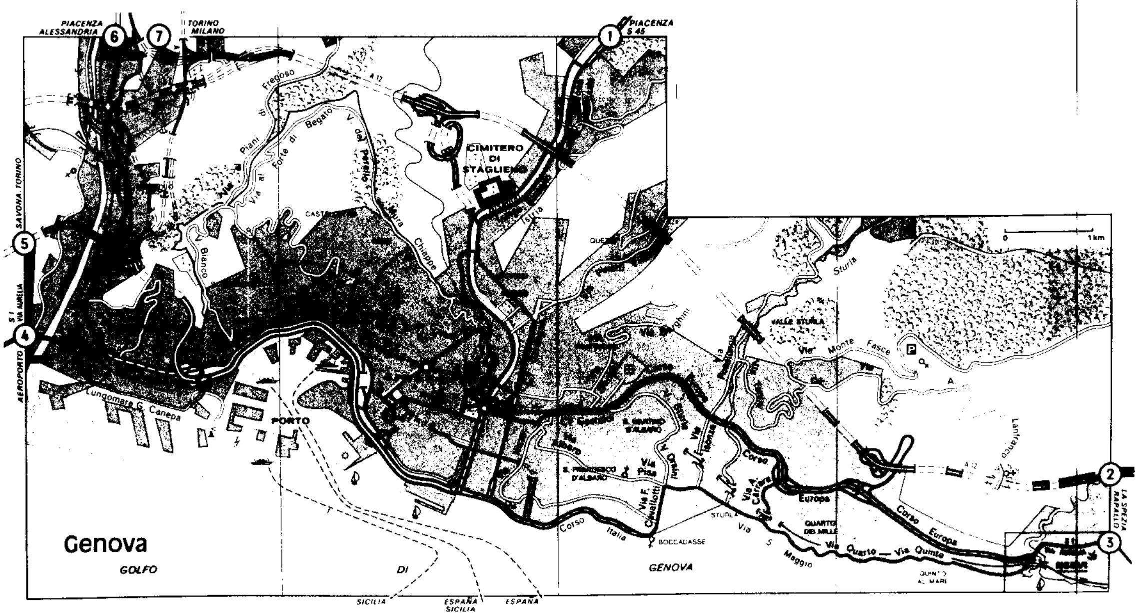
Station: Genova Sestri 44° 25' N 08° 51' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions[1]	***2***

1. Uncertain data.

Main topography, city morphology, industrial sources and monitoring network



City: Glasgow	*Country*: United Kingdom

I. GENERAL DATA

		City	Conurbation
Population	(number)	650 000 (1994)	***894 000***
Total area	(km^2)		
Built-up area	(km^2)	150 (1994)	***150***
Coordinates	(lat-/longitude)	55° 53' N 4° 18' W	

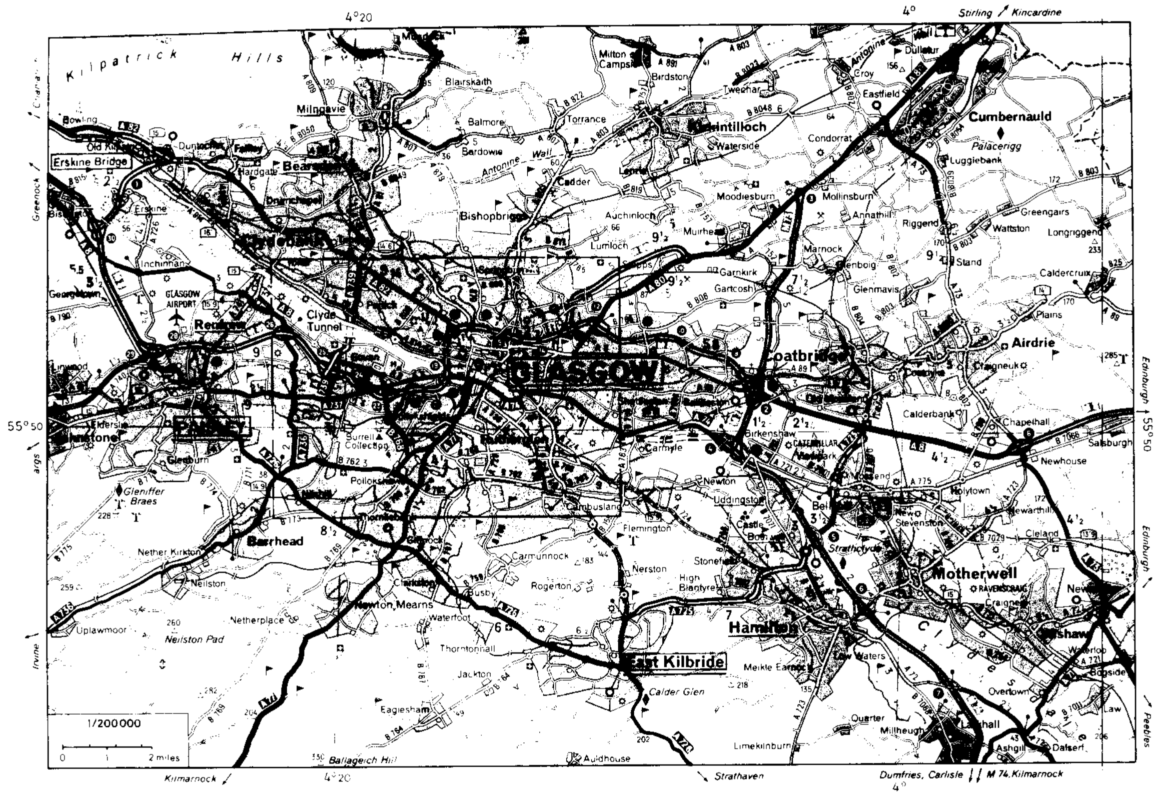
II. TOPOGRAPHY AND CLIMATOLOGY

Region: Western Europe *Topography*: coastal, valley *(-)*	Climate: Cfb (Köppen-Geiger) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	8.7	7.9	92
precipitation (mm)	931	1201	1038
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.2 (+)***	***3.8 (0)***	***4.3 (+)***
winter smog index	***12 (0)***	***14 (0)***	***18 (0)***
summer smog index	***1 (++)***	***0 (++)***	***4 (+)***

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA

Monitoring network

Smoke/SO_2 monitoring for Warren Spring Laboratories - 5 sites throughout city.
NO_2 diffusion tubes - new 10 year survey commenced 1993 (4 sites).
Heavy metals in air - millipore samples (5 sites).

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations	
	Reg. background		City		City	
	1985	1990	1985/86	1990/91	1985/86	1990/91
Number of stations			3	2	Montrose street	Bailliest
Annual average		*9*	40	33	40	32
Winter average			40	36	40	36
Maximum (24 h)			108	86	119	89
98 percentile (24 h)			77	69	82	74
Number of days exceeding the WHO-AQG			0	0	0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: black smoke µg m^{-3}	Mean of stations				Highest observed concentrations	
	Reg. background		City		City	
	1985	1990	1985/86	1990/91	1985/86	1990/91
Number of stations			3	2	Bailliest	Bailliest
Annual average		*8*	18	15	20	14
Winter average			26	23	31	22
Maximum (24 h)			139	133	150	136
98 percentile (24 h)			82	78	106	80
Number of days exceeding the WHO-AQG						
Number of days exceeding 2 x WHO-AQG			0	0	0	0

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	19__	1985	19__	1985	1990	1985	19__
Number of stations										
Annual average								50		
Maximum (24 h)								103		
Maximum (1 h)								218		
Number of days exceeding the WHO-AQG								0		
Number of days exceeding 2 x WHO-AQG								0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

City: Glasgow **Country**: United Kingdom

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		
Annual average		1.3
Maximum (8 h)		9.0
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	City	
	1985	1990
Station number/name		
Annual average	600	300
Maximum monthly average		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

---

1. Uncertain data.

City: Gothenburg	***Country***: Sweden

I. GENERAL DATA

		City		Conurbation
Population	(number)	514 000 (1989)		***734 000 (1992)***
Total area	(km^2)			654 (1989)
Built-up area	(km^2)			***132 (1989)***
Co-ordinates	(lat-/longitude)	57°43' N 11°58' E		

Major activities and development trends (1980-1990, 1990-2000)

Important commercial, industrial and administrative centre. Major industrial activities are concentrated in and around the harbour areas, on the island Hisingen. Petrochemical industries in the north side of the harbour. The largest car factory in Sweden, Volvo, is located in Torslanda on Hisingen.

Constituent communities: Gøteborg, Mölndal and Partille.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: West coast of Sweden.
Topography: Located at the river Göta älv estuary, surrounded by hills, there are 3-4 valleys leading into the centre *(++)*.

Climate: Coastal climate (Cfb).
Meteorology: Rainy all year, seldom snow or ice.

Averages	1980-1989	1985	1989
temperature (°C)	7.1	5.3	8.4
precipitation (mm)	706.2	1 027.2	832.7
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.0 (+)***	***3.6 (0)***	***4.5 (+)***
winter smog index	***18.7 (0)***	***25.0 (-)***	***11.6 (0)***
summer smog index	***2.4 (+)***	***0.2 (++)***	***2.4 (+)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	6.2	8.2	8.2	4.4	3.0	6.3	8.3
1985	Wind speed m s^{-1}	3.4	3.7	4.4	4.8	3.2	3.3	4.0
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	10.7	12.7	12.5	8.2	5.4	6.0	
	Wind speed m s^{-1}	5.5	4.7	5.6	5.7	4.0	<0.5	

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	1.9	3.0	4.1	9.2	11.2	12.9	16.7
1990	Wind speed m s^{-1}	2.2	2.2	2.5	3.0	2.7	3.6	5.1
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	13.1	8.3	5.8	4.8	2.7	6.2	
	Wind speed m s^{-1}	5.8	5.5	5.1	3.7	3.2	<0.5	

City: Gothenburg **Country**: Sweden

Main topography, city morphology, industrial sources and monitoring network

^
N

1. FEMMAN
2. JÄRNTOKHOL
3. MÖLNDAL
4. VOLVO
5. BP
6. SHELL

City: Gothenburg **Country:** Sweden

III. EMISSIONS

Annual emissions per source and totals in 1992 (kt a^{-1})

Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	1.015	15.00	67.45	8.525		
Domestic/space heating	0.52	0.9	0.08	0.06		
Industry and power plants	0.55	1.7	0.07	11.3		
Total	2.1	17.5	67.6	19.9		
Per capita (**kg**)	2.9	23.8	92.1	27.1		
Per km^2 (**t**)	3.2	26.8	103.8	30.4		

Emission class	1992
Winter smog emissions	***1***
Summer smog emissions	***2***

Major (industrial) point sources

(see city map)

Volvo Car factory: VOC = 1 186 t a^{-1}, NO_X = 148 ", SO_2 = 6 "

Shell Oil refinery: VOC = 4 039 t a^{-1}, NO_X = 598 ", SO_2 = 626 "

OK/BP Oil refinery: VOC = 3 200 t a^{-1}, NO_X = 597 ", SO_2 = 328 "

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles	Total traffic activity veh km a^{-1}	Total annual consumption of fuel for traffic	Consumption (m^3 a^{-1}) 1985	Consumption (m^3 a^{-1}) 1988	Average Sulphur content (%) 1985	Average Sulphur content (%) 19__
Total	202 185	2.42 x 10^9					
of which:							
· passenger cars	196 406	2.3 x 10^9	Diesel oil		311 000		
· buses	805	0.045 x 10^9	Petrol/Gasoline				
· freight traffic >3.5 t	4 794	0.13 x 10^9	LPG				

Traffic

Number of cars with catalytic converters, ≈ 40% (1992/93).

City: Gothenburg **Country:** Sweden

Local policies to reduce air pollution
Industry: When establishing a rebuilding power plants with power effects more than 50 MW and produced energy/unit and year over 50 GWH, the emissions are limited to 100 µg/ms input fuel. **Traffic:** Emissions of VOC must be reduced by at least 40 % and NO_x by 30 % before 1996 (compared to 1988). **Domestic/space heating:** Total emissions of NO_x from composition and space heating must not exceed 1200 t a^{-1} by 1995.

VI. AIR QUALITY DATA

Monitoring network
6 monitoring stations report hourly to our computer system. Alerts are sent via personal "mobitex" receiver to all personnel. Daily reports are sent to local radio stations and reports are read into a telephone answering system three times daily. If the pollution level exceeds alert levels, they will be informed more frequently.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations			1	2				1		2
Annual average		2	10.7	7.1	10.7	9.3		4.2	15.5	3.3
Winter average			19.3	9.4	19.3	11.6		6.0	22.3	4.6
Maximum (24 h)			88.3	29.5	88.3	34.0		25.9	91.6	24.5
98 percentile (24 h)			68.2	23.6	68.2	26.4		17.8	61	17.4
Number of days exceeding the WHO-AQG			0	0	0	0		0	0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0		0	0	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: µg m^{-3} Black smoke	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	19__	1985	1992
Number of stations			1	1	1	1			1	1
Annual average		8	8	5	8	5			6	4
Winter average			34	9	34	9			10	10
Maximum (24 h)			49	35	49	35			42	32
98 percentile (24 h)			28	22	28	22			28	17
Number of days exceeding the WHO-AQG			0	0	0	0			0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0			0	0

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Winter smog classification	1992
Exceedance class	***0.5***
Exposure class[1]	***1***

City: Gothenburg **Country**: Sweden

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1992	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations			1	2				1		
Annual average			36	30	36	28		35		
Maximum (24 h)			117	100	117	104		88		
Maximum (1 h)			288	181	288	213		138		
Number of days exceeding the WHO-AQG			0	0	0	0		0		
Number of days exceeding 2 x WHO-AQG			0	0	0	0		0		

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

O_3 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1992	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations			1	2				1		2
Annual average			40.9	43.7	40.9	36.9		46.3		
Summer average			55.8	56.0	55.8	50.9		50.0		
Maximum (1 h)			155.4	91.0	155.4	92.0		77.9		
Maximum (8 h)										
98 percentile (1 h)			115.9	94.0	115.9	94.5		76.6		
Number of days exceeding the WHO-AQG			0	0	0	0		0		
Number of days exceeding 2 x WHO-AQG			0	0	0	0		0		

WHO-AQG Ozone (1h max.) = 150 $\mu g\ m^{-3}$

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		1
Annual average		0.9
Maximum (8 h)		5.8
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 $mg\ m^{-3}$

1. Uncertain data

City: Hamburg	*Country*: Germany

I. GENERAL DATA

		City		Conurbation
Population	(number)	***1 626 000***		
Total area	(km^2)	***755***		
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	53° 33' N 10° 00' E		

Major activities and development trends (1980-1990, 1990-2000)
Seaport with trading and industrial activities. An airport is present. Industrial activities in the south are iron and metal casting, heavy engineering, food processing and chemical and pharmaceutical products

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, north western part of the country
Topography: plain (+)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	8.5	7.6	9.9
precipitation (mm)	674	751	677
wind speed ($m\ s^{-1}$)	***3.7 (0)***	***3.5 (0)***	***3.4 (0)***
winter smog index	***12 (0)***	***18 (0)***	***10 (0)***
summer smog index	***7 (+)***	***4 (+)***	***9 (0)***

Station: 10147 53° 38' N 10° 00' E

III. EMISSIONS

Annual emissions per inhabitant in 1990 (kg $inh^{-1}\ a^{-1}$)

	SO_2	NO_x	VOC
Traffic	1.8	14.7	8.3
Domestic/space heating	1.6	2.1	4.9
Industry and power plants	9.5	5.2	5.4
Total	12.9	22.0	18.6

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***4***

Main topography, city morphology, industrial sources and monitoring network

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*7*				
Mean of stations in city background	1989	3	28.7	279	143	8	1
Highest observed concentrations	1989		30.7	302	146	13	1

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*20*				
Mean of stations in city background	1989	2	55	316	153	20	1
Highest observed concentrations	1989		60	321	159	23	1

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class[1]	***2***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	3	42.4	86.7	178	0	0
Highest observed concentrations	1989		50.6	94	190	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	2	37.2	212	136		0	***2***
Highest observed concentrations	1989		38.6	213	135		0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Hannover	*Country*: Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	***514 000***	
Total area	(km^2)		
Built-up area	(km^2)	***204***	
Coordinates	(lat-/longitude)	52° 33' N 9° 44' E	

Major activities and development trends (1980-1990, 1990-2000)
Main industrial activities: railway engineering, cars, engines, iron casting, electrotechnics, rubber, textiles, synthetic materials and food processing.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, centre part of Lower Saxony
Topography: plain (+)

Climate: Cfb
Meteorology:

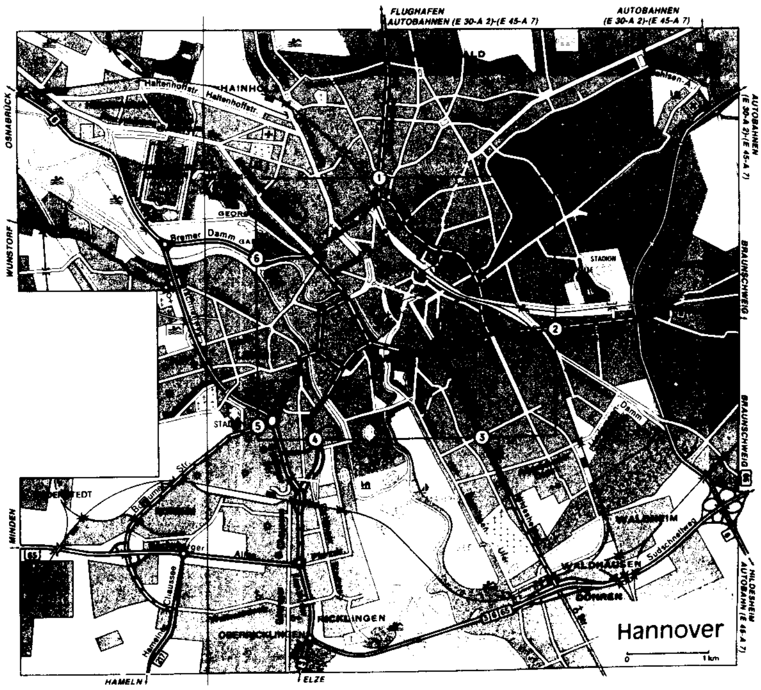
Averages	1980-1989	1985	1989
temperature (°C)	9.0	8.3	10.4
precipitation (mm)	544	662	524
wind speed ($m\ s^{-1}$)	***3.4 (0)***	***3.3 (0)***	***3.4 (0)***
winter smog index	***12 (0)***	***14 (0)***	***9 (0)***
summer smog index	***11 (0)***	***7 (+)***	***16 (0)***

Station: 10338 52° 28' N 9° 42' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***1***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*12*				
Mean of stations in city background	1989	1	26	379	154	6	1
Highest observed concentrations	1989		26	379	154	6	1

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (24 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*27*				
Mean of stations in city background	1989	1	41	301	144	10	3
Highest observed concentrations	1989		41	301	144	10	3

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class [1]	***3***
Exposure class [1]	***3***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	1	44	110	168	0	0
Highest observed concentrations	1989		44	110	168	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	1	42	260	148	25	0	***3***
Highest observed concentrations	1989		42	260	148	25	0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Helsinki | **Country**: Finland

I. GENERAL DATA

		City	Conurbation
Population	(number)	491 000 (1990)	***821 000 (1990)***
Total area	(km^2)	184 (1990)	743 (1990)
Built-up area	(km^2)	105.3 (1990)	***241.8 (1990)***
Co-ordinates	(lat-/longitude)	60 ° 15 ' N 25 ° 0 ' E	

Major activities and development trends (1980-1990, 1990-2000)

Administration, banking, services.
City centre does not grow anymore, but conurbation area will grow and spread mainly along the railway lines.
Deep recession will slow down the growth, but trend is clear.

Constituent communities: Helsinki Espoo, Vantaa, Kauniainen.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Northern Europe at a coastal plain by the Baltic Sea.
Topography: The area is a coastal plain. The city centre is on a peninsula ***(++)***.

Climate: (Dfb)
Meteorology: Surface inversions in winter and spring. Sea-land breezes do not affect air quality noticeably.

Averages	1980-1989	1985	1989
temperature (°C)	4.6	2.2	6.9
precipitation (mm)	541.6	674.3	648.3
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.5 (0)***	***3.3 (0)***	***3.6 (0)***
winter smog index	***27.2 (-)***	***35.4 (-)***	***21.1 (-)***
summer smog index	***3.7 (+)***	***1.3 (++)***	***4.0 (+)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

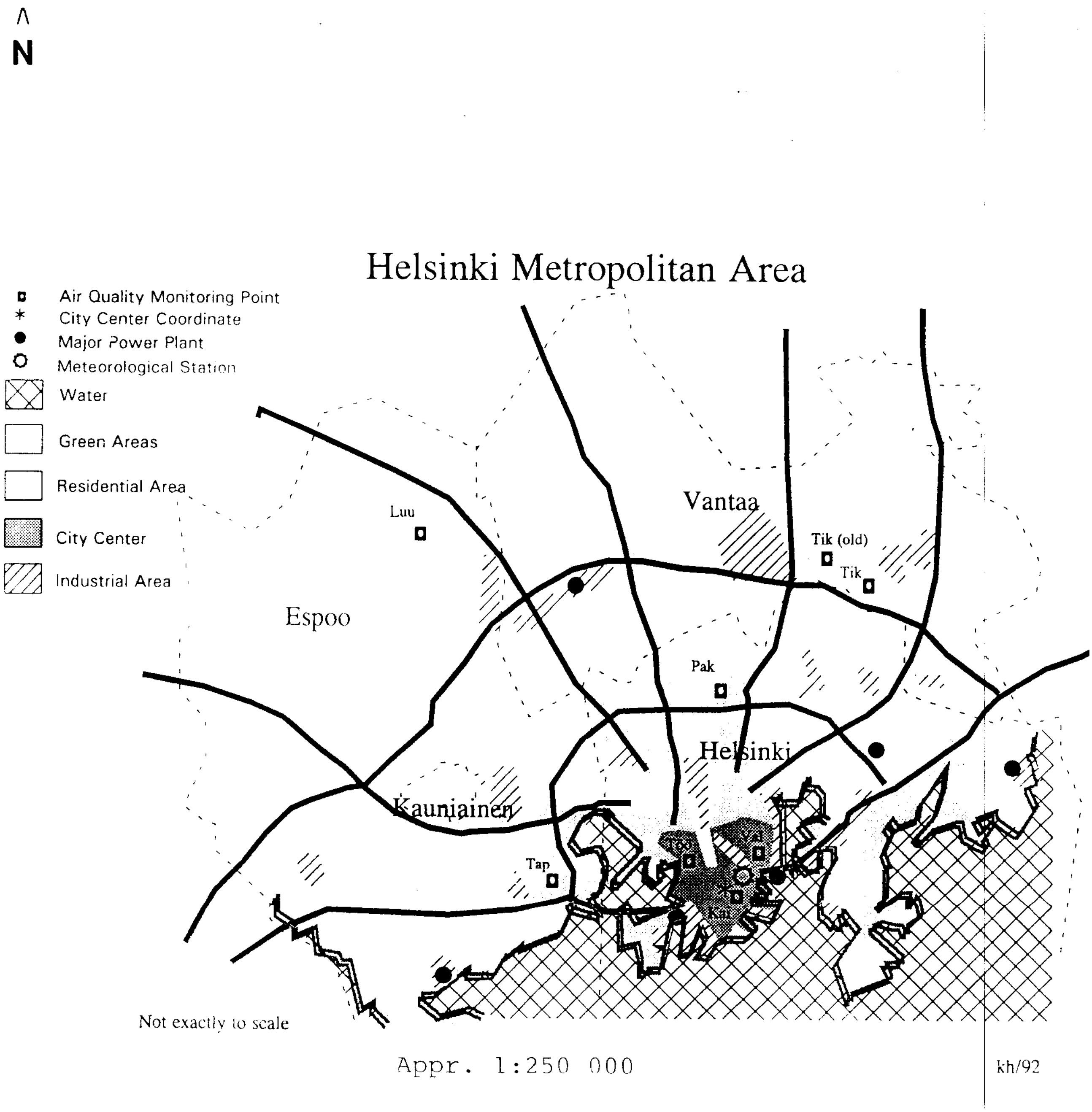
Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	9.2	12.2	10.2	19.3	1.8	1.6	6.5
1985	Wind speed m s^{-1}	3.8	4.0	5.1	5.3	3.9	4.4	5.7
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	8.9	7.9	12.1	8.6	0.4	2.1	
	Wind speed m s^{-1}	6.8	6.5	4.8	3.8	3.8	0	

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	6.6	3.5	5.3	8.6	7.6	7.7	3.9
1990	Wind speed m s^{-1}	3.6	3.1	3.2	3.9	4.5	4.2	4.6
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	5.0	9.7	17.7	11.1	10.8	3.6	
	Wind speed m s^{-1}	5.6	5.3	5.7	4.2	4.4	0	

City: Helsinki **Country**: Finland

Main topography, city morphology, industrial sources and monitoring network



City: Helsinki **Country**: Finland

III. EMISSIONS

Annual emissions per source and totals in 1985 (Kt a^{-1})

Conurbation	SO_2	NO_x	CO	VOC	Particulate matter *	Pb
Traffic	0.9	11.0	45.0	5.5	1.1	0.087
Domestic/space heating	2.7	-	-	-	?	-
Industry and power plants	34.1	16.7	-	?	2.4	-
Total	37.7	27.7	45.0	5.5	?	0.087
Per capita (**kg**)	48	35	57	?		0.1
Per km^2 (**t**)	51	37				0.12

Annual emissions per source and totals in 1990 (Kt a^{-1})

Conurbation	SO_2	NO_x	CO	VOC	Particulate matter *	Pb
Traffic	0.7	17.7	60.3	7.3	1.3	0.024
Domestic/space heating	0.4	-	-	-	0.1	-
Industry and power plants	20.8	18.0	-	3.7	2.2	-
Total	21.9	35.7	60.3	11.0	3.6	0.024
Per capita (**kg**)	27	44	73	13	4.3	0.029
Per km^2 (**t**)	29	48	81	15	4.8	0.032

* Particulate Matter is mainly re-emission. Emissions are low. The numbers are the point combustion emissions.

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***2***

Major (industrial) point sources
(see city map) There are 5 major power plants using coal and natural gas. No major industry in the area.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

Conurbation	Number of vehicles	Total traffic activity veh km a^{-1}
Total	337 931	4.99×10^9
of which:		
· passenger cars	297 266	4.169×10^9
· buses	1 809	0.132×10^9
· freight traffic >3.5 t	38 856	0.689×10^9

Total annual consumption of fuel for traffic

Conurbation	Consumption (10^6l) 1985	Consumption (10^6l) 1990	Average Sulphur content (%) 1985	Average Sulphur content (%) 1990
Diesel oil	155	164	<0.3	<0.2
Petrol/Gasoline	285	333	<0.1	<0.05
LPG				

Traffic
New cars equipped with catalytic converters. About 60 % of the gasoline is unleaded in 1990. The share has grown to 87% in 1993.

City: Helsinki **Country**: Finland

Local policies to reduce air pollution

Industry and power plant:
Combined heat and power production since 1950's.
The total efficiency (from fuel energy to net energy) is nowadays about 85%.

Choices of fuels: the proportion of natural gas is increasing.

Governmental policies to reduce emissions are being adopted:
- Desulphurisation units have been installed in the biggest power plants since 1987.
- The reduction of the sulphur content of fuels since the mid of 1980's.
- Electrostatic precipitators to reduce particle emissions.
- Introducing low-NO_x-techniques 1990-1997.

The effects of these measures can be seen in the emissions and the estimates emissions (t a^{-1}) of the energy production, see table below.

		Energy Companies	Area sources and small point sources
	SO_2		
Emissions:	1985	31 000	2 700
	1990	19 000	2 500
Estimated	1995	11 000	
emissions:	2000	7 800	
	NO_x		
Emissions:	1985	16 000	
	1990	18 000	800
Estimated	1995	12 000	
emissions:	2000	11 000	
	Particulates		
Emissions:	1985	2 408	
	1990	2 000	200
Estimated	1995	929	
emissions:	2000	547	
	CO_2		
Emissions:	1985		
	1990	4 666 000	500 000
Estimated	1995	5 429 000	
emissions:	2000	5 725 000	

Traffic:
Governmental policies to reduce emissions are adopted.

- E g. all new passenger cars must have three-way catalytic converters since 1992.
- the emissions of diesel fuelled vehicles are regulated also.
- The lead content of gasoline was 0.7 g/l at the end of the 1970's, 0.4 g/l since 1981, and 0.15 g/l since 1986. Lead free gasoline has been sold since 1985. The effects this reduction on ambient air quality can be seen.

Local policies:
There have been efforts to enhance and favour public transport. The proportion of public transport is quite large (60-70%) of the traffic heading to the centre of Helsinki, much less in suburban areas.

New underground lines are being built and planned, and there are plans to extend the car free zones in the centre of Helsinki. In order to limit the number of private cars in the city centre of Helsinki, the number of parking places has been limited in the 1980's.

In Helsinki traffic emissions have been and are estimated to be as follows: (t/year):

year	CO	HC	NO_x	CO_2	PM	SO_2	Pb
1980	20000	2500	4800	36400			
1985	26000	3200	6200	465000			
1990	31000	3900	7500	566000	590	190	10
1995	22000	2800	6500	600000	530	130	4
2000	16000	1900	4300	536000	350	140	0

Domestic/space heating:
The proportion of the total heating demand is about 90% in Helsinki Metropolitan area.

- New residential areas mainly join the central district heating network.
- The observed reduction in SO_2 concentrations in ambient air is mainly due to the introduction of district heating (the policy of high stacks) till the mid of 1980's and after that to the reduction of the sulphur content of fuels and the introduction of desulphurisation units in the biggest power plants.

City: Helsinki **Country**: Finland

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

City ($t\ a^{-1}$, gas $1000\ m^3$)		Annual consumption 1985	Annual consumption 1990	Average Sulphur content (t) 1985	Average Sulphur content (t) 1990
(area sources)	Fuel oil	190 000	70 000		
Power plants	Fuel oil, low S	529	879		
	Fuel oil, high S	119 954	34 803		
	Coal	1 336 723	1 332 286		
	Natural gas	0	23 075		
Conurbation ($t\ a^{-1}$, gas $1000\ m^3$)					
(area sources)	Fuel oil	270 000	140 000		
Power plants	Fuel oil, low S		1 283		
	Fuel oil, high S		41 767		
	Coal		1 740 474		
	Natural gas		142 122		

Space/domestic heating: general remarks

Very large district heating system.
About 80 % of the total building stock is heated by district heating.

VI. AIR QUALITY DATA

Monitoring network

The institute responsible for the network is Helsinki Metropolitan Area Council. The main objectives of the network are to monitor the general air quality in the area and especially the effects of traffic and energy production on air quality. Reports on air quality are published monthly and annually mainly for the authorities but they're sent to the press as well. The evaluation of air quality based on air quality index is read in the radio every day. The public will be specially informed when the concentrations get high and exceed the guide values.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations		1	1	2	1	2	1	1	1	1
Annual average		4 *(5)*	18	12	18	13	-	15	32	17
Winter average		6	22	15	22	15	40	14	35	21
Maximum (24 h)		45	87	62	87	72	-	62	246	104
98 percentile (24 h)		22	69	42	69	45	-	45	122	55
Number of days exceeding the WHO-AQG		0	0	0	0	0	-	0	4	0
Number of days exceeding 2 x WHO-AQG		0	0	0	0	0	-	0	0	0

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: TSP $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1986	1990	1986	1990
Number of stations		1	2	2	2	2	1	1	1	1
Annual average		22 *(11)*	53	42	53	44	75	73	70	53
Winter average		18	-	36	-	36	-	86	-	54
Maximum (24 h)		88	187	309	221	331	383	462	256	493
98 percentile (24 h)		53	135	123	140	129	231	267	195	151
Number of days exceeding the WHO-AQG		0	4	4	5	4	23	22	20	9
Number of days exceeding 2 x WHO-AQG		0	0	1	0	1	4	4	1	1

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

City: Helsinki **Country**: Finland

Winter smog classification	1990
Exceedance class	***2***
Exposure class[1]	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				2		2		1		1
Annual average				27		27		49		42
Maximum (24 h)				103		110		146		105
Maximum (1 h)				197		209		195		168
Number of days exceeding the WHO-AQG				0		0		0		0
Number of days exceeding 2 x WHO-AQG				0		0		0		0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	19__	1985	1990	1985	19__
Number of stations		1		1		1		1		
Annual average		44		33		33		18		
Winter average		37		22		22		11		
Maximum (1 h)		156		125		125		108		
Maximum (8 h)		-		-		-		-		
98 percentile (1 h)		86		75		75		52		
Number of days exceeding the WHO-AQG		1		0		0		0		
Number of days exceeding 2 x WHO-AQG		0		0		0		0		
Exceedance class				***1***						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		Töö
Annual average		1.6
Maximum (8 h)		12
Number of days exceeding the WHO-AQG		1
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1986	1990
Station number/name	KAI	KAI
Annual average	0.12	0.06
Maximum monthly average	0.23	0.08
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

City: Helsinki **Country**: Finland

VII. Effects

Effects of air pollution on health
There is some evidence (according to studies conducted in Hersivor Misa and Ersgunine) that air pollutants cause health effects at lower concentration than previously was thought. Concentrations measured in Hersivor Misa cause some health effects.

Effects of air pollution on nature
The effect of air pollutants on nature are clearly demonstrated in bio-indicator studies conducted by Hersivor Met. Misa Council

Effects of air pollution on buildings/material
The effect of pollutants (SO_2) on corrosion has been shown in a corrosion study by Hersivor Met. Misa Council.

1. Uncertain data

City: Istanbul	*Country*: Turkey

I. GENERAL DATA

		City	Conurbation
Population	(number)	6 620 000 (1990)	***6 886 000 (1990)***
Total area	(km^2)		***1991 (1990)***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	41° 02' N 28° 57' E	

Major activities and development trends (1980-1990, 1990-2000)
Capital of Turkey. Metropolis. Administrative, commercial and industrial centre. Harbour. Industry: food, textile, chemicals, machine manufacturing. The number of inhabitants increased from 5 476 000 in 1985 to 6 620 000 in 1990 (3.8%). Same growth is expected up to the year 2000.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Mediterranean (South Europe) Bosporus (Black sea/Medit. sea)
Topography: coastal, plain 39 m a.s.l. ***(0)***

Climate: Csa (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)			
precipitation (mm)			
cloud cover (8^{-1})			
wind speed[1] (m s^{-1})	***4.1 (+)***	***3.7 (0)***	***3.2 (0)***
winter smog index[1]	***18 (0)***	***17 (0)***	***16 (0)***
summer smog index[1]	***18 (0)***	***10 (0)***	***30 (-)***

VI. AIR QUALITY DATA

Monitoring network
Responsible: Ministry of Health, Regional Hygiene Institute. 15 stations. Air quality report is sent by fax to responsible authorities. Information on air quality (daily) on TV.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	19__	1985	19__	1985	19__
Number of stations				7-16						
Annual average		*3*		195						
Winter average				349						
Maximum (24 h)				912						
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				185						
Number of days exceeding 2 x WHO-AQG				115						

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations
(acidimetric) Concentrations among the highest in Europe.

Particulate matter: black smoke $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	19__	1985	19__	1985	19__
Number of stations				6-16						
Annual average		*15*		101						
Winter average				162						
Maximum (24 h)				437						
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				114						
Number of days exceeding 2 x WHO-AQG				17						

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Winter smog classification	1990
Exceedance class[2]	*5*
Exposure class	*4*

1. Less than 75% of the data available.

2. Uncertain data.

***City*:** Izhevsk[1]	***Country*:** Russian Federation

I. GENERAL DATA

		City		Conurbation
Population	(number)	635 000 (1992)		***635 000 (1992)***
Total area	(km^2)	260 (1991)		***260 (1991)***
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	56° 49' N 53° 11' E		

Major activities and development trends (1980-1990, 1990-2000)
Izhevsk is the capital of Udmurtiya, and a large industrial city. Weapons manufacturing, heavy engineering, wood industry.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography*:** The city is situated in the west Pre-Urals. The river Izh divides the city into two non-equal parts. The left bank is big and its height is 140-250 m above sea level, the right bank is smaller and lower (river basin). *(-)*	Climate: Dfb (Köppen-Geiger) Meteorology: Surface inversions: 33% Air stagnations: 6%.

Averages	1980-1989	1985	1989	1980-1988[3]
temperature (°C)	2.7	1.1	3.7	2.9
precipitation (mm)		457		447
cloud cover (8^{-1})				7.2
wind speed ($m\ s^{-1}$)	***4.0 (+)***	***4.6 (+)***	***3.6 (0)***	3.8
winter smog index [2]	***39 (-)***	***33 (-)***	***35 (-)***	
summer smog index	***11 (0)***	***11 (0)***	***21 (0)***	
Station:				Izhevsk 56° 49' N 53° 16' E

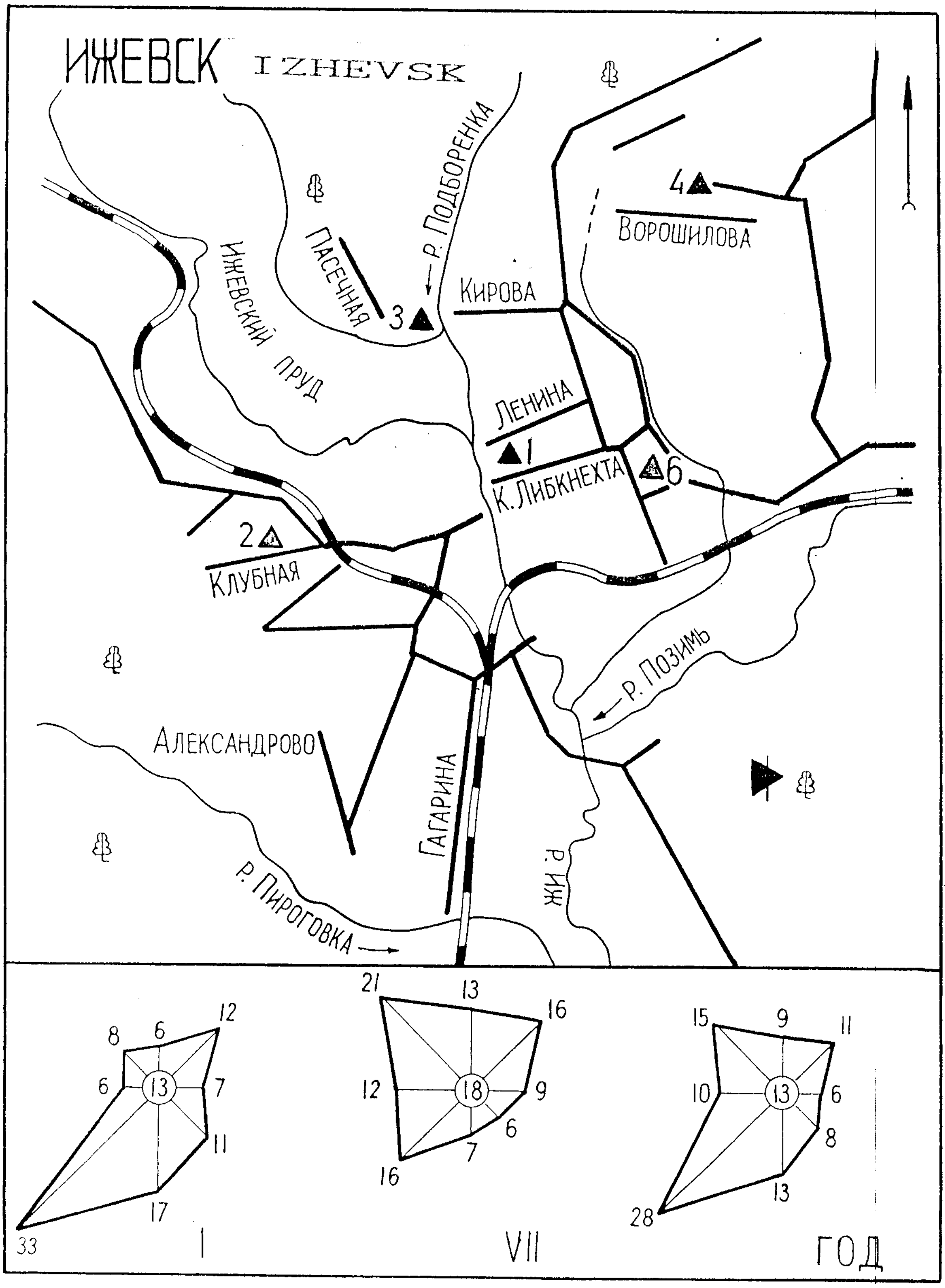
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	3	4	9	6	7	11	13	12	11	8	10	6	13
$m\ s^{-1}$	4.6	4.8	4.8	3.5	3.4	4.8	5.8	5.1	4.7	4.3	4.6	4.6	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	6	5	5	5	10	10	16	16	10	7	6	11
$m\ s^{-1}$	4.4	3.8	3.6	3.2	3.0	4.8	5.1	5.3	5.0	4.5	4.2	4.3	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	2.6	44		-	
Domestic/space heating						
Industry and power plants	4.7	14.4	7.5		20	
Total	4.7	17.0	51.5		20	
Per capita (**kg**)	7.5	26.9	81.6		31.7	
Per km^2 (**t**)	18.1	65.4	198.1		76.9	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	2.1	44.0	-	-	
Domestic/space heating						
Industry and power plants	5.5	15.7	8.7	5.4	17.1	0.0002
Total	5.5	17.8	52.7	5.4	17.1	
Per capita (**kg**)	8.4	27.1	80.3	8.2	26.1	
Per km^2 (**t**)	21.2	68.5	202.7	20.7	65.8	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***2***

Major (industrial) point sources

Industry: heavy engineering, chemical, metallurgical and woodworking industry. Stack heights generally are lower than 20 m (90%). About 6% of stacks are between 20-60 m high. Most industries are located in the south-west and north-east of the city. Industrial enterprises release many specific pollutants (e.g. ammonia, sulphuric acid, acetone).

Traffic

Traffic is responsible for 50% of anthropogenic emissions.

VI. AIR QUALITY DATA

Monitoring network
5 AQ monitoring stations are operational. (State Service of Observations of the Environment). The stations function under the guidance of Nizhny Novgorod Centre for Environmental Monitoring. MGO exercises general scientific and methodical guidance.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1	No. 1	No. 1	No. 1	No. 4	No. 4	No. 2	No. 2
Annual average			200	100	200	100	100	100	100	100
Winter average			200	100	200	100	100	100	100	100
Maximum (24 h)										
98 percentile (20 min)			780	390	780	390	390	390	390	390
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Reported annual average TSP concentrations represent the lower limit of the monitor.

Winter smog classification	1990
Exceedance class[5]	*2*
Exposure class[5]	*2*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1	No. 1	No. 1	No. 1	No. 4	No. 4	No. 6	No. 6
Annual average			50	20	50	20	40	20	40	60
Maximum (24 h)										
Maximum (20 min)			580	420	580	420	1170	420	480	390
Number of days exceeding the WHO-AQG			3	1	3	1	3	3	10	17
Number of days exceeding 2 x WHO-AQG			0	0	0	0	2	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
WHO-AQG for nitrogen dioxide is likely to be exceeded on a few days in city background areas. At the industrial site exceedances are more regularly observed.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		4
Annual average		1
Maximum (8 h)		
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		6
Annual average		0.0019
Maximum monthly average		0.0046

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1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station, the location of the meteorological station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Katowice | **Country**: Poland

I. GENERAL DATA

	City	Conurbation
Population (number)	***360 000 (1990)***	
Total area (km^2)	165 (1990)	
Built-up area (km^2)	***46 (1990)***	
Co-ordinates (lat-/longitude)	50° 13' N 19° 02' E	

Major activities and development trends (1980-1990, 1990-2000)

Heavy industry, administration.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe
Topography: Upland *(-)*

Climate: (Dfb)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)			
precipitation (mm)			
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)[1]	***2.5 (-)***		***2.3 (-)***
winter smog index[1]	***26.2 (-)***		***17.9 (0)***
summer smog index[1]	***18.8 (0)***		***17.1 (0)***

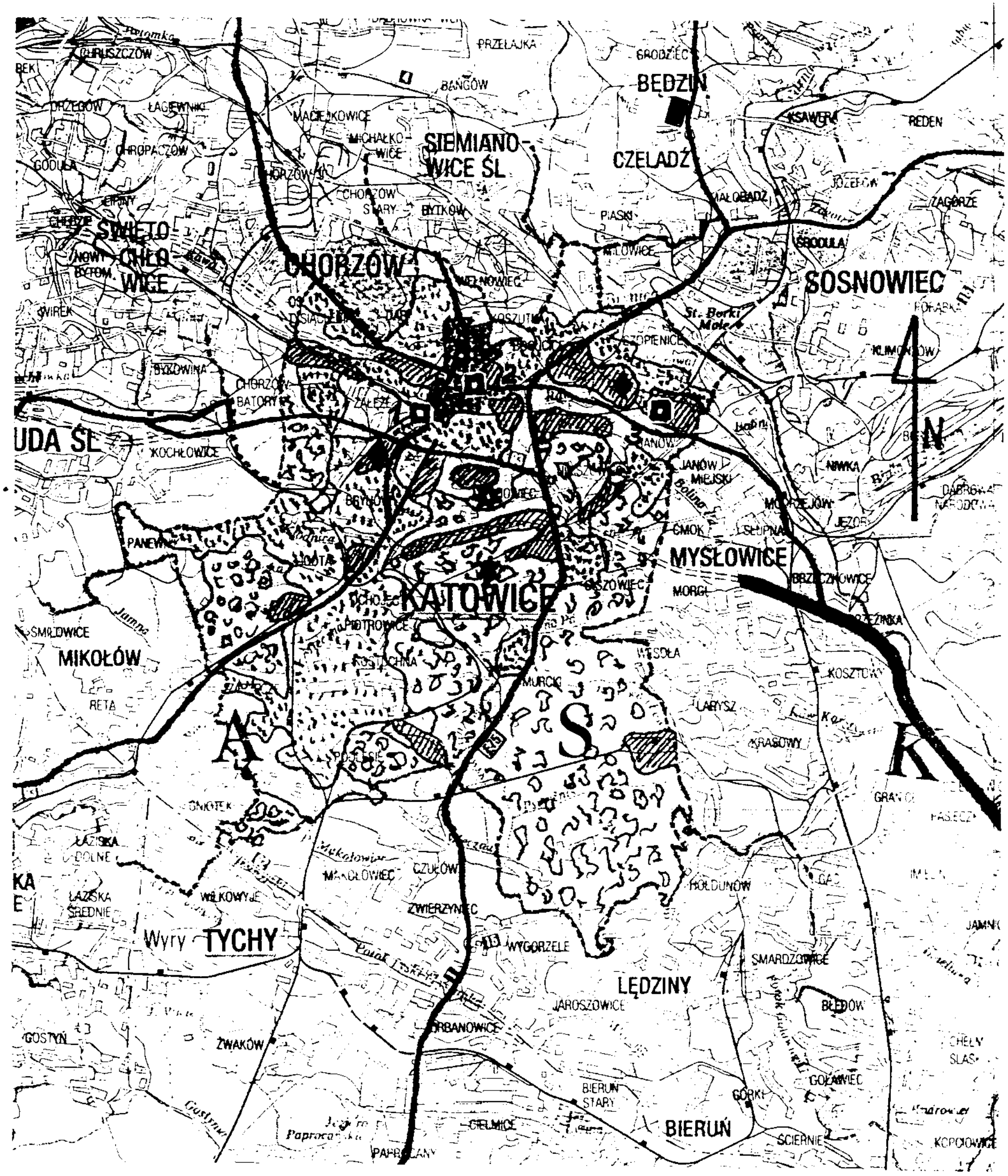
LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	3.9	3.9	5.6	7.7	5.4	3.8	4.7
1980-1990	Wind speed $m\ s^{-1}$	2.0	1.9	2.7	3.2	2.7	2.2	2.7
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	14.2	19.1	12.1	8.0	4.5	7.1	
	Wind speed $m\ s^{-1}$	3.7	4.2	3.6	3.6	2.7	0	

City: Katowice **Country:** Poland

Main topography, city morphology, industrial sources and monitoring network

N



Scale 1 : 200 000

City centre/Commercial area		City Centre Coordinate	★
Residential Area		Meteorological (Wind) Station	✩
Industrial Area		Air Quality Monitoring Point	◘
Woodlands/Parks/'Green' Areas		Major Industrial Point Source	♦
Water		Municipal Boundary	
Main Road		Motorway	

City: Katowice **Country:** Poland

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***5***
Summer smog emissions	***2***

Major (industrial) point sources

(see city map)

VI. AIR QUALITY DATA

Monitoring network

26 for gas pollutants, 23 for PM_{10} and 740 for dust fall.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			2	2	2	2				
Annual average		*31*	84	90	95	96				
Winter average			121	121	140	134				
Maximum (24 h)			285	326	304	361				
98 percentile (24 h)			199	218	199	223				
Number of days exceeding the WHO-AQG			60	78	72	99				
Number of days exceeding 2 x WHO-AQG			1.5	9	2	15				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: $\mu g\ m^{-3}$ (PM_{10})	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			2	2	2	2				
Annual average		*38*	258	147	263	151				
Winter average			323	171	334	182				
Maximum (24 h)			673	376	748	389				
98 percentile (24 h)			431	277	468	290				
Number of days exceeding the WHO-AQG (120)			344	243	348	249				
Number of days exceeding 2 x WHO-AQG			166	20	176	25				

WHO-AQG PM_{10} (24h max.) = 70 $\mu g\ m^{-3}$

Winter smog classification	1990
Exceedance class	***3***
Exposure class	***4***

City: Katowice **Country:** Poland

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			2	2	2	2				
Annual average			97	79	102	94				
Maximum (24 h)			215	194	230	233				
Maximum (1 h)			-	-	-	-				
Number of days exceeding the WHO-AQG			20	17	33	31				
Number of days exceeding 2 x WHO-AQG			0	0	0	0				

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		1
Annual average		7.4
Maximum (8 h)		-
Number of days exceeding the WHO-AQG		-
Number of days exceeding 2 x WHO-AQG		-

WHO-AQG CO (8h max.) = 10 $mg\ m^{-3}$

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	1	1
Annual average	0.52	0.29
Maximum monthly average	0.87	0.43
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Uncertain data

City: Kazan[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 099 000 (1992)	***1 099 000 (1992)***
Total area	(km^2)	285 (1990)	***285 (1990)***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	55 ° 45' N 49° 10' E	

Major activities and development trends (1980-1990, 1990-2000)
Kazan is the capital of Tatarstan, a large industrial and cultural centre of the Middle Volga Region. Important railway junction and river port. Refineries, petro-chemical industry, clothing industry.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Situated on the left bank of the Volga (Samara Reservoir) where the Kazanka River flows into the Volga. *(-)*

Climate: Dfb (Köppen-Geiger)
Meteorology: Frequency of surface inversions: 34%, air stagnations: 7%, wind velocity 0-1 m s^{-1}: 19%, calms 8%.

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	3.3	3.4	4.4	4.3
precipitation (mm)				510.1
cloud cover (8^{-1})				6.4
wind speed (m s^{-1})	***4.8 (+)***	***4.7 (+)***	***4.6 (+)***	3.1
winter smog index	***31 (-)***	***32 (-)***	***31 (-)***	
summer smog index	***14 (0)***	***10 (0)***	***12 (0)***	

Station: Kazan 55° 47' N 49° 11' E

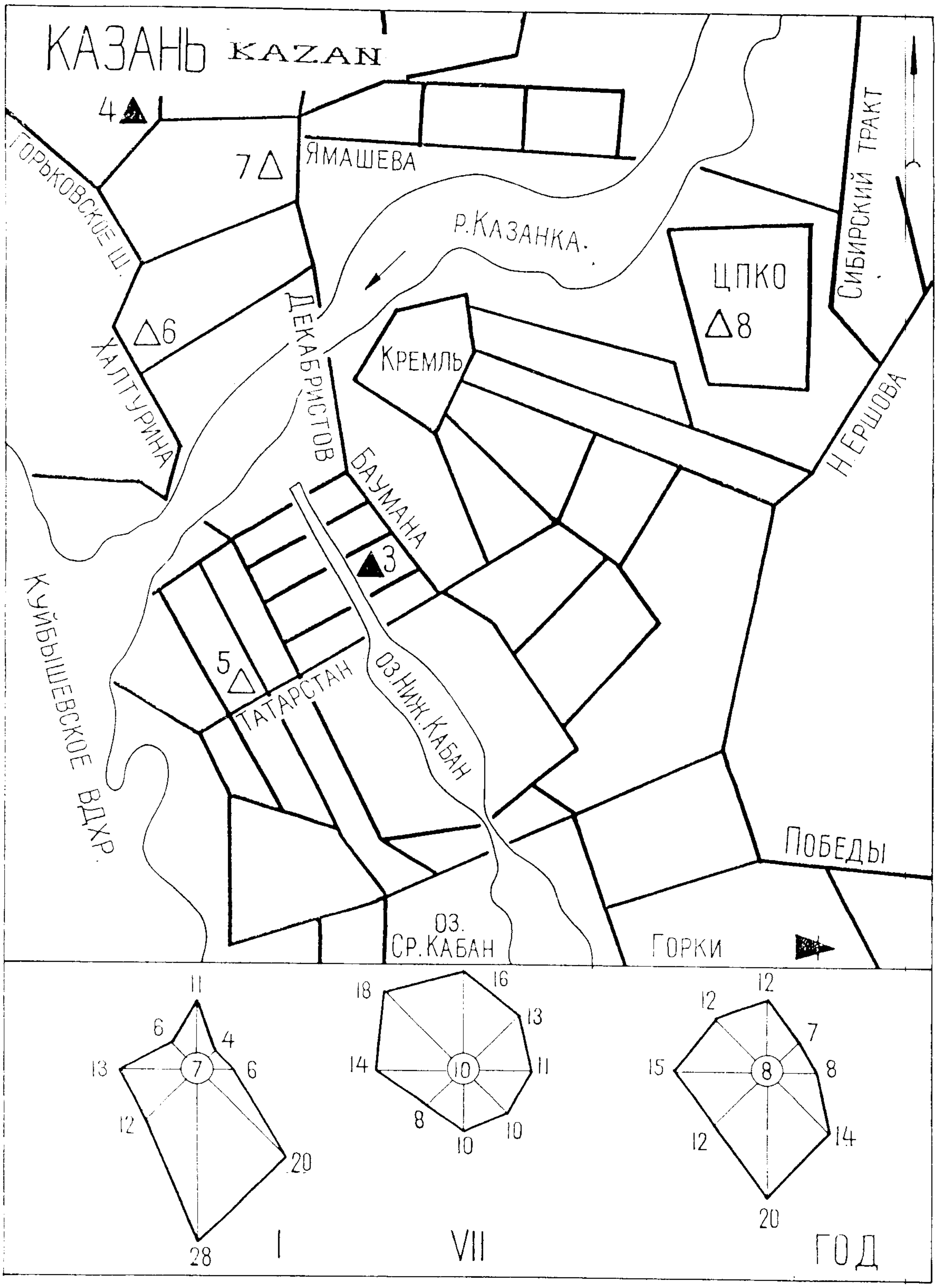
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	6	4	7	7	14	14	6	9	11	11	7	17
m s^{-1}	3.2	3.6	3.4	2.9	3.2	4.0	4.2	3.7	4.2	4.4	4.2	3.7	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	6	4	5	6	9	12	9	9	11	12	11	6	3
m s^{-1}	3.2	2.4	2.3	3.1	3.4	3.8	3.9	4.0	4.0	4.5	3.4	3.5	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.3	77.8		-	
Domestic/space heating						
Industry and power plants	16.0	14.5	10.4		11.3	
Total	16.0	19.8	88.2		11.3	
Per capita (**kg**)	15.0	18.5	82.6		10.6	
Per km² (**t**)	56.1	69.5	309.5		39.7	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.5	64.0	-	-	
Domestic/space heating						
Industry and power plants	13.5	15.2	13.3	29.4	10.1	0.0001
Total	13.5	19.7	77.3	29.4	10.1	
Per capita (**kg**)	12.5	18.2	71.3	27.1	9.3	
Per km² (**t**)	47.4	69.1	271.2	103.2	35.4	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***2***

Major (industrial) point sources

Industry is scattered over different parts of the city, but the largest sources of emissions are in the right-bank area of the city. Emissions come basically from low sources. Besides the emissions given in the Table, 691 t benzol, 196 t acetone and 68 t of phenol are also emitted.

IV. TRAFFIC DATA

Traffic

Traffic is responsible for 50% of all emissions.

Local policies to reduce air pollution

Domestic/space heating:
In the period 1986-1990 more and more natural gas was used instead of fuel oils and coal. Small stationary combustion sources were closed.

VI. AIR QUALITY DATA

Monitoring network
6 monitoring stations are operational (State Service for Observations of the Environment). Observations are made by the Kazan Observatory. The general guidance is carried out by the Samara Centre of Observations of the Natural Environment under the Volga Region Administration for Hydrometeorology.

Sulphur dioxide concentrations
Concentrations of sulphur dioxide were assessed by a method which is not specific for the given pollutant and which does not provide the necessary measurement accuracy; they are therefore not included in this report.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.5,6,8	No.5,6,8	No. 5	No. 5	No. 3	No. 3	No. 4	No. 4
Annual average			100	100	100	100	100	100	100	100
Winter average			80	50	100	70	120	83	50	67
Maximum (24 h)										
98 percentile (20 min)			390	390	390	390	390	390	390	390
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Reported TSP concentrations are high. Highest concentrations are observed during the summer. The WHO-AQG is likely to be breached in all areas of the city.

Winter smog classification	1990
Exceedance class[4]	***2***
Exposure class[4]	***2***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.5,6,8	No.5,6,8	No. 6	No. 6	No. 3	No. 3	No. 4	No. 4
Annual average			40	40	50	50	40	30	30	50
Maximum (24 h)										
Maximum (20 min)			177	307	190	330	160	490	160	410
Number of days exceeding the WHO-AQG			0	1	0	1	0	2	0	4
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations show no clear trend. The WHO-AQG is likely to be breached on a few days per year in city background areas.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	5	5
Annual average	4	2
98 Percentile (20 min)	16	10

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	8	8
Annual average	0.0016	0.0004
Maximum monthly average	0.0057	0.0018

Formaldehyde concentrations/Benzo(a)pyrene concentrations
Formaldehyde and B(a)P concentrations show a downward trend. B(a)p levels are above the WHO-AQG.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	3	3
Annual average	3	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		6
Annual average		0.03
Maximum monthly average		0.08
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Reported CO and Pb concentrations are low and do not exceed WHO-AQGs.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. Not the named ODS station, the location of the meteorological station is shown on the map.
3. The location of the meteorological station is shown on the map.
4. Uncertain data.

City: Kharkov[1]	*Country*: Ukraine

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 621 000 (1991)	***1 621 000 (1991)***
Total area	(km²)	305 (1992)	305 (1992)
Built-up area	(km²)	226 (1992)	***226 (1992)***
Coordinates	(lat-/longitude)	50° 0' N 36° 15' E	

Major activities and development trends (1980-1990, 1990-2000)
Kharkov is one of the most important industrial, cultural and scientific centres of Ukraine. Industry: heavy engineering, petro-chemicals, building materials.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: Situated between the Lopan, Kharkov, Uda and Severny Donets Rivers on five hills (river basin). *(-)*	Climate: Dfb (Köppen-Geiger). Meteorology: Temperate unfavourable conditions for diffusing pollutants. Surface inversions: 25%, calms: 20.7%, air stagnations: 10%. per year.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	7.5	4.9	8.7	7.1
precipitation (mm)				649.5
cloud cover (8^{-1})				6.2
wind speed [2] ***($m\ s^{-1}$)***	***3.8 (0)***	***4.0 (+)***	***3.8 (0)***	4.1
winter smog index [2]	***22 (-)***	***25 (-)***	***14 (0)***	
summer smog index [2]	***19 (0)***	***13 (0)***	***18 (0)***	

Station: Kharkov 49° 56' N 36° 17' E

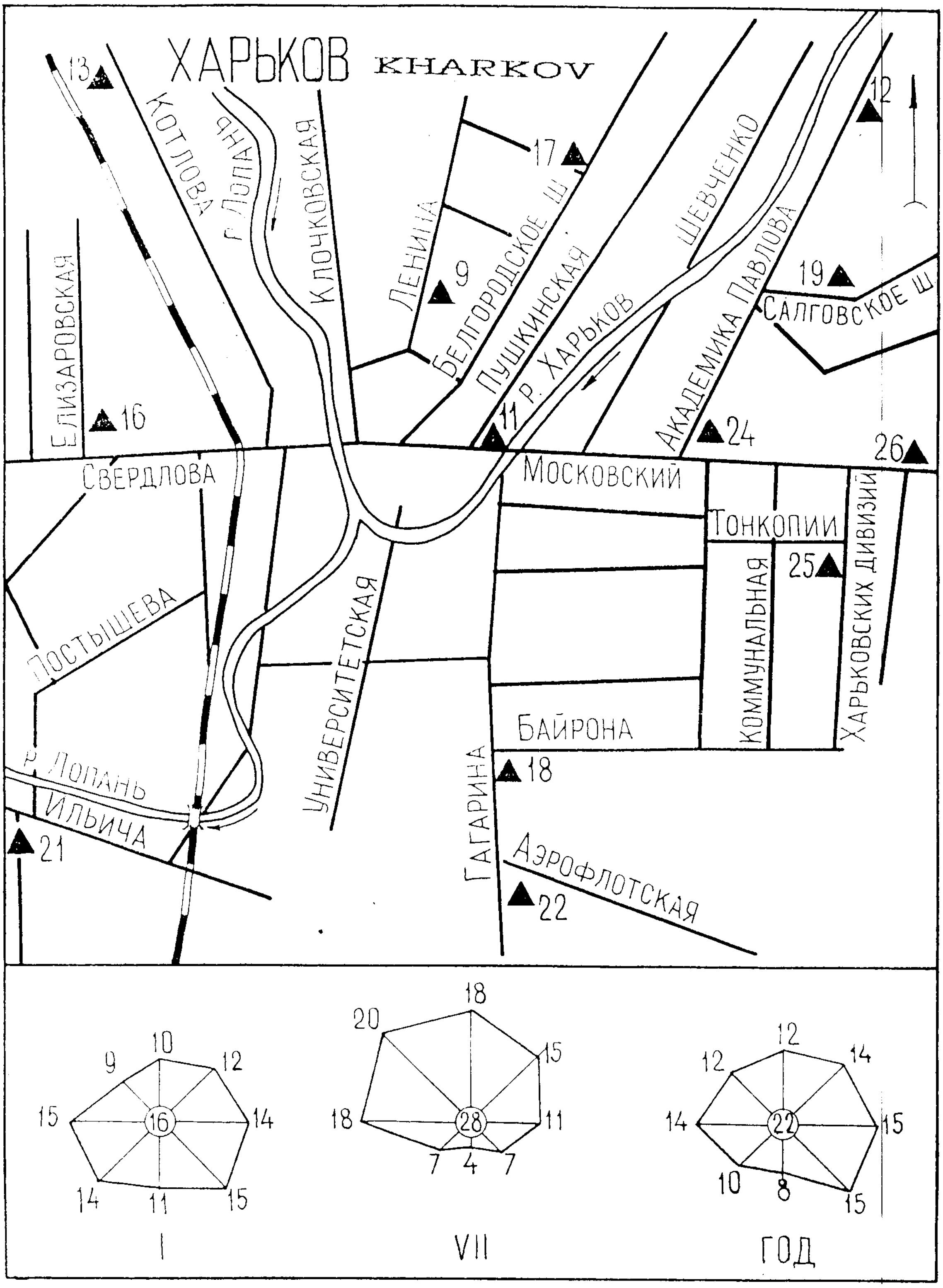
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	7	7	9	13	7	7	8	10	10	11	6	10
$m\ s^{-1}$	3.9	4.3	5.5	5.0	4.8	4.7	4.4	4.2	4.2	4.3	4.2	4.3	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	3	6	5	9	6	5	10	15	13	16	8	11
$m\ s^{-1}$	4.6	4.9	4.5	5.0	4.8	4.5	4.2	4.7	4.6	4.7	4.3	4.8	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	6.5	98.4		-	
Domestic/space heating						
Industry and power plants	3.9	7.4	17.9		16.2	
Total	3.9	13.9	116.3		16.2	
Per capita (**kg**)	2.5	8.8	73.3		10.2	
Per km^2 (**t**)	17.3	61.5	514.6		71.7	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.6	94.6	-	-	
Domestic/space heating						
Industry and power plants	2.0	7.0	18.3	7.0	13.7	0.006
Total	2.0	12.6	112.9	7.0	13.7	
Per capita (**kg**)	1.2	7.8	69.7	4.3	8.5	
Per km^2 (**t**)	8.9	55.7	499.6	31.0	60.6	

Emission class	1990
Winter smog emissions	*2*
Summer smog emissions	*2*

Major (industrial) point sources

petro-chemicals, heavy engineering, building materials. Most important: heavy engineering.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	*35 311*	*1 003.9* x 10^6
of which:		
· passenger cars	*2 768*	*155.8* x 10^6
· buses	*3 782*	*152.2* x 10^6
· freight traffic >3.5 t	*20 172*	*556.0* x 10^6

Total annual consumption of fuel for traffic

	Consumption ($kt\ a^{-1}$) 1985	Consumption ($kt\ a^{-1}$) 1990	Average Sulphur content (t) 1985	Average Sulphur content (t) 19__
Diesel oil	*126.0*	*128.6*	-	-
Petrol/Gasoline	*254.7*	*188.3*	-	-
LPG		*6.3*	-	-

Traffic

The Traffic contribution to total emissions is estimated to be almost 70%, which is higher than in other cities of the former SU. *No streets with more than 10 000 vehicles per day. Total public transport activity: non-electric-powered transport 1 139.392 million passenger km a^{-1}, electric-powered transport: 4 826.560 million passenger km a^{-1}.*

VI. AIR QUALITY DATA

Monitoring network
13 stations are operational (State Service of the State of the Environment in Ukraine). The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the State Committee of the Ukraine for Hydrometeorology in the charge of the network.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 19, 22, 24		No. 22		No. 18		No. 11
Annual average		*6*		7		8		10		10
Winter average				9		8		9		23
Maximum (24 h) *calculated*				*58*		*68*		*92*		*106*
98 percentile (20 min)*				30		35		46		51
Number of days exceeding the WHO-AQG (*+calc.*)				0 (*0*)		0 (*0*)		0 (*0*)		0 (*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations are low. Concentrations do not exceed the national and WHO-AQG standards. During winter average sulphur dioxide concentrations in industrial areas are 2 times higher than the annual mean.

Particulate matter: $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 19, 22, 24	No. 19, 22, 24	No.24	No.24	No.18	No.18	No. 11	No. 11
Annual average		*19*	133	137	100	150	200	190	200	310
Winter average			167	133	100	130	167	150	200	300
Maximum (24 h)										
98 percentile (20 min)			415	530	390	610	470	1120	470	500
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Suspended particulate concentrations
Reported TSP concentrations are high and show an upward trend. The WHO-AQG is likely to breached on numerous days per year.

Winter smog classification	1990
Exceedance class[5]	***2***
Exposure class[5]	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 19, 22, 24	No. 19, 22, 24	No. 19	No. 19	No. 18	No. 18	No. 11	No. 11
Annual average			30	27	40	30	60	50	30	50
Maximum (24 h)										
Maximum (20 min)			287	317	220	110	400	370	190	410
Number of days exceeding the WHO-AQG			0	1	0	0	18	2	0	1
Number of days exceeding 2 x WHO-AQG			0	0	0	0	1	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported mean nitrogen dioxide concentrations are relatively low compared to the number of days on which the WHO-AQG is exceeded.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	18	18
Annual average	3	3
Maximum (8 h)		
Number of days exceeding the WHO-AQG	1	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		19
Annual average		0.13
Maximum monthly average		0.29
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO and Pb concentrations do not exceed WHO-AQGs.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	11	11
Annual average	2	5
98 Percentile (20 min)	12	30

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		18
Annual average		0.0026
Maximum monthly average		0.0057

VII. EFFECTS

Effects of air pollution on health
According to 1988 data, in Kharkov the number of cases of respiratory diseases is 29% higher than on average for the cities of the former Soviet Union.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. Less than 75% of the data available.
3. Not the named ODS station. The location of the meteorological station is shown on the map.
4. The location of the meteorological station is shown on the map.
5. Uncertain data.

City: Kiev[1]	*Country*: Ukraine

I. GENERAL DATA

		City	Conurbation
Population	(number)	2 500 000 (1987)	***2 500 000 (1987)***
Total area	(km^2)	825 (1991)	***825 (1991)***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	50° 25' N 30° 30' E	

Major activities and development trends (1980-1990, 1990-2000)
Kiev is the capital of Ukraine, a large commercial, scientific, cultural and industrial centre. Kiev is one of the oldest cities of eastern Europe. The city is in with monuments and is an important tourist centre. Industry: variety of activities.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Kiev is situated on the hilly right bank and on the low left bank of the Dnieper River. The city territory is cut with deep ravines in which polluted air can accumulate (*river basin*). ***(-)***

Climate: Dfb (Köppen-Geiger)
Meteorology: (In winter)low-level inversions: 40%, (annual):28%, calms (0-1 m s^{-1}): 35%, air stagnations: 8%

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	7.2	5.6	9.3	7.6
precipitation (mm)		478	649	593.4
cloud cover (8^{-1})				6.6
wind speed (m s^{-1})	***3.7 (0)***	***4.3 (+)***	***2.1 (--)***	2.5
winter smog index	***19 (0)***	***16 (0)***	***20 (0)***	
summer smog index	***15 (0)***	***16 (0)***	***20 (0)***	

Station: Kiev 50° 24' N 30° 27' E

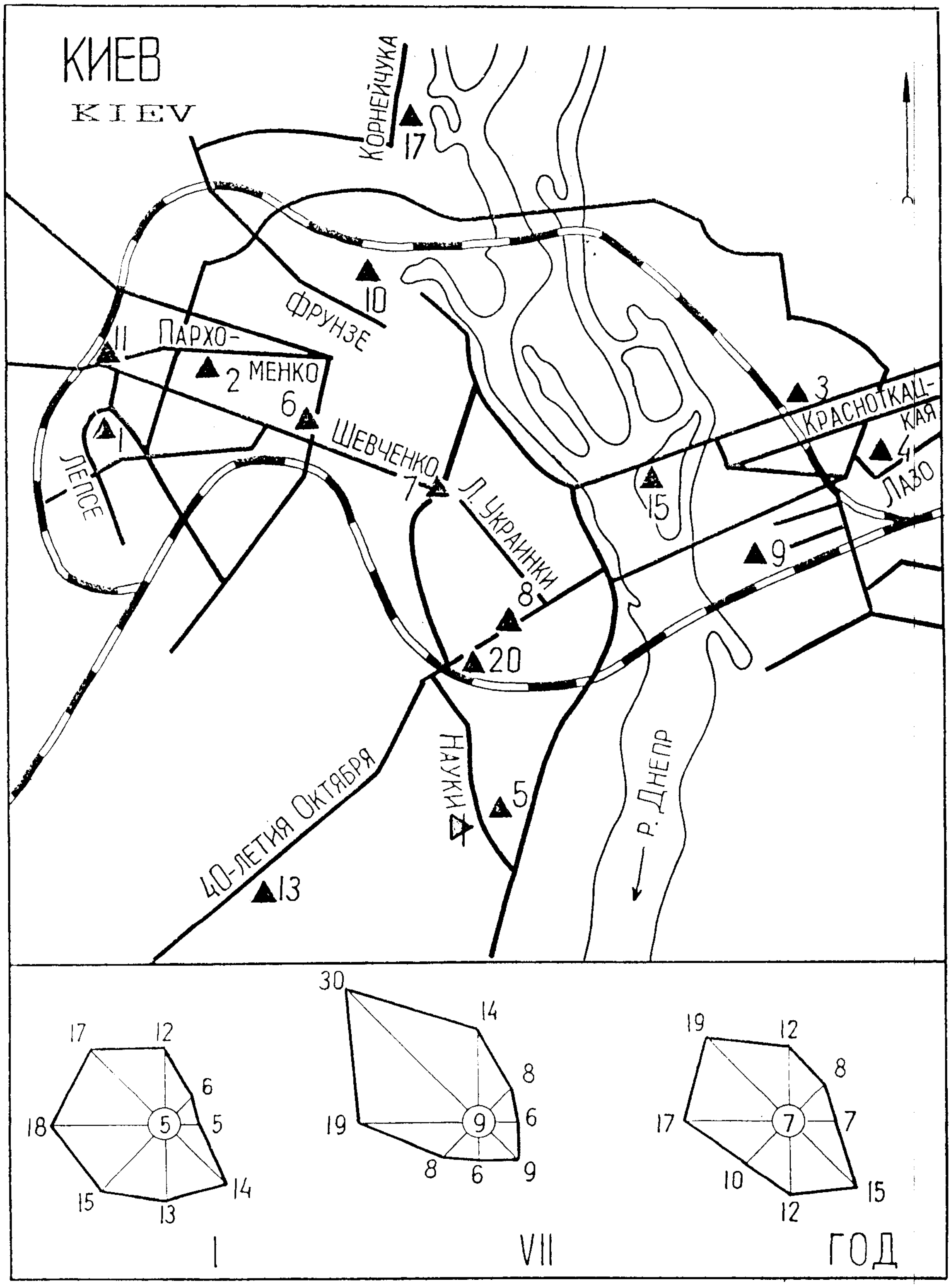
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	9	6	3	3	7	11	10	9	13	10	8	11	3
m s^{-1}	3.3	2.3	2.1	1.9	1.9	2.3	2.8	2.8	2.8	2.4	2.4	2.8	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	8	4	2	2	5	8	11	8	13	18	11	10	4
m s^{-1}	3.0	2.3	1.9	1.9	1.8	2.1	2.8	3.0	3.1	2.7	2.7	3.0	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	11.9	194.0		-	
Domestic/space heating						
Industry and power plants	19.2	21.9	5.5		12.3	
Total	19.2	33.8	199.5		12.3	
Per capita (**kg**)	7.6	13.3	78.4		4.8	
Per km^2 (**t**)	23.3	41.0	241.8		14.9	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	11.4	177.2	-	-	
Domestic/space heating						
Industry and power plants	13.7	19.2	4.1	6.2	7.1	0.0044
Total	13.7	30.6	181.3	6.2	7.1	
Per capita (**kg**)	5.4	12.0	71.3	2.4	2.8	
Per km^2 (**t**)	16.6	37.1	219.8	7.5	8.6	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***2***

Major (industrial) point sources

The main industrial branches are: petro-chemicals, chemicals, radio equipment, computer technology and building materials. Power stations are responsible for 50% of total emissions. In addition to the emissions given in the Table, also emitted: 270 t of hydrogen sulphide, 251 t of ammonia, 1 219 t of carbon bisulphide.

VI. AIR QUALITY DATA

Monitoring network
15 stations are operational (State Service for the State of the Environment in Ukraine). The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the State Committee of the Ukraine for Hydrometeorology is in the charge of methodology.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 5,13,15		No. 15		No. 7		No. 11
Annual average		*7*		13		16		13		13
Winter average				17		22		15		22
Maximum (24 h) *calculated*				*150*		*200*		*150*		*150*
98 percentile (20 min)*				70		90		70		70
Number of days exceeding the WHO-AQG (*+calc.*)				0 (*2*)		0(*4*)		0 (*1*)		0 (*1*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations are low. The chances of exceeding the WHO-AQG are low.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 13,15	No. 5,13,15	No. 13	No. 13	No. 7	No. 7	No. 11	No. 11
Annual average		*20*	100	100	100	100	100	100	100	300
Winter average			116	100	<u>133</u>	100	<u>100</u>	100		220
Maximum (24 h)										
98 percentile (20 min)			390	280	390	270		330	390	700
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Reported TSP concentrations are relatively low but the WHO-AQG is likely to be exceeded on a few days per year.

Winter smog classification	1990
***Exceedance class*[4]**	***2***
***Exposure class*[4]**	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 5,13,15	No. 5,13,15	No. 15	No. 15	No. 7	No. 7	No. 11	No. 11
Annual average			40	50	40	60	50	70	50	100
Maximum (24 h)										
Maximum (20 min)			347	350	360	410	310	350	260	500
Number of days exceeding the WHO-AQG			1	4	1	9	0	0	0	53
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	2

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high and show an upward trend. The WHO-AQG is exceeded on a few days per year.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	7	7
Annual average	2	7
98 Percentile (20 min)	8	38

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		11
Annual average		0.0062
Maximum monthly average		0.0130

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	7	7
Annual average	1	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		11
Annual average		0.48
Maximum monthly average		1.09
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

VII. EFFECTS

Effects of air pollution on health
According to 1988 data, in Kiev the number of cases of respiratory diseases is 61% and of malignant tumours 22% higher than the average for the cities of the former Soviet Union.

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1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station, the location of the station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

City: Krakow	*Country*: Poland

I. GENERAL DATA

		City	Conurbation
Population	(number)	***800 000 (1992)***	
Total area	(km^2)	***220 (1992)***	
Built-up area	(km^2)		
Co-ordinates	(lat-/longitude)	50 ° 04' N 19° 57' E	

Major activities and development trends (1980-1990, 1990-2000)

Heavy industry, business, administration, tourism.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: In the south of Poland by Vistula river
Topography: The valley of Vistula river *(-)*

Climate: (Dfb)
Meteorology: Sometimes inversions in valley

Averages	1980-1989	1985	1989
temperature (°C)	7.3		8.7
precipitation (mm)	100.2		715.5
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)[1]	***2.3 (--)***		***2.1 (--)***
winter smog index[1]	***30.5 (-)***		***21.2 (-)***
summer smog index[1]	***19.7 (0)***		***16.6 (0)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		N 345-15	NNE 15-45	ENE 45-75	E 75-105	ESE 105-135	SSE 135-165	S 165-195
Average windrose 1990	Freq. %	1.8	3.5	0	9.7	0	0.3	0.1
	Wind speed $m\ s^{-1}$	>0.5	>0.5	>0.5	>0.5	>0.5	>0.5	>0.5
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	7.6	0	55	10	0	12	
	Wind speed $m\ s^{-1}$	>0.5	>0.5	>0.5	>0.5	>0.5	>0.5	

III. EMISSIONS

Annual emissions per source and totals in 1991 ($kt \cdot a^{-1}$)

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic						
Domestic/space heating						
Industry and power plants	59	32	163	18	44	
Total						
Per capita (**kg**)						
Per km^2 (**kg**)						

Emission class	1991
Winter smog emissions[1]	***4***
Summer smog emissions	***2***

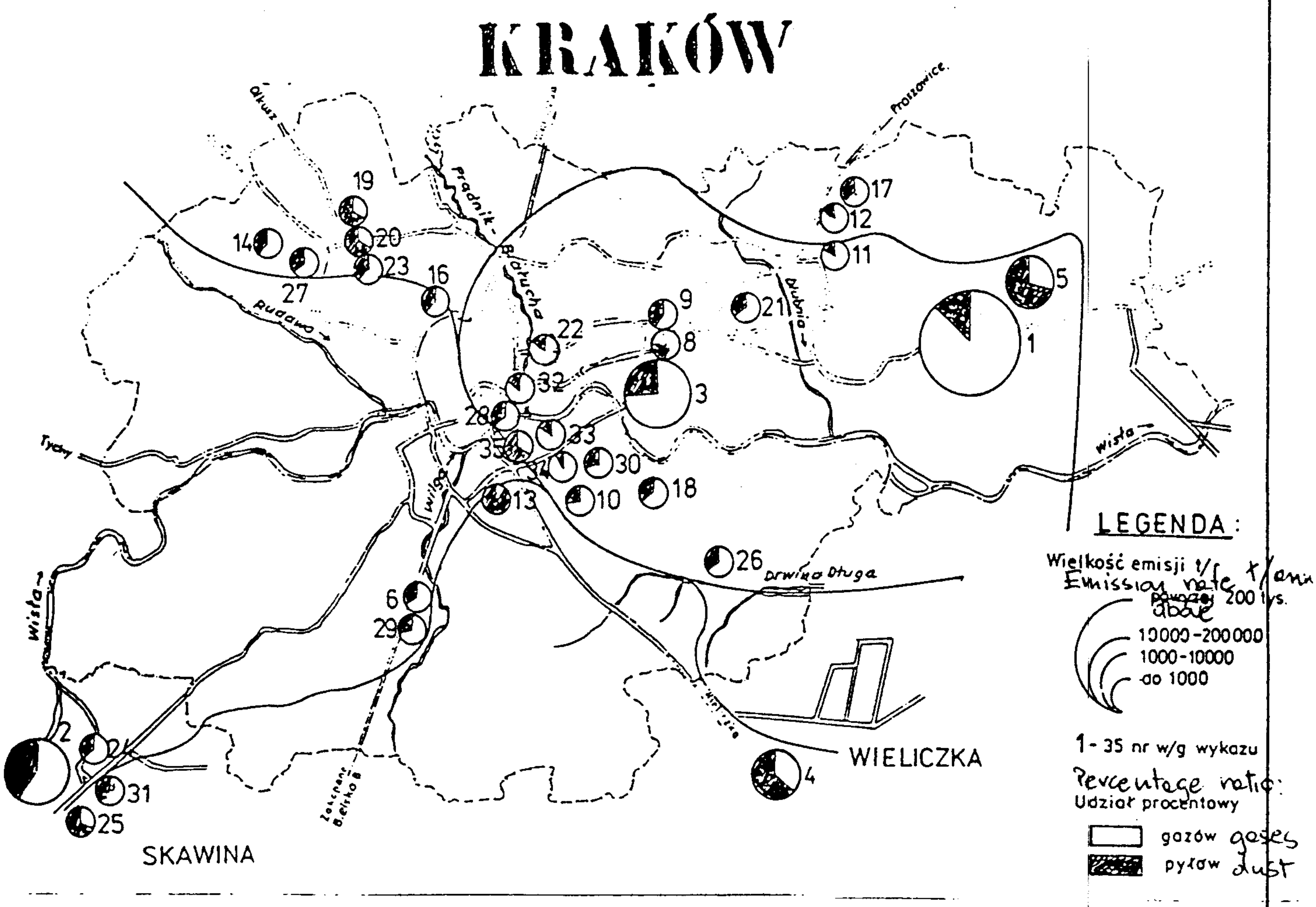
Major (industrial) point sources

(see city map)

Steel production. Power and heating plants. Cement plants. Chemical plants.

City: Krakow **Country**: Poland

Main topography, city morphology, industrial sources and monitoring network



Scale 1 : 150 000

City: Krakow **Country**: Poland

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles	Total traffic activity veh km a^{-1}
Total	28 000	x 10^9
of which:		
· passenger cars	19 500	
· buses		
· freight traffic >3.5 t		

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

Coal boilers and gas boilers.

VI. AIR QUALITY DATA

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations				1		1		1		1
Annual average		*24*		47		47		29		64
Winter average										
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				13		13		0		45
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: PM_{10} $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	1992	1985	19__
Number of stations				1		1		1		
Annual average		*34*		54		54		88		
Winter average										
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				15		15		55		
Number of days exceeding 2 x WHO-AQG										

WHO-AQG PM_{10} (24h max.) = 70 $\mu g\ m^{-3}$

City: Krakow **Country:** Poland

Winter smog classification	1992
Exceedance class	***2***
Exposure class[1]	***3***

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations				1		1		1		3
Annual average				31		31		69		
Maximum (24 h)										
Maximum (1 h)										
Number of days exceeding the WHO-AQG				0		0		0		
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		1
Annual average		4.0
Maximum (8 h)		
Number of days exceeding the WHO-AQG		6
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data

City: Krasnodar[1]	*Country*: Russian Federation

I. GENERAL DATA

		City		Conurbation
Population	(number)	595 000 (1992)		***595 000 (1992)***
Total area	(km^2)	174 (1991)		***174 (1991)***
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	45° 02' N 39° 00' E		

Major activities and development trends (1980-1990, 1990-2000)
Administrative centre. Industry: Refineries, electro-technical.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: Sited on the Pricubanskaya Plain, on the right high bank of the Cuban River (*plain*). ***(0)***	Climate: Dfb (Köppen-Geiger) Meteorology: wind velocity 0-1 m s^{-1}:34%, surface inversions: 30%, Air stagnations: 10%.			
Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	11.5	9.1	12.0	11.2
precipitation (mm)				1027.3
cloud cover (8^{-1})				6.2
wind speed [2] ***(m s^{-1})***	***3.6 (0)***	***3.8 (0)***	***3.3 (0)***	2.4
winter smog index [2]	***24 (-)***	***26 (-)***	***29 (-)***	
summer smog index [2]	***49 (-)***	***37 (-)***	***49 (-)***	
Station:			Krasnodar 45° 02' N 39° 09' E	

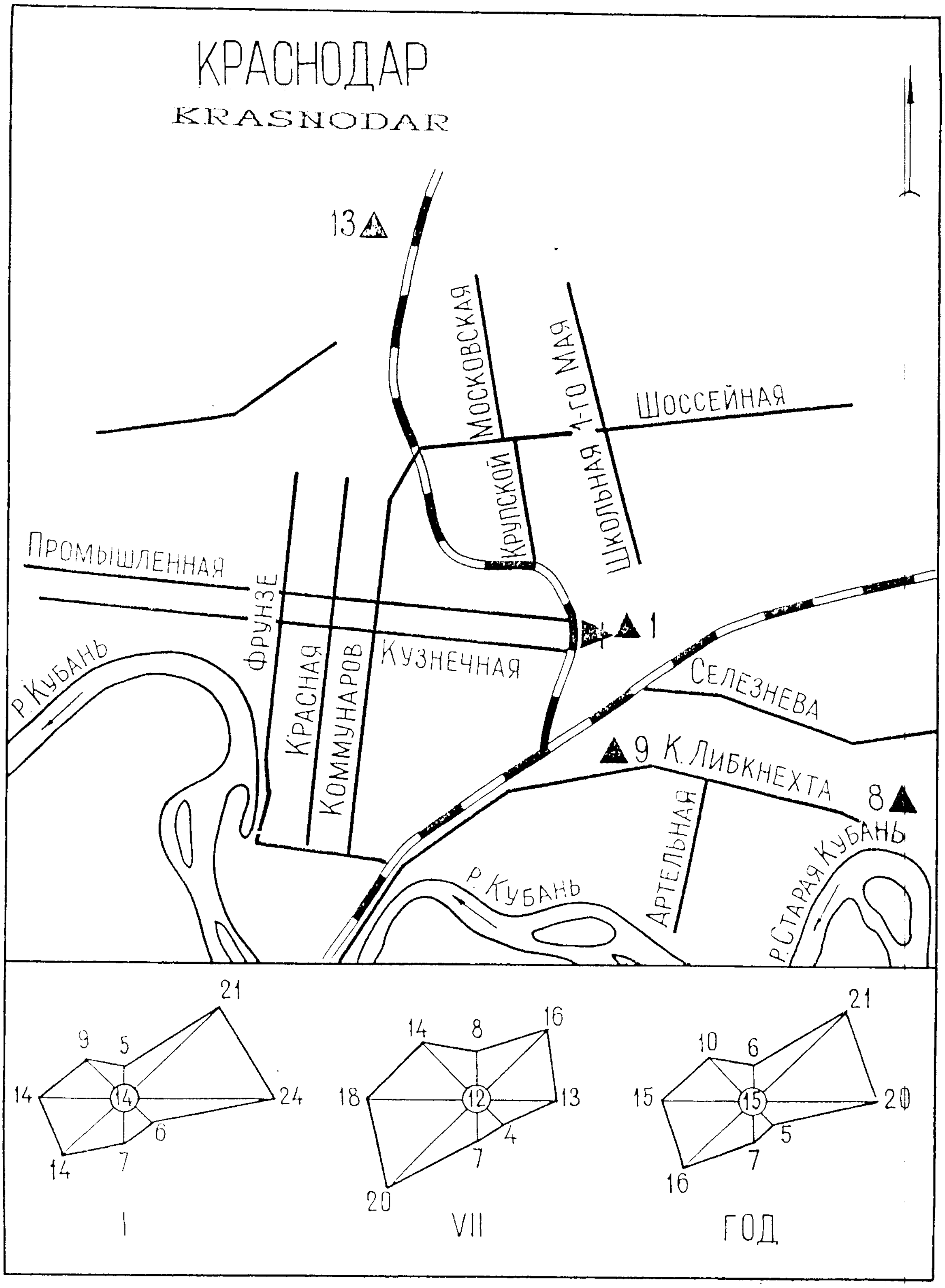
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	3	5	10	9	9	9	4	4	10	19	9	9	20
m s^{-1}	3.5	4.1	3.8	3.7	3.8	4.0	3.5	4.6	5.1	5.5	4.4	4.0	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	10	16	9	3	3	4	14	13	11	7	5	16
m s^{-1}	2.4	2.8	3.4	3.2	2.6	2.4	2.9	3.8	3.6	3.6	3.2	2.9	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	6.4	108.9		-	
Domestic/space heating						
Industry and power plants	28.4	6.6	18.1		6.5	
Total	28.4	13.0	127.0		6.5	
Per capita (**kg**)	45.6	20.8	203.9		10.4	
Per km^2 (**t**)	163.2	74.7	729.9		37.4	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	11.4	117.5	-	-	
Domestic/space heating						
Industry and power plants	16.6	6.4	13.3	7.3	4.9	0.0003
Total	16.6	17.8	130.8	7.3	4.9	
Per capita (**kg**)	26.7	28.6	210.0	11.7	7.9	
Per km^2 (**t**)	95.4	102.3	751.7	41.9	28.2	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***2***

Traffic
Traffic is responsible for 74% of all emissions.

VI. AIR QUALITY DATA

Monitoring network
3 stations are operational (State Service of Observations of the Environment). The stations function under the guidance of Centre for Monitoring the Environment of North-Caucasian Administration for Hydrometeorology.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1	No. 1	No. 1	No. 1	No. 9	No. 9	No. 8	No. 8
Annual average		*16*	300	300	300	300	300	300	300	200
Winter average			<u>167</u>	254	<u>167</u>	254	<u>133</u>	301	<u>233</u>	250
Maximum (24 h)										
98 percentile (20 min)				860		860		860		780
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Reported TSP concentrations are high. The WHO-AQG is likely to be exceeded on numerous days, especially during winter.

Winter smog classification	1990
Exceedance class[5]	*3*
Exposure class[5]	*4*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1	No. 1	No. 1	No. 1	No. 9	No. 9	No. 8	No. 8
Annual average			40	20	40	20	70	110	80	40
Maximum (24 h)										
Maximum (20 min)			240	150	240	150	240	680	190	1020
Number of days exceeding the WHO-AQG			0	0	0	0	0	<u>32</u>	0	<u>7</u>
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	<u>3</u>

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are relatively low in city background areas. At the traffic site and industrial site the WHO-AQG is exceeded. On 3 days the concentration at the industrial site even exceeded the WHO-AQG by a factor 2.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	9	9
Annual average	10	21
98 Percentile (20 min)		51

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		9
Annual average		0.0028
Maximum monthly average		0.0062

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	9	9
Annual average	3	4
Maximum (8 h)		
Number of days exceeding the WHO-AQG	<u>10</u>	<u>1</u>
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		8
Annual average		0.02
Maximum monthly average		0.07
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
The WHO-AQG for CO is exceeded on the traffic site.

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1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station, the location of the station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Krivoy Rog[1]	*Country*: Ukraine

I. GENERAL DATA

		City		Conurbation
Population	(number)	769 000 (1992)		***769 000 (1992)***
Total area	(km^2)	426 (1992)		***426 (1992)***
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	47° 55' N 33° 24' E		

Major activities and development trends (1980-1990, 1990-2000)
Krivoy Rog is a very important industrial centre of the Dnepropetrovsk region. Concentrated heavy industries and mining. Blast-furnaces, metallurgical and chemical plants, building materials.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: river basin (banks of the Ingulets River). *(-)*	Climate: Bsk (Köppen-Geiger) Meteorology: Surface inversions: 36%, In winter 10-500 m inversions: 50-80%. Frequency of weak winds:18%, calms 5%, air stagnations 9%.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	8.6	5.8	10.0	8.0
precipitation (mm)	308	674	321	606.1
cloud cover (8^{-1})				6.7
wind speed [2] ***($m\ s^{-1}$)***	***4.1 (+)***	***3.7 (0)***	***4.1 (+)***	4.3
winter smog index [2]	***18 (0)***	***22 (-)***	***16 (0)***	
summer smog index	***27 (-)***	***27 (-)***	***24 (0)***	

Station: Krivoy Rog 47° 56' N 33° 20' E

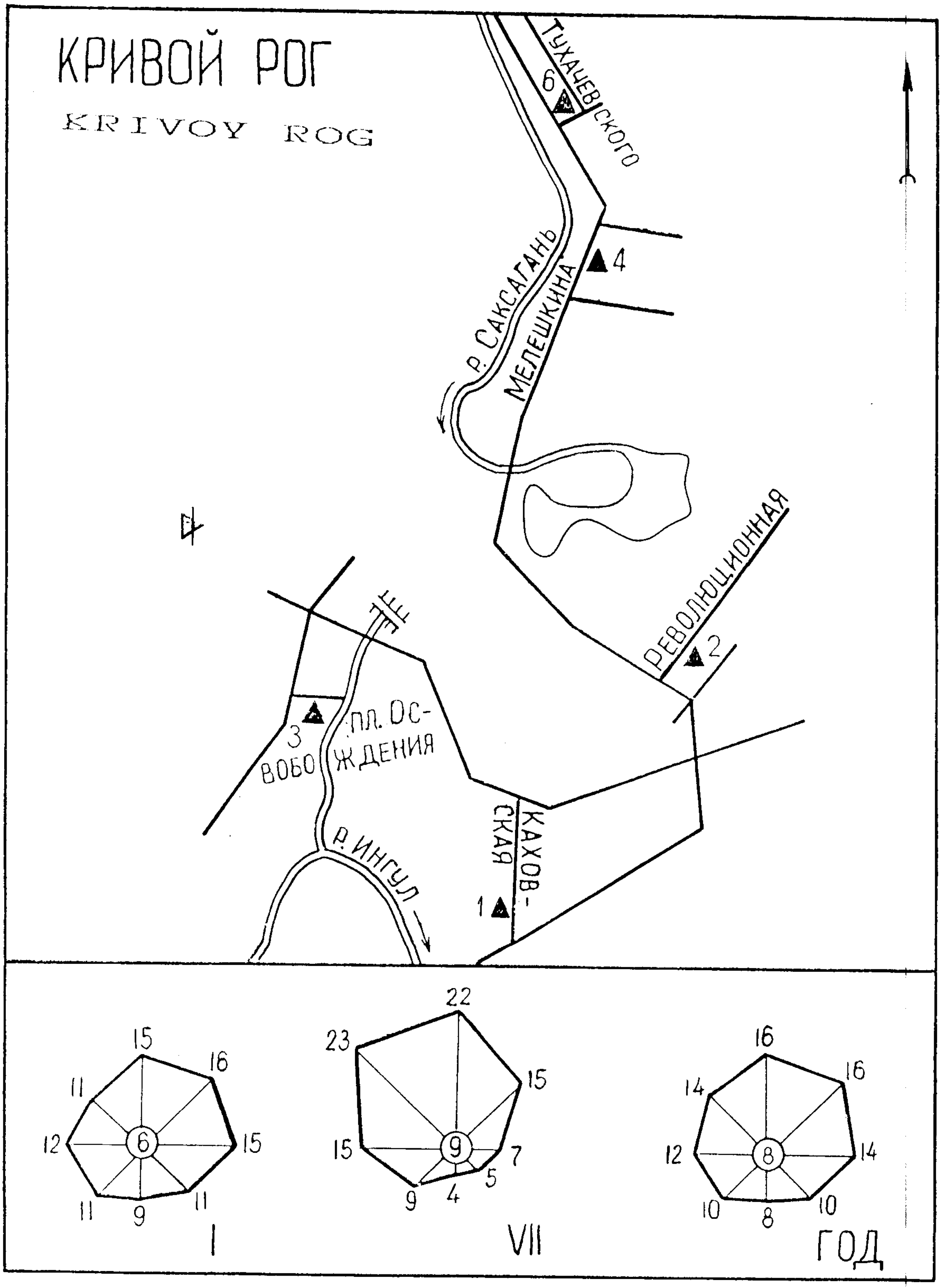
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	13	8	10	10	6	6	7	9	6	7	10	8	11
$m\ s^{-1}$	4.8	4.7	4.8	4.4	4.3	4.5	4.4	4.0	3.6	4.0	4.5	4.7	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	11	7	7	6	6	4	9	12	10	9	9	10	5
$m\ s^{-1}$	4.7	4.1	4.2	4.0	4.1	4.1	3.9	4.5	4.1	4.6	4.4	4.6	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.4	58.0		-	
Domestic/space heating						
Industry and power plants	98.1	36.8	902.3		207.9	
Total	98.1	41.2	960.3		207.9	
Per capita (**kg**)	140.5	59.0	1 375.8		297.9	
Per km^2 (**t**)	230.3	96.7	2 254.3		488.1	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	3.6	46.5	-	-	
Domestic/space heating						
Industry and power plants	82.0	30.8	753.3	3.7	166.9	0.0001
Total	82.0	34.4	799.8	3.7	166.9	
Per capita (**kg**)	111.8	46.9	1 089.7	5.0	227.4	
Per km^2 (**t**)	192.5	80.8	1 877.5	8.7	391.8	

Emission class	1990
Winter smog emissions	*4*
Summer smog emissions	*2*

Major (industrial) point sources

The basic branches of industry are ferrous metallurgy, building materials and mining . Enterprises of metallurgical and building industry are located in south-west part of the city, mining in north and south-east areas. The basic contribution to industrial emissions (98%) is made by metallurgical plants. In addition to the emissions given in the Table, also emissions of 2 567 t of hydrogen sulphide, 2 560 t of benzol, 790 t of ammonia, 505 t of naphtha and 203 t of phenol.

Traffic

Emissions from traffic are estimated to be 5.4% of total emissions (relatively low because of high industrial output).

VI. AIR QUALITY DATA

Monitoring network

4 stations are operational in Krivoy Rog (State Service for Observations of the Environment in Ukraine). The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the State Committee of the Ukraine for Hydrometeorology is in charge of methodology.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 1, 3		No. 1		No. 4		No. 2
Annual average		*13*		28		29		24		37
Winter average				36		37		27		43
Maximum (24 h) *calculated*				*260*		*290*		*219*		*338*
98 percentile (20 min)*				130		140		110		170
Number of days exceeding the WHO-AQG (*+calc.*)				2(*8*)		2(*10*)		1(*5*)		3(*15*)
Number of days exceeding 2 x WHO-AQG				0(*≥1*)		0(*≥1*)		0		0(*≥1*)

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are among the highest in the former SU cities. Compared to cities in central Europe concentrations still remain relatively low. The WHO-AQG is exceeded on a few days per year in background areas.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1, 3	No. 1, 3	No. 3	No. 3	No. 4	No. 4	No. 2	No. 2
Annual average		*29*	400	365	400	390	400	360	500	510
Winter average			415	360	450	370	450	370	470	520
Maximum (24 h)										
98 percentile (20 min)			940	970	940	1035	940	960	1330	1520
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations are very high, especially during the winter. The WHO-AQG is exceeded on numerous days.

Winter smog classification	1990
Exceedance class[5]	*4*
Exposure class[5]	*4*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1, 3	No. 1, 3	No. 3	No. 3	No. 4	No. 4	No. 2	No. 2
Annual average			125	75	120	80	100	80	120	90
Maximum (24 h)										
Maximum (20 min)			430	375	460	400	430	440	420	520
Number of days exceeding the WHO-AQG			1	1	1	2	0	4	52	2
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	1	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high. The WHO-AQG is likely to be exceeded on a few days per year in background areas. At the industrial point extensive exceedances have been reported.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		2
Annual average		16
98 Percentile (20 min)		50

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		2
Annual average		0.0069
Maximum monthly average		0.0339

Phenol concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	2	2
Annual average	13	6
98 Percentile (20 min)	31	22

NH_3 concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	2	2
Annual average	70	150
98 Percentile (20 min)	250	440

Formaldehyde concentrations/Benzo(a)pyrene concentrations/ Phenol concentrations/Ammonia concentrations
In the industrial area (station 2) the annual mean concentration of formaldehyde is 5 times, ammonia 4 times, phenol 2 times and BaP (in winter months) more than 30 times higher than their national standards. It is possible that near station 2 (in the south-west area) the air pollution is affected not only by the emissions from metallurgical enterprises, which are located here, but also by the emissions from north enterprises during northerly circulations.

VII. EFFECTS

Effects of air pollution on health
According to 1988 data, in Krivoy Rog the number of cases of malignant tumour is 58% higher than the average for the cities of the former Soviet Union.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station, the location of the station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Leeds	**Country**: United Kingdom

I. GENERAL DATA

		City	Conurbation
Population	(number)	***712 000 (1991)***	
Total area	(km^2)		
Built-up area	(km^2)		***180***
Co-ordinates	(lat-/longitude)	53° 50' N 1° 35' W	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: ***Topography**: (0)*	Climate: (Cfb) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	8.9	8.4	10.1
precipitation (mm)	509.7	699.9	452.3
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***4.2 (+)***	***4.0 (+)***	***4.1 (+)***
winter smog index	***9.7 (0)***	***9.6 (0)***	***10.2 (0)***
summer smog index	***1.7 (++)***	***0.1 (++)***	***5.3 (+)***

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

Major (industrial) point sources
(see city map)

City: Leeds **Country**: United Kingdom

VI. AIR QUALITY DATA

Monitoring network
Part of EC smoke/SO_2 directive monitoring network (234 sites). Operated by Warren Spring Laboratory on behalf of UK Department of Environment. Lead monitoring as part of 5 site multi-element UK network. SO_2 and black smoke sites: Allerton 1, Leeds 26, Leeds 28, Leeds 37 and Morley 4

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			5	5	5	5				
Annual average		*31*	41	33	52	40				
Winter average			47	34	61	40				
Maximum (24 h)			210	178	229	211				
98 percentile (24 h)			121	106	134	122				
Number of days exceeding the WHO-AQG			6	2	10	10				
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: Black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			5	5	5	5				
Annual average		*20*	16	14	31	21				
Winter average			24	20	47	29				
Maximum (24 h)			150	75	234	92				
98 percentile (24 h)			82	51	148	76				
Number of days exceeding the WHO-AQG			4	0	12	4				
Number of days exceeding 2 x WHO-AQG										

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Winter smog classification	1990
Exceedance class	***1***
Exposure class	***4***

Pb concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		
Annual average	0.31	0.12
Maximum monthly average		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data

City: Leipzig	*Country*: Germany

I. GENERAL DATA

	City		Conurbation
Population (number)	***511 000***		
Total area (km^2)			
Built-up area (km^2)			***140***
Coordinates (lat-/longitude)	51° 20' N 12° 25' E		

Major activities and development trends (1980-1990, 1990-2000)
Industrial and trading city, traffic junction with airport.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, eastern part of the country
Topography: plain (+)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.0	8.2	10.4
precipitation (mm)	370.0	378.9	427.0
wind speed ($m\ s^{-1}$)	***3.9 (0)***	***4.2 (+)***	***3.8 (0)***
winter smog index	***13.1 (0)***	***10.8 (0)***	***15.0 (0)***
summer smog index	***12.8 (0)***	***7.6 (0)***	***17.6 (0)***

Station: 9469 51° 25' N 12° 14' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***5***
Summer smog emissions[1]	***3***

VI. AIR QUALITY DATA

Monitoring network

SO_2 concentrations were in
1985: 336 μg m^{-3} annual average with a maximum of 1227 μg m^{-3}, and in
1990: 170 μg m^{-3} annual average with a maximum of 857 μg m^{-3}.

Regional background (1990):
SO_2 concentration: 58 μg m^{-3} annual average.
TSP concentration: 55 μg m^{-3} annual average.

Winter smog classification	1989
Exceedance class	***5***
Exposure class	***4***

1. Uncertain data.

City: Lille	*Country*: France

I. GENERAL DATA

		City	Conurbation
Population	(number)		***950 000 (1992)***
Total area	(km^2)		
Built-up area	(km^2)		***198***
Coordinates	(lat-/longitude)	50° 39' N 3° 05' E	

Major activities and development trends (1980-1990, 1990-2000)
Industrial conurbation (Lille-Roubaix-Tourcoing)

II. TOPOGRAPHY AND CLIMATOLOGY

Region: West Europe
Topography: plain *(+)*

Climate: Cfb (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	10.0	9.8	10.6
precipitation (mm)	566	596	575
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.0 (+)***	***4.1 (+)***	***3.6 (0)***
winter smog index [1]	***9 (+)***	***9 (+)***	***9 (+)***
summer smog index	***9 (0)***	***8 (0)***	***13 (0)***

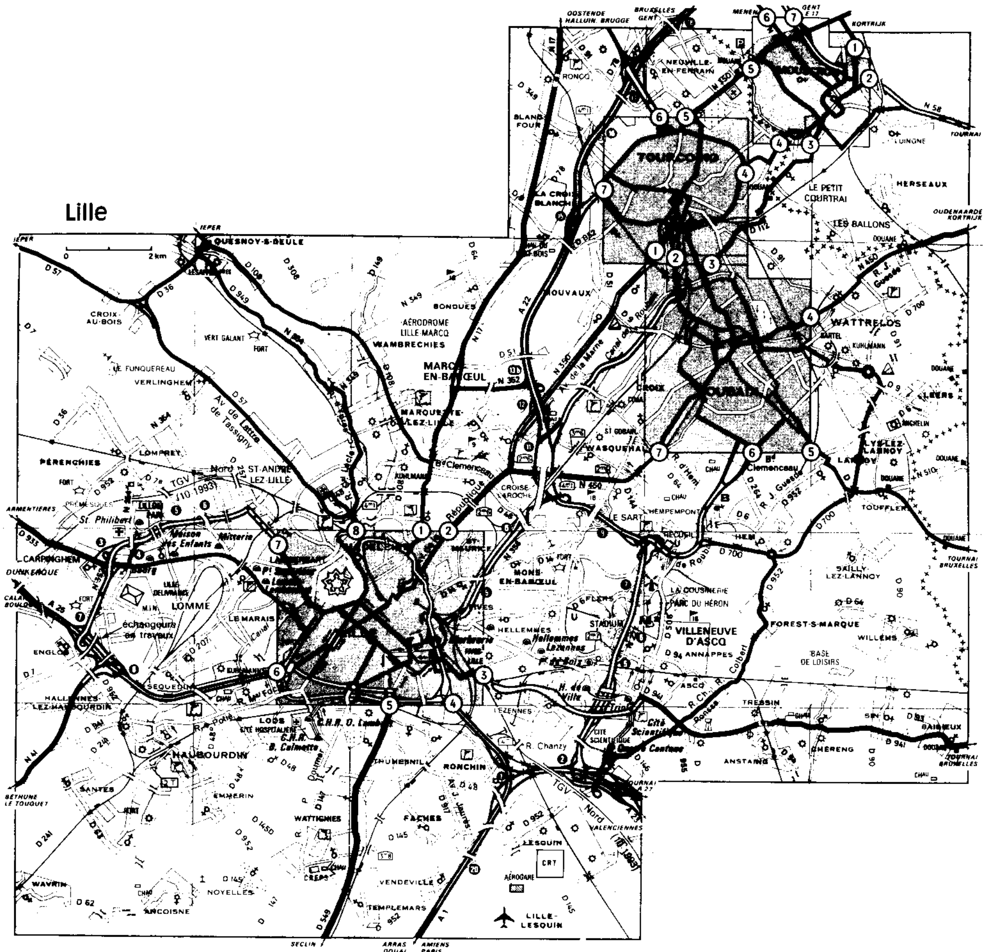
Station: Lille 50° 34' N 3° 06' E

III. EMISSIONS

Emission class	1990
Winter smog emissions [2]	***2***
Summer smog emissions [2]	***3***

Main topography, city morphology, industrial sources and monitoring network

Lille



VI. AIR QUALITY DATA

SO_2 concentrations[3] µg/m[-3]	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1989	1985	1989	1985	19__	1985	1989
Number of stations			2	2	S5d	S5d			S7	S7
Annual average		*13*	39	33	47	35			50	30
Winter average			47	41	56	43			60	45
Maximum (24 h)			396	191	461	221			391	240
98 percentile (24 h)			197	99	204	109			232	138
Number of days exceeding the WHO-AQG			18	3	23	3			31	9
Number of days exceeding 2 x WHO-AQG			4.5	0	6	0			6	0

WHO-AQG SO_2 (24h max.) = 125 µg/m[-3]

Sulphur dioxide concentrations[4]

(UV fluorescence) 1985-88: downward trend, 1989-90: upward trend.

Annual report (1990)

number of stations	8(13)
mean concentration (annual)	28
highest mean concentration	37
highest 24 h concentration	158
number of stations 24 h >125	3

Particulate matter[3]: TSP µg/m[-3]	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	19__	1985	19__	1985	19__	1985	1989
Number of stations									S8	S8
Annual average		*23*							78	56
Winter average										
Maximum (24 h)									371	155
98 percentile (24 h)									202	122
Number of days exceeding the WHO-AQG									41	8
Number of days exceeding 2 x WHO-AQG									8	0

WHO-AQG TSP (24h max.) = 120 µg m[-3]

Suspended particulate concentrations[4]

annual report 1990 TSP

number of stations	2(2)
annual mean concentration	37
highest 24 h maximum	141

Winter smog classification	1989/90
Exceedance class	***2***
Exposure class	***4***

Nitrogen dioxide concentrations[4]	
Annual report (1990)	
number of stations	1(2)
highest annual mean concentration	28
p 50 (1 h) highest	24
highest 24 h concentration	81
p 98 (1 h) highest	65
1 h highest maximum	141
WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}	

Ozone concentrations[4]	
Annual report 1990	
number of stations	1(1)
annual mean concentration	20
p 98 (1 h)	56
maximum 1 h	119
hours > 150	0
WHO-AQG Ozone (1h max.) = 150 µg m^{-3}	
Exceedance class	*1*

Carbon monoxide concentrations/Lead concentrations[4]	
Annual report 1990	
Lead	
number of stations	1(2)
annual mean concentration (max)	0.37
24 h highest maximum concentration	1.44
WHO-AQG Lead (annual average) = 0.5 µg m^{-3}	

1. Less than 75% of the data available.

2. Uncertain data.

3. EC-DGXI/B3 Air Pollution Information System (APIS).

4. Stroebel R. (ed), Air Quality in France, annual report 1990.

City: Lisboa	*Country*: Portugal

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 329 000 (1991)	***2 000 000 (1991)***
Total area	(km^2)		
Built-up area	(km^2)		***100***
Coordinates	(lat-/longitude)	38° 44' N 9° 08' W	

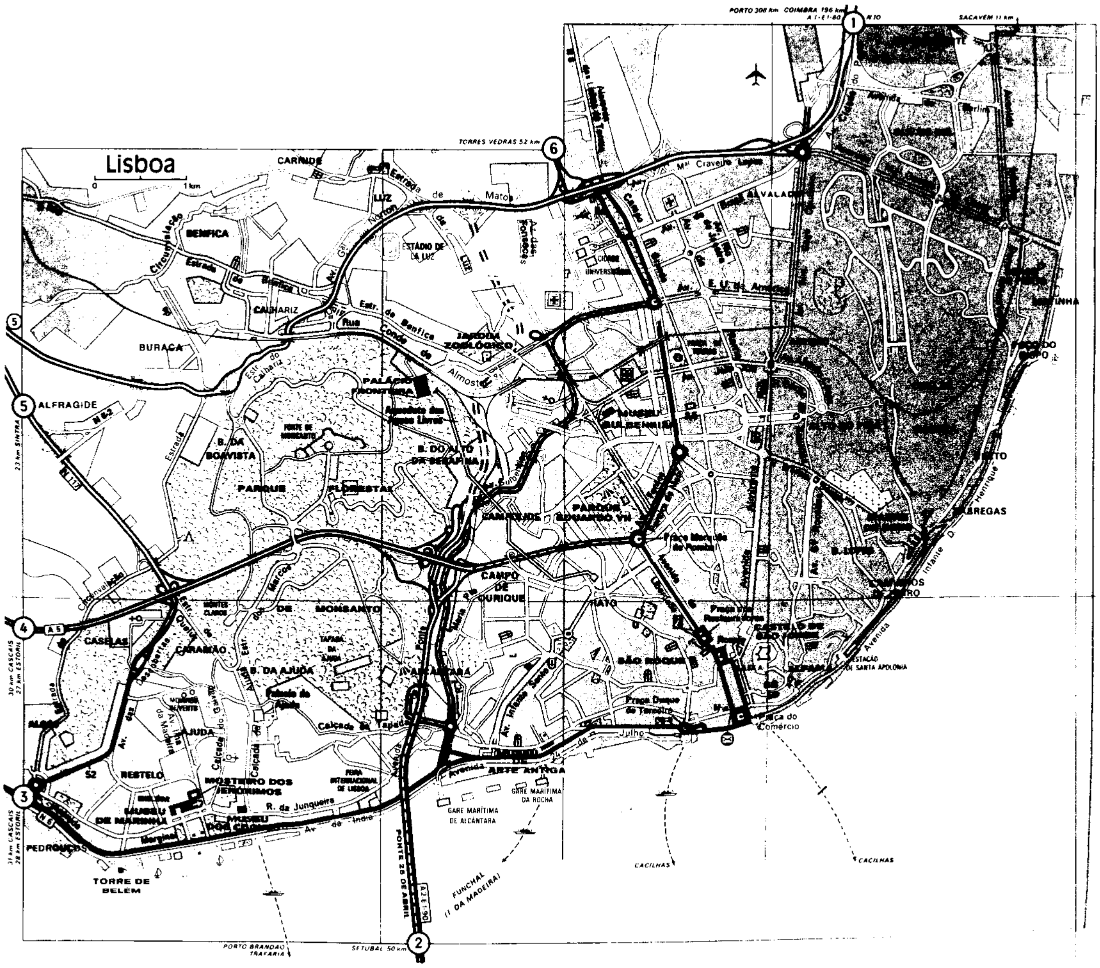
II. TOPOGRAPHY AND CLIMATOLOGY

Region: Southern Europe ***Topography***: coastal, hills ***(0)***	Climate: Csa (Köppen-Geiger) Meteorology:

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions[1]	***3***

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1986	1990	1986	1990	1986	1990	1986	1990	1986	1990
Number of stations			1	1						
Annual average		*2*	7	20	7	20	12			
Winter average			16	32	16	32	25			
Maximum (24 h)			94	141	94	141	120			
98 percentile (24 h)			39	66	39	66	75			
Number of days exceeding the WHO-AQG			0	1	0	1	0			
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0			

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1986	1990	1986	1990	1986	1990	1986	1990	1986	1990
Number of stations			1							
Annual average		*4*	21		21		117			
Winter average			37		37		85			
Maximum (24 h)			177		177		312			
98 percentile (24 h)			87		87		238			
Number of days exceeding the WHO-AQG			3		3		96			
Number of days exceeding 2 x WHO-AQG			0		0		4			

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Winter smog classification	1990
Exceedance class	***1***
Exposure class[1]	***1***

NO_2 **concentrations** µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations				1						
Annual average				33		33				
Maximum (24 h)				103		103				
Maximum (1 h)				218		218				
Number of days exceeding the WHO-AQG				0		0				
Number of days exceeding 2 x WHO-AQG				0		0				

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 **concentrations** µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations				1						
Annual average				37		37				
Summer average				40		40				
Maximum (1 h)				341		341				
Maximum (8 h)				76		76				
98 percentile (1 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. Uncertain data.
2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Liverpool	**Country**: United Kingdom

I. GENERAL DATA

		City		Conurbation
Population	(number)	***470 000 (1986)***		
Total area	(km^2)			
Built-up area	(km^2)			***150***
Co-ordinates	(lat-/longitude)	53° 25' N 2° 55' W		

II. TOPOGRAPHY AND CLIMATOLOGY

Region: ***Topography**: (++)*	Climate: (Cfb) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	9.4	8.7	10.3
precipitation (mm)	703.7	869.5	798.3
cloud cover (8^{-1})			
wind speed (m s^{-1})	***5.3 (++)***	***5.1 (++)***	***5.4 (++)***
winter smog index	***5.9 (+)***	***6.9 (+)***	***4.4 (+)***
summer smog index	***0.6 (++)***	***0.3 (++)***	***0.9 (++)***

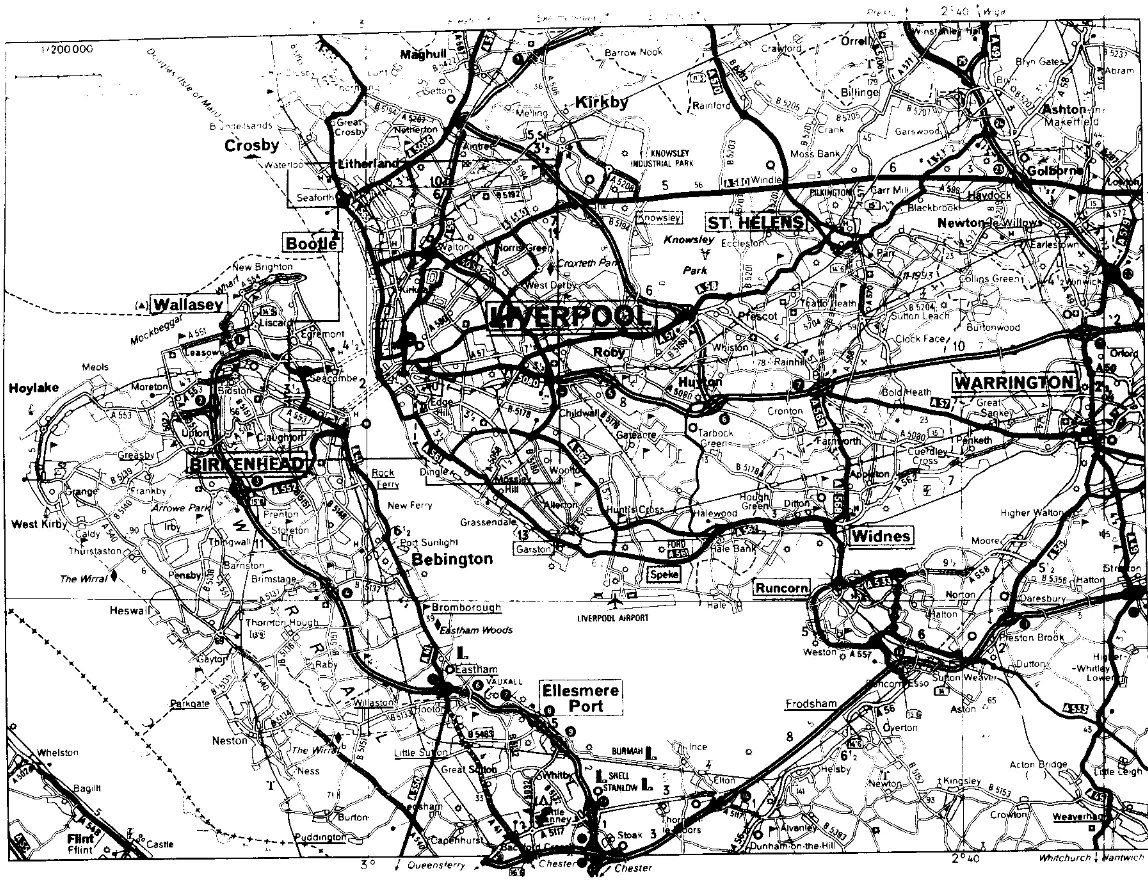
III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***3***
Summer smog emissions[1]	***2***

Major (industrial) point sources
(see city map)

City: Liverpool **Country**: United Kingdom

Main topography, city morphology, industrial sources and monitoring network



City: Liverpool **Country:** United Kingdom

VI. AIR QUALITY DATA

Monitoring network
Part of EC smoke/SO_2 directive monitoring network. Operated by Warren Spring Laboratory on behalf of UK Department of the Environment (234 sites). SO_2 sites: Crosby 3, Liverpool 16, Liverpool 22, Wallasey 9 black smoke sites: Crosby 3, Liverpool 16, Liverpool 22

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			4	4	4	4				
Annual average		*47*	39	41	51	48				
Winter average			46	44	60	50				
Maximum (24 h)			142	174	168	259				
98 percentile (24 h)			103	108	130	124				
Number of days exceeding the WHO-AQG			2	3	7	6				
Number of days exceeding 2 x WHO-AQG			0	0	0	1				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: Black smoke $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations	1	1	3	3	3	3				
Annual average	12	3 *(17)*	18	16	22	18				
Winter average	17	5	22	23	29	27				
Maximum (24 h)	51	27	88	120	111	138				
98 percentile (24 h)	44	16	55	74	77	91				
Number of days exceeding the WHO-AQG	0	0	0	0	1	1				
Number of days exceeding 2 x WHO-AQG										

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Winter smog classification	1990
Exceedance class	***3***
Exposure class	***4***

1. Uncertain data

City: Ljubljana	**Country**: Slovenia

I. GENERAL DATA

		City	Conurbation
Population	(number)	***273 000 (1990)***	322 000
Total area	(km²)	290 (1990)	
Built-up area	(km²)	***43 (1990)***	
Co-ordinates	(lat-/longitude)	46° 2'N 14° 31' E	

Major activities and development trends (1980-1990, 1990-2000)

Cultural, commercial and administrative centre. Industrial activities spread from the centre to the outskirts in a star shape. Building, metal work, chemicals, electronics, wood-making industry and food industry.

The population has not increased significantly in the 1980-1990 period. Similar trend is expected up to the year 2000.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: South eastern Europe, 100 km from the Adriatic Sea.
Topography: On a basin at 300 m above sea level, surrounded by hills and mountains. ***(--)***

Climate: (Cfa)
Meteorology: Weak winds prevail. Temperature inversions when calm.

Averages	1980-1989	1985	1989
temperature (°C)	8.6	8.6	8.9
precipitation (mm)	1221.5	1453.3	1545.9
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)[1]	***0.9 (--)***	***0.8 (--)***	***0.7 (--)***
winter smog index[1]	***33.2 (-)***	***31.0 (-)***	***34.8 (-)***
summer smog index	***39.9 (-)***	***51.6 (-)***	***30.0 (-)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

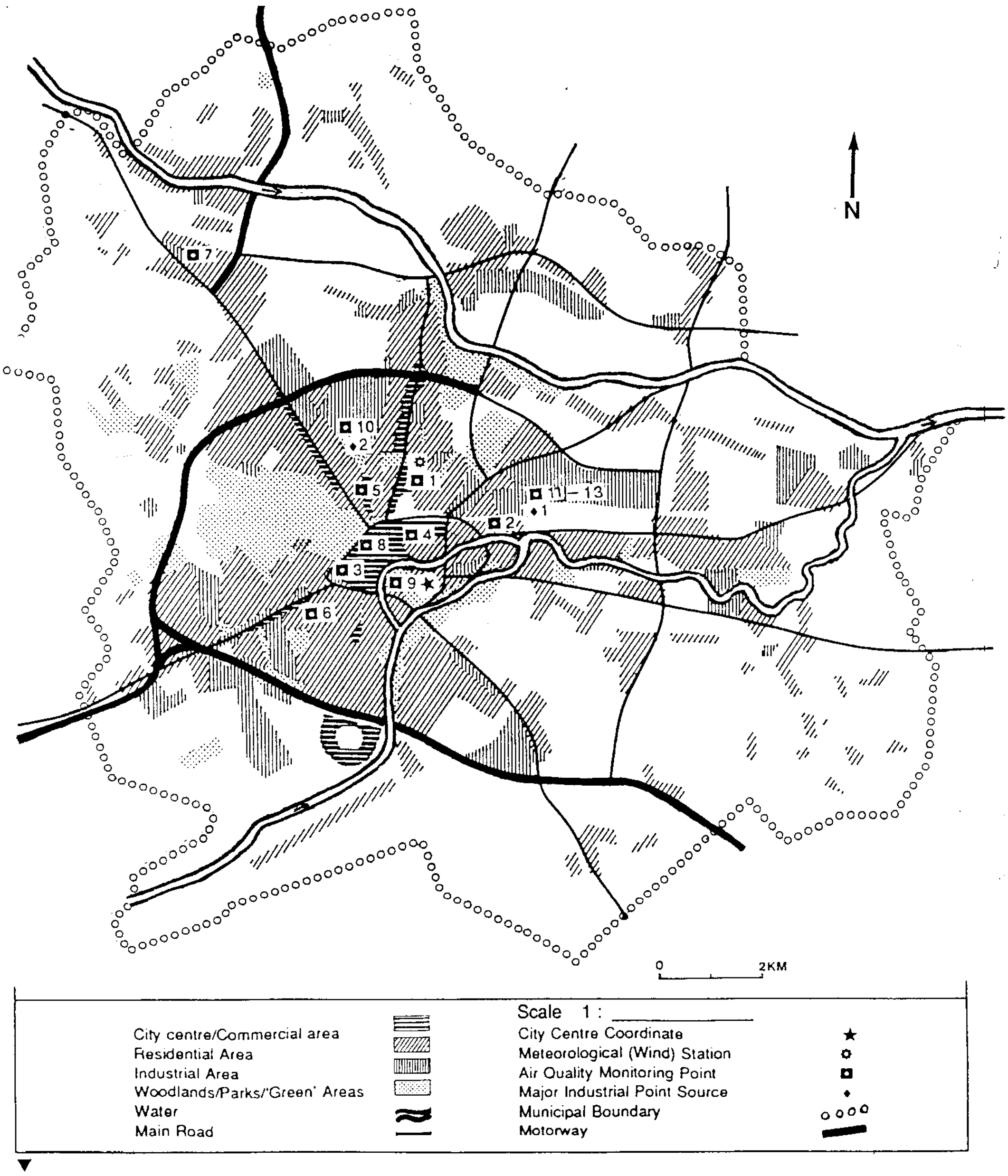
Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	5.4	16.6	17.8	9.8	6.1	8.4	7.5
1985	Wind speed $m\ s^{-1}$	1.1	1.3	1.5	1.7	1.5	1.4	2.4
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	6.7	6.2	5.6	5.8	4.0	0.1	
	Wind speed $m\ s^{-1}$	2.8	2.1	1.4	1.3	1.2		

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	6.0	17.0	18.2	8.7	4.9	8.2	8.1
1990	Wind speed $m\ s^{-1}$	1.1	1.2	1.4	1.7	1.6	1.4	2.2
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	6.2	6.4	5.5	6.5	4.3	0.0	
	Wind speed $m\ s^{-1}$	2.4	1.7	1.2	1.3	1.2		

City: Ljubljana **Country**: Slovenia

Main topography, city morphology, industrial sources and monitoring network



City: Ljubljana **Country:** Slovenia

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.43	5.57				0.06
Domestic/space heating	11.18	1.1				
Industry and power plants	22.00	1.9				
Total	33.61	8.57				
Per capita (**kg**)	123.1	31.5				
Per km² (**t**)	781.4	200.0				

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.44	6.67				0.08
Domestic/space heating	5.6	0.68				
Industry and power plants	14.0	1.5				
Total	20.04	8.85				
Per capita (**kg**)	73.3	32.6				
Per km² (**t**)	465.1	207.0				

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions[1]	***1***

Major (industrial) point sources

Major industry:
- Izolirka - Manufacturing of insulating materials
- Saturnus - Metal manufacturing industry
- Kartazna tovarna - Paper manufacturing industry
- Julon - Artificial fibres works
- Tovarna mocnih krmil - Preparation of animal fooder
- Kemicna tovarna Moste - Rubber works and $Al(OH)_3$ production
- TEOL - Chemical manufacturing industry
- Kolinska - Food industry
- Zito - Food industry
- Pivovarna Union - Food industry (brewery)
- Slovenijavino - Food industry (beverages)
- Alko - Food industry (beverages)
- Plutal - Cork manufacturing
- WorksIskra Elektronska Industrija - Electronic industry
- Lek - Pharmaceutical industry
- Litostroj - Metal manufacturing industry
- IMP - Metal manufacturing industry
- Tobacna tovarna - Tobacco manufacturing company
- Ilirija - Chemical industry

The majority of industry in the Ljubljana municipality is of a manufacturing type and the emissions are not serious.

Power plants: TE TOL Co-generation Power plant, coal fired
KEL Power Plant, gas-fired

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles 1992 1985	Total traffic activity veh km a^{-1} 1991
Total	120 798	x 10^9
of which:	114 104	
· passenger cars	545	
· buses	6 149	
· freight traffic >3.5 t		

Total annual consumption of fuel for traffic

	Consumption ($t\ a^{-1}$)		Average Sulphur content (%)	
	1985	1991	1985	1991
Diesel oil	72 700	73 700	1	1
Petrol/Gasoline	76 600	112 000		
LPG				

City: Ljubljana **Country:** Slovenia

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption		Average Sulphur content (%)	
		1985	1990	1985	1990
Fuel oil low sulphur	($t\ a^{-1}$)	43 800	81 400	1	1
Fuel oil high sulphur	($t\ a^{-1}$)	106 400	44 700	3	3
Coal	($t\ a^{-1}$)	103 820	52 529	1.5	1.2
Wood	($t\ a^{-1}$)	2 350	1 300		
Natural/city gas	($10^6\ m^3\ a^{-1}$)	21.07	32.4		
Total	($t\ a^{-1}$)				

Space/domestic heating: general remarks

Many buildings in Ljubljana are connected to the Te Tol network of the off-site heating system. In the last years, utilisation of natural gas for heating has been increased. The use of coal and oil for domestic and space heating is common, however, in the outskirts.

Local policies to reduce air pollution

Industry and power plants:

Although few industrial areas exist on the outskirts, some small plants are still operating within the town. It is planned that industry should move gradually from the residential area within the town to the outskirts.

For TE TOL Power Plant operating at present without SO_2 cleaning device, rehabilitation is planned. During the last two heating seasons, the power plant used mostly low-sulphur coal reducing the SO_2 emissions significantly.

Please see also: D. Hrcek et. al., Air pollution in Slovenia, 1992, p. 112 and 119.

Traffic:

Several years ago an infrastructure for bicycles was established in order to reduce passenger-car traffic. Most of the circular thoroughfares around the city have already been constructed. In the city centre, a pedestrian area has been arranged.

Public transportation in Ljubljana consists of buses and no other means is planned in the near future. Further limitation of passenger car traffic is planned by limiting parking places in the city centre and by arranging of parking areas at the outskirts.

Domestic/space heating:

Two heating plants provide off-site residential and commercial heating, namely TE TOL and KEL. There is a tendency to widen the existing network of the off-site heating. Introduction of a regulation prohibiting the use of high-sulphur coal in domestic/space heating is being planned.

VI. AIR QUALITY DATA

Monitoring network

Two automatic monitoring stations (SO_2, NO_x, O_3, CO), 8 24h SO_2 + Black smoke stations, 5 stations for deposited matter and precipitation quality measurements, 1 station for suspended particulates, 2 automatic monitoring stations provide half-hour data to the Hydrometeorological Institute.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991/92	1985	1991/92	1985	1991/92	1985	1991/92
Number of stations			4	5	4	5	4	5	1	1
Annual average		*11*	83	50	90	60	110	59	90	110
Winter average			135	74	150	90	270	100	150	110
Maximum (24 h)			410	335	440	450	500	480	480	350
98 percentile (24 h)			280	~170	320	220	370	308	300	310
Number of days exceeding the WHO-AQG			79	34	97	45	124	48	96	38
Number of days exceeding 2 x WHO-AQG			19	5	24	11	52	10	22	10

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

City: Ljubljana **Country:** Slovenia

Sulphur dioxide concentrations
SO_2: Acidimetric

Particulate matter: Black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991/92	1985	1991/92	1985	1991/92	1985	1991/92
Number of stations			4	4	4	4	4	4	1	1
Annual average		*21*	28	23	30	30	40	30	30	50
Winter average			43	35	40	50	60	50	40	50
Maximum (24 h)			150	185	190	280	300	310	170	230
98 percentile (24 h)			108	100	120	140	160	170	100	200
Number of days exceeding the WHO-AQG			3	5	4	9	13	12	1	8
Number of days exceeding 2 x WHO-AQG			0	1	0	4	2	4	0	0

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Winter smog classification	1991/92
Exceedance class	***2***
Exposure class	***4***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1991	1985	1991	1985	1991	1985	1991/92	1985	1991
Number of stations								1		
Annual average								54		
Maximum (24 h)								186		
Maximum (1 h)								361		
Number of days exceeding the WHO-AQG								5		
Number of days exceeding 2 x WHO-AQG								0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		1
Annual average		2.5
Maximum (8 h)		6.9
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data

***City*:** Lodz	***Country*:** Poland

I. GENERAL DATA

		City		Conurbation
Population	(number)	***845 000 (1992)***		
Total area	(km^2)			
Built-up area	(km^2)	***120***		
Coordinates	(lat-/longitude)	51° 49' N 19° 28' E		

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe ***Topography*:** plain *(+)*	Climate: Dfb (Köppen-Geiger) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	7.9	6.5	9.4
precipitation (mm)	265	202	454
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.6 (0)***	***3.3 (0)***	***3.1 (0)***
winter smog index	***17 (0)***	***22 (-)***	***19 (0)***
summer smog index	***11 (0)***	***9 (0)***	***18 (0)***

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions[1]	***2***

VI. AIR QUALITY DATA

Winter smog classification	1990
Exceedance class	***1***
Exposure class[1]	***3***

1. Uncertain data.

***City*:** London	***Country*:** United Kingdom

I. GENERAL DATA

		City	Conurbation
Population	(number)	6 680 000 (1994)	***10 570 000 (1990)***
Total area	(km^2)	***1598***	
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	51° 30 ' N 0° 10 ' W	

Major activities and development trends (1980-1990, 1990-2000)
London is the capital of the United Kingdom and one of the world's major financial centres. The administrative area of Greater London comprises 33 districts (32 London Boroughs and the City of London). The population has fallen 10% over the past 20 years but is forecast to rise slightly over the next 20. The main activities are financial, commercial and consumer services. Urban development extends beyond the boundary of Greater London, and the population of the conurbation (for which there is no official boundary) is fairly stable at about 10.5 million.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: NW-Europe
Topography*:** plain ***(+)

Climate: Cfb
Meteorology:

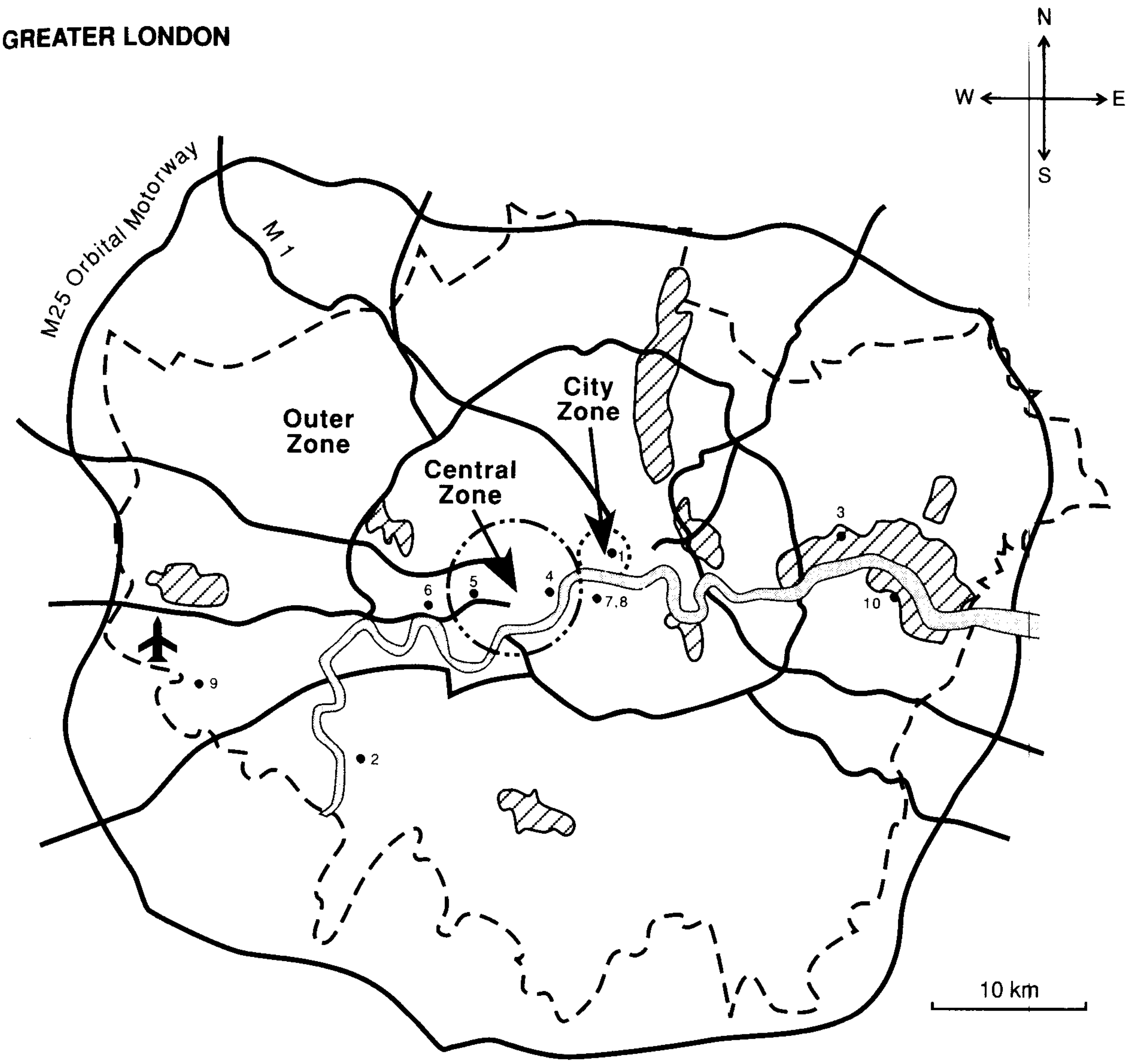
Averages	1980-1989	1985	1989
temperature (°C)	10.7	10.1	12.0
precipitation (mm)	479	531	560
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.6 (0)***	***3.5 (0)***	***3.3 (0)***
winter smog index	***7.8 (+)***	***12 (0)***	***4.4 (+)***
summer smog index	***6.3 (+)***	***2.5 (+)***	***14 (0)***

Climatological diagram 1980-1989
Cold spells are rare but often accompanied by subsidence inversions. Hot sunny spells are also rare but can cause occasional photochemical smog formation. Relatively high wind speed favours the dispersion of emitted pollutants.
London causes a pronounced urban heat island effect, city temperatures are typically 2-3 °C higher than the surrounding rural areas. Autumn (September-November) usually induces the highest pollution levels. High barometric pressure over the South-east of England and continental Europe results in light winds thus reducing the dilution of air pollution. The concurrent cooling of the ground causes a temperature inversion (a few tens of meters above the surface).

Station: London/Heathrow airport (nr 3772); located 42 km from the city centre 51° 29 ' N 0 ° 27 ' E

Main topography, city morphology, industrial sources and monitoring network

GREATER LONDON



Legend

- Industrial Areas
- River Thames
- Greater London Area
- Monitoring station

1. GEMS City of London (CCC) SO_2, SPM
2. GEMS Kingston-upon-Thames (SR) SO_2, SPM
3. GEMS Barking (SI) SO_2, SPM
4. WSL Central London (CCC) SO_2, CO, NO_2, O_3
5. WSL Cromwell Road (CCM) SO_2, CO, NO_2
6. WSL West London (CCR) CO, NO_2
7. LSS Central London (CCC) SO_2, PM_{10}, CO, NO_2, O_3
8. LSS Central London (CCC) SO_2, PM_{10}, CO, NO_2, O_3
9. LSS West London - Hounslow (SR) SO_2, PM_{10}
10. LSS East London (SR/SI) SO_2, PM_{10}, CO, NO_2, O_3

City zone - 4 sites
Central zone - 6 sites
Outer zone - 13 sites

Main topography, city morphology, industrial sources and monitoring network
London has been a city of importance since Roman times, lying at the lowest point on the River Thames which could then be bridged. The modern financial centre of London, frequently referred to as "the City", lies on top of the Roman city with the central business district extending westwards from it. Hills to the north and south rise to 200 metres to form the Thames river basin. By the start of the Second World War London stretched between 45 and 50 kilometres east to west and 40 kilometres north to south, and had reached its peak population of 8.61 million. Since 1945 further outward growth of the continuous built-up area has been severely limited by the Green Belt. However, many of the areas left as open land in the period of rapid expansion between 1918 and 1939 were built over. As a result, the population of outer London continued to grow for some years, even though the population of Greater London as a whole was falling as a consequence of the declining inner London population. Since 1945 the main growth areas have lain beyond the Green Belt. The Green Belt is a key element of London's structure, still restraining the further outward spread of the continuous built-up area and providing valuable recreational opportunities for Londoners. Nevertheless, it has not prevented the development of almost continuous urban corridors linking London, for example, to Watford in the north west and Woking in the south west. Completion of the M25 orbital motorway in 1986, the route of which lies almost entirely within the Green Belt, has led to an intensification of pressure for development within the Green Belt and beyond. The principal changes within London since 1945 have been the decline of manufacturing industry, the closure of the London docks in the east, and the growth of Heathrow Airport and the associated commercial activities in the west. Aviation fuel delivered to Heathrow Airport now accounts for over 19% of energy supplied in London. However, the high level of fuel supply is not reflected in the aircraft landing and takeoff cycle emissions because the majority of the emissions occur away from London. The decline of manufacturing industry and the switch from coal and fuel oil to natural gas has greatly reduced emissions of sulphur dioxide and particulates. The principal source of black smoke, carbon monoxide, nitrogen oxides and energy-related volatile organic compounds is now road traffic. The endemic congestion and very slow traffic speeds, particularly in central London, contribute greatly to the levels of emissions. However, the construction of new roads as a means of relieving this congestion is widely rejected as only likely to generate further traffic. Improved management, including the imposition of charges for vehicle use on congested roads, is regarded as being more likely to be effective in the long term

III. EMISSIONS

Annual emissions per source and totals in 1983 (kt a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	2	59			8	
Domestic/space heating	11	7			2	
Industry and power plants	37	13			1	
Total	50	79			11	
Per capita (**kg**)	7.5	11			1.6	
Per km^2 (**t**)	32	50			7.0	

Annual emissions per source and totals in 1991 (kt a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter**	Pb
Traffic	6	104	641	113	19	
Domestic/space heating	0.2	9	1	1	0	
Industry and power plants	20	18	1	1*	0.8	
Total	26	137	648	116*	20	
Per capita (**kg**)	3.8	20	97	17*	3	
Per km^2 (**t**)	16	86	405	72*	12	

* Only includes VOC from fuel combustion and does not include industrial processes.
** Measured as black smoke.

Emission class	1990
Winter smog emissions	*2*
Summer smog emissions[1]	*5*

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles 1988	Total traffic activity x 10^9 veh km a^{-1}
Total	2 362 000	36

Traffic

The level of road traffic in London has increased by 7% over the past 20 years, having been restrained by the chronic congestion. Average traffic speeds have fallen from 29 km/h to 24 km/h generally and from 20 km/h to 18 km/h in central London over the same period.

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

In 1965 coal and fuel oil met 56% of London's space and domestic heating needs but by 1991 this had fallen to less than 10%. These fuels have largely been replaced by natural gas.

Local policies to reduce air pollution

Specific legislation restricting the sulphur content of fuel (coal and oil) to below 1% has been in force since 1972 in the city of London.

Traffic:
The number of car journeys into central London peaked in 1984 and has declined since, mainly owing to the introduction of cheap travel passes on public transport, stricter parking restrictions and the completion of London's orbital motorway, the M25. The M25 has accelerated the relocation of employment to the outskirts of London, thus increasing traffic movements in this area.

VI. AIR QUALITY DATA [2]

Monitoring network

As part of the national network the Warren Spring Laboratory (WSL) operates three urban monitor stations, for smoke, SO_2, NO_2, CO, O_3 and lead, and co-ordinates the smoke/SO_2 monitors undertaken by London boroughs. Some of the boroughs undertake their own monitoring, however, few of these data are ever published.

Sulphur dioxide concentrations

Monitoring of SO_2 at County Hall in London dates back to 1931. Annual mean concentrations of between 300-400 μg^{-3} were typical until the mid 1960s when a steady decline began. Annual mean concentrations today are around 30 μg m^{-3}. The main source of SO_2 pollution is now power stations outside London on the Thames estuary. These SO_2 emissions often descend over London when light prevailing winds are from the east. Such conditions are usually responsible for the worst SO_2 episodes.

Regional background concentration: *21* μg m^{-3}

Particulate matter: (Black smoke) μg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1986	1989	1985	19__	1985	19__	1985	19__
Number of stations										
Annual average		*21*	12							
Winter average										
Maximum (24 h)			119							
98 percentile (24 h)			39							
Number of days exceeding the WHO-AQG			0							

WHO-AQG black smoke (24h max.) = 125 μg m^{-3}

Suspended particulate concentrations

Annual mean black smoke concentrations have now levelled out generally below 30 μg m^{-3}.

NO_2 concentrations μg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1989	1985	1989	1984	1989	1985	19__
Number of stations			1	1						
Annual average			60	70	60	70	90	85		
Maximum (24 h)			126	160	126	160	305	288		
Maximum (1 h)			212	406	212	406	487	509		
Number of days exceeding the WHO-AQG			0	1	0	1	17	14		
Number of days exceeding 2 x WHO-AQG			0	0	0	0		0		

WHO-AQG NO_2 (24h max.) = 150 μg m^{-3}

Nitrogen dioxide concentrations
During the second week of December 1991 (12-15) London experienced the highest NO_2 concentrations since records began (1h max.: 867 µg m^{-3}; 8 hour: >600 µg m^{-3}; 72 hour: >205 µg m^{-3}).

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1989	1985	1989	1985	19__	1985	19__
Number of stations			1	1						
Annual average			31	20	31	20				
Summer average			47	27	47	27				
Maximum (1 h)			292	211	292	211				
Maximum (8 h)			153	135	153	135				
98 percentile (1 h)			116	90	116	90				
Number of days exceeding the WHO-AQG			14	6	14	6				

2

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Ozone concentrations
Ozone measurements started in 1972 at one station, in 1982 a 4 year survey with 20 stations started. The survey revealed that precursor emissions generated in London can increase downwind O_3 concentrations by between 38-154 µg m^{-3} within a few hours (up to 10 hours).

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1986
Station number/name		
Annual average	1.45	0.66
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
The exceedances of CO in 1989 were mainly in November (13 days) and December (8 days). The reduction in permissible lead levels in petrol from 0.4 to 0.15 g/l, which came into force in January 1986 brought down the measured concentration in the air by more than 50%. The introduction of unleaded petrol (nil beginning of 1987, 33% market share in May 1990) has further brought down lead concentrations in recent years.

1. Uncertain data.

2. References SO_2,PM,CO,Pb: - EC-DGXI/B3 Air Pollution Information System (APIS).
- Urban air pollution in megacities of the world, WHO/UNEP 1992, Oxford.

City: Luxembourg	*Country*: Luxembourg

I. GENERAL DATA

	City		Conurbation
Population (number)			***78 000 (1992)***
Total area (km^2)			55 (1989)
Built-up area (km^2)			***22 (1992)***
Coordinates (lat-/longitude)	49° 37' N 6° 08' E		

Major activities and development trends (1980-1990, 1990-2000)
Capital of Luxembourg, commercial and administrative centre.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: West Europe
Topography: valley *(--)*

Climate: Cfb (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	8.4	7.6	9.7
precipitation (mm)	855	1200	897
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.5 (0)***	***3.5 (0)***	***3.1 (0)***
winter smog index	***9 (0)***	***10 (0)***	***11 (0)***
summer smog index	***7 (0)***	***4 (+)***	***9 (0)***

Station: Luxembourg 49° 37' N 06° 13' E

III. EMISSIONS

Annual emissions per source and totals in 1989 (t a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	174	1 560				
Domestic/space heating	210	210				
Industry and power plants	200	280				
Total	584	2 050				
Per capita (**kg**)	7.5	26.3				
Per km^2 (**t**)	26.5	93.2				

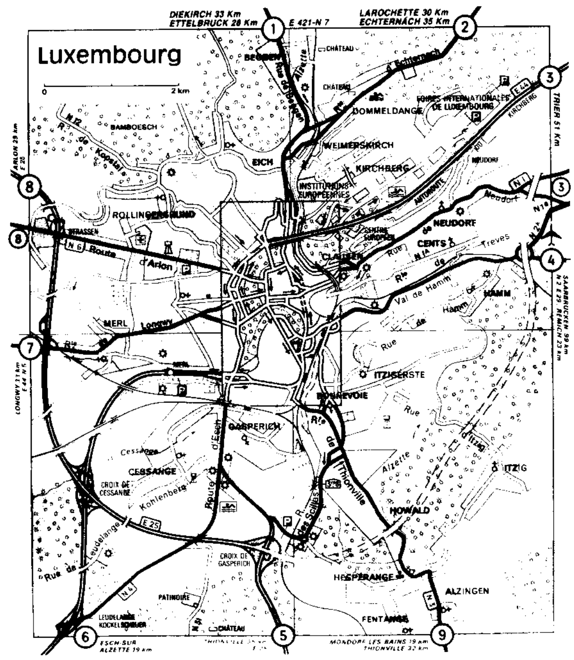
Emission class	1990
Winter smog emissions	***1***
Summer smog emissions[1]	***1***

Major (industrial) point sources[2]

Leudelange waste incinerator 300 t NO_x, 100 t SO_2.

(NO_x emission per square km up to 240 t in Luxembourg-city, SO_x emission per square km up to 120 t in Luxembourg-city)

Main topography, city morphology, industrial sources and monitoring network



IV. TRAFFIC DATA

Vehicle statistics and traffic activity			**Total annual consumption of fuel for traffic**				
City	Number of vehicles 1989	Total traffic activity veh km a^{-1}	City	Consumption ($t\ a^{-1}$)		Average Sulphur content (t)	
				1985	1989	1985	19__
Total		1.437×10^6	fuel use				
of which:							
· passenger cars		1.23×10^6	passenger cars		74.1		
· freight traffic <3.5 t		0.114×10^6	freight <3.5 t		10.1		
· freight traffic >3.5 t + buses		0.093×10^6	freight >3.5 t		18.4		

VI. AIR QUALITY DATA

SO_2 concentrations[3] $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		City centre		City background **strong acidity**	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1989
Number of stations			Bonnv.	Bonnv.	Bonnv.	Bonnv.	Centre	Centre	No. 353	No. 353
Annual average		*10*	28	28	28	28	26	36	29	16
Winter average									38	-
Maximum (24 h)			78	105	78	105	105	137	116	95
98 percentile (24 h)			64	81	64	81	89	103	94	46
Number of days exceeding the WHO-AQG			0	0	0	0	0	>0	0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter[3]: TSP/black smoke $\mu g\ m^{-3}$	Observed concentrations									
	Reg. background		City background **black smoke**		City background **TSP**		Traffic site		Industrial site	
	1985	1990	1985	1989	1985	1990	1985	19__	1985	19__
Number of stations			No. 353	No. 353	Bonnv.	Bonnv.				
Annual average		*23*	9	9	58	42				
Winter average			8							
Maximum (24 h)			76	49	227	148				
98 percentile (24 h)			34	27	197	128				
Number of days exceeding the WHO-AQG			0	0						
Number of days exceeding 2 x WHO-AQG			0	0						

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$
WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Winter smog classification	1989/90
Exceedance class	*0.5*
Exposure class[1]	*1*

Nitrogen dioxide concentrations[4]			
Data from annual report			
Bonnevoi (residential station):	annual mean		1990: 51
	maximum (1/2h)		1990: 168.
Centre (traffic station):	annual mean	1985: 37	1990: 67,
	maximum (1/2h)	1985: 166	1990: 320.

city centre (streets) annual mean 45-70 µg m^{-3}, residential areas (not directly exposed) 35-45 µg m^{-3}.

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Ozone concentrations[4]

Data from annual report

City centre 1990

annual mean:	19
maximum (1/2h):	111
98 p (1/2h):	68

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Carbon monoxide concentrations[4]

Data taken from annual report

Centre 1990

annual mean:	1.5
maximum (1/2h):	16.1
98 p (1/2h):	5.3

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data.

2. Emissions und Immissionskadaster für die Agglomeration Luxemburg, Umweltverwaltung Luxemburg, entwurf 1991.

3. EG-DGXI/B3 Air Pollution Information System (APIS).

4. Resultats de mesure par annee (1990).

***City*:** Lvov[1]	***Country*:** Ukraine

I. GENERAL DATA

		City		Conurbation
Population	(number)	***800 000 (1990)***	1	200 000 (1992)
Total area	(km²)	***166 (1992)***		
Built-up area	(km²)			
Coordinates	(lat-/longitude)	49° 50' N 24° 00' E		

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and administrative centre (cultural and scientific centre of West Ukraine. Industries: heavy engineering, wood processing, chemicals, metallurgy. The number of inhabitants increased from 667 000 in 1980 to 800 000 in 1990. The number is expected to grow to 850 000 in 2000.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography*:** Southern part of city is located on plain, other parts in basin of river Poltva (river basin). *(-)*	Climate: Dfb (Köppen-Geiger) Meteorology: moderate dispersion conditions Surface inversions: 29% wind 0-1 m s^{-1}: 28%, calms 16-21%.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	7.2	5.4	8.4	7.3
precipitation (mm)				781.5
cloud cover (8^{-1})				6.9
wind speed[2] (m s^{-1})	***3.7 (0)***	***3.7 (0)***	***3.9 (0)***	4.2
winter smog index[2]	***21 (-)***	***25 (-)***	***18 (0)***	
summer smog index	***9 (0)***	***6 (+)***	***12 (0)***	
Station:				Lvov 49° 49' N 23° 57' E

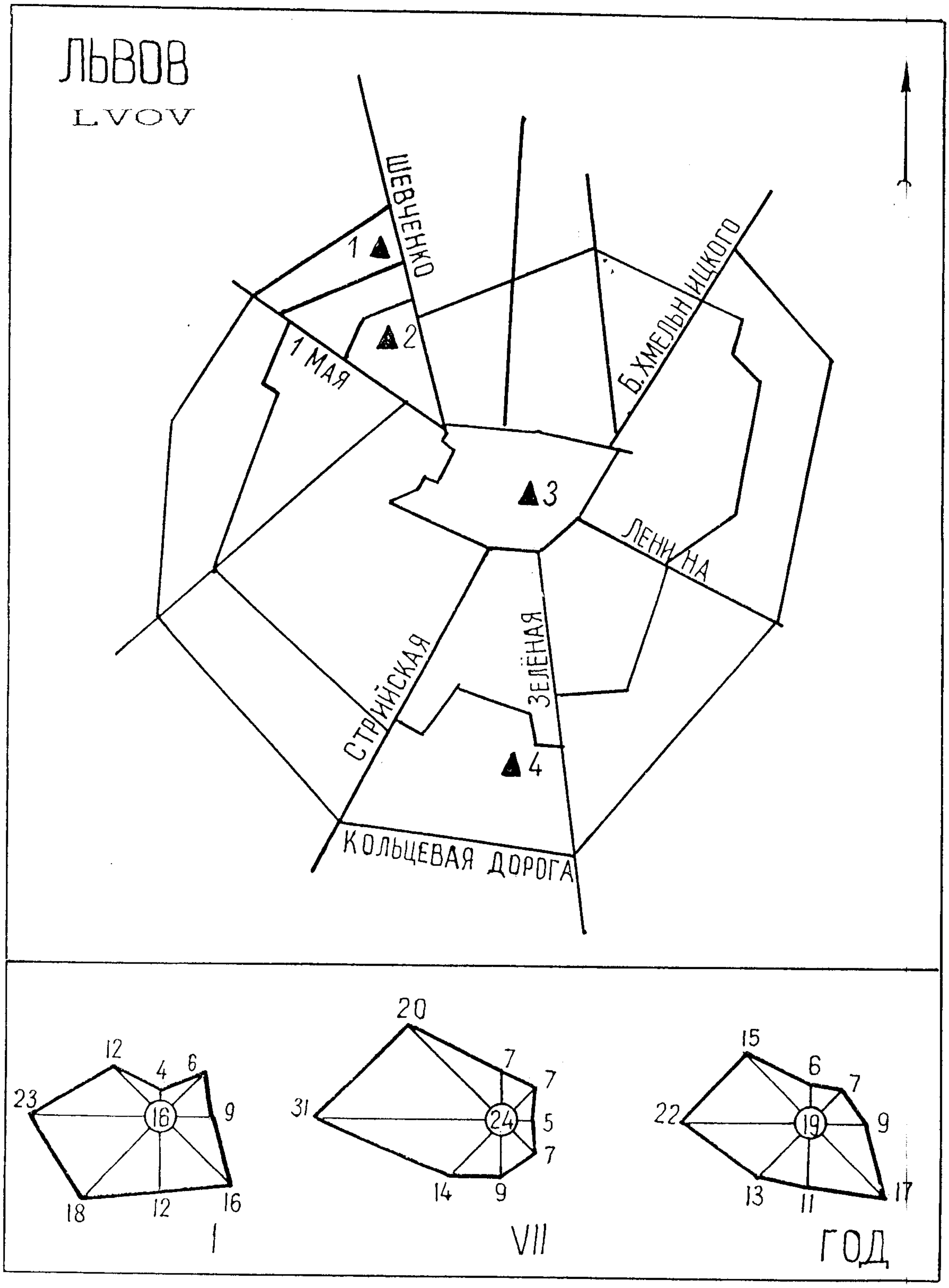
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	3	3	3	13	13	5	5	10	16	16	8	16
m s^{-1}	3.5	3.2	3.4	4.0	4.4	4.5	3.5	3.9	4.4	4.8	4.9	4.3	

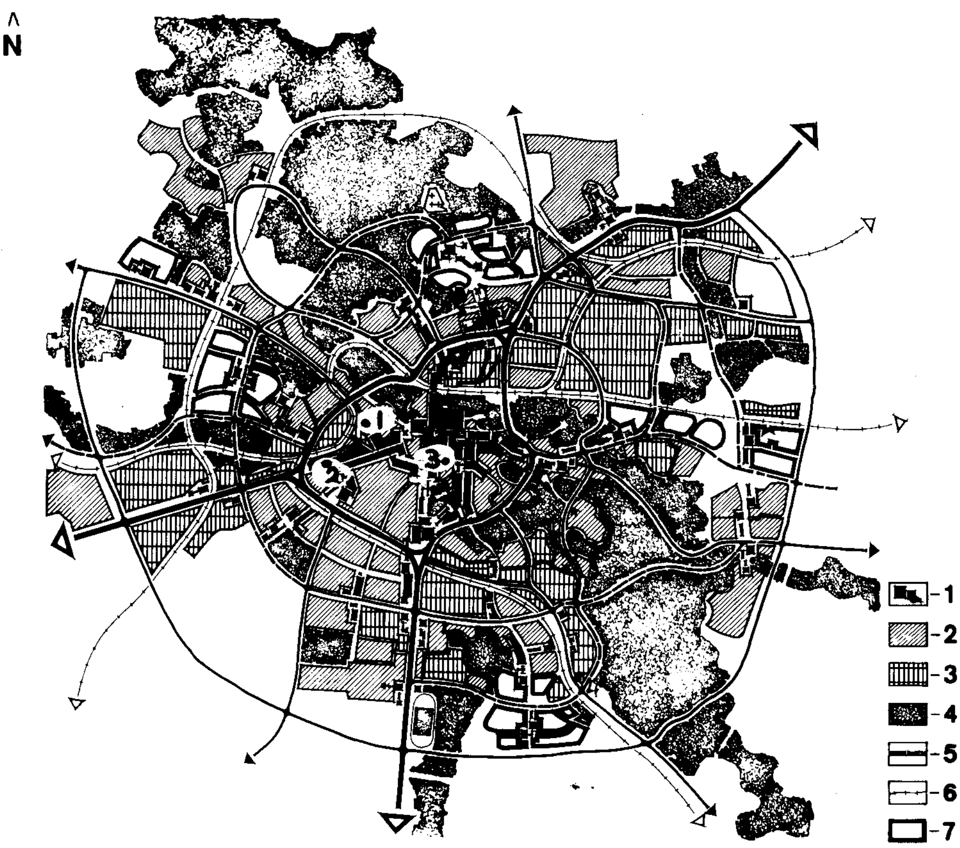
Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	4	2	2	8	9	7	7	12	22	15	7	21
m s^{-1}	4.2	3.7	3.6	4.4	4.7	4.0	4.0	4.3	4.7	4.9	4.9	4.3	

Main topography, city morphology, industrial sources and monitoring network



Main topography, city morphology, industrial sources and monitoring network



1. city centre
2. Residential area
3. Industrial area
4. Woodlands (parks)
5. Main road
6. Railway road
7. Perspective buildings
• Air quality monitoring point

III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	11.5	65.9		-	
Domestic/space heating						
Industry and power plants	3.5	2.9	6.1		5.7	
Total	3.5	14.4	72.0		5.7	
Per capita (**kg**)	4.6	18.8	93.9		7.4	
Per km² (**t**)	21.1	86.8	433.7		34.3	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.6	74.6	-	-	
Domestic/space heating						
Industry and power plants	0.9	2.6	2.6	2.6	2.7	0.0004
Total	0.9	7.2	77.2	2.6	2.7	
Per capita (**kg**)	1.1	9.0	96.5	3.3	3.4	
Per km² (**t**)	5.4	43.4	465.1	15.7	16.3	

Emission class	1990
Winter smog emissions	*1*
Summer smog emissions	*1*

Major (industrial) point sources

The level of air pollution forms under the influence of emissions from enterprises of oil chemistry, machine construction, energy production, wood working, radio engineering, electronic engineering. In addition to the emissions, given in Table, there are released into the atmosphere fluoric compounds (115 t), benzol (123 t), toluene (236 t), xylene (954 t), styrene (146 t).

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	*114 000*	x 10^9
of which:		
· passenger cars	*68 000*	
· buses	*30 000*	
· freight traffic >3.5 t	*15 000*	

Total annual consumption of fuel for traffic

	Consumption (kt a^{-1}) 1985	Consumption (kt a^{-1}) 1992	Average Sulphur content (t) 1985	Average Sulphur content (t) 19__
Diesel oil		*2.0*		
Petrol/Gasoline		*40.6*		
LPG		*0*		

Traffic

Main city roads (10-50 000 veh/day) 127 km. Total public transport activity (buses): 104 289 000 passenger km day^{-1}. Narrow streets in centre make unacceptable conditions for transport. Average speed 30 km/h. Traffic contribution to total emission: 87%.

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

90% is heated through the two heat and power co-generation plants. Natural gas consumption 1985: 1 716x10^6 m^3 a^{-1}, 1992: 1 755.2x10^6 m^3 a^{-1}.

Local policies to reduce air pollution

Industry: *VOC emission reduction installations (heavy engineering).*
Traffic: *Reserved lanes for public transport are widespread in the city centre. Limited parking spots and parking meters in city centre.*
Domestic/space heating: *Small boiler houses were closed when the new heat/power plant became operational. However, no reduction of sulphur dioxide emissions due to the increase of population numbers.*

VI. AIR QUALITY DATA

Monitoring network

4 stations are operational (State Service for Monitoring the State of the Environment in Ukraine). The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the Ukraine State Committee for Hydrometeorology is in charge of methodology.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 3		No. 3		No. 1		No. 4
Annual average		*8*		45		45		48		52
Winter average				43		43		47		52
Maximum (24 h) *calculated*				*85*		*85*		*101*		*97*
98 percentile (20 min)*				70		70		80		80
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0(*0*)		0(*0*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day **WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}**

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are low, no exceedance of the WHO-AQG has been observed. *In 1985 9 days above 125 µg m^{-3} were observed.*

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 3	No. 3	No. 3	No. 3	No. 1	No. 1	No. 2	No. 2
Annual average		*20*	200	180	200	180	300	190	300	190
Winter average				200		200	270	200		200
Maximum (24 h)										
98 percentile (20 min)				330		330		340		340
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations are high and the WHO-AQG is likely to be exceeded.

Winter smog classification	1990
Exceedance class[5]	*3*
Exposure class[5]	*3*

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 3	No. 3	No. 3	No. 3	No. 1	No. 1		No. 4
Annual average			50	70	50	70	40	70		70
Maximum (24 h)										
Maximum (20 min)			110	90	110	90	130	170		180
Number of days exceeding the WHO-AQG			0	0	0	0	0			
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0			

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations do not exceed the WHO-AQG standard.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	1	1
Annual average	2	4
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		2
Annual average		0.06
Maximum monthly average		0.19
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

Carbon monoxide concentrations/Lead concentrations
Reported CO and Pb concentrations are low.

VII. EFFECTS

Effects of air pollution on health

1991 data (per 100.000 inhabitants)

	adults	children
neoplasts	137.9	8.3
respiratory dis.	4 579.8	11 623
skin diseases	287.9	319.1

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. Less than 75% of the data available.
3. Not the named ODS station, the location of the station is shown on the map.
4. The location of the meteorological station is shown on the map.
5. Uncertain data.

City: Lyon	**Country**: France

I. GENERAL DATA

		City	Conurbation
Population	(number)	409 000(1982)	***1 262 000 (1992)***
Total area	(km^2)		
Built-up area	(km^2)		***150***
Coordinates	(lat-/longitude)	45° 46' N 4° 50' E	

Major activities and development trends (1980-1990, 1990-2000)
Commercial centre, traffic junction (airport, river port, motorways). Varied industry, most important : textiles.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: West Europe
Topography: river basin (valley) ***(-)***

Climate: Cfb (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.0	8.1	10.5
precipitation (mm)			
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.9 (-)***	***4.2 (-)***	***3.8 (-)***
winter smog index	***13 (0)***	***11 (0)***	***15 (0)***
summer smog index [1]	***13 (-)***	***8 (-)***	***18 (-)***

Station: Lyon Sutolas 45° 44' N 05° 05' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[2]	***3***
Summer smog emissions[2]	***3***

VI. AIR QUALITY DATA

SO_2 concentrations[3] µg m^{-3}	Mean of stations				**Observed concentrations**					
	Reg. background		City background		Industrial site[1]		Industrial site[2]		Industrial site	
	1985	19__	1985	19__	1985	1989	1985	1989	1985	19__
Number of stations					Pierre	Pierre	Mouch	Mouch		
Annual average					28	59	37	54		
Winter average					37	82	82	92		
Maximum (24 h)					259	261	315	231		
98 percentile (24 h)					146	196	182	197		
Number of days exceeding the WHO-AQG					6	37	14	15		
Number of days exceeding 2 x WHO-AQG					1	1	2	0		

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations[4]

Conurbation mean 1990

number of stations	10(11)	4(5)
annual average	29	48
max. annual average	38	115
24h maximum (1 station)	702	239
number of stations 24h >125	9	5

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Suspended particulate concentrations[4]

Conurbation mean 1990

TSP

number of stations	4(2)
max. annual average	65
24h maximum (1 station)	180

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

black smoke

24h maximum: 221

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Winter smog classification	1990
Exceedance class[2]	***3***
Exposure class	***3***

Nitrogen dioxide concentrations[4]		
(chemiluminescence)		
Conurbation mean 1990		
number of stations	1(3)	0(3)
annual average	41	<u>90</u>
24h maximum (1 station)	110	<u>192</u>
WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}		

Ozone concentrations[4]	
1990:	
1 station.	
annual average	10
98 p (1h)	62
1h maximum	152
number of days with 1h >150	1
WHO-AQG Ozone (1h max.) = 150 µg m^{-3}	
Exceedance class	***1***

Carbon monoxide concentrations/Lead concentrations[4]			
CO		**Lead**	
1990:		1990:	
max. annual average	9	annual average (3 stations)	0.78
p 98	28		
1h maximum	70		
WHO-AQG CO (8h max.) = 10 mg m^{-3}		**WHO-AQG Lead (annual average) = 0.5 µg m^{-3}**	

---

1. Less than 75% of the data available.

2. Uncertain data.

3. EC-DGXI/B3 Air Pollution Information System (APIS).

4. Stroebel R. (ed), Air Quality in France, annual report 1990.

City: Madrid	**Country**: Spain

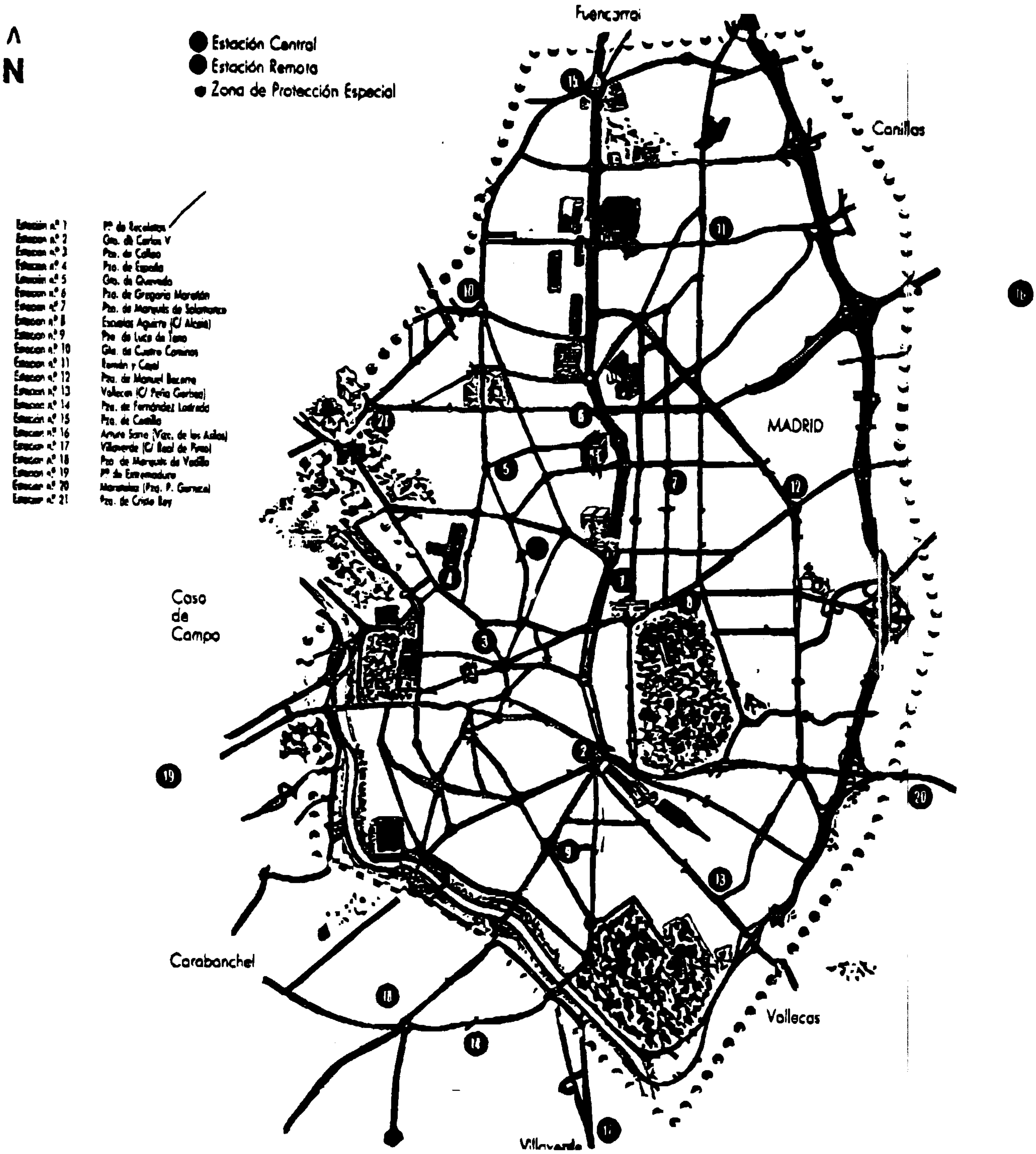
I. GENERAL DATA

		City		Conurbation
Population	(number)	2 991 000 (1989)		***3 120 000***
Total area	(km^2)			
Built-up area	(km^2)			***100***
Coordinates	(lat-/longitude)	40° 25' N 3° 43' W		

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Southern Europe ***Topography***: plain *(+)*	Climate: Csa (Köppen-Geiger) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	14.1	14.1	15.0
precipitation (mm)	395	334	753
cloud cover (8^{-1})			
wind speed (m s^{-1})	***2.1 (--)***	***1.9 (--)***	***2.0 (--)***
winter smog index	***45 (-)***	***42 (-)***	***34 (-)***
summer smog index	***87 (--)***	***100 (--)***	***93 (--)***

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	19__	1990	19__	19__	1985	1991	19__	19__	19__	19__
Number of stations					5*	5*				
Annual average		*5*			95	40				
Winter average					163	99				
Maximum (24 h)										
98 percentile (24 h)					425	215				
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

* Stations 5-10m from streets, but very little SO_2 due to traffic.

Particulate matter: TSP µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	19__	1990	19__	19__	19__	19__	1985	1992	19__	19__
Number of stations							5	5		
Annual average		*11*					67	56		
Winter average							67	51		
Maximum (24 h)										
98 percentile (24 h)							267	128		
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (max. 24 hour) = 120 µg m^{-3}

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	19__	19__	19__	19__	19__	19__	1985	1992	19__	19__
Number of stations							3	5		
Annual average							89	98		
Maximum (24 h)										
Maximum (1 h)								210		
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	1985	1992
Station number/name	Marqués de Vadillo	1. Recoletos
Annual average	9.6	3.7
Maximum (**24 h**)		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

City: Manchester | **Country**: United Kingdom

I. GENERAL DATA

		City	Conurbation
Population	(number)	451 000 (1985)	***2 578 000***
Total area	(km²)		
Built-up area	(km²)		***280***
Co-ordinates	(lat-/longitude)	53° 30' N 2° 15' W	

II. TOPOGRAPHY AND CLIMATOLOGY

Region:
Topography**:** ***(0)***

Climate: (Cfb)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.4	8.8	10.2
precipitation (mm)	703.6	747.8	721.2
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.0 (+)***	***3.8 (0)***	***3.7 (0)***
winter smog index	***7.6 (+)***	***11.2 (0)***	***7.1 (+)***
summer smog index	***2.2 (+)***	***0.6 (++)***	***5.4 (+)***

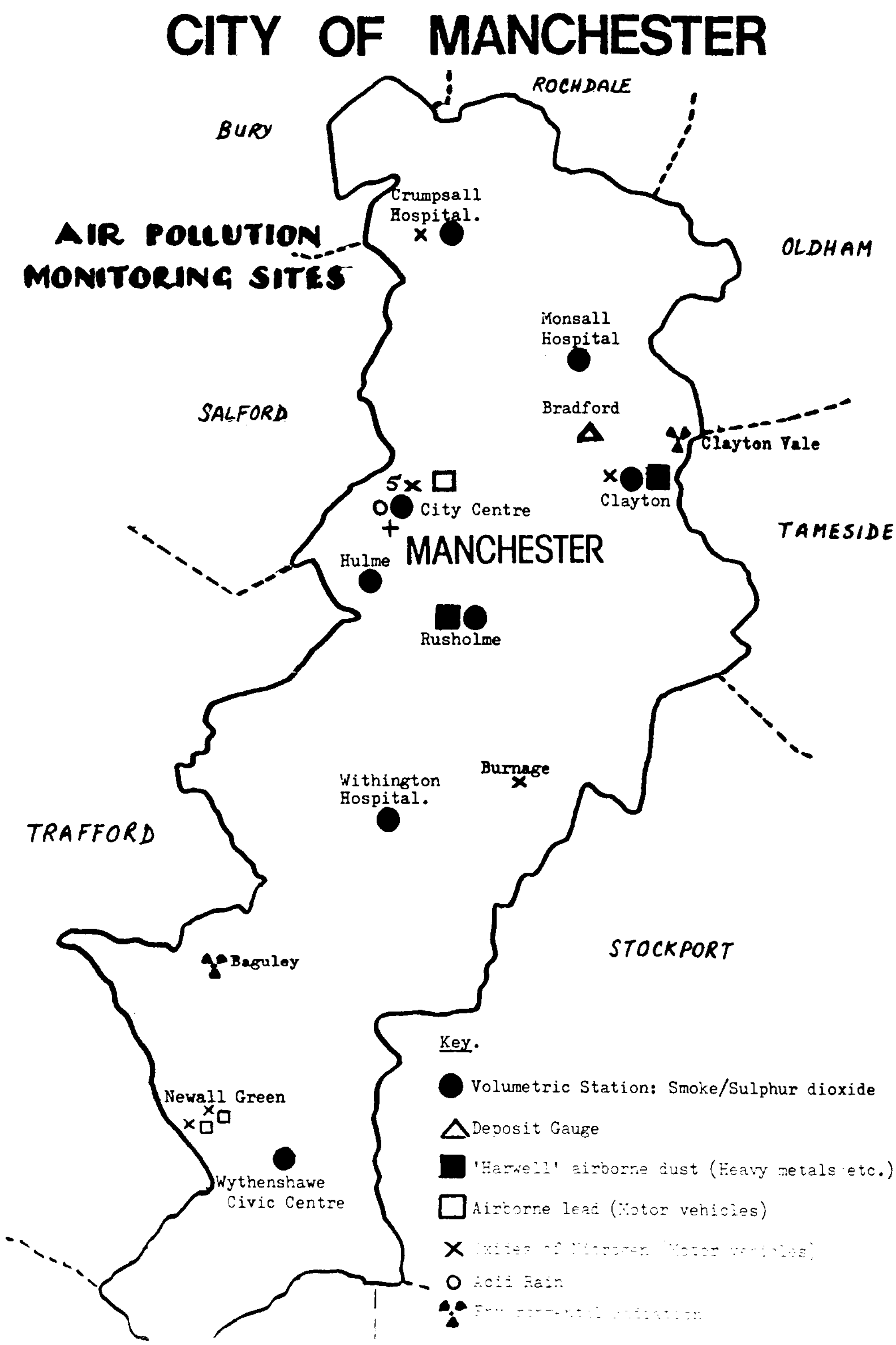
III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

Major (industrial) point sources
(see city map)

City: Manchester **Country**: United Kingdom

Main topography, city morphology, industrial sources and monitoring network



City: Manchester **Country**: United Kingdom

VI. AIR QUALITY DATA

Monitoring network

Part of EC smoke/SO_2 directive monitoring network (234 sites).
1 EC NO_2 directive continuous monitoring station (7 sites).
operated by Warren Spring Laboratory on behalf of UK Department of the Environment lead monitoring as part of UK "lead in petrol" survey (8 sites in UK).
SO_2 and black smoke: Manchester 11, Manchester 15, Manchester 21

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			3	3						
Annual average		*32*	48	41	48	48				
Winter average			56	41	60	47				
Maximum (24 h)			165	127	216	135				
98 percentile (24 h)			116	100	123	106				
Number of days exceeding the WHO-AQG			5	1	5	1				
Number of days exceeding 2 x WHO-AQG			0	0	0	0				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: Black smoke $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			3	3	3	3				
Annual average		*20*	18	21	20	26				
Winter average			25	29	26	34				
Maximum (24 h)			84	201	96	219				
98 percentile (24 h)			67	83	68	89				
Number of days exceeding the WHO-AQG			1	4						
Number of days exceeding 2 x WHO-AQG										

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Winter smog classification	1990
Exceedance class	***2***
Exposure class	***4***

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1992	1985	1992	1985	19__	1985	19__
Number of stations				1		1				
Annual average				60		60				
Maximum (24 h)				280		280				
Maximum (1 h)				713		713				
Number of days exceeding the WHO-AQG				6		6				
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

City: Manchester **Country**: United Kingdom

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991/92
Station number/name		
Annual average		1.2
Maximum (8 h)		8.8
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	Piccadilly	Piccadilly
Annual average	0.47	0.13
Maximum monthly average	0.76	0.23
Number of days exceeding the WHO-AQG	19 weeks	0
Number of days exceeding 2 x WHO-AQG	1 week	0

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data

City: Mariupol[1]	***Country***: Ukraine

I. GENERAL DATA

		City	Conurbation
Population	(number)	545 000 (1992)	***545 000 (1992)***
Total area	(km^2)	169 (1991)	***169 (1991)***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	47° 05' N 37° 34' E	

Major activities and development trends (1980-1990, 1990-2000)
Industrial centre (ferrous metallurgy).Important sea port (Azov Sea) for Donetsk region. Number of inhabitants rose from 529 000 in 1987 to 545 000 in 1992.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: Coastal siting (Azov Sea), Kalchic river mouth. ***(++)***	Climate: Bsk (Köppen-Geiger) Meteorology: Inversions often appear (in January 40%).			
Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	9.7	5.7	9.7	8.8
precipitation (mm)				545.3
cloud cover (8^{-1})				5.6
wind speed [2] ***(m s^{-1})***	***5.1 (++)***	***5.2 (++)***	***5.1 (++)***	5.6
winter smog index [2]	***16 (0)***	***20 (0)***	***12 (0)***	
summer smog index	***17 (0)***	***11 (0)***	***13 (0)***	
Station:				Mariupol 47° 04' N 37° 30' E

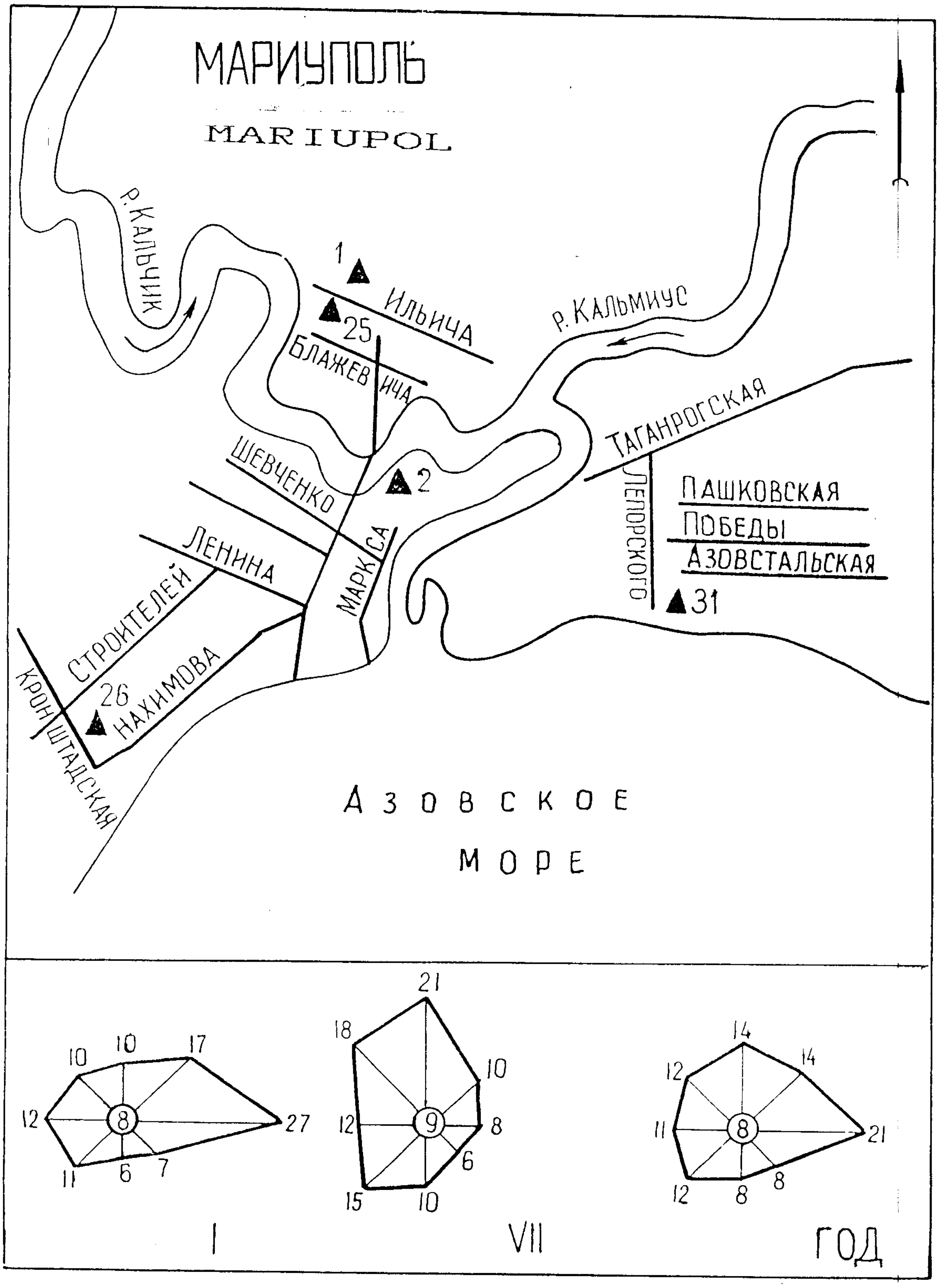
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	8	12	19	4	3	5	6	8	15	10	6	11
m s^{-1}	4.4	5.7	6.8	8.0	5.2	4.9	6.1	6.4	6.3	5.9	5.3	3.9	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	12	5	7	15	6	2	4	7	6	11	12	13	5
m s^{-1}	4.2	3.9	4.4	5.6	4.4	4.1	4.0	5.5	6.1	6.2	5.2	5.0	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	1.9	28.6		-	
Domestic/space heating						
Industry and power plants	54.1	30.5	573.5		112.9	
Total	54.1	32.4	602.1		112.9	
Per capita (**kg**)	102.3	61.3	1 138.2		213.4	
Per km^2 (**t**)	320.1	191.7	3 562.7		668.1	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	1.9	28.2	-	-	
Domestic/space heating						
Industry and power plants	54.7	46.4	411.8	2.4	91.7	0.0002
Total	54.7	48.3	440.0	2.4	91.7	
Per capita (**kg**)	101.9	89.9	819.4	4.5	170.8	
Per km^2 (**t**)	323.7	285.8	2 603.5	14.2	542.6	

Emission class	1990
Winter smog emissions	***4***
Summer smog emissions	***2***

Major (industrial) point sources
Ferrous metallurgy and heavy engineering. The basic contribution to industrial emissions (98%) is made by ferrous metallurgical plants. The industrial enterprises are located in all city areas. Also emitted are: 1 736 t of hydrogen sulphide, 881 t of benzol, 507 t of ammonia, 178 t of naphtha and 366 t of toluene.

VI. AIR QUALITY DATA

Monitoring network
5 Stations are operational (State of Service for Monitoring the Environment in Ukraine). The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the State Committee of the Ukraine for Hydrometeorology in charge of methodology.

SO_2 concentrations	Mean of stations				Highest observed concentrations					
μg m^{-3}	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No.25,26		No. 25		No. 31		No. 2
Annual average		*24*		21		22		24		24
Winter average				23		24		28		26
Maximum (24 h) *calculated*				*74*		*72*		*91*		*91*
98 percentile (20 min)*				50		50		60		60
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0(*0*)		0(*0*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 μg m^{-3}

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations are low, especially when compared to emission estimates.

Particulate matter:	Mean of stations				Highest observed concentrations					
μg m^{-3}	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.25,26	No.25,26	No.25	No.25	No.31	No.31	No. 1	No. 1
Annual average		*49*	150	185	200	240	100	150	300	250
Winter average			<u>150</u>	215	<u>200</u>	280		200	370	350
Maximum (24 h)										
98 percentile (20 min)				720		980		550		1090
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 μg m^{-3}

Suspended particulate concentrations
Reported TSP concentrations are high, especially during winter. Highest concentrations are monitored in the north-west part of the city (industrial area). The WHO-AQG is likely to be exceeded on numerous days per year.

Winter smog classification	1990
***Exceedance class*[5]**	***2***
***Exposure class*[5]**	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.25,26	No.25 26	No. 25	No. 25	No. 31	No. 31	No. 1	No. 1
Annual average			60	40	70	50	70	50	60	40
Maximum (24 h)										
Maximum (20 min)			245	300	270	360	260	360	230	460
Number of days exceeding the WHO-AQG			1	1	2	2	4	1		2
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0		0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high. The WHO-AQG is exceeded on a few days per year in all areas of the city.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		2
Annual average		8
98 Percentile (20 min)		29

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		2
Annual average		0.0057
Maximum monthly average		0.0128

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	31	31
Annual average	1	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		1
Annual average		0.06
Maximum monthly average		0.13
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Reported concentrations are low.

VII. EFFECTS

Effects of air pollution on health
According to 1988 data, the number of cases of respiratory diseases is 87% higher than the average for the cities of the former Soviet Union.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station. The location of the meteorological station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Marseille	*Country*: France

I. GENERAL DATA

	City		Conurbation
Population (number)	867 000 (1982)		***810 000 (1992)***
Total area (km^2)			
Built-up area (km^2)			***75***
Coordinates (lat-/longitude)	43° 18' N 5° 22' E		

Major activities and development trends (1980-1990, 1990-2000)
Regional metropolis. Administrative and commercial centre, harbour.
Refineries, chemical and metallurgical industry within 30 km distance.
Municipalities in conurbation: Marseille, Aubergne, Aix en Provence, Plan de Cuques, Allarch.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Mediterranean, Southern Europe
Topography: Coastal, hills ***(0)***

Climate: Csa (Köppen-Geiger)
Meteorology: Mistral (local wind), inversions in winter.

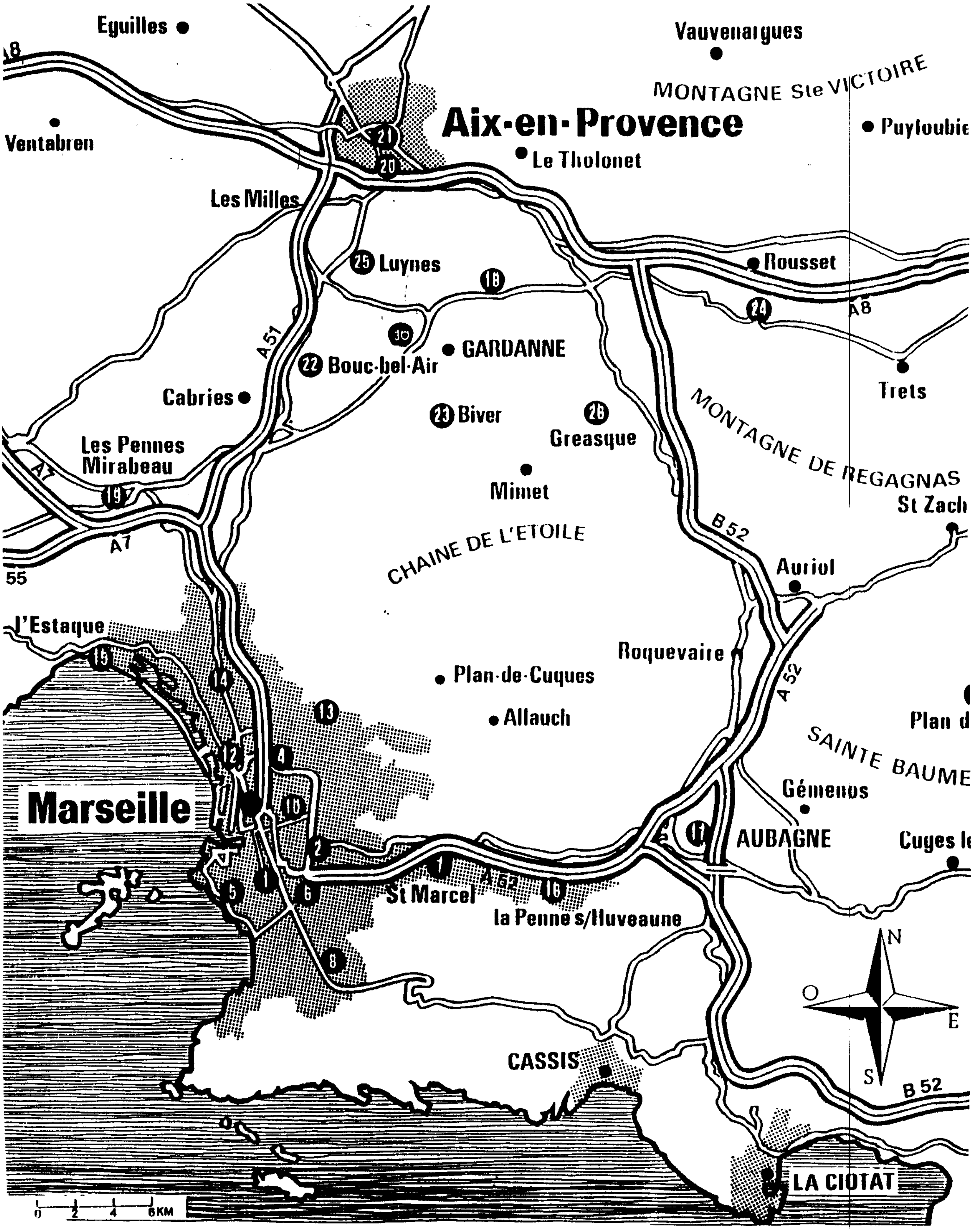
Averages	1980-1989	1985	1989
temperature (°C)	14.4	13.9	14.3
precipitation (mm)			
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.7 (+)***	***4.2 (+)***	***4.7 (+)***
winter smog index	***3 (++)***	***3 (++)***	***1 (++)***
summer smog index	***38 (-)***	***45 (-)***	***30 (-)***

Station: Marseille Marignane 43° 27' N 05° 14' E

Local wind distribution (1990)[1]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	10.4	1.2	4.6	12	9.4	3.5	3.6	1.3	3.4	7.3	10.1	12.6	20.6
m s^{-1}	5	4	5	5	5	4	2	3	3	5	5	6	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Emission class	1990
Winter smog emissions[2]	*3*
Summer smog emissions[2]	*2*

Major (industrial) point sources
No major point sources present, no incinerators.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total		x 10^6
of which:		
· passenger cars	341 000	
· buses	800	25
· freight traffic >3.5 t		

Traffic
Public transport: buses 90 x 10^6 passenger km a^{-1}, electric-powered 72 x 10^6 passenger km a^{-1}.

Local policies to reduce air pollution
Industry: Since 1983 \`Zone de protection Speciale' (ZPS): 15 Oktober - 15 April only use of low-sulphur fuels. Use of natural gas instead of coal is rising.

VI. AIR QUALITY DATA

Monitoring network
(Regional) network is operated by AIRMARFAIX. 27 automatic stations are operational

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	19__	1985	19__
Number of stations			9	10	national	national				
Annual average		*5*	39	26	50	40				
Winter average			40	28	57	43				
Maximum (24 h)			172	93	259	125				
98 percentile (24 h)			101	67	139	95				
Number of days exceeding the WHO-AQG			3.1	0.1	10	1				
Number of days exceeding 2 x WHO-AQG			0.2	0	1	0				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations
(UV fluorescence) Concentrations show downward trend.

Particulate matter: black smoke $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	1991	1985	19__
Number of stations			4	4	Canet	Canet	national	national		
Annual average		*10*	28	21	44	24	80	66		
Winter average			31	31	48	31	90	70		
Maximum (24 h)			122	101	158	97	188	141		
98 percentile (24 h)			82	69	121	71	152	126		
Number of days exceeding the WHO-AQG			1.75	0.25	5	0	33	11		
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0		

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Suspended particulate concentrations
(photometrical) Concentrations show downward trend. In busy streets, the WHO-AQG is still likely to be breached.

Winter smog classification	1990
Exceedance class	*1*
Exposure class	*1*

City: Marseille **Country**: France

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		**Traffic**		City background		Traffic site		Industrial site	
	1985	19__	1985	1991	1985	19__	1985	1991	1985	19__
Number of stations			4	4			Plomb.	Plomb.		
Annual average			71	70			88	90		
Maximum (24 h)			171	151			218	202		
Maximum (1 h)			779	325			499	338		
Number of days exceeding the WHO-AQG			0.75	4			1	15		
Number of days exceeding 2 x WHO-AQG			0	0			0	0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
(chemiluminescence) Concentrations show no clear trend.

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1991	1985	1991	1985	19__	1985	19__
Number of stations			Paradis	Paradis	Paradis	Paradis				
Annual average			<u>52</u>	31	<u>52</u>	31				
Summer average										
Maximum (1 h)			183	73	183	73				
Maximum (8 h)			94	70	94	70				
98 percentile (1 h)										
Number of days exceeding the WHO-AQG			2	0	2	0				
Number of days exceeding 2 x WHO-AQG			0	0	0	0				
Exceedance class				*1*						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Ozone concentrations
(UV photometrical)

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name	Plombieres	Plombieres
Annual average	5	3
Maximum (8 h)	18	6
Number of days exceeding the WHO-AQG	3	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name	Marchel	Bd.faculte
Annual average	2.17	0.36
Maximum monthly average	3.30	0.67
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Not the named ODS station.

2. Uncertain data.

City: Milan	*Country*: Italy

I. GENERAL DATA

	City	Conurbation
Population (number)		***1 432 000 (1992)***
Total area (km^2)		
Built-up area (km^2)		***160***
Coordinates (lat-/longitude)	45° 28' N 9° 12' E	

Major activities and development trends (1980-1990, 1990-2000)
One of the most important financial and industrial centres of Italy. Varied industry, among others: electronics, textile, metallurgy, chemicals.

II. TOPOGRAPHY AND CLIMATOLOGY

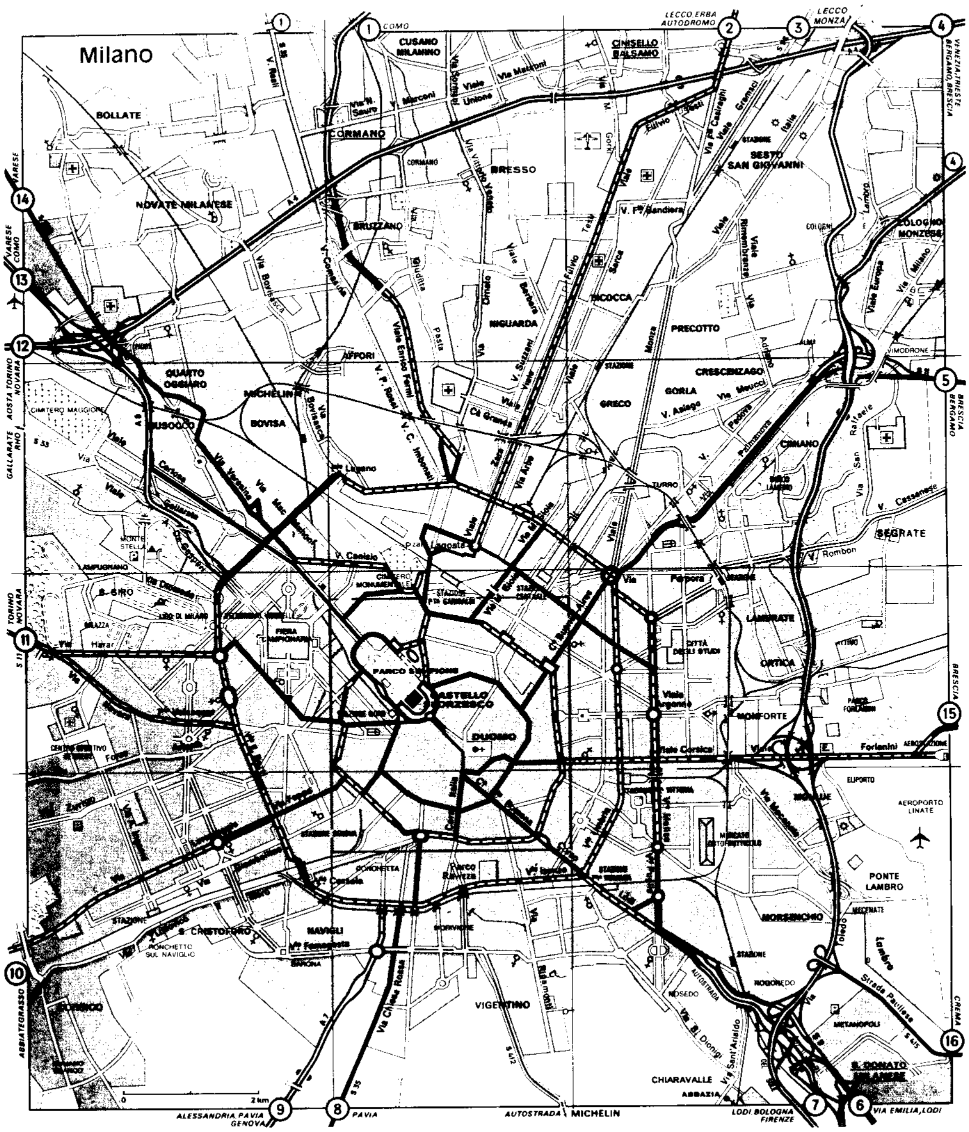
Region: South Europe
Topography: plain (of river Po) ***(+)***

Climate: Cfa (Köppen-Geiger)
Meteorology: frequent inversions and calms

Averages	1980-1989	1985	1989
temperature (°C)	12.4	12.0	13.2
precipitation (mm)	996	1053	1066
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***0.9 (--)***	***0.9 (--)***	***0.7 (--)***
winter smog index	***60 (--)***	***54 (--)***	***63 (--)***
summer smog index	***73 (-)***	***88 (--)***	***75 (-)***

Station: Milano Linato 45° 26' N 09° 17' E

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS[1]

Annual emissions per source and totals in 1985 (t a^{-1})						
Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	988	13 470	90 250			
Domestic/space heating	10 269	3 511	1 471			
Industry and power plants	11 716	1 497	184			
Total	22 972	18 477	91 905			
Per capita (**kg**)	16.0	12.9	64.2			
Per km² (**t**)	143.6	115.5	574.4			

Annual emissions per source and totals in 1988 (t a^{-1})						
Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	1 392	14 617	85 489			
Domestic/space heating	5 559	3 281	1 127			
Industry and power plants	3 127	535	87			
Total	10 088	18 433	86 703			
Per capita (**kg**)	7.1	12.9	60.6			
Per km² (**t**)	63.1	115.2	541.9			

Emission class	1990
Winter smog emissions[2]	***3***
Summer smog emissions[2]	***3***

IV. TRAFFIC DATA

Traffic
Traffic volume entering the city has almost doubled over the last 10 years.

VI. AIR QUALITY DATA [3]

Monitoring network

Air Quality is being monitored at 10 sites in Milan (part of the provincial network). SO_2: 6 sites, NO_x: 9 sites, TSP: 4 sites, O_3: 2 sites, CO: 8 sites, NMHC: 1 site.

Air quality data - general

Sulphur dioxide concentrations have decreased during the last 10 years because of the conversion of domestic heating plants from gas oil to natural gas. On the other hand nitrogen dioxide concentrations are growing. Hourly values are frequently greater than 200-300 µg m^{-3} in summer, spring and autumn. In winter concentrations can exceed 600 µg m^{-3}. CO hourly concentrations reach peak values of 18 mg m^{-3} and average values over 8 hours of 14 mg m^{-3} in summer and of 3 514 mg m^{-3} in winter.

SO_2 (µg m^{-3})

station number	median 1985/86	median 1990	median winter 90/91	98 p 1985	98 p 1990
1	90			<u>302</u>	
2	106	28	72	<u>437</u>	160
3	73			<u>295</u>	
4	51			<u>119</u>	
5	80			<u>206</u>	
6	74	24	72	<u>337</u>	173
7	59	30	88	<u>205</u>	172
8	58			<u>252</u>	
9	68	21		<u>184</u>	
10	94	23	64	<u>430</u>	119
11		20	85		195
mean	75	24	76	277	164

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Concentrations show a marked downward trend since 1973, the WHO-AQG however is still exceeded.

TSP (µg m^{-3})

station number	median 1985/86	median 1990/91	95 p 1985/86	95 p 1990/91
1	103	70	248	128
2	129	70	280	129
3	168		345	
mean	138	70	291	129

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Concentrations show a clear downward trend (since 1986-87). The WHO-AQG however is still exceeded.

NO_2 (µg m^{-3})

station number	median 1985/86	median **1990**	98 p 1985/86	98 p **1990**
1	64	101	194	297
2	47	109	323	259
3	39	105	120	270
4		135		319
5		113		293
6		114		324
7		103		292
8		103		307
9		141		319
mean	50	114	212	298

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Concentrations show an marked upward trend, the WHO-AQG is exceeded frequently, on some sites by a factor 2.

Ozone (µg m^{-3})

Station Juvara

days 1 h > 200 µg m^{-3}	
1985/86	1
1990	1

annual mean	
1985	16
1990	34

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

The WHO-AQG can be exceeded on a couple of days per year.

CO (mg m^{-3})

Station	median 1990/91	exceedance WHO-AQG	max. 1 h
Mar.	5.2	57	37
Zav.	4.5	41	26
Ver.	3.9	21	23
Sen.	5.2	72	27
Cen.	3.4	<u>12</u>	<u>25</u>
Aqu.	3.1	<u>25</u>	<u>42</u>

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Concentrations are very high, the WHO-AQG is exceeded extensively.

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1. Source: Studi per la valutazione della qualita`dell'aria nella provincia di Milano. Aggiornamento al marzo 1991 (Comune di Milano, Provincia di Milano, Unita Socio Sanitaria Locale Milano).

2. Uncertain data.

3. Sources:
   - Studi per la valutazione della qualita`dell'aria nella provincia di Milano. Aggiornamento al marzo 1991 (Comune di Milano, Provincia di Milano, Unita Socio Sanitaria Locale Milano).
   - Report on the state of the environment in Italy. Ministry of the Environment (1990).
   - Bardeshi et al.: Analysis of the impact on air quality of motor vehicle traffic in the Milan urban area. Atmospheric Environment, Vol. 25B, No.3, pp. 415-428 (1991).

City: Minsk[1]	*Country*: Belarus

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 600 000 (1992)	***1 600 000 (1992)***
Total area	(km^2)	220 (1991)	220 (1991)
Built-up area	(km^2)	181 (1992)	***181 (1992)***
Coordinates	(lat-/longitude)	53° 51' N 27° 30' E	

Major activities and development trends (1980-1990, 1990-2000)
Minsk is the capital of Belarus. It is a large scientific, cultural and industrial centre. During the 1980's the industrial development of the city continued as well as the increase in traffic activity. Industries: varied, among others, car and tractor manufacturing, building materials, engineering.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Minsk is located in on the south-east slope of Minsk Hill on both banks of Svisloch River at the height of 200-220 m above sea level (river basin). *(-)*

Climate: Dfb (Köppen-Geiger).
Meteorology: Low-level inversions:18%, Air stagnation: 8%.

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	5.9	4.1	7.8	6.2
precipitation (mm)				665.2
cloud cover (8^{-1})				6.7
wind speed ($m\ s^{-1}$)	***2.5 (-)***	***2.5 (-)***	***2.2 (-)***	2.7
winter smog index	***23 (-)***	***25 (-)***	***22 (-)***	
summer smog index	***9 (0)***	***11 (0)***	***11 (0)***	

Station: Minsk 53° 52' N 27° 32' E

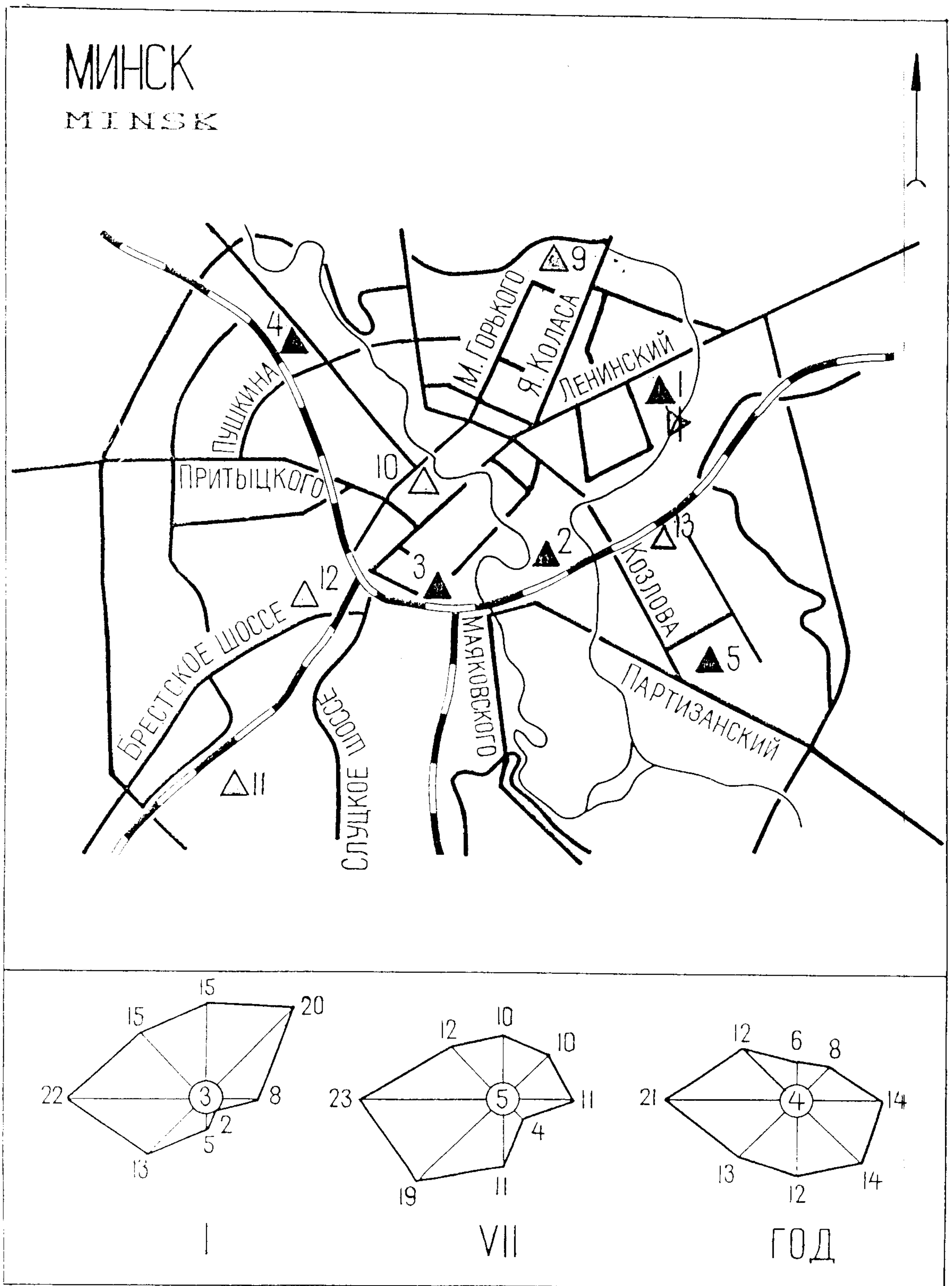
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %													
$m\ s^{-1}$													

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	3	4	5	7	6	10	12	14	17	11	7	5
$m\ s^{-1}$	3.0	2.5	2.6	2.9	3.1	3.0	3.1	3.0	3.1	2.7	2.6	2.6	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a[-1])

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	8.7	93.0		-	
Domestic/space heating						
Industry and power plants	29.9	17.6	41.2		10.1	
Total	29.9	26.3	134.2		10.1	
Per capita (**kg**)	19.4	17.1	87.0		6.6	
Per km² (**t**)	165.2	145.3	741.4		55.8	

Annual emissions per source and totals in 1990 (kt a[-1])

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	11.2	112.6	-	-	
Domestic/space heating						
Industry and power plants	18.7	17.6	39.5	13.0	9.3	0.0071
Total	18.7	28.8	152.1	13.0	9.3	
Per capita (**kg**)	11.9	18.3	96.8	8.3	5.9	
Per km² (**t**)	103.3	159.1	840.3	71.8	51.4	

Emission class	1990
Winter smog emissions[4]	***2***
Summer smog emissions	***2***

Major (industrial) point sources

Minsk practically has no enterprises with considerable emissions. Heat and power co-generation is responsible for 39% of industrial emissions. Emissions come basically from low sources. Most enterprises are located in the centre, as well as in the south-east and north-west of the city.

IV. TRAFFIC DATA

Traffic

Traffic is responsible for 60% of total emissions. Due to increasing traffic CO and NO_x emissions show an upward trend.

VI. AIR QUALITY DATA

Monitoring network

10 stations are operational (State Service Environmental Monitoring, Republican Centre of Radiation Control and Monitoring of Natural Environment, Chief Administration for Hydrometeorology under the Soviet of Ministers of Belarus.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.1,2,9	No.1,2,9	No. 9	No. 9	No. 5	No. 5	No. 4	No. 4
Annual average		*6*	30	20	30	20	30	30	30	20
Winter average				26		30		30		25
Maximum (24 h) *calculated*				*140*		*76*		*224*		*125*
98 percentile (20 min)*				75		50		120		80
Number of days exceeding the WHO-AQG (*+calc.*)			0	0(*2*)	0	0(*0*)	0	0(*6*)	0	0(*0*)
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are low. At the traffic site the WHO-AQG is likely to be exceeded on a few days per year.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.1,2,9	No.1,2,9	No. 9	No. 9	No. 5	No. 5	No. 4	No. 4
Annual average		*21*	167	100	200	100	200	200	200	100
Winter average			122	100	117	100	133	130	200	100
Maximum (24 h)										
98 percentile (20 min)			720	460	780	390	780	470	780	390
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations are relatively low compared to those monitored in other cities of the former Soviet Union (emissions are also relatively low). However, the WHO-AQG is likely to be exceeded on a few days per year. Concentrations increase during the summer.

Winter smog classification	1990
Exceedance class[4]	***2***
Exposure class	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.1,2,9	No.1,2,9	No. 2	No. 2	No. 5	No. 5	No. 4	No. 4
Annual average			20	37	20	60	30	30	20	20
Maximum (24 h)										
Maximum (20 min)			260	400	220	480	320	230	180	220
Number of days exceeding the WHO-AQG			0.3	7	0	13	3	0	0	0
Number of days exceeding 2 x WHO-AQG			0	1	0	1	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are relatively low compared to those measured in other cities of the former Soviet Union. In background areas however, concentrations show an upward trend. The WHO-AQG is exceeded on up to 13 days per year.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	9	9
Annual average	6	4
98 Percentile (20 min)	28	18

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	city background	
	1985	1990
Station number/name		9
Annual average		0.0027
Maximum monthly average		0.0171

CO concentrations mg/m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	5	5
Annual average	1	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg/m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	5	5
Annual average	0.06	0.11
Maximum monthly average	0.24	0.38
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Reported CO and Pb concentrations are low and do not exceed the WHO-AQG.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station, the location of the meteorological station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

City: Moscow[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	9 000 000 (1992)	***9 000 000 (1992)***
Total area	(km^2)	1 042 (1991)	1 042 (1991)
Built-up area	(km^2)	994 (1992)	***994 (1992)***
Coordinates	(lat-/longitude)	55° 45' N 37° 42' E	

Major activities and development trends (1980-1990, 1990-2000)
Moscow is the capital of the Russian Federation. It is the most important industrial, political, cultural, scientific and commercial centre of the RF. *Moscow is the centre of an area of intense industrial development, the Central Industrial Region. Varied industry, among others: motor vehicle manufacturing, machine tools, precision engineering, electronics. 1 steel works (high grade steel for specialized products), 1 refinery (oil piped from Volga-Ural oil field), (petro)chemicals and timber processing..* Moscow has a few river ports, railway stations and airports. *The number of inhabitants rose 1 million since 1980, UN estimates suggest that Moscow will have a population of 10.11 million by the year 2000. The population density within the Moscow highway circle is 10 000 p km^{-2}.*

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: Situated in the shallow valley of the Moskva river (river basin/plain). ***(0)***	Climate: Dfb (Köppen-Geiger) Meteorology: Calms (0-1) m s^{-1}: 34%, surface inversions: 26%, Air stagnation: 10%. Mean wind speed is low (2.3 m s^{-1}), *however in southern and south-eastern districts mean wind speed increases to 5-7 m s^{-1}.*

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	5.2	3.9	7.1	5.6
precipitation (mm)	513	636	795	643.9
cloud cover (8^{-1})				7.3
wind speed[2] (m s^{-1})	***2.3 (-)***	***1.5 (--)***	***0.9 (--)***	1.3
winter smog index	***42 (-)***	***40 (-)***	***54 (--)***	
summer smog index	***19 (0)***	***19 (0)***	***31 (-)***	
Station:				Moscow 55° 45' N 37° 34' E

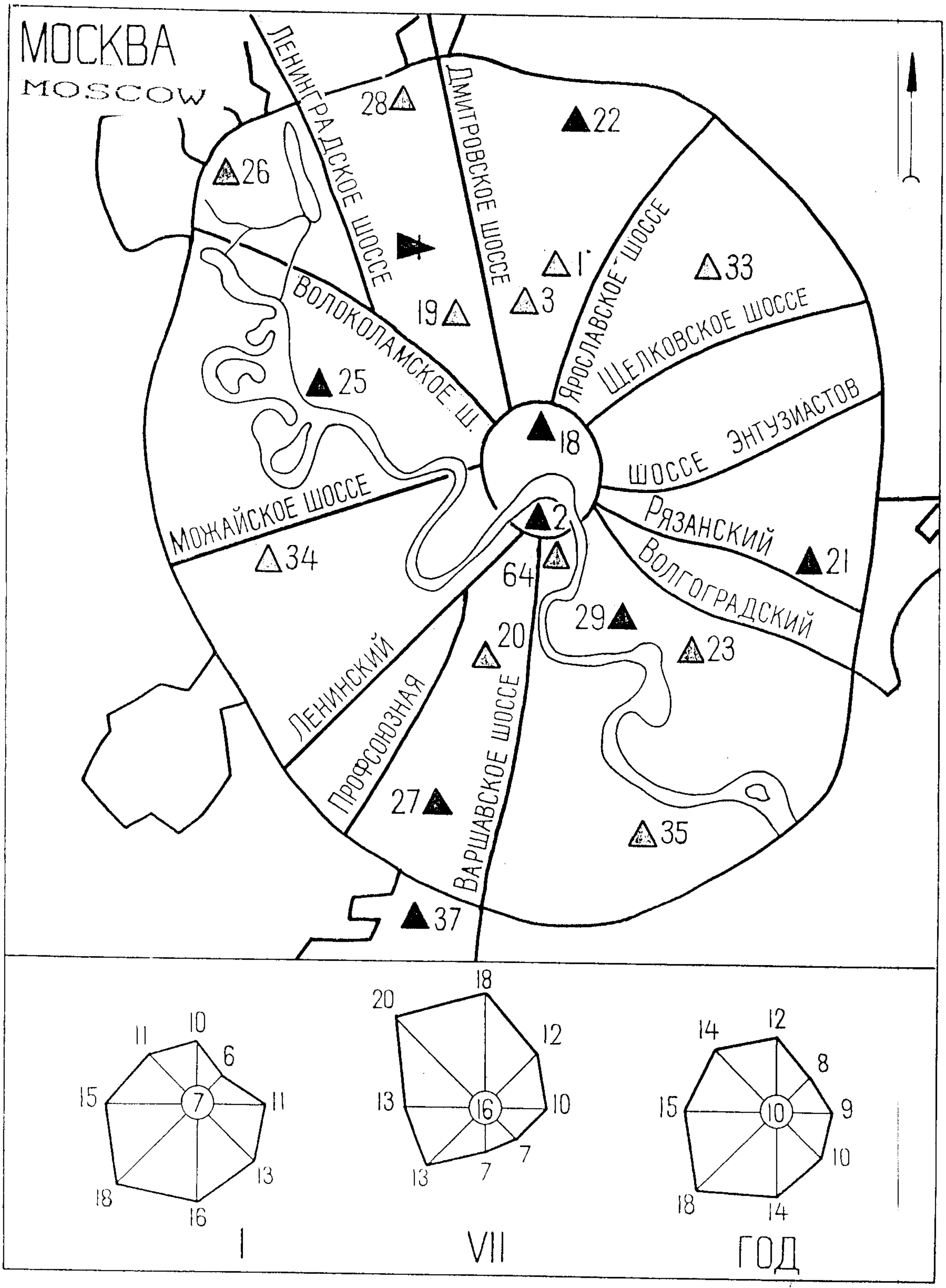
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	5	4	6	11	8	5	9	16	11	11	9	10
m s^{-1}	1.6	1.4	1.5	1.7	2.2	2.0	1.5	1.7	1.9	2.0	2.2	1.9	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	6	5	5	3	5	11	8	13	17	9	7	11	15
m s^{-1}	1.9	1.7	1.6	1.2	1.5	1.6	1.5	1.3	1.5	1.5	1.6	1.9	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	41.6	633.4		-	
Domestic/space heating						
Industry and power plants	70.6	98.7	28.1		29.8	
Total	70.6	140.3	661.5		29.8	
Per capita (**kg**)	8.2	16.3	76.8		3.5	
Per km² (**t**)	71.0	141.2	665.5		30.0	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	41.6	663.4	-	-	
Domestic/space heating						
Industry and power plants	51.9	115.2	29.9	25.6	23.4	0.0084
Total	51.9	156.8	663.3	25.6	23.4	
Per capita (**kg**)	5.9	17.8	75.3	2.9	2.7	
Per km² (**t**)	52.2	157.8	667.3	25.8	23.5	

Emission class	1990
Winter smog emissions	*2*
Summer smog emissions	*4*

Major (industrial) point sources

(Table above) Reported SO_2 and particulate matter emissions *per capita* are among the lowest of the cities in the former Soviet Union.
1600 industrial enterprises and industrial zones are distributed evenly throughout the city. Prevailing stack height is low, only 3% of stacks is more than 50 m high.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles **1985**	Total traffic activity veh km a^{-1}
Total	*665 000*	x 10^9
of which:		
· passenger cars	*500 000*	
· buses	*25 000*	
· freight traffic	*105 000*	

Traffic

Moscow has a system of motorways which generally follows a spoked wheel (orbital and radial) pattern. Surface public transport: 3 935 million passengers (60% by bus), underground:
2 741 million passengers.

Local policies to reduce air pollution
Industry: *Strict planning restrictions have been placed on new industries wanting to develop in the city. Relocation of heavy industry out of the city has been slow.* **Traffic**: *The construction of the Moscow orbital highway (see map) diminished the flow of traffic through the city. Currently up to 90% of transit freight traffic passes the city by the orbital highway. Ban on the sale of leaded petrol.* **Domestic/space heating**: Use of natural gas instead of oil and coal in many boiler-houses and heat-power stations. In the period 1987-1990 the use of coal was reduced by over 70%, the use of heavy fuel oil by approx. 30%.

VI. AIR QUALITY DATA

Monitoring network
The State Service for Observations and Control of Environmental Pollution Levels is responsible for the network (19 stations operational). Supervision by the Moscow Centre for Hydrometeorology and Control of the Environment.

SO_2 concentrations	Mean of stations				Highest observed concentrations					
$\mu g\ m^{-3}$	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 2,21,22		No. 22				No. 29
Annual average		*13*		1		2				3
Winter average				3		1				8
Maximum (24 h) *calculated*										
98 percentile (20 min)				-		-				
98 percentile (24h) *calc.*										
Number of days exceeding the WHO-AQG				0		0				0
Number of days exceeding 2 x WHO-AQG				0		0				0

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations are extremely low considering emission estimates, as in most cities of the former Soviet Union. They call into question the accuracy and sensitivity of the monitoring method. It is not clear whether the problem stems from the extrapolation of 20-minute exposure data to annual means, the representativeness of the network, the analysis of samples, or data handling. Comparison of the SO_2 method employed in Moscow with ISO approved methods should be seen as a major priority for the authorities. Maximum concentrations of up to 240 $\mu g\ m^{-3}$ (20-min.) have been observed in industrial areas. Once again, even maximum values would appear to be very low when compared with cities with similar estimated emissions.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.2,21, 22,27,28	No.2,21, 22,27,28	No. 2	No. 2	No. 18	No. 18	No. 33	No. 33
Annual average		100 *(26)*	120	100	200	100	200	100	200	100
Winter average			140	100	150	100	300	100	300	100
Maximum (24 h)										
98 percentile (20 min)		390	404	430	470	600	470	390	470	390
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Since dust emissions have dropped considerably in recent years, so have concentrations. The concentration field over the city is homogeneous. The WHO-AQG is likely to be exceeded on a few days per year. During episodes, concentrations can reach 1 000 µg m^{-3} at some sites, especially in north-western and south-eastern districts.

Winter smog classification	1990
Exceedance class[5]	***2***
Exposure class[5]	***2***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.1,2,3, 21,22, 27,28	No.1,2,3, 21,22, 27,28	No. 22	No. 22	No. 19	No. 19	No. 29	No. 29
Annual average	22	10	53	76	50	100	40	90	70	150
Maximum (24 h)										
Maximum (20 min)	110	30	368	490	220	690	410	520	780	720
Number of days exceeding the WHO-AQG	0	0	<u>1</u>	<u>13</u>	<u>1</u>	<u>41</u>	<u>1</u>	<u>3</u>	<u>6</u>	<u>102</u>
Number of days exceeding 2 x WHO-AQG	0	0	0	<u>1</u>	0	<u>3</u>	0	0	<u>1</u>	<u>8</u>

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are very high and show an upward trend. Most NO_x comes from electricity generation (70%), motor vehicles account for 19%. The WHO-AQG is exceeded on a broad scale, even by a factor 2 on the industrial site and at some city background locations. From the Table it is clear that the highest concentrations are not found at the traffic site. It can be concluded that what was seen as a city background location, is in fact influenced by industry.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	20	20
Annual average	6	15
98 Percentile (20 min)		90

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		34
Annual average		0.0009
Maximum monthly average		0.0045

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	18	9
Annual average	6	3
Maximum (8 h)		
Number of days exceeding the WHO-AQG	7	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		19
Annual average		0.03
Maximum monthly average		0.12
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Reported CO concentrations show a downward trend. *Highest concentrations are observed in the centre (station 18) and southern districts of the city (20-30% higher than in other parts) during the summer at night and in the early morning.* The WHO-AQG has not been exceeded in recent years. Reported Pb concentrations show a downward trend and do not exceed the WHO-AQG.

Ozone
Ozone is not considered a problem in Moscow. Occasional studies show that, even when suitable meteorological conditions occur, levels rarely exceed guidelines. Scavenging of ozone by nitrogen oxide is thought to be an important factor. The contribution of the urban plume to downwind rural concentrations is not known.

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1. Text and figures printed in italics (except for concentration data) were taken from UNEP/WHO (GEMS), Urban Air Pollution in Megacities of the World (1992).
2. Less than 75% of the data available.
3. Not the named ODS station, the location of the meteorological station is shown on the map.
4. The location of the meteorological station is shown on the map.
5. Uncertain data.

City: Munich	*Country*: Germany

I. GENERAL DATA

		City		Conurbation
Population	(number)	***1 206 000***		1 229 000
Total area	(km^2)	***200***		
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	48° 08' N 11° 35' E		

Major activities and development trends (1980-1990, 1990-2000)
Administrative and economical centre of the south of Germany. Traffic junction and airport.
Industries: Cars, instruments, chemical products and beer.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, the south of Bavaria
Topography: river basin **(-)**

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	7.9	6.9	9.0
precipitation (mm)	772.8	1028.6	903.5
wind speed (m s^{-1})	***2.8 (-)***	***2.7 (-)***	***2.5 (-)***
winter smog index	***9.9 (0)***	***8.8 (+)***	***11.3 (0)***
summer smog index	***13.2 (0)***	***13.5 (0)***	***11.7 (0)***

Station: 10866 48° 08' N 11° 42' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***4***

Main topography, city morphology, industrial sources and monitoring network

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*8*				
Mean of stations in city background	1989	2	8.5	41.5	31.5	0	0
Highest observed concentrations:							
City background	1989		9.7	49	37	0	0
Traffic site	1989		15.3	47	39	0	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Winter smog classification	1989
Exceedance class	***0.5***
Exposure class	***1***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	1	49.1	130	263	0	0
Highest observed concentrations:							
City background	1989		49.1	130	263	0	0
Traffic site	1989		75.2	140	314	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1989	1	13.4	164	74		0	*1*
Highest observed concentrations	1989		13.4	164	74		0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations Traffic site 1985	 1989
Station number/name		Zentrum
Annual average		4.1

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

***City*:** Naples	***Country*:** Italy

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 067 000 (1992)	***1 206 000 (1992)***
Total area	(km^2)		
Built-up area	(km^2)		***93***
Coordinates	(lat-/longitude)	40° 50' N 14° 15' E	

Major activities and development trends (1980-1990, 1990-2000)

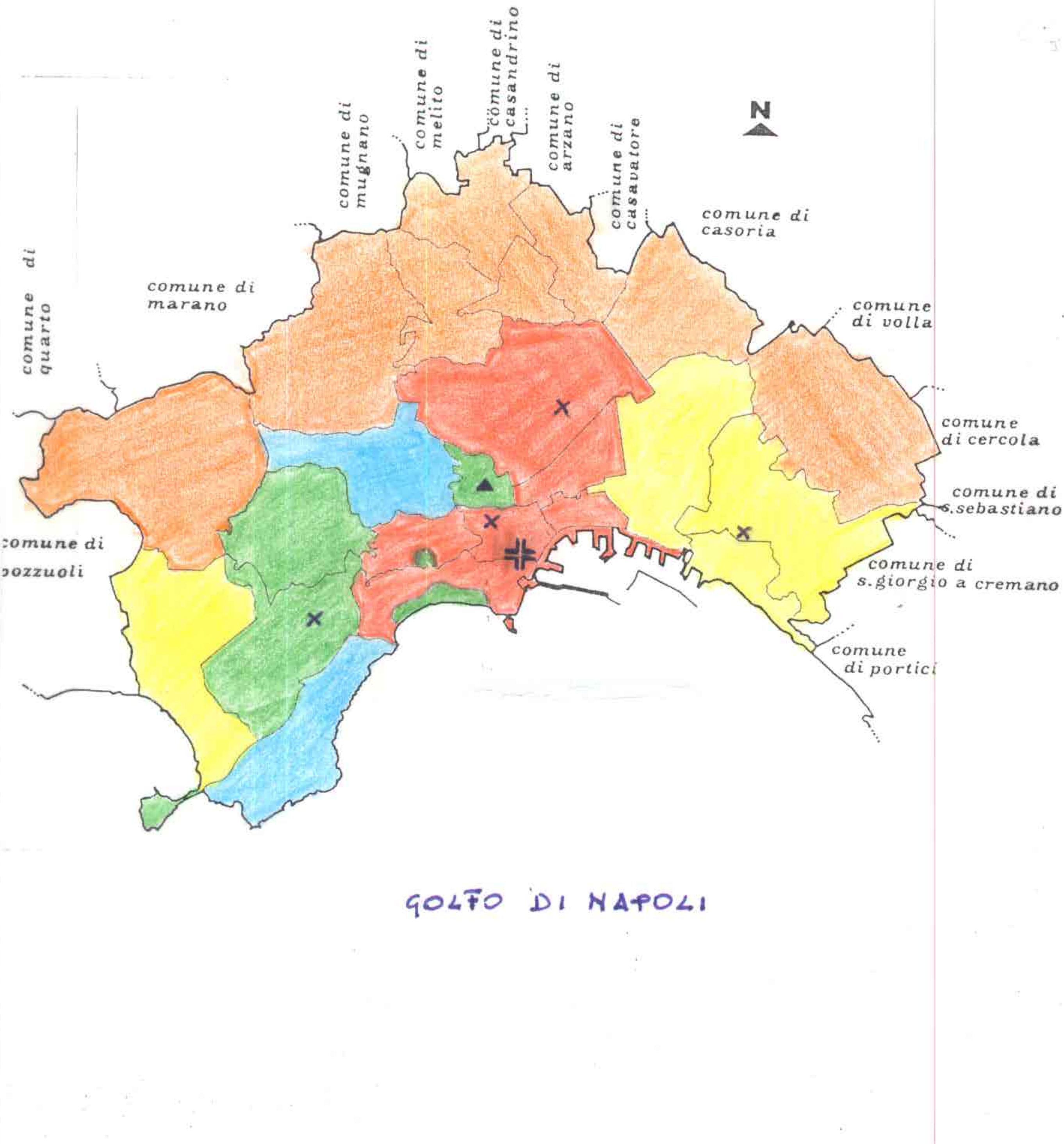
II. TOPOGRAPHY AND CLIMATOLOGY

Region: South Europe (Mediterranean) ***Topography*:** coastal, hills ***(0)***	Climate: Csa Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	15.7	16.0	16.4
precipitation (mm)	1034	1179	952
cloud cover (8^{-1})			
wind speed (m s^{-1})	***1.8 (--)***	***2.0 (--)***	***2.3 (-)***
winter smog index	***12 (0)***	***10 (0)***	***13 (0)***
summer smog index	***87 (--)***	***97 (--)***	***77 (-)***
Station:	Napoli Capodichino 40° 51' N 14° 18' E		

Local wind distribution (1985)

Direction	N	NE	E	SE	S	SW	W	NW
Frec. %	54	122	48	5	130	139	74	65
m s^{-1}	4	7	7	4	6	6	7	5

Main topography, city morphology, industrial sources and monitoring network



City centre /commercial area
Residential area
Industrial area
Woodlands/parks/ 'green' areas
Other: PERIFERIA

Scale 1 : 125.000
City coordinate (see page 2)
Major point sources (+I, II, ..X)
x Air quality monitoring station (1,2,..10)
Meteorological (wind) station
Main road

III. EMISSIONS

Annual emissions per source and totals in 1992 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.2	4.5	108.0	37.0		
Domestic/space heating						
Industry and power plants						
Total						
Per capita (**kg**)						
Per km^2 (**t**)						

Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions[1]	***3***

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	641 000	2.64×10^9
of which:		
· passenger cars	634 000	2.54×10^9
· buses	900	0.04×10^9
· freight traffic >3.5 t	7 000	0.06×10^9

Total annual consumption of fuel for traffic

	Consumption (kt a^{-1})		Average Sulphur content (t)	
	1985	1992	1985	1990
Diesel oil		70		
Petrol/Gasoline		203		
LPG				

Traffic

47% of the city roads have a width between 3.00 and 5.00 m.
44% of the city roads have a width between 5.00 and 10.00 m.
9% of the city roads have a width more than 10.00 m.

About 7% of the cars have catalytic converters.

The average occupation of passenger cars is 1.5.

VI. AIR QUALITY DATA

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	19__	1985	19__
Number of stations			4	4						
Annual average		*3*	39	29	51	45				
Winter average			43	34	56	54				
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations
Measuring method: Fluorescence.

Particulate matter: TSP µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	19__	1985	19__
Number of stations			3	3						
Annual average		*8*	161	111	181	161				
Winter average			150	111	165	159				
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Measuring method: Beta dust.

CO concentrations mg m^{-3}	Highest observed concentrations	
	1985	1992
Station number/name		
Annual average	4	6
Maximum (8 h)	9	20
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	1985	1992
Station number/name		
Annual average	2.2	1.5
Maximum monthly average	2.8	1.6
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Measuring method CO: Infrared. Measuring method Pb: AAS.

1. Uncertain data.

City: Nizhniy Novgorod[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	***1 448 000 (1992)***	2 549 000 (1992)
Total area	(km^2)		
Built-up area	(km^2)	***343 (1992)***	
Coordinates	(lat-/longitude)	50° 16' N 44° 00' E	

Major activities and development trends (1980-1990, 1990-2000)
Very old Russian city (from 1932 till 1991 called Gorky). Industrial and commercial city, also cultural and tourist centre. River port, airport. Industries: heavy engineering, building materials, refineries, (petro)chemicals, wood processing and food industry. 29 townships make up the conurbation.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: The city is situated on the East-European Plain at the point where the Volga and Oka rivers join (river basin). *(-)*	Climate: Dfb (Köppen-Geiger) Meteorology: Calms: 22%. Surface inversions: 25-40% . Air stagnations: 7-12%.

Averages	1988[2]
temperature (°C)	4.6
precipitation (mm)	579.9
cloud cover (8^{-1})	7.0
wind speed ($m\ s^{-1}$)	2.8
winter smog index	
summer smog index	

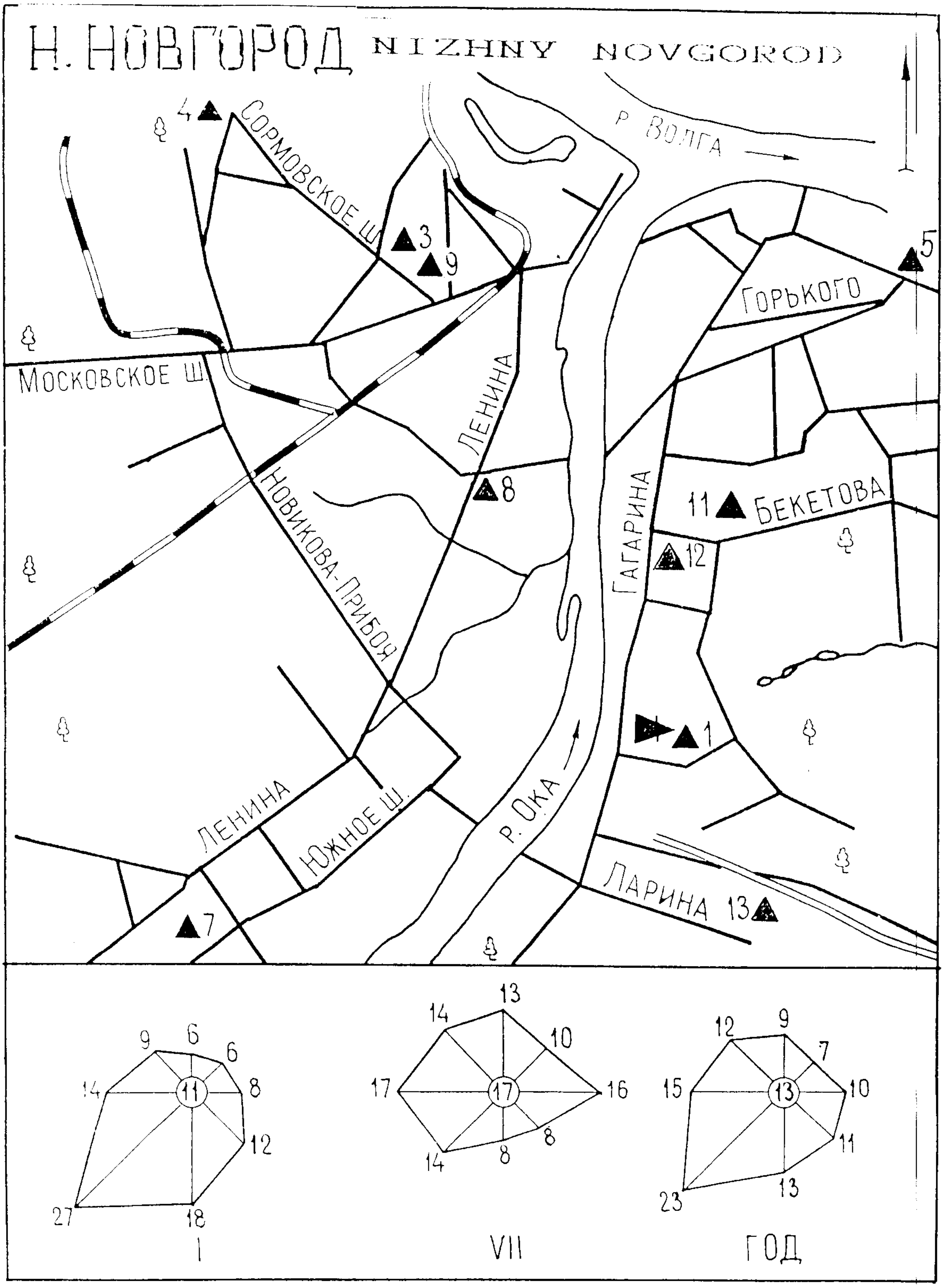
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	4	7	7	7	10	8	9	12	13	11	8	3
$m\ s^{-1}$	2.6	2.7	3.2	3.4	2.5	2.5	2.4	2.6	2.6	2.7	3.2	3.3	

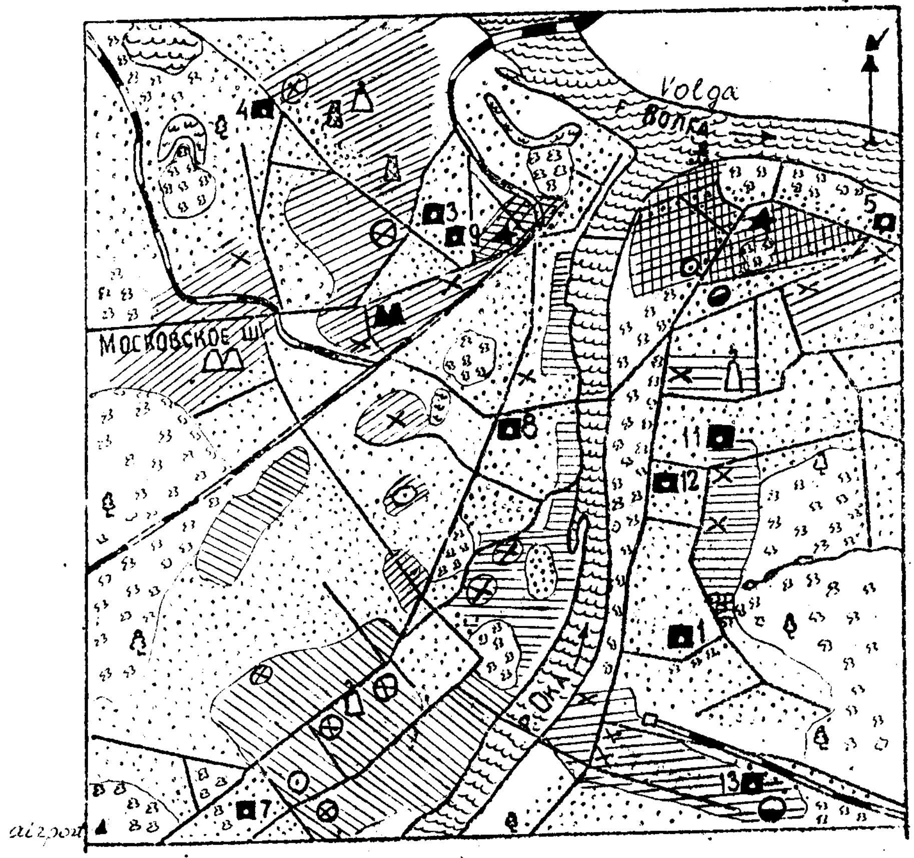
Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	3	4	6	10	7	7	11	16	13	11	8	3
$m\ s^{-1}$	3.3	2.8	2.6	3.0	3.2	2.6	2.6	2.6	2.6	2.8	3.2	3.5	

Main topography, city morphology, industrial sources and monitoring network



Main topography, city morphology, industrial sources and monitoring network



thermal electric power station; ⊗ machine works; oil works
metallurgical works; building industry, building materials
× the rest

	City centre /commercial area		Scale 1 : (схема)
	Residential area		City coordinate (see page 2)
	Industrial area	⊗ ×	Major point sources (+I, II, ...X)
	Woodlands/parks/ 'green' areas		Air quality monitoring station (1,2,..10)
	Other: water	▲	Meteorological (wind) station
			Main road, motorway

III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	7.1	103.8		-	
Domestic/space heating						
Industry and power plants	57.1	16.0	32.4		25.7	
Total	57.1	23.1	136.2		25.7	
Per capita (**kg**)	40.1	16.2	95.6		18.0	
Per km^2 (**t**)	166.5	67.4	397.1		74.9	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	6.3	89.0	-	-	
Domestic/space heating						
Industry and power plants	59.6	27.9	42.5	8.1	20.0	0.008
Total	59.6	34.2	131.5	8.1	20.0	
Per capita (**kg**)	41.5	24.0	91.5	5.6	13.9	
Per km^2 (**t**)	173.8	99.7	383.4	23.6	58.3	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***2***

Major (industrial) point sources

Stack heights are generally less than 20 m. More than 80% (90% of total emission) of all enterprises are situated on the left bank of the River Volga, the machine and automobile construction enterprises are in north-west part of the city.
-Two thermo-electric power plants (see map): H=80, 2x150, 180 and 100 m (fuel oil/natural gas)
-refinery (see map): H=<50 m
-metallurgy (see map): H<100 m
-building materials (see map): H<50 M

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

City	Number of vehicles	Total traffic activity
	1990	veh km a^{-1}
Total	*107 288*	x 10^9
of which:		
· passenger cars	*82 647*	
· buses	*4 214*	
· freight traffic >3.5 t	*20 427*	

Total annual consumption of fuel for traffic

City	Consumption (kt a^{-1})		Average Sulphur content (t)	
	1985	1990	1985	1990
Diesel oil		*78.8*		*0.2*
Petrol/Gasoline		*167.4*		
LPG				

Traffic

Buses: 61%; tramway, underground and trolley-buses: 39% of all passengers. Annual increase traffic (number of vehicles) 5-6% (1985-1990).

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

City		Annual consumption 1985	Annual consumption 1990	Average Sulphur content (t) 1985	Average Sulphur content (t) 1990
Fuel oil low sulphur	(t a^{-1})				
Fuel oil high sulphur	(t a^{-1})				
Coal	(t a^{-1})		*28 570*		*0.5-1*
Wood	(t a^{-1})		*4 200*		
Natural/city gas	(10^6 m^3 a^{-1})		*226.44*		
Total	(t a^{-1})				

Space/domestic heating: general remarks

102 boiler houses: 11 combust coal, 91 natural gas (stacks 40-100 m). 20.212 local combustion units (stacks 5-10 m) combust coal or wood.

Local policies to reduce air pollution

Industry: *The use of natural gas in 2 major power plants will reduce their emissions by 45% in 1995. Studies on emission fees.*
Traffic: *'Ecological' control of cars by militia on main roads. Traffic regulations and construction of motorway to reduce traffic through the city are under study.*

VI. AIR QUALITY DATA

Monitoring network

10 stations are operational (State Service for Observations and Control of Environmental Pollution levels) The stations function under the guidance of Nizhniy Novgorod Centre for Monitoring the Environment of the Upper Volga Region, Administration for Hydrometeorology.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 1,7		No. 7		No. 11		No. 3
Annual average		3 *(6)*		3		4		7		21
Winter average		4		4		6		9		25
Maximum (24 h) *calculated*		*15*		*37*		*48*		*88*		*232*
98 percentile (20 min)*		9		17		22		40		110
Number of days exceeding the WHO-AQG (*+calc.*)		0(*0*)		0(*0*)		0(*0*)		0(*0*)		0(*5*)
Number of days exceeding 2 x WHO-AQG		0		0		0		0		

* based on 20-minute values, sampled 3 times a day **WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$**

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are very low. Annual average regional background and city background concentrations do not seem to differ. The WHO-AQG is likely to be exceeded on a few days per year at the industrial site.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1, 7	No. 1, 7	No. 7	No. 7	No. 11	No. 11	No. 9	No. 9
Annual average		100 *(14)*	250	150	300	200	500	200	300	200
Winter average		100	175	155	200	200	400	180	300	150
Maximum (24 h)										
98 percentile (20 min)		390	970	740	1160	1100	1630	470	1160	1020
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Reported TSP concentrations are high, peak levels extremely high but concentrations show a downward trend. The WHO-AQG is likely to be exceeded on numerous days per year.

Winter smog classification	1990
Exceedance class[4]	***2***
Exposure class[4]	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 7, 1	No. 7, 1	No. 7	No. 7	No. 11	No. 11	No. 13	No. 13
Annual average		20	70	30	80	40	50	20	70	40
Maximum (24 h)										
Maximum (20 min)		100	995	255	1260	420	610	350	530	940
Number of days exceeding the WHO-AQG		0	<u>18</u>	<u>6</u>	<u>22</u>	<u>12</u>	<u>1</u>	0	<u>29</u>	<u>15</u>
Number of days exceeding 2 x WHO-AQG		0	<u>3</u>	<u>3</u>	<u>4</u>	<u>5</u>	0	0	<u>1</u>	<u>1</u>

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high. It is unclear why concentrations in city background areas are higher than at the traffic site.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	13	13
Annual average	3	3
98 Percentile (20 min)	16	19

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		9
Annual average		0.0026
Maximum monthly average		0.0040

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	11	11
Annual average	1	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		3
Annual average		0.21
Maximum monthly average		0.55
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Reported CO and Pb concentrations do not exceed WHO-AQGs.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. The location of the meteorological station is shown on the map.
3. The location of the meteorological station is shown on the map.
4. Uncertain data.

***City*: Nuremberg**	***Country*: Germany**

I. GENERAL DATA

		City	Conurbation
Population	(number)	***500 000 (1992)***	800 000 (1993)
Total area	(km^2)	186	
Built-up area	(km^2)	***95 (1993)***	
Coordinates	(lat-/longitude)	49° 27' N 11° 05' E	

Major activities and development trends (1980-1990, 1990-2000)
Industrial and trading city with airport and harbour (Rhine-Main-Danube Canal).
Precision products.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, in the north of Bavaria.
***Topography*:** river basin (-)

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	8.8	7.7	9.9
precipitation (mm)	528	639	502
wind speed ($m\ s^{-1}$)	***2.5 (-)***	***2.4 (-)***	***2.3 (-)***
winter smog index	***15 (0)***	***14 (0)***	***11 (0)***
summer smog index	***19 (0)***	***18 (0)***	***18 (0)***

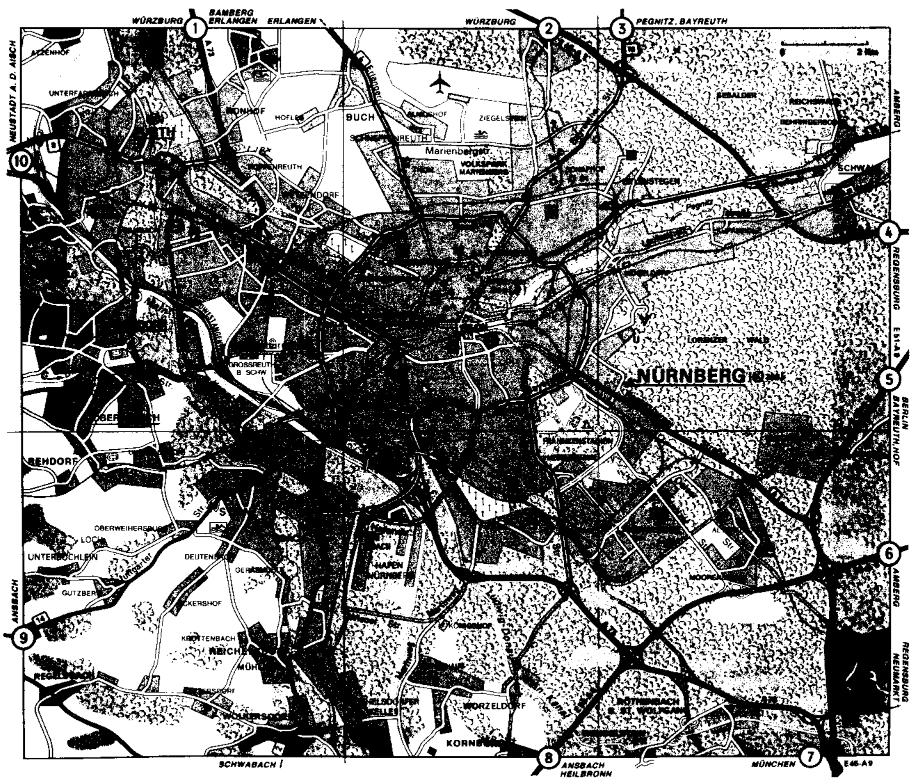
Station: 10763 — 49° 30' N 11° 05' E

III. EMISSIONS

Annual emissions per inhabitant in 1990 ($kg\ inh^{-1}\ a^{-1}$)			
Conurbation	SO_2	NO_x	VOC
Total	6.4-10	15-31.5	26

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*14*				
Mean of stations in city background	1989	1	17.4	106	63	0	0
Highest observed concentrations	1989		17.4	106	63	0	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Winter smog classification	1989
Exceedance class	***1***
Exposure class[1]	***1***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1989	1	38.9	104	254	0	0
Highest observed concentrations	1989		38.9	104	254	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Odessa[1]	*Country*: Ukraine

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 141 000 (1987)	*1 141 000 (1987)*
Total area	(km^2)	150 (1986)	*150 (1986)*
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	46° 30' N 30° 46' E	

Major activities and development trends (1980-1990, 1990-2000)
Administrative, scientific and cultural centre. Important harbour (Black Sea). Varied industry: refinery, (petro)chemicals, heavy engineering, building materials, fertilizers etc.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: flat plain near the sea (coastal). *(++)*

Climate: Bsk (Köppen-Geiger)
Meteorology: temperate unfavourable conditions for dispersing pollutants. Calms: 6%, low-level inversions: 35%, air stagnations: 6%. In July: pronounced land-sea breezes.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	10.5	7.6	11.4	9.8
precipitation (mm)				662.1
cloud cover (8^{-1})				6.8
wind speed[2] ***($m\ s^{-1}$)***	*4.4 (+)*	*5.3 (++)*	*2.7 (-)*	3.0
winter smog index[2]	*16 (0)*	*15 (0)*	*14 (0)*	
summer smog index	*23 (0)*	*17 (0)*	*22 (0)*	

Station: Odessa 46° 29' N 30° 38' E

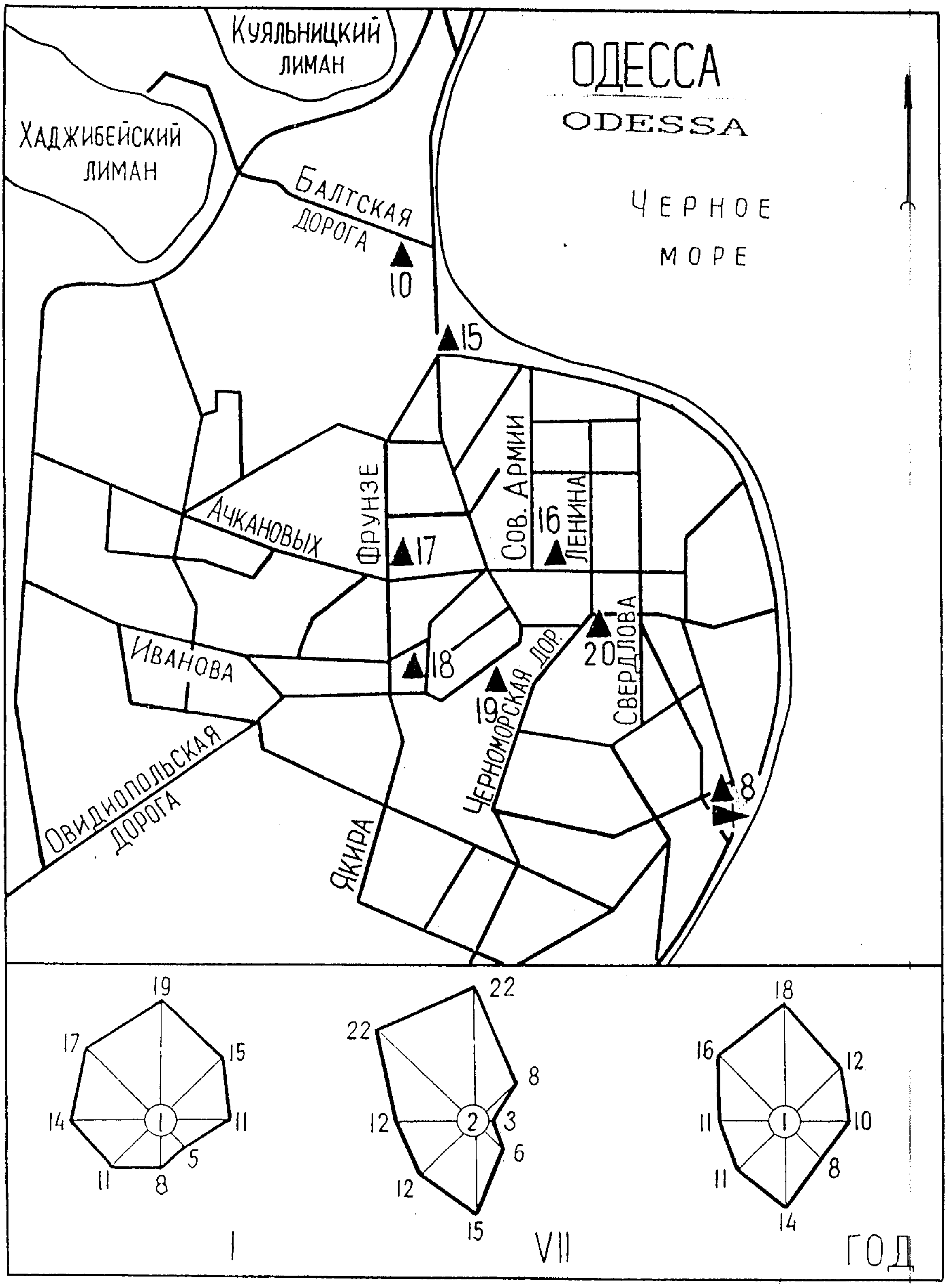
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	9	8	7	5	3	7	9	7	8	10	12	15	2
$m\ s^{-1}$	3.1	4.1	4.0	4.1	2.6	2.8	3.1	2.6	2.3	2.1	2.5	3.0	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	8	7	3	4	3	4	12	9	12	11	13	14	8
$m\ s^{-1}$	2.8	3.3	3.1	3.2	3.0	2.8	3.1	2.7	2.4	2.3	2.8	3.0	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	6.9	111.5		-	
Domestic/space heating						
Industry and power plants	15.3	5.5	27.5		19.1	
Total	15.3	12.4	139.0		19.1	
Per capita (**kg**)	13.4	10.9	121.8		16.7	
Per km^2 (**t**)	102.0	82.7	926.7		127.3	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.5	86.8	-	-	
Domestic/space heating						
Industry and power plants	12.7	5.3	31.0	10.8	14.1	0.001
Total	12.7	10.8	117.8	10.8	14.1	
Per capita (**kg**)	11.1	9.5	103.2	9.5	12.4	
Per km^2 (**t**)	84.7	72.0	785.3	72.0	94.0	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***2***

Major (industrial) point sources

Industrial emissions are caused by more than 200 sources (petro-chemicals, heavy engineering, production of fertilizers, building material industry etc.). Besides the emissions figures given in the table also 288 t HF, 420 t NH_3 and 19 t HCl among others are emitted by the industrial enterprises. Industrial enterprises are concentrated in the low N and NE districts of the city. N and NE winds transport the polluted air to the residential and commercial districts of the city.
Emission estimates are to low, when compared to concentrations measured. A number of important source categories (harbour, military etc) is not included in the estimates.

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

700 sources which combust mainly fuel oils and coal.

VI. AIR QUALITY DATA

Monitoring network

8 stations are operational (State Service for Observations and Control of the Natural Environment in Ukraine). The Odessa Hydrometeorological Observatory is responsible for the network. The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring of the State Committee of the Ukraine for Hydrometeorology is in charge of methodology.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 8,16,19		No. 19		No.10		No. 18
Annual average		*8*		44		48		53		61
Winter average				47		50		53		62
Maximum (24 h) *calculated*				*140*		*150*		*174*		*193*
98 percentile (20 min)*				98		105		120		135
Number of days exceeding the WHO-AQG (*+calc.*)				0(*2*)		0(*3*)		0(*6*)		0(*10*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are among the highest monitored in cities of the former Soviet Union. Still, concentrations are low compared to concentrations measured in other parts of Europe. Concentrations are not in line with emission estimates given for Odessa. The WHO-AQG is likely to be exceeded on a few days per year.

Particulate matter: $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 8,16,19	No. 8,16,19	No. 16	No. 16	No. 10	No. 10	No. 18	No. 18
Annual average		*20*	300	270	400	330	600	420	600	340
Winter average			206	220	267	283	400	483	467	317
Maximum (24 h)										
98 percentile (20 min)			860	780	1250	880	2020	1020	1720	890
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Suspended particulate concentrations

Reported TSP concentrations are very high, peak values can reach extremely high values. TSP concentrations showed no difference between industrial and background stations. The highest annual concentrations have been measured near the motorway. In summer concentrations are higher than in winter. Prevailing winds from the sea in Odessa lead to a relatively clean strip of air with a width of 1 km. The WHO-AQG is likely to be exceeded on numerous days per year.

Winter smog classification	1990
***Exceedance class*[5]**	*4*
***Exposure class*[5]**	*4*

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 8,16,19	No. 8,16,19	No. 19	No. 19	No. 10	No. 10	No. 18	No. 18
Annual average			60	97	60	120	70	110	70	120
Maximum (24 h)										
Maximum (20 min)			140	317	150	360	170	360	140	420
Number of days exceeding the WHO-AQG			0	11	0	5	0	0	0	8
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Nitrogen dioxide concentrations

Reported concentrations are high. They are related to the traffic intensity and the high intensity of the sun, which causes a rapid transformation from NO to NO_2. The WHO-AQG is exceeded, most exceedances are reported from city background areas.

Formaldehyde concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	18	18
Annual average	20	23
98 percentile (20 min)	40	50

Phenol concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	18	18
Annual average	8	7
98 percentile (20 min)	16	18

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	10	10
Annual average	3	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		15
Annual average		0.17
Maximum monthly average		0.61
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

Carbon monoxide concentrations/Lead concentrations

Carbon monoxide concentrations show almost no difference between city background and highway stations. Concentrations in residential areas can be even higher than along motorways. A possible explanation is the great amount of street crossings in Odessa where traffic jams occur. The WHO-AQG however is almost never exceeded. Pb concentrations are relatively high for Soviet standards.

VII. EFFECTS

Effects of air pollution on health

As a consequence of the polluted air in Odessa the number of adults with respiratory diseases is 48% higher than the average in cities of the former Soviet Union, the number of cancers are found to be 38% higher, despite of the positive influence of the sea climate.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. Less than 75% of the data available.
3. Not the named ODS station. The location of the meteorological station is shown on the map.
4. The location of the meteorological station is shown on the map.
5. Uncertain data.

***City*:** Oslo	***Country*:** Norway

I. GENERAL DATA

		City	Conurbation
Population	(number)	462 000 (1990)	***616 000 (1990)***
Total area	(km^2)	450 (1990)	1 100 (1990)
Built-up area	(km^2)	200 (1990)	***400 (1990)***
Co-ordinates	(lat-/longitude)	59° 56' N 10° 44' E	

Major activities and development trends (1980-1990, 1990-2000)
Commercial and administrative centre. Number of inhabitants increased from 452 x 10^3 in 1980 to 462 x 10^3 in 1990. Number of cars crossing the city boundary each day has increased from 199 x 10^3 in 1980 to 293 x 10^3 in 1990.
A slow increase in population and 1% yearly increase in car traffic is expected from 1990-2000.

II. TOPOGRAPHY AND CLIMATOLOGY

Region:
Topography*:** Hills 300-500 m high. Three valley outlets at the end of the Oslo fjord. ***(--)

Climate: Rainy climate (Dfb)
Meteorology: Ground based inversion in winter. Drainage winds down the valleys towards the fjord and the city centre.

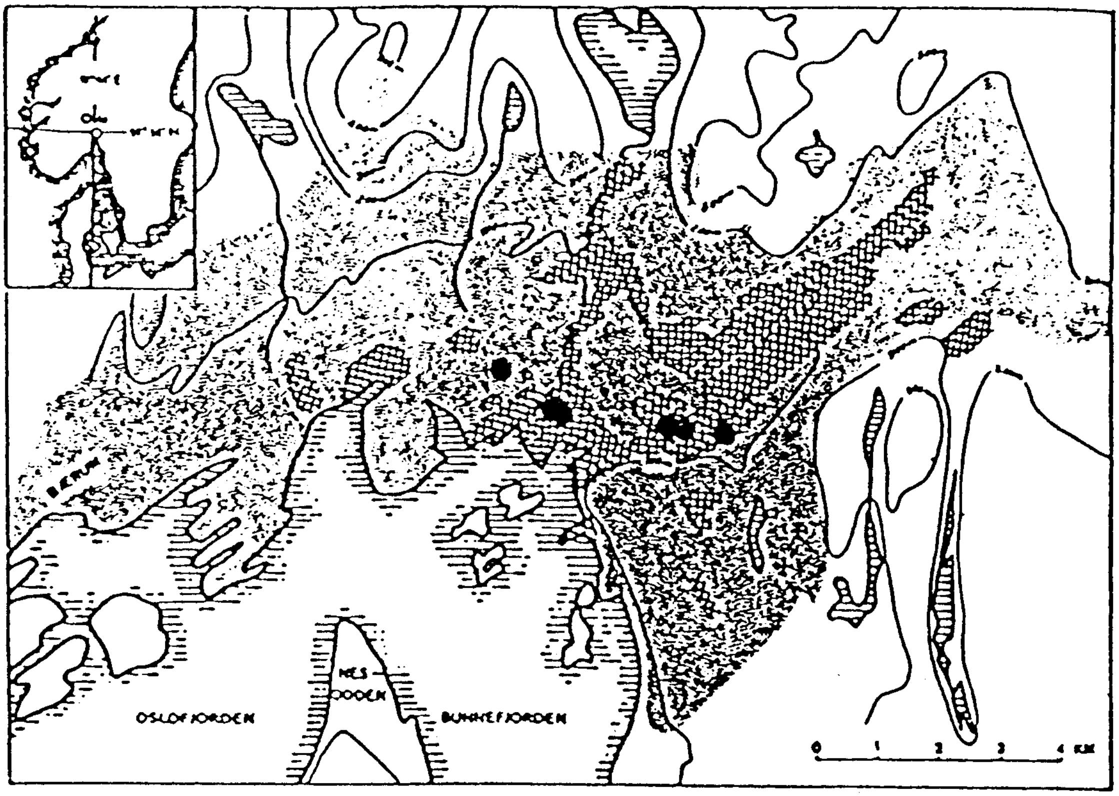
Averages	1980-1989	1985	1989
temperature (°C)	6.1	4.4	8.3
precipitation (mm)	720.6	843.5	740.6
cloud cover (8^{-1})			
wind speed (m s^{-1})	***2.2 (-)***	***2.0 (--)***	***2.2 (-)***
winter smog index	***52.8 (--)***	***55.0 (--)***	***46.2 (-)***
summer smog index	***6.6 (+)***	***0.3 (++)***	***9.0 (0)***

Climatological diagram 1980-1989

Wind speed (annual average)		:	2.25 m s^{-1}
No. of days per year	$T_m < 0°$ C	:	141.4
(T_m = minimum temperature each day)	$T_m < -10°$ C	:	28.7
Frequency of calm and light wind conditions		:	48.8 %

City: Oslo **Country**: Norway

Main topography, city morphology, industrial sources and monitoring network



City centre/ commercial
Residential
Industry area
Forest
AQ mon. station
● Main source

City: Oslo **Country:** Norway

III. EMISSIONS

Annual emissions per source and totals in 1985 (t a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	1 062	10 755	33 765		851	
Domestic/space heating	2 406	1 460	12 393		1 112	
Industry and power plants	1 847	1 082	340		66	
Total	5 315	13 297	46 498		2 099	
Per capita (**kg**)	12	28	100		4	
Per km^2 (**t**)	11.8	29.5	103		4.5	

Emission class	1985
Winter smog emissions	*1*
Summer smog emissions	*2*

Major (industrial) point sources

(see city map)

Six centralised heating plants with stack heights from 26 m to 90 m. No major industry emission.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles	Total traffic activity veh km a^{-1}	**Total annual consumption of fuel for traffic**	Consumption (t a^{-1}) 1985	Consumption (t a^{-1}) 19__	Average Sulphur content (%) 1985	Average Sulphur content (%) 19__
Total	197 814	2.0 x 10^9					
of which:	163 475						
· passenger cars	2 060		Diesel oil	69.6x10^3		0.17	
· buses	32 279		Petrol/Gasoline	178.4x10^3		-	
· freight traffic >3.5 t			LPG	0		-	

Traffic

Public transportation system includes buses, subway and electric trams.

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption 1985	Annual consumption 1990	Average Sulphur content (%) 1985	Average Sulphur content (%) 1990
Fuel oil low sulphur	10^3 (t a^{-1})	151.0	84.8	0.2	0.2
Fuel oil high sulphur	10^3 (t a^{-1})	72.8	12.8	0.8	0.8
Coal	10^3 (t a^{-1})	6.0		1.0	
Wood	10^3 (t a^{-1})	37.0			
Natural/city gas	(10^6 m^3 a^{-1})				
Total	(t a^{-1})				

Space/domestic heating: general remarks

Hydro electric power is used for space heating. A large part of the oil used for space heating is used in centralised heating plants.

City: Oslo **Country:** Norway

Local policies to reduce air pollution
Industry: A prominence system given by the Air Pollution Control Authority in Norway. **Traffic**: Public transportation system is subsidised to some extent. Parking restrictions are introduced in the central areas of the city. Catalytic converter required on new cars from 1989. **Domestic/space heating**: Low-sulphur content required in oil to be used in Oslo.

VI. AIR QUALITY DATA

Monitoring network	
24h	SO_2 and black smoke values are measured at three city background stations.
1h	CO, NO_2 and NO are measured at two city background and two traffic sites for two winter months each year.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1984-85	1990	1984-85	1989-90	1985	1990	1985	1990	1985	19__
Number of stations			3	3	3	3		2		
Annual average		*1*	17	8	22	9				
Winter average			26	11	33	14		33		
Maximum (24 h)			105	40	118	49		86		
98 percentile (24 h)			71	26	86	33				
Number of days exceeding the WHO-AQG			0	0	0	0				
Number of days exceeding 2 x WHO-AQG			0	0	0	0				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations
SO_2 has been a problem during winter smog periods. The concentrations have decreased with decreasing emissions from home heating and centralisation of domestic heating.

Particulate matter: Black smoke $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1989-90	1985	1989-90	1985	1989-90	1985	19__
Number of stations			3	3	3	3	-	2		
Annual average		*4*	26	25	33	34	-	-		
Winter average			36	34	43	50	-	-		
Maximum (24 h)			170	166	189	193	319	210		
98 percentile (24 h)			109	98	118	118	-	-		
Number of days exceeding the WHO-AQG			6	4	6	6	-	-		
Number of days exceeding 2 x WHO-AQG			-	-	-					

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Suspended particulate concentrations
Car traffic is the main source; wood burning for domestic heating during winter contributes to suspended particulate concentrations.

Winter smog classification	1990
Exceedance class	***2***
Exposure class	***2***

City: Oslo **Country**: Norway

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1989-90	1985	1989	1985	1989	1985	19__
Number of stations				2				2		
Annual average				-						
Maximum (24 h)				76		90		119		
Maximum (1 h)				98				209		
Number of days exceeding the WHO-AQG				0				0		
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Exceedances may occur in streets with high traffic intensity.

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1992	1985	1992	1985	19__	1985	19__	1985	19__
Number of stations				3						
Annual average				-						
Summer average		84		31						
Maximum (1 h)		169		88						
Maximum (8 h)		159		83						
98 percentile (1 h)				-						
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										
Exceedance class				*1*						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Ozone concentrations
Low ozone concentrations are observed in Oslo. Ozone episodes on large scale are observed outside Oslo.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		St.Olavs pl.
Annual average		
Maximum (8 h)		17.3
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1989
Station number/name		Strømsveien
Annual average		
Maximum monthly average		0.71
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
8h max. AQG is exceeded in streets located in the city centre and close to congested traffic during rush hours.

City: Palermo	*Country*: Italy

I. GENERAL DATA

		City	Conurbation
Population	(number)		***714 000 (1984)***
Total area	(km^2)		
Built-up area	(km^2)		***50***
Coordinates	(lat-/longitude)	38° 08' N 13° 23' E	

Major activities and development trends (1980-1990, 1990-2000)
Most important economic and cultural centre of Sicily. Shipping and tourism. Industry: textiles, chemicals, shipyards.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: South Europe (Mediterranean)
Topography: coastal, hills ***(0)***

Climate: Csa (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	18.6	19.0	18.3
precipitation (mm)	623	520	791
cloud cover (8^{-1})			
wind speed [1] ***(m s^{-1})***	***3.6 (+)***	***3.0 (0)***	***4.5 (+)***
winter smog index [1]	***0 (++)***	***0 (++)***	***0 (++)***
summer smog index [1]	***53 (-)***	***88 (--)***	***44 (-)***

Station: Palermo Boccadifalco 38° 06' N 13° 18' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[2]	***3***
Summer smog emissions[2]	***2***

VI. AIR QUALITY DATA

Information from Girafe (EC) suggests that air quality is only monitored near a power plant. (ENEL network)

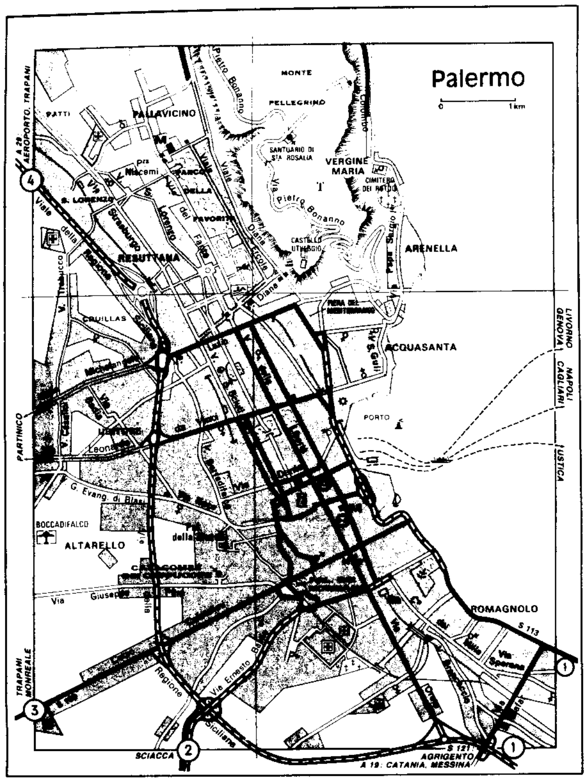
Sulphur dioxide[3]

nr	**1985** median	**1985** 98 p	
1	24	78	
2	11	104	
3	9	78	
	15	87	(mean)

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

1. Less than 75% of the data available.
2. Uncertain data.
3. Report on the state of the Environment, Ministry of environment, 1989 (Italy).

Main topography, city morphology, industrial sources and monitoring network



City: Paris	*Country*: France

I. GENERAL DATA

		City	Conurbation
Population	(number)	2 189 000 (1990)	***8 510 000 (1990)***
Total area	(km^2)	105 (1985)	***1200 (1990)***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	48° 52 ' N 2 ° 20 ' E	

Paris and its suburbs is an area of 12 000 km^2, with 10.25 million inhabitants (1985) and sometimes called 'Ile de France'. It is subdivided in three parts: central Paris 'Ville de France' (2.2 million inhabitants, 105 km^2), the inner suburbs 'Petite Couronne' (4 million inhabitants, 759 km^2) and the outer suburbs 'Grande Couronne' (4 million inhabitants, 12 000 km^2). Depending on the part of the Grande Couronne that is taken into account population estimates of the conurbation differ from 6.2 to 8.5 to 10.25 million inhabitants. Although the population of the region has been expanding steadily since the 1950s, it has also drifted from the city centre triggering a relatively large decline in the centre, a smaller decline in the Petite Couronne since 1975 and a very sharp increase in the population of the Grande Couronne. Paris can be considered as a large urban agglomeration which includes several industrial zones. It is the fourth largest conurbation of this type within Europe.

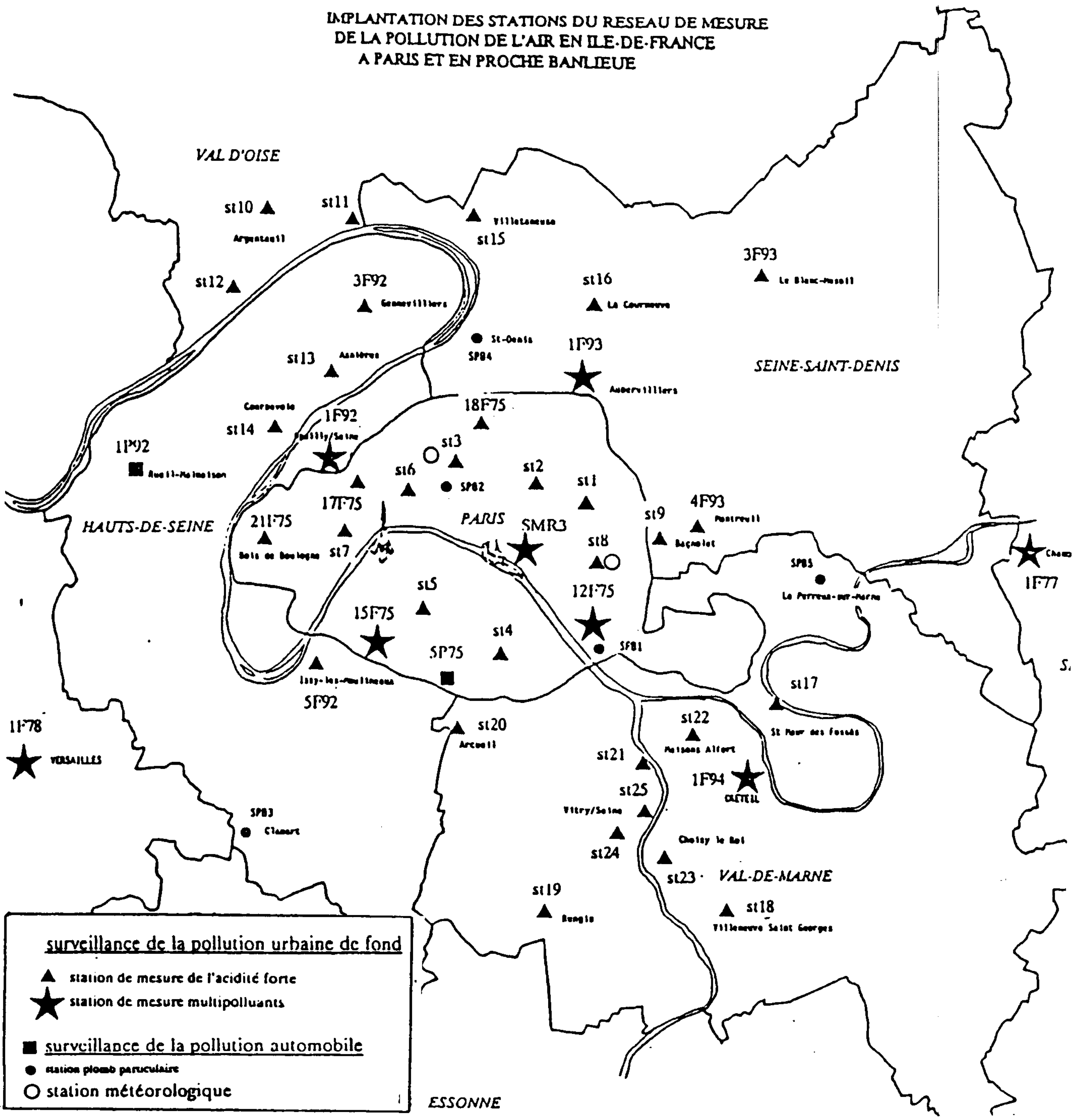
II. TOPOGRAPHY AND CLIMATOLOGY

Region: W-Europe ***Topography***: Plain ***(+)***	Climate: Cfb (Marine-west-coast) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	10.8	10.0	11.4
precipitation (mm)	520	510	560
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.6 (0)***	***3.5 (0)***	***3.4 (0)***
winter smog index	***7 (+)***	***9 (+)***	***7 (+)***
summer smog index	***15 (0)***	***15 (0)***	***25 (-)***

Paris can be characterised as a flat terrain city with a coastal meteorology, with relatively strong winds with an average wind speed of 3-5 m s^{-1} (at a height of 75 m) for most days of the year. The strongest winds are coming from south-south-west followed by north-north-eastern and western winds. The lowest wind speeds are measured when the winds come from east-north-east to east-south-east and north-west. The wind direction pattern applies to a large extent to all seasons of the year. The wind speed, however, is in general lowest in the summer. Winter episodes occur mainly in the first two months of the year and are characterized by anti-cyclonic conditions, temperatures in the range of or slightly below 0°C, clear sky and a light or zero, mostly eastern, wind causing stable atmospheric conditions with low altitude inversion layers, sometimes also with dense low-level fog.

Station: Paris/Orly; Distance to centre: 15 km — 48° 44 ' N 2° 24 ' E

Main topography, city morphology, industrial sources and monitoring network



N.B.: L'emplacement des symboles indique le lieu de la station et non pas le centre de la commune.

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})						
Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	13	100		170	7	
Domestic/space heating	42	17		40	4	
Industry/power plants	65	37		90	45	
Total	122	157		460	58	
Per capita (**kg**)	14	18		54	6.8	
Per km^2 (**t**)	100	130		380	48	

Annual emissions per source and totals in 1990 (kt a^{-1})						
Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	18	123		200	10	
Domestic/space heating	32	10		40	3	
Industry/power plants	48	24		80	21	
Total	100	163		540	36	
Per capita (**kg**)	12	19		64	4.2	
Per km^2 (**t**)	83	140		450	30	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***5***

IV. TRAFFIC DATA

Vehicle statistics and traffic activity		**Total annual consumption of fuel for traffic**	
Ile de France	Number of vehicles (1987)	Ile de France	Consumption (m^3) 1987
Total of which: · passenger cars · buses · freight traffic >3.5 t	4 200 000	Diesel oil Petrol/Gasoline LPG	1 500 000 4 000 000

Traffic
Daily 2.7 million vehicles entered and left central Paris in 1987; a 100% increase in 20 years.

VI. AIR QUALITY DATA [1]

Monitoring network

In 1990 the network was modernised, in line with the decreasing trend of SO_2 and particle concentrations, and the number of measurement stations reduced from 173 to 73. (27 Paris centre, 28 Petite Couronne, 18 Grande Couronne)
In 1993 the new network will be in full operation with 50 SO_2 , 36 NO_2, 36 Black smoke, 19 Ozone, 15 particles and 1 CO urban background stations; 9 NO_2, 2 particles, 9 CO, 6 Lead and 1 benzo(a)pyrene traffic stations. At the Eiffel tower NO_2, O_3 and SO_2 will be measured at 3 heights (3.5m, 57m and 280m).

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations		Highest observed concentrations	
	City background		City background	
	1984	1991	1984	1991
Number of stations	5	13		
Annual average	56	25	67	43
Winter average	78		99	
Maximum (24 h)	224		269	222
98 percentile (24 h)	167		208	
Number of days exceeding the WHO-AQG				
Number of days exceeding 2 x WHO-AQG				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations

SO_2 is measured in Paris since the 1950s. Since then levels have fallen by almost 80% and are now below the EC limit values in nearly all parts of Ile-de-France. The only exception is the area around the Vitry power plants where peak values above the EC limit values occur.
Regional background: 10 $\mu g\ m^{-3}$

Particulate matter: $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations			
	City background				City background			
	Black smoke		**TSP**		**Black smoke**		**TSP**	
	1984	1991	1985	1991	1984	1991	1985	1991
Number of stations	5	10	1	6			1	
Annual average	39	39	155	43	44	61	155	59
Winter average	54		133		61		133	
Maximum (24 h)	155		997		172	367	997	191
98 percentile (24 h)	117		548		127		548	
Number of days exceeding the WHO-AQG								
Number of days exceeding 2 x WHO-AQG								

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$
WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Suspended particulate concentrations

Black smoke levels have fallen by 75% since the 1950s but the concentrations have remained much the same for the last seven years.
Regional background TSP: 17 $\mu g\ m^{-3}$

Winter smog classification	1991
Exceedance class	2
Exposure class	2

NO_2 concentrations µg m^{-3}	Mean of stations		Highest observed concentrations			
	City background		City background		Traffic site	
	1985	1991	1985	1991	1985	1991
Number of stations	3					
Annual average	50		53		66	67
Maximum (24 h)	200		166		538	235
98 percentile (1 h)	157		192		236	174
Maximum (1 h)	448		418		1212	519
Number of days exceeding the WHO-AQG						
Number of days exceeding 2 x WHO-AQG						

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
NO_2 concentrations -mostly influenced by traffic- do not show a clear trend and breaches of the EC limit value occur from time to time.

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985		1985	1991	1985	1991	1985		1985	19__
Number of stations			2	4						
Annual average			25	16	25	19				
Summer average										
Maximum (1 h)			175	154	223	263				
Maximum (8 h)				128		226				
98 percentile (1 h)			68	72	76	99				
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										
Exceedance class				**2**						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		
Annual average	4.7	8.0
Maximum (1h)	46.8	34.3
Maximum (8 h)		22.4
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		6
Annual average		0.70
Maximum monthly average		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Background lead concentrations have remained stable over the last years at levels below the AQG. At kerbside stations the levels decreased, now showing concentrations in the range of 1-2 µg m^{-3}.

1. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Perm[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 119 000 (1992)	***1 119 000 (1992)***
Total area	(km^2)	722 (1991)	722 (1991)
Built-up area	(km^2)	270 (1991)	***270 (1991)***
Coordinates	(lat-/longitude)	58° 01' N 56° 10' E	

Major activities and development trends (1980-1990, 1990-2000)
Large industrial, cultural and scientific centre. River port and airport. Industry: refinery, (petro)chemicals, heavy engineering, pulp and paper.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: The city is situated on the eastern part of Russian Plain, it stretches for 50 km along the Kama River (river basin). ***(-)***

Climate: Dfc (Köppen-Geiger)
Meteorology: The frequency of wind velocity 0-1 m s^{-1}: 22%, surface inversions: 41%, air stagnations: 12%.

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	2.1	1.3	3.1	3.1
precipitation (mm)				523.1
cloud cover (8^{-1})				6.3
wind speed (m s^{-1})	***3.8 (0)***	***4.1 (+)***	***4.1 (0)***	2.2
winter smog index	***33 (-)***	***27 (-)***	***27 (-)***	
summer smog index	***11 (0)***	***4 (+)***	***4 (0)***	

Station: Perm 58° 01' N 56° 18' E

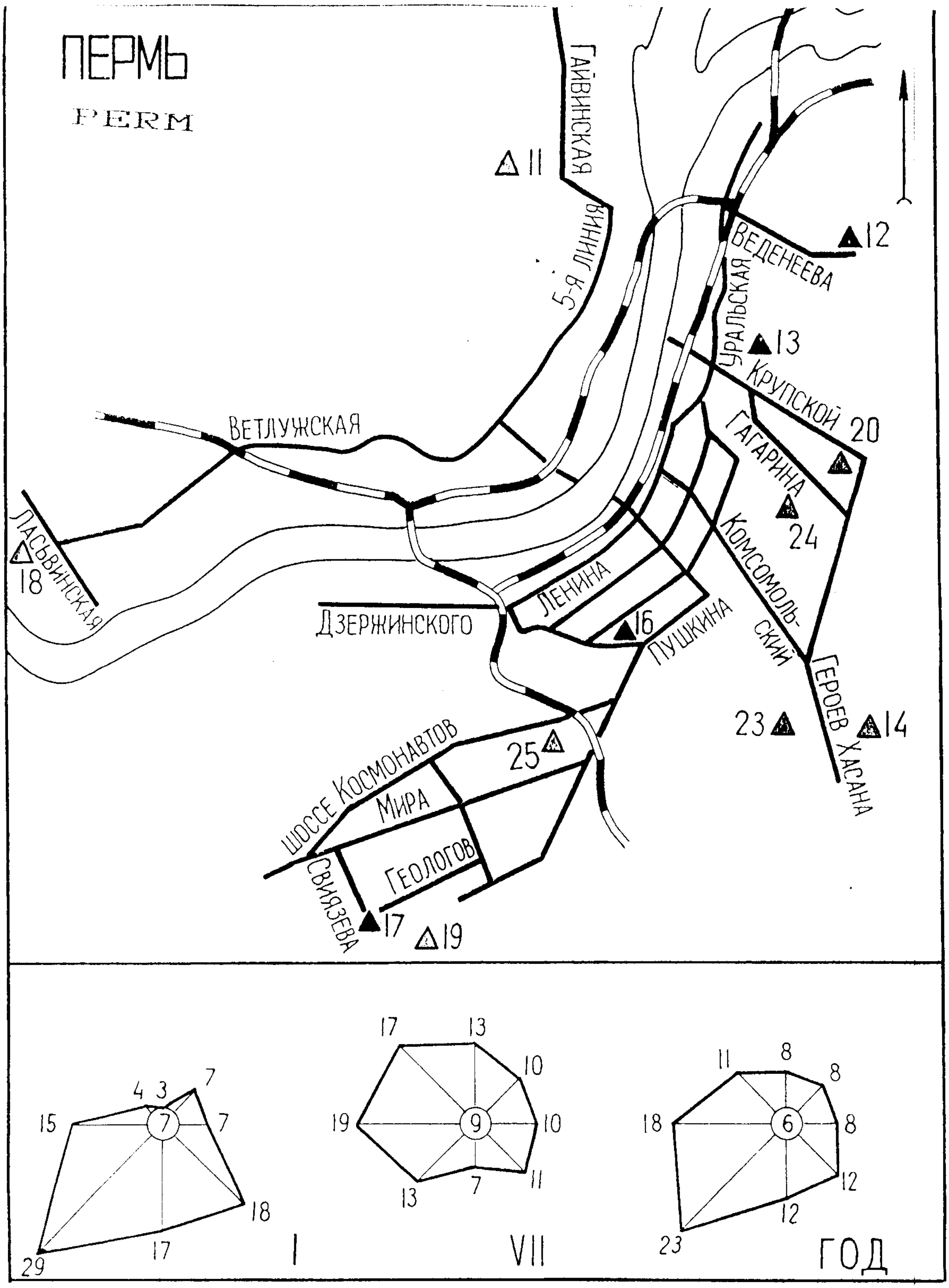
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	4	5	4	9	19	7	12	11	7	11	7	23
m s^{-1}	2.6	2.4	3.2	3.0	3.2	3.3	3.2	4.1	3.4	2.6	2.6	2.5	

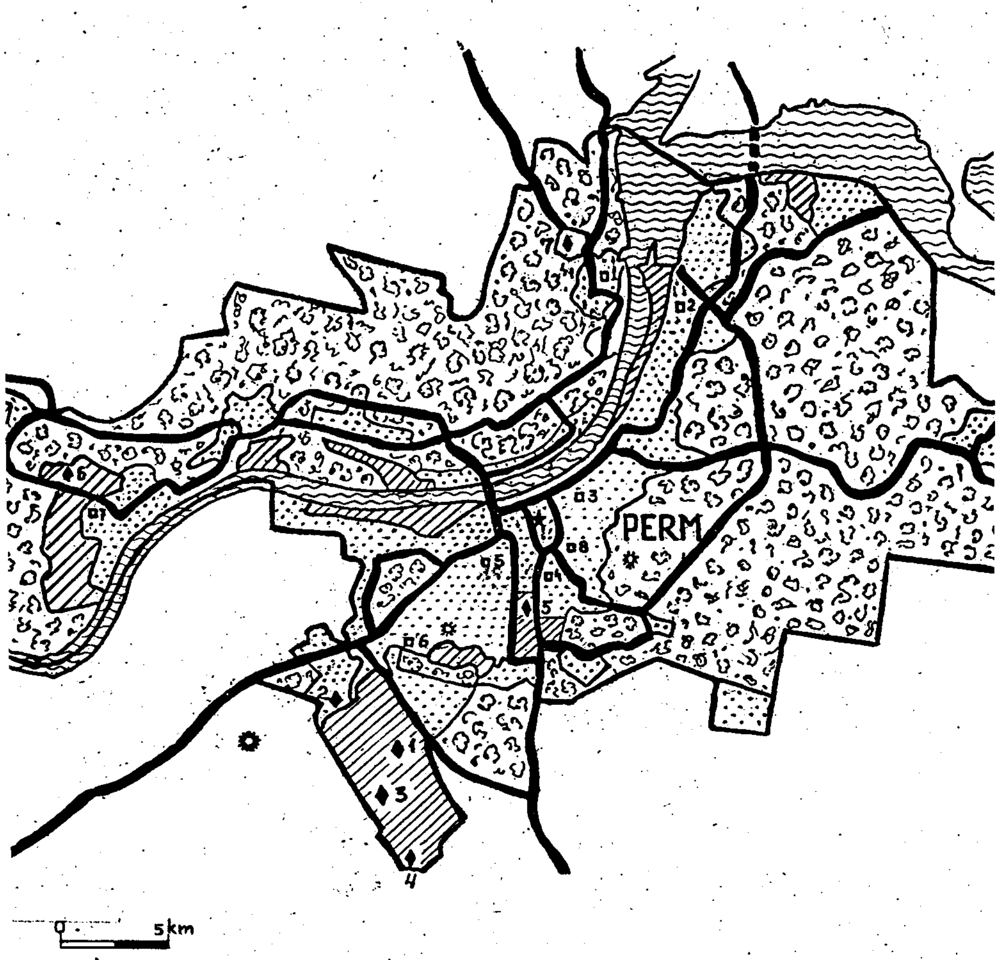
Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	4	5	5	8	13	16	15	10	6	6	7	8
m s^{-1}	1.8	1.7	2.0	2.2	1.3	2.7	2.8	3.0	2.8	2.3	2.6	2.3	

Main topography, city morphology, industrial sources and monitoring network



Main topography, city morphology, industrial sources and monitoring network



City centre/Commercial area		City Centre Coordinate	★
Residential Area		Meteorological (Wind) Station	
Industrial Area		Air Quality Monitoring Point	
Woodlands/Parks/'Green' Areas		Major Industrial Point Source	♦
Water		Municipal Boundary	
Main Road		Motorway	

III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.3	62.3		-	
Domestic/space heating						
Industry and power plants	39.0	26.9	25.3		12.9	
Total	39.0	31.2	87.6		12.9	
Per capita (**kg**)	36.3	29.0	81.5		12.0	
Per km² (**t**)	144.4	115.6	324.4		47.8	

Annual emissions per source and totals in 1990 (kt a^{-1})	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.4	64.3	-	-	
Domestic/space heating						
Industry and power plants	32.4	22.2	18.6	86.7	10.4	0.0001
Total	32.4	26.6	82.9	68.7	10.4	
Per capita (**kg**)	29.5	24.3	75.6	62.6	9.5	
Per km² (**t**)	120.0	98.5	307.0	254.4	38.5	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***4***

Major (industrial) point sources

Also emitted by industry: 1 446 t ammonia, 1 875 t toluene, 1 456 t benzol, 702 t xylene.
Four power stations (7.5 x 10^6 MW) (see map) 1: 120 m, 5: 120 m, 6: 180 m, 7: 120 m.
(petro)chemicals: 58% of total industrial emissions, power stations: 13.7%, heavy engineering: 4%.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles *1990*	Total traffic activity veh km a^{-1}
Total	*93 462*	x 10^9
of which:		
· passenger cars	*79 662*	
· buses	*2 800*	
· freight traffic >3.5 t	*11 000*	

Total annual consumption of fuel for traffic	Consumption (kt a^{-1}) 1990	Consumption (kt a^{-1}) 1991	Average Sulphur content (t) 1985	Average Sulphur content (t) 19__
Diesel oil	*28.5*	*28.0*		
Petrol/Gasoline	*95.9*	*96.2*		
LPG				

Traffic

Traffic is responsible for 34% of anthropogenic emissions. *Transit traffic has to pass through the city centre.*

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

1990: 22 500 t wood and 10 000 10^6 m^3 a^{-1} natural gas. Heating capacity of power stations is 4 457 MW. In addition there are 159 boiler houses in operation (86% of city area), 86 combust coal, 55 fuel oil, 18 natural gas. In other parts of the city coal and wood are used in local stoves.

Local policies to reduce air pollution

Industry: *Policies are planned to reduce emissions by 1996 to a level that maximum permissible concentrations are not exceeded.*
Traffic: *Introduction of lead-free petrol is foreseen. Optimalisation of speed control traffic. Tramway is planned. Building of a new bridge has begun.*
Domestic/space heating: *A new heat and power co-generation plant will be build in the near future, so a number of small boiler houses can be closed.*

VI. AIR QUALITY DATA

Monitoring network

8 Stations are operational (State Service for Observations and Control of Environmental Pollution Levels). The stations function under the guidance of Perm Hydrometeorology Observatory and Ekaterinburg Centre for Monitoring the Environment of the Urals.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 13, 17, 20		No. 17		No. 16		No. 12
Annual average				14		18		22		15
Winter average				15		21		30		15
Maximum (24 h) *calculated*				*150*		*190*		*198*		*99*
98 percentile (20 min)*				70		90		100		55
Number of days exceeding the WHO-AQG (*+calc.*)				0(*2*)		0 (*3*)		0(*4*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day **WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$**

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are low. The WHO-AQG can be exceeded on a few days per year.

Particulate matter: $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.13, 17, 20	No.13, 17, 20	No. 13	No. 13	No. 16	No. 16	No. 12	No. 12
Annual average			100	130	100	200	100	200	100	200
Winter average				<u>200</u>		<u>200</u>		217		167
Maximum (24 h)										
98 percentile (20 min)				440		470		470		470
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Suspended particulate concentrations
Reported TSP concentrations are relatively low compared to other cities in the former Soviet Union. The WHO-AQG is likely to be exceeded on a few days per year.

Winter smog classification	1990
Exceedance class[4]	*2*
Exposure class[4]	*3*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.13,17	No.13,17	No. 17	No. 17	No. 16	No. 16	No. 12	No. 12
Annual average			25	40	20	40	20	50	20	30
Maximum (24 h)										
Maximum (20 min)			275	345	160	470	140	220	100	210
Number of days exceeding the WHO-AQG			1	0	2	0	0	0	0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Nitrogen dioxide concentrations are likely to exceed the WHO-AQG on a few days per year.

HF µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		18
Annual average		13
98 Percentile (20 min)		55

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		17
Annual average		0.0036
Maximum monthly average		0.0154

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	16	16
Annual average	1	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		13
Annual average		0.03
Maximum monthly average		0.06
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO and Pb concentrations are low and do not exceed WHO-AQG standards.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station. The location of the meteorological station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

City: Porto	*Country*: Portugal

I. GENERAL DATA

		City	Conurbation
Population	(number)		***1 315 000***
Total area	(km^2)		
Built-up area	(km^2)		***100***
Coordinates	(lat-/longitude)	41° 09' N 8° 37' W	

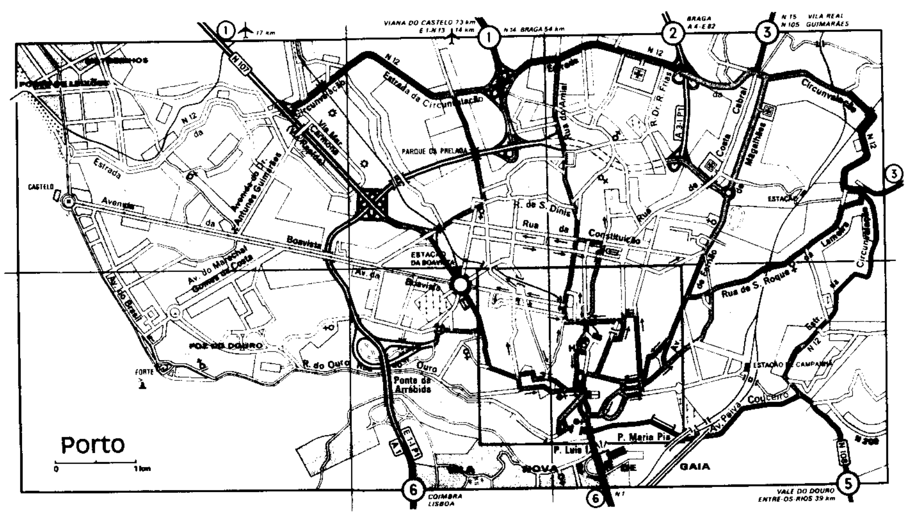
II. TOPOGRAPHY AND CLIMATOLOGY

Region: Southern Europe ***Topography***: coastal, hills ***(0)***	Climate: Csb (Köppen-Geiger) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	14.3	14.4	150
precipitation (mm)	937	1179	1082
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.7 (0)***	***4.0 (+)***	***3.0 (-)***
winter smog index	***1 (++)***	***1 (++)***	***0 (++)***
summer smog index	***14 (0)***	***14 (0)***	***26 (-)***

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***3***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1986	1990	1985	1990
Number of stations										
Annual average		*2*					41			
Winter average							38			
Maximum (24 h)							121			
98 percentile (24 h)							83			
Number of days exceeding the WHO-AQG							0			
Number of days exceeding 2 x WHO-AQG							0			

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1986	19__	1985	1990
Number of stations										
Annual average							23			
Winter average							<u>30</u>			
Maximum (24 h)							80			
98 percentile (24 h)							67			
Number of days exceeding the WHO-AQG							0			
Number of days exceeding 2 x WHO-AQG							0			

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Winter smog classification	1990
Exceedance class	***2***
Exposure class	***4***

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Poznan	*Country*: Poland

I. GENERAL DATA

		City	Conurbation
Population	(number)	***589 000 (1990)***	
Total area	(km^2)		
Built-up area	(km^2)	***125***	
Coordinates	(lat-/longitude)	52° 25' N 16° 53' E	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe *Topography*: plain *(+)*	Climate: Cfb (Köppen-Geiger) Meteorology: -		
Averages	1980-1989	1985	1989
temperature (°C)	8.2	7.2	9.8
precipitation (mm)	241	125	330
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.3 (0)***	***3.3 (0)***	***2.8 (-)***
winter smog index	***19 (0)***	***18 (0)***	***17 (0)***
summer smog index	***13 (0)***	***11 (0)***	***22 (0)***

III. EMISSIONS

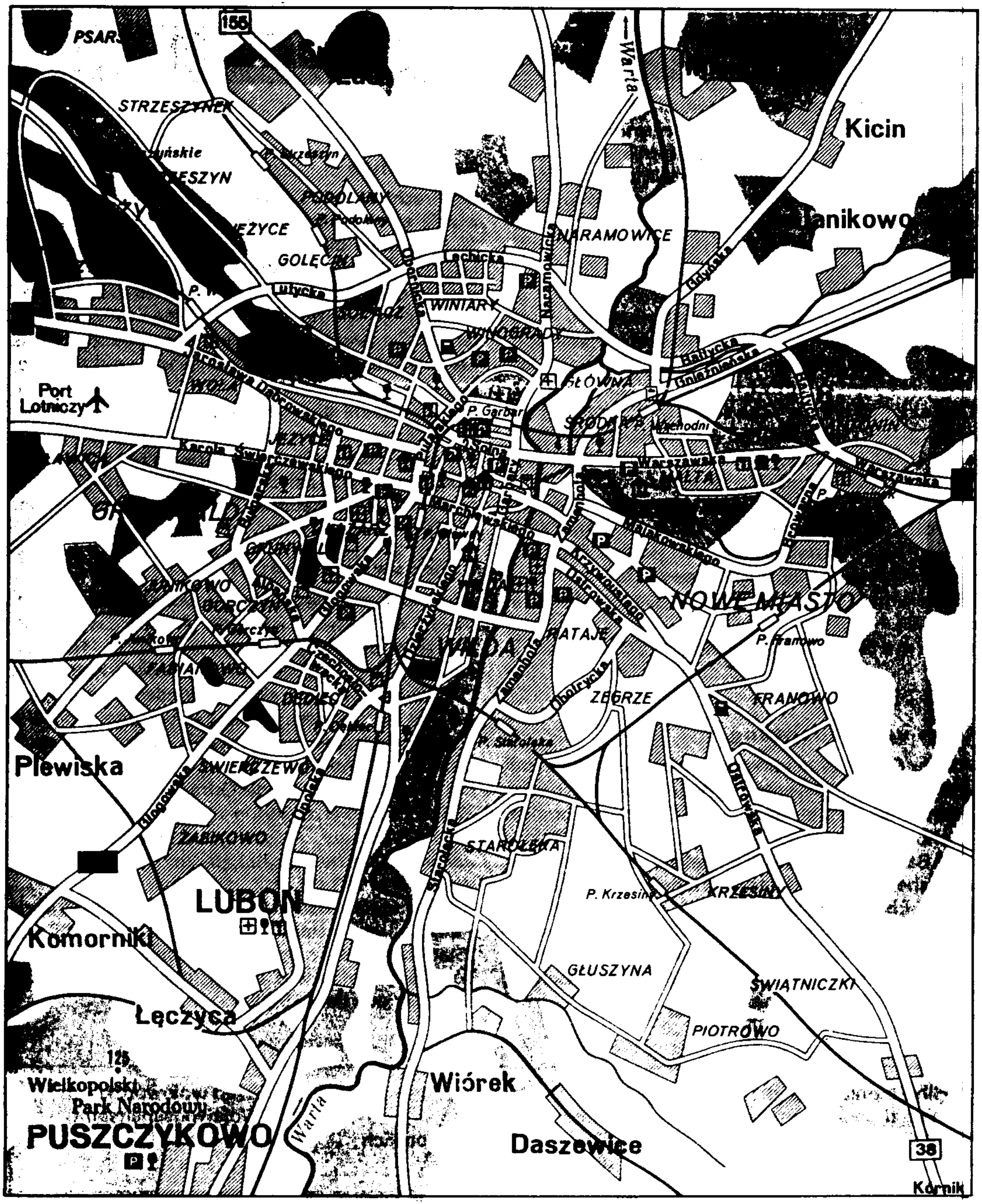
Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions[1]	***2***

VI. AIR QUALITY DATA

Winter smog classification	1990
Exceedance class[1]	***2***
Exposure class[1]	***3***

1. Uncertain data

Main topography, city morphology, industrial sources and monitoring network



City: Prague	*Country*: Czech Republic

I. GENERAL DATA

		City	Conurbation
Population	(number)	***1 216 000 (1992)***	
Total area	(km^2)	495 (1991)	
Built-up area	(km^2)	***210 (1991)***	
Co-ordinates	(lat-/longitude)	50 ° 06 ' N 14 ° 26 ' E	

Major activities and development trends (1980-1990, 1990-2000)
Economic, commercial, political, cultural centre. 10% of industry in CSFR (heavy and light machinery, electronics, food industry, light manufacturing, chemical industry, printing industry).

No big increase of population is expected, only from migration. The population of Prague is stabilised.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe
Topography: Valley of Moldau river and kettle-like depression. Geomorphological conditions with altitude differences about 2 000 m. *(-)*

Climate: Moderate with continental regime (CFB).
Meteorology: Summer maximum and winter minimum precipitation. Wind: west to south-west.

Averages	1980-1989	1985	1989
temperature (°C)	7.8	7	9
precipitation (mm)	416.3	505.8	449.4
cloud cover (8^{-1})			
wind speed (m s^{-1})	***4.1 (+)***	***3.9 (0)***	***3.9 (0)***
winter smog index	***13.4 (0)***	***12.4 (0)***	***14.5 (0)***
summer smog index	***11.9 (0)***	***10.5 (0)***	***12.5 (0)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

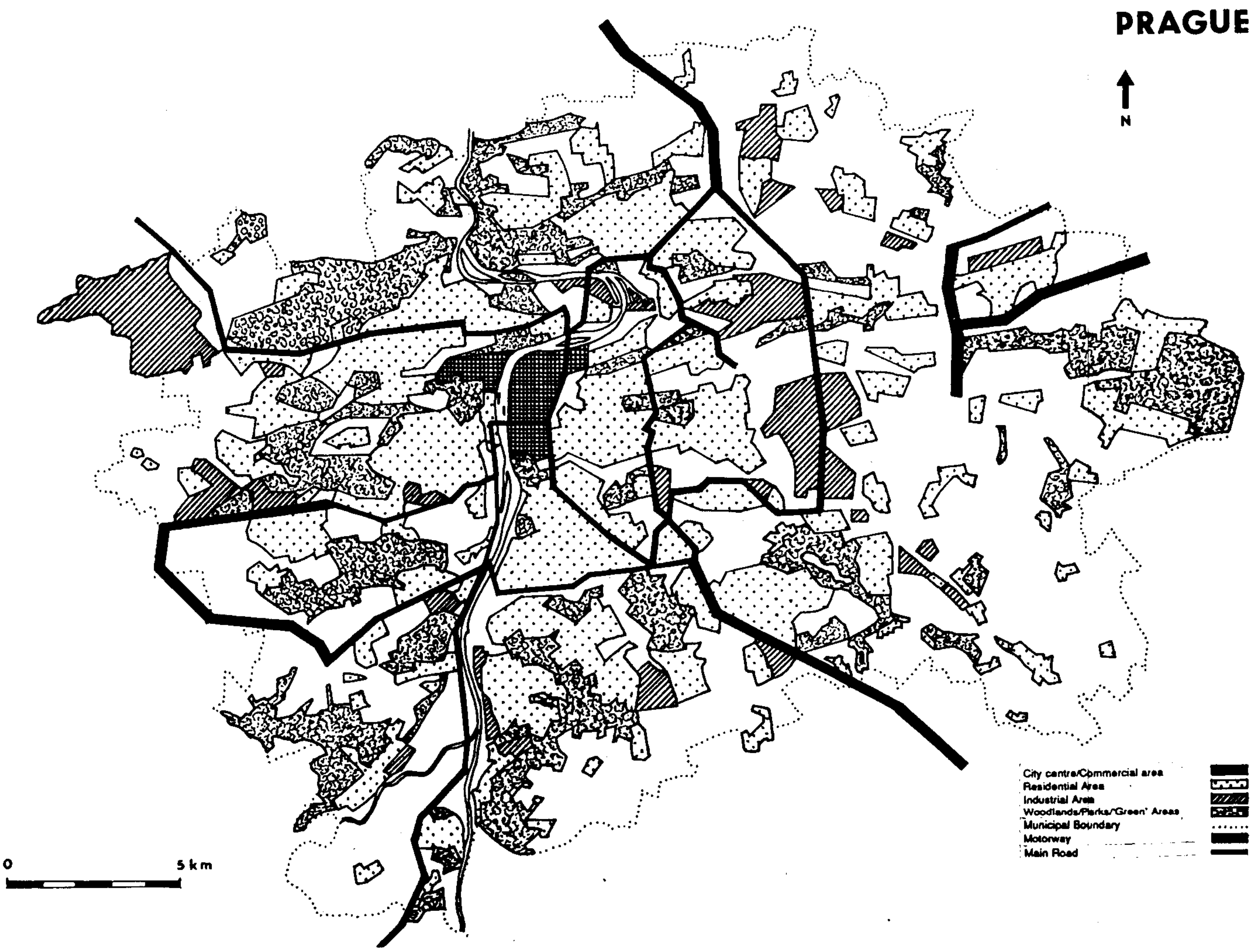
Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	7.3	5.3		7.6	12.0		8.0
1985	Wind speed m s^{-1}	3.9	2.7		3.1	3.4		2.9
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	26.2		17.2	13.2		3.2	
	Wind speed m s^{-1}	5.3		5.6	4 9		<1	

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	6.1	5.5		7.1	9.6		8.3
1990	Wind speed m s^{-1}	3.5	3.3		3.3	3.8		3.9
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	31.2		15.9	13.4		2.8	
	Wind speed m s^{-1}	5.9		6.2	4.9		<1	

City: Prague **Country**: Czech Republic

Main topography, city morphology, industrial sources and monitoring network



City: Prague **Country**: Czech Republic

III. EMISSIONS

Annual emissions per source and totals in 1985 (Kt a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic						
Domestic/space heating	14,9	3.3			15.0	
Industry and power plants	51.2	16.0			10.1	
Total	66.1	19.3			25.1	
Per capita (**kg**)	56	16			21	
Per km^2 (**t**)	132.2	38.6			50.2	

Annual emissions per source and totals in 1990 (Kt a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.4	6.7	11.5	5.5		0.025
Domestic/space heating	21.0	7.3	27.0	6.1	15.1	
Industry and power plants	24.4	8.9	2.5	0.7	5.9	
Total	45.8	22.9	41.0	12.3	21.0	
Per capita (**kg**)	38	19	34	10	17	
Per km^2 (**t**)	91.6	45.8	82.0	24.2	42.0	

Emission class	1990
Winter smog emissions[1]	***3***
Summer smog emissions	***2***

Major (industrial) point sources

(see city map)

The most important emitters in Prague are big heat-power plants and boiler stations producing energy both for space/domestic heating and industry. The share of technological emissions on the total is low in Prague (except some specific pollutants). Total number 221 big emitters above 5MK, 26 stacks >6.

No. (see map)	Source	Stack height (m)	So_2	NO_x	Particulate matter (t per year)
I.	Heat-power plant Malesice	149, 95, 85	8 411	2 626	129
II.	Heat-power plant Michle	150, 120	2 826	612	1 035
III.	Incinerator Vysocany	120, 98	2 643	615	242
IV.	Heat-power plant Treboradice	150	1 172	1 150	102
V.	Heat-power plant Veleslavin	85, 35	1 836	372	1 033
VI.	Heat plant Juliska	53, 38	840	168	<100
VII.	Power plant Holesovice	100, 70	234	201	<100
VIII.	Cement plant Radotin	63	<100	234	379
IX.	Avia car industry	75	440	<100	404
X.	Sugar plant Cakovice	82, 25, 25	314	<100	301

IV. TRAFFIC DATA

Vehicle statistics and traffic activity			**Total annual consumption of fuel for traffic**				
City	Number of vehicles	Total traffic activity veh km a^{-1}		Consumption (t a^{-1})		Average Sulphur content (%)	
				1985	1990	1985	19__
Total	438 624	2.1 x 10^9					
of which:							
· passenger cars	344 544	1.7	Diesel oil				
· buses	3 069	-	Petrol/Gasoline		130000		
· freight traffic >3.5 t	ca. 30 000	0.4	LPG		145000		
					-		

City: Prague **Country**: Czech Republic

Traffic	
Passenger per car in Prague:	3.6 (1990), i.e. 176 cars per 1 000 people.
Average use of car per year:	6 000-8 000 km per year
Average occupation of a passenger car in Prague:	1.66 person per car

Cars are usually very old (about 150 000 cars are older than 10 years), catalytic converters are fitted to only the newest cars.

Total length of streets: 2 570 km.

Traffic is increasing with the economic and social changes.

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption		Average Sulphur content (%)	
		1985	1990	1985	19__
Fuel oil low sulphur	(TJ a^{-1})	20 202	8 646		
Fuel oil high sulphur	(TJ a^{-1})				
Coal + coke	(TJ a^{-1})	36 016	27 230	Coal 2-4 %	
Wood	(TJ a^{-1})				
Natural/city gas	(TJ a^{-1})	28 567	44 011		
Total	(TJ a^{-1})				

Space/domestic heating: general remarks

Heat is produced with a heavy burden of emissions from stationary sources. There are about 5 000 medium and small boiler stations, 3 800 of them using solid fuel. 200 000 local heating systems. The highest density of emitters is in the centre of the city.

Local policies to reduce air pollution

Industry:
See domestic/space heating.

Traffic:
No strict measures introduced yet. New cars should have catalytic converters probably after the end of 1993.

Domestic/space heating:
Nothing important happened in the last 10 years as far as air pollution abatement from these sources is concerned.

VI. AIR QUALITY DATA

Monitoring network

1991 34 stations.
19 by Health Service, 11 by Czech Hydrometeorological Institute and 4 by the Research Institute for Plant Production.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	19__	1985	19__
Number of stations			6	10	6	10				
Annual average		*44*	122	75	189	114				
Winter average			164	98	221	171				
Maximum (24 h)			744	429	935	631				
98 percentile (24 h)										
Number of days exceeding the WHO-AQG 150			60	35	146	76				
Number of days exceeding 2 x WHO-AQG 300			22	6	74	32				

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

City: Prague **Country**: Czech Republic

Particulate matter: TSP ($\mu g\ m^{-3}$)	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	19__	1985	19__
Number of stations			3	4	3	4				
Annual average		*52*	113	84	129	110				
Winter average			132	92	154	121				
Maximum (24 h)			417	356	429	435				
98 percentile (24 h)										
Number of days exceeding the WHO-AQG 150			33	26	44	51				
Number of days exceeding 2 x WHO-AQG 300			7	2	8	4				

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Winter smog classification	1991
Exceedance class	***3***
Exposure class	***4***

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1991	1985	1991	1985	19__	1985	19__
Number of stations			3	7	3	7				
Annual average			66	56	95	106				
Maximum (24 h)			300	327	330	549				
Maximum (1 h)										
Number of days exceeding the WHO-AQG 100			41	31	74	117				
Number of days exceeding 2 x WHO-AQG 200			9	6	19	16				

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		
Annual average		0.390
Maximum monthly average		0.613
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Uncertain data

City: Reykjavik	Country: Iceland

I. GENERAL DATA

		City	Conurbation
Population	(number)	***112 000 (1992)***	150 000 (1992)
Total area	(km^2)	114 (1992)	
Built-up area	(km^2)	***4 (1992)***	
Co-ordinates	(lat-/longitude)	64 ° 08 ' N 21° 55 ' E	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: At the sea in the south western part of Iceland ***Topography***: At sea level, flat to the south, hills to the east and north ***(0)***	Climate: Good dispersion conditions (Cfc). Meteorology: Open land and windy, periods in winter with calm or light winds for days.		
Averages	1980-1989	1985	1989
temperature (°C)	4.1	4.4	3.9
precipitation (mm)	732.3	632.5	1 052.4
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***5.31 (++)***	***5.3 (++)***	***5.7 (++)***
winter smog index	***15.9 (0)***	***16.5 (0)***	***11.7 (0)***
summer smog index	***0.0 (++)***	***0.0 (++)***	***0.0 (++)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	8.0	6.2	14.9	22.7	12.0	7.4	8.0
1985	Wind speed $m\ s^{-1}$	6.0	5.7	5.1	5.3	7.5	6.6	6.8
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	4.5	2.4	4.0	2.9	4.1	1.0	
	Wind speed $m\ s^{-1}$	5.7	4.4	3.9	4.4	4.7		

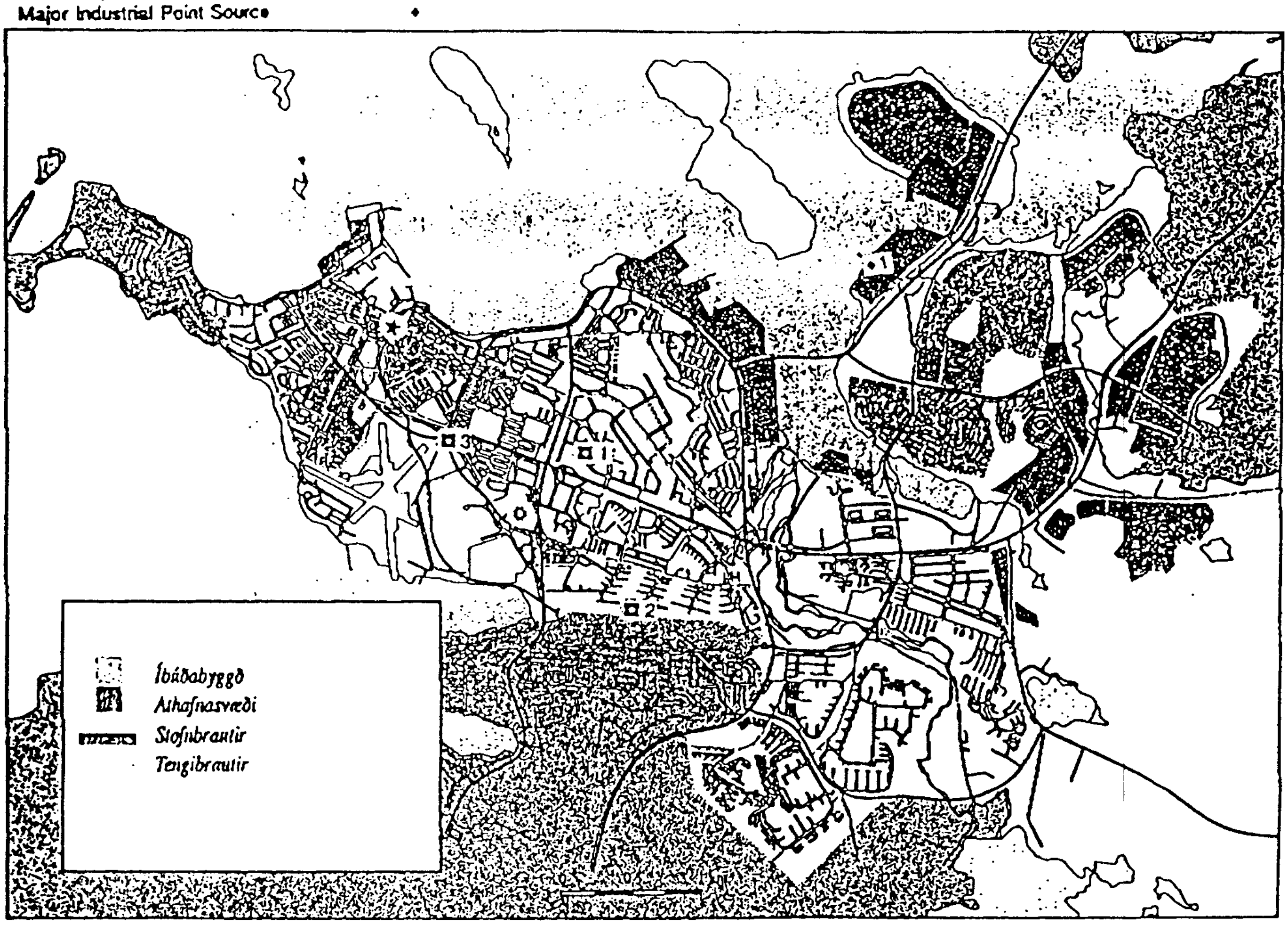
LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	8.9	5.5	11.8	17.7	12.0	8.8	9.7
1990	Wind speed $m\ s^{-1}$	6.5	5.8	5.4	5.3	6.6	6.3	5.5
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	8.1	3.6	3.7	2.8	3.7	0.5	
	Wind speed $m\ s^{-1}$	7.4	6.2	4.7	5.4	5.1		

City: Reykjavik **Country**: Iceland

Main topography, city morphology, industrial sources and monitoring network

City Centre Coordinate ★
Meteorological (Wind) Station ○
Air Quality Monitoring Point ◘
Major Industrial Point Source ♦



City: Reykjavik **Country**: Iceland

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.2	1.3	20	3.3		0.037
Domestic/space heating	~0	~0	~0	~0		
Industry and power plants						
Total						
Per capita (**kg**)	2	13	20	33		0.37
Per km² (**t**)	1.8	11	180	28		0.33

Annual emissions per source and totals in 1990 (kt a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.02	1.5	24	3.8		0.014
Domestic/space heating	~0	~0	~0	~0		
Industry and power plants						
Total						
Per capita (**kg**)	0.2	15	24	38		0.14
Per km² (**t**)	0.18	13	210	33		0.12

Emission class	1990
Winter smog emissions	*1*
Summer smog emissions[1]	*1*

Major (industrial) point sources
(see city map) There are very few air polluting industrial activities. The most important is a fertiliser factory emitting NO_2.The factory is allowed to emit 200 ppm in the exhaust.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles	Total traffic activity veh km a^{-1}	**Total annual consumption of fuel for traffic**	Consumption (t a^{-1}) 1985	Consumption (t a^{-1}) 1990	Average Sulphur content (%) 1985	Average Sulphur content (%) 1990
Total		0.197 x 10^9					
of which:	50 069						
· passenger cars	45 351		Diesel oil	5 900	6 704	0.2	0.18
· buses	4 718		Petrol/Gasoline	62 800	73 300	0.012	0.012
· freight traffic >3.5 t			LPG				

Traffic
The traffic is mostly passenger-car traffic. Little use of buses, bicycles or motorcycles. Traffic jams occur in the city centre and at few junctions during rush hours. Very few cars are equipped with catalytic converters, but from 1.7.1992 all new cars must have such a device.

City: Reykjavik **Country**: Iceland

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption		Average Sulphur content (%)	
		1985	19__	1985	1990
Fuel oil low sulphur	($t\ a^{-1}$)	~118		0.2	0.18
Fuel oil high sulphur	($t\ a^{-1}$)				
Coal	($t\ a^{-1}$)				
Wood	($t\ a^{-1}$)				
Natural/city gas	($10^6\ m^3\ a^{-1}$)				
Total	($t\ a^{-1}$)				

Space/domestic heating: general remarks

Almost entirely geothermal hot water.

Local policies to reduce air pollution

Industry and power plants:
Special operating permits for polluting industry in effect from 1972. For less polluting industries in effect from 1990.

Traffic:
All new imported cars after 1 July 1992 must be equipped with catalytic converters. Lead-free Gasoline imported from 1988/04/13. 80% of Gasoline consumed in 1993 was lead-free.

Domestic/space heating:
No need for measures since main generation source is geothermal hot water.

VI. AIR QUALITY DATA

Monitoring network

Hollustuvernd riksins (HVR) has one station measuring suspended particulates (1986-1991) located at Miklatorg (3). Lead has been analysed every sixth day.
Heibrigôiseftirlit Reykjavikur (HES) has one mobile measuring station NO_1, NO_2, SO_2, CO and suspended particulates.
This station was in 1991 located at three different places (Safamyri (1), Fossvogsdal (2) and Miklatorg (3) and at five places in 1990. The measurements started in June 1990.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1991	1985	1991	1985	1991	1985	1991	1985	19__
Number of stations	1	1		1		1		1		
Annual average	0.2	0.1		3.2		3.2		5.5		
Winter average	0.2	0.1		3.2		3.2		5.5		
Maximum (24 h)	4.0	0.5		16.0		16.0		12.0		
98 percentile (24 h)										
Number of days exceeding the WHO-AQG	0	0		0		0		0		
Number of days exceeding 2 x WHO-AQG	0	0		0		0		0		

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

City: Reykjavik **Country**: Iceland

Particulate matter: Dust ($\mu g\ m^{-3}$)	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1991	1985	1991	1985	1990	1985	19__
Number of stations				1		1		1		
Annual average				18.6		18.6		24		
Winter average				18.7		18.7		30		
Maximum (24 h)				134		134		147		
98 percentile (24 h)								75		
Number of days exceeding the WHO-AQG				1		1		11		
Number of days exceeding 2 x WHO-AQG				0		0		1		

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$
WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$
WHO-AQG PM_{10} (24h max.) = 70 $\mu g\ m^{-3}$

Winter smog classification	1991
Exceedance class	*0.5*
***Exposure class*[1]**	*1*

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1991	1985	1991	1985	1991	1985	19__
Number of stations				2		1		1		
Annual average				15.4		13.9		32		
Maximum (24 h)				54		57		149		
Maximum (1 h)										
Number of days exceeding the WHO-AQG				0		0		0		
Number of days exceeding 2 x WHO-AQG				0		0		0		

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name		HES (3)
Annual average		0.75
Maximum (8 h)		2.7
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1986	1990
Station number/name	HVR (3)	HVR (3)
Annual average	0.46	0.04
Maximum monthly average	0.99	0.09
Number of days exceeding the WHO-AQG	14	0
Number of days exceeding 2 x WHO-AQG	4	0

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Uncertain data

City: Riga	*Country*: Latvia

I. GENERAL DATA

		City	Conurbation
Population	(number)		***897 000 (1992)***
Total area	(km^2)		
Built-up area	(km^2)		***307 (1992)***
Coordinates	(lat-/longitude)	56° 53' N 24° 08' E	

Major activities and development trends (1980-1990, 1990-2000)
Capital of Latvia. Commercial and industrial centre, harbour. 65% of all industry in Latvia is located in the Riga conurbation (metallurgy, shipyards, heavy engineering, chemicals).

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe *Topography*: coastal, plain *(++)*	Climate: Dfb (Köppen-Geiger) Meteorology: frequent inversions		
Averages	1980-1989	1985	1989
temperature (°C)	6.5	5.0	8.3
precipitation (mm)		697	704
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.8 (0)***	***3.7 (0)***	***4.2 (+)***
winter smog index	***21 (-)***	***23 (-)***	***15 (0)***
summer smog index	***5 (+)***	***5 (+)***	***5 (+)***
Station:	Riga 56° 58' N 24° 04' E		

III. EMISSIONS

Annual emissions per source and totals in 1990 (t a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	126	6 641	76 571	12 859	32	
Domestic/space heating + Industry and power plants	6 784	2 422	7 683	4 025	3 485	
Total	6 910	9 063	85 000	16 937	3 517	
Per capita (**kg**)	7.7	10.1	94.8	18.9	3.9	
Per km^2 (**t**)	22.5	29.5	276.9	55.2	11.5	

Emission class	1990
Winter smog emissions	***1***
Summer smog emissions	***2***

Major (industrial) point sources

Local heating plants (1991, t)

Number:	157
Particles:	679
SO_2:	5 810
NO_x:	2 158
CO:	4 494

VI. AIR QUALITY DATA[1]

SO_2 (µg m^{-3})

year	annual average	max. concentration (20-30 min.)	time % exceedance of standards
1986	20	110	0
1990	4	140	0
1991	7		

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Dust (µg m^{-3})

year	annual average	max. concentration (20-30 min.)	time % exceedance of standards
1986	100	2 000	3
1990	100	1 800	3
1991	100		

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1990
Exceedance class[2]	*4*
Exposure class[2]	*4*

NO_2 (µg m^{-3})

year	annual average	max. concentration (20-30 min.)	time % exceedance of standards
1986	40	260	5
1990	60	740	17
1991	70		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

CO (mg m^{-3})

year	annual average	max. concentration (20-30 min.)	time % exceedance of standards
1986	1	15	0.4
1990	1	21	0.3
1991	1		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Air Quality Management in Latvia, 1990, Latvian Republic Environmental protection Committee, Air Protection Department.

2. Uncertain data.

City: Rome	*Country*: Italy

I. GENERAL DATA

		City	Conurbation
Population	(number)	***2 830 000 (1990)***	3 710 000 (1990)
Total area	(km^2)		
Built-up area	(km^2)	***125 (1990)***	
Coordinates	(lat-/longitude)	41° 53 ' N 12°30 ' E	

Major activities and development trends (1980-1990, 1990-2000)
Rome is the capital city of Italy and mainly oriented on (governmental) services and tourism.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: S-Europe (mediterranean)
Topography: plain, river basin ***(0)***

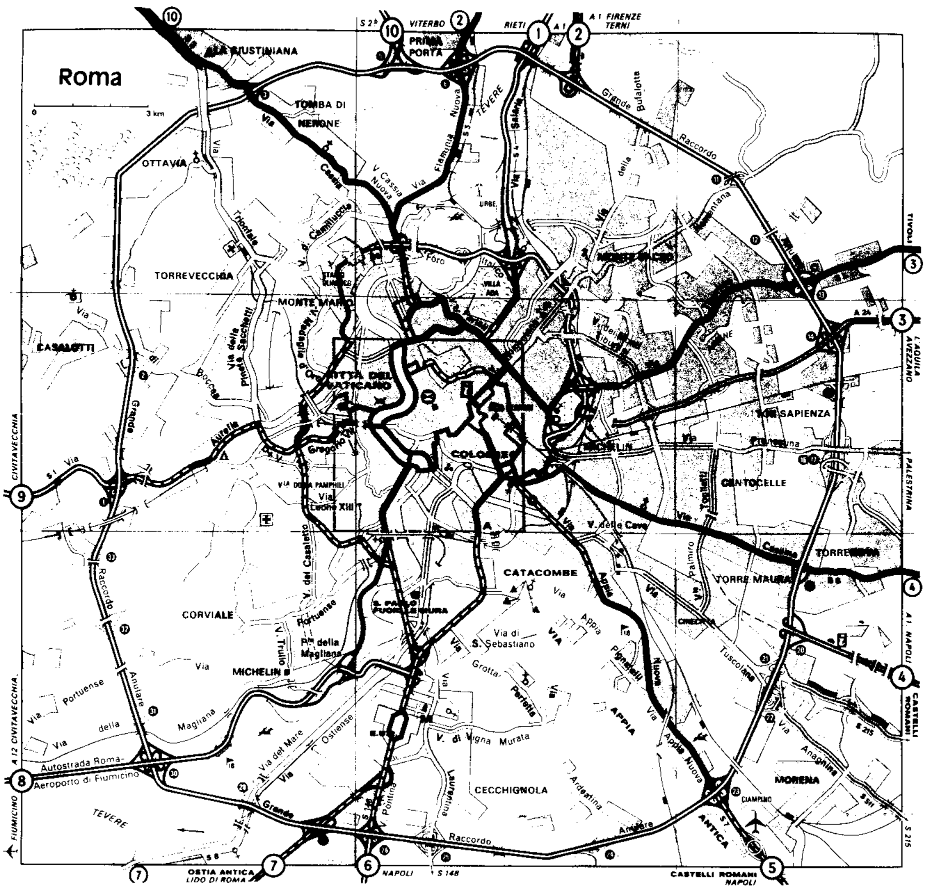
Climate: Csa
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	15.5	15.7	15.0
precipitation (mm)	820	675	1130
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.2 (0)***	***2.9 (-)***	***3.8 (0)***
winter smog index	***5.6 (+)***	***3.3 (++)***	***1.8 (++)***
summer smog index	***52 (-)***	***76 (-)***	***31 (-)***

Temperate rainy (humid mesothermal) climate. This wet-winter, dry-summer climate results from seasonal alternation of conditions. Prolonged hot and sunny summer spells cause favourable meteorological conditions for photochemical smog. Summer drought favours episodes of dust pollution.

Station: Rome (nr 16424), 6 km from city centre — 41° 48 ' N 12° 14 ' E

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***5***
Summer smog emissions[1]	***4***

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1984	1990	1984	1985	1984	1985	1985	19__	1985	19__
Number of stations			1	1	1	1				
Annual average		*5*	65	34	65	34				
Winter average										
Maximum (24 h)			338	260	338	260				
98 percentile (24 h)			130		130					
Number of days exceeding the WHO-AQG			6	3	6	3				
Number of days exceeding 2 x WHO-AQG			1		1					

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1976	1977	1976	1977	1985	19__	1985	19__
Number of stations			1	1	1	1				
Annual average		*10*	151	133	151	133				
Winter average										
Maximum (24 h)			477	620	477	620				
98 percentile (24 h)			327	317	327	317				
Number of days exceeding the WHO-AQG			144	139	144	139				
Number of days exceeding 2 x WHO-AQG			32	18	32	18				

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1977/85
Exceedance class	***3***
Exposure class[1]	***3***

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Rostov on the Don[1]	*Country*: Russian Federation

I. GENERAL DATA

		City		Conurbation
Population	(number)	1 100 000 (1992)		***1 100 000 (1992)***
Total area	(km^2)			
Built-up area	(km^2)	354 (1992)		***354 (1992)***
Coordinates	(lat-/longitude)	47° 15' N 39° 45' E		

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and industrial centre on the river Don, near the sea of Azov. Harbour and traffic junction. Industry: electronics, heavy engineering, food processing. Increasing importance as a commercial centre. During the period 1987-1990 new motorways were built, a forest was planted. In the north-west part of the city a new industrial area was developed, industries from the city centre were relocated to this new area.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Rostov is located on the right bank of the Don River 30 km from the Azov Sea (river basin). *(-)*

Climate: Bsk (Köppen-Geiger)
Meteorology: Wind velocity 0-1 m s^{-1}: 20%, surface inversions 31%.

Averages	1980-1989	1985	1989	1989[3]
temperature (°C)	9.3	7.8	10.4	9.5
precipitation (mm)				558.4
cloud cover (8^{-1})				5.9
wind speed[2] (m s^{-1})	***4.9 (++)***	***5.2 (++)***	***4.8 (+)***	3.1
winter smog index[2]	***13 (0)***	***21 (-)***	***15 (0)***	
summer smog index	***30 (-)***	***22 (0)***	***31 (-)***	

Station: Rostov on the Don 47° 15' N 39° 49' E

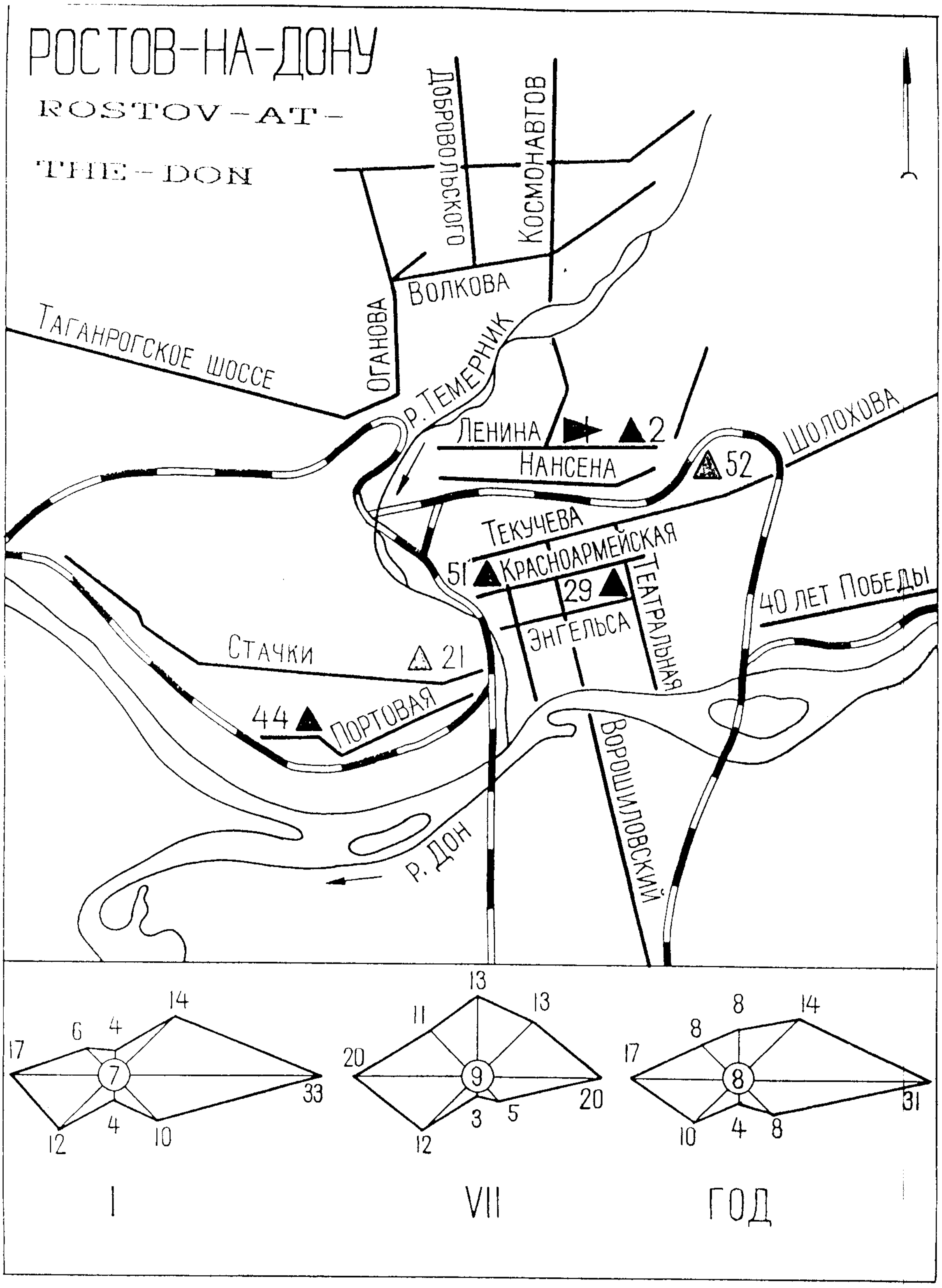
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	1	3	20	14	5	5	5	8	19	9	8	3	10
m s^{-1}	1.9	2.3	3.4	2.8	2.3	2.1	2.1	2.1	2.5	2.6	2.4	2.3	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	3	3	4	6	18	10	3	11	20	13	6	3	43
m s^{-1}	1.7	1.7	2.1	2.7	3.3	2.3	1.7	2.0	2.6	2.0	1.6	1.2	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.1	87.2		-	
Domestic/space heating						
Industry and power plants	14.9	3.8	9.5		6.5	
Total	14.9	8.9	96.7		6.5	
Per capita (**kg**)	14.8	8.9	96.3		6.5	
Per km^2 (**t**)	42.1	25.1	273.2		18.4	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.8	79.4	-	-	
Domestic/space heating						
Industry and power plants	10.9	4.2	10.1	8.6	9.2	0.0044
Total	10.9	9.0	89.5	8.6	9.2	
Per capita (**kg**)	10.4	8.6	85.1	8.2	8.8	
Per km^2 (**t**)	30.8	25.4	252.8	24.3	26.0	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***2***

Major (industrial) point sources

Emissions of heat and power co-generation are responsible for 26% of industrial emissions. Low sources prevail. In addition to emissions given in the Table there are emitted 18 t hydrogen sulphide, 23 t carbon bisulphide and 42 t of hydrogen fluoride.
Emissions are concentrated in the centre and north-western part of the city.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	*90 892*	
of which:		
· passenger cars	*65 446*	*0.13 x 10^9*
· buses	*2 970*	*0.14 x 10^9*
· freight traffic >3.5 t	*15 393*	*0.5 x 10^9*

Traffic

Public transport activity: buses 2.4 x 10^9 passenger km a^{-1}. In 1990, 11% of all private cars was older than 10 years.

Local policies to reduce air pollution
Industry: *Relocation of enterprises to reduce pollution levels.* **Traffic**: *Construction of metro is being planned, Construction of orbital motorway around the city is under construction.* **Domestic/space heating**: *Increase number of central boiler houses.*

VI. AIR QUALITY DATA

Monitoring network
6 Stations are operational (State Service for Observations and Control of Environmental Pollution Levels, North-Caucasian Administration for Hydrometeorology).

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 2,21,44		No. 21		No. 51		No. 29
Annual average		*51*		6		11		23		8
Winter average				6		12		32		6
Maximum (24 h) *calculated*				*74*		*160*		*194*		*83*
98 percentile (20 min)*				34		70		100		40
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0 (*2*)		5(*4*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations are low. Concentrations are relatively high at station 51 due to the emissions from diesel-fuelled cars and the industrial zone nearby. The WHO-AQG is generally not exceeded (except at the traffic site).

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 2,21,44	No. 2,21,44	No. 44	No. 44	No. 51	No. 51	No. 29	No. 29
Annual average		*81*	200	167	300	200	500	600	600	600
Winter average			170	182	200	240	270	498	300	358
Maximum (24 h)										
98 percentile (20 min)			920	650	1370	780	1940	1410	2330	2020
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Reported TSP concentrations are high, peak values extremely high (relatively high natural dust in the atmosphere). Dust concentrations decrease in winter, particularly when the ground is covered with snow. The WHO-AQG is exceeded on numerous days.

Winter smog classification	1990
Exceedance class[5]	**2**
Exposure class[5]	**3**

NO$_2$ concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 2,21,44	No. 2,21,44	No. 44	No. 44	No. 51	No. 51	No. 52	No. 52
Annual average			53	27	60	30	60	70	60	60
Maximum (24 h)										
Maximum (20 min)			423	290	370	350	420	640	590	420
Number of days exceeding the WHO-AQG			1	0.3	1	1	16	10	4	4
Number of days exceeding 2 x WHO-AQG			0.3	0	1	0	0	0	0	1

WHO-AQG NO$_2$ (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high. The WHO-AQG is exceeded, especially at the traffic site.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	51	51
Annual average	7	5
Maximum (8 h)		
Number of days exceeding the WHO-AQG	13	7
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		51
Annual average		0.25
Maximum monthly average		0.51
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO concentrations at the traffic station 51 are more than 5 times as high as in residential districts, and more than 2.5 times as high as at the industrial site. The WHO-AQG is exceeded at traffic sites. Pb concentrations are relatively low.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station. The location of the meteorological station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Rotterdam	*Country*: Netherlands

I. GENERAL DATA

		City		Conurbation
Population	(number)	582 000 (1991)		***1 089 000***
Total area	(km^2)	201		307
Built-up area	(km^2)			***183***
Coordinates	(lat-/longitude)	51° 55' N 4° 29' E		

Major activities and development trends (1980-1990, 1990-2000)

Harbour and port activities, chemical and petrochemical industries.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: western Europe, western part of the Netherlands
Topography: plain, coastal **(++)**

Climate: moderate coastal climate with precipitation during all seasons (Cfb)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.8	8.7	10.9
precipitation (mm)	647	859	667
wind speed ($m\ s^{-1}$)	***4.8 (+)***	***4.7 (+)***	***4.2 (+)***
winter smog index	***7.3 (+)***	***9.3 (0)***	***6.2 (+)***
summer smog index	***4.5 (+)***	***2.9 (+)***	***5.5 (+)***

Station: 6344 51° 57' N 4° 27' E

Main topography, city morphology, industrial sources and monitoring network

Main topography, city morphology, industrial sources and monitoring network

Rotterdam; the morphological town in 89, densities.

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})

Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic		18		11		
Domestic/space heating						
Industry and power plants	91	27		25		
Total	91	45		36		
Per capita (**kg**)	83.6	41.3		33.1		
Per km^2 (**t**)	497.3	245.9		196.7		

Annual emissions per source and totals in 1990 (kt a^{-1})

Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic		18		11		
Domestic/space heating						
Industry and power plants	67	36		21		
Total	67	54		32		
Per capita (**kg**)	61.5	49.6		29.4		
Per km^2 (**t**)	366.1	295.1		174.9		

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***3***

Major (industrial) point sources

Major industries are:
5 oil refineries (in total: 65 x 10^6 t/year)
9 petrochemical industries
19 chemical industries
4 power plants
2 waste incinerator plants (municipal waste: 1.4 x 10^6 t/year, chemical waste: 0.13 x 10^6 t/year)
4 bulk terminals (coal, ore, grain; total: 94 x 10^6 t/year)
19 bulk store terminals (in total: 135 x 10^6 t/year)

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity x 10^9 veh km a^{-1}
Total		
of which:		
· passenger cars	183 000	
· buses		
· freight traffic >3.5 t	22 000	

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

Mainly natural gas is used for space heating.

Local policies to reduce air pollution

Industry:
Emission restrictions.
Stricter emission standards:
- >60% reduction of SO_2 emission in 2000 compared to 1985.
- 40% reduction of NO_2 emission in 2000 compared to 1985.
- 50% reduction of VOC emission in 2000 compared to 1985.

VI. AIR QUALITY DATA

Monitoring network

The common network of municipalities (Dienst Centraal Milieubeheer Rijnmond) had 22 stations in 1990. 9 Stations are situated in the city background, 2 at a traffic site, 9 at an industrial site and 2 in the countryside.
The national monitoring network (RIVM) includes 1 station in the city background and 1 at a traffic site.

SO_2 concentrations	Mean of stations				Highest observed concentrations					
μg m^{-3}	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			10	7						
Annual average		*11*	35.7	16.6	53.7	25.4	46.5	26.8	52.2	36.8
Winter average										
Maximum (24 h)			282.7	93.4	322	136	351	114	432	155
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				0				0		
Number of days exceeding 2 x WHO-AQG				0		0		0		0

WHO-AQG SO_2 (24h max.) = 125 μg m^{-3}

Particulate matter: TSP	Mean of stations				Highest observed concentrations					
μg m^{-3}	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	1990
Number of stations				1		1				1
Annual average		*23*		44.5		44.5				55.8
Winter average										
Maximum (24 h)				137		137				263
98 percentile (24 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG				0		0				

WHO-AQG TSP (24h max.) = 120 μg m^{-3}

Winter smog classification	1990
Exceedance class[1]	*1*
Exposure class	*2*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations		1	2	3			1			
Annual average		32.7	39.5	42.5	43.5	44.7	52.5			
Maximum (24 h)		76	225	122	388	145	128			
Maximum (1 h)		206	437	280	644	441	269			
Number of days exceeding the WHO-AQG		0	≥1	0	≥1	0				
Number of days exceeding 2 x WHO-AQG		0		0	≥1	0				

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations		1	2	3		1	1			
Annual average		42.6	33.1	34.3	36.9	38.1	25.7			
Summer average										
Maximum (1 h)		273	232	288	240	307	149			
Maximum (8 h)										
98 percentile (1 h)		128.3	106.0	116.5	108.0	126.3	91.0			
Number of days exceeding the WHO-AQG							0			
Number of days exceeding 2 x WHO-AQG		0	0	0	0		0			
Exceedance class				***2***						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		433
Annual average		0.74
Maximum (8 h)		8.38
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	2701	1602
Annual average	0.402	0.081
Maximum monthly average	0.608	0.133
Exceeding the WHO-AQG	no	no
Exceeding 2 x WHO-AQG	no	no

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data

City: Samara[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 244 000 (1992)	***1 244 000 (1992)***
Total area	(km^2)		
Built-up area	(km^2)	466 (1992)	***466 (1992)***
Coordinates	(lat-/longitude)	53° 10' N 50° 10' E	

Major activities and development trends (1980-1990, 1990-2000)
Large industrial and cultural centre, river port. Industry: refineries, (petro)chemicals, heavy engineering, airplanes. Hydro-electric plant.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Sited on the left bank of the Volga. The central and most ancient part of the city lies along the Volga and its tributaries Samara and Soka (river basin).*(-)*

Climate: Dfb (Köppen-Geiger)
Meteorology: Surface inversions 38%, air stagnations 17%, wind velocity 0-1 m s^{-1} 20%.

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	4.4	4.8	5.6	5.2
precipitation (mm)				548.9
cloud cover (8^{-1})				6.3
wind speed (m s^{-1})	***3.3 (-)***	***2.6 (-)***	***3.4 (0)***	3.0
winter smog index	***59 (--)***	***60 (--)***	***45 (-)***	
summer smog index	***35 (-)***	***35 (-)***	***36 (-)***	

Station: Samara 53° 15' N 50° 27' E

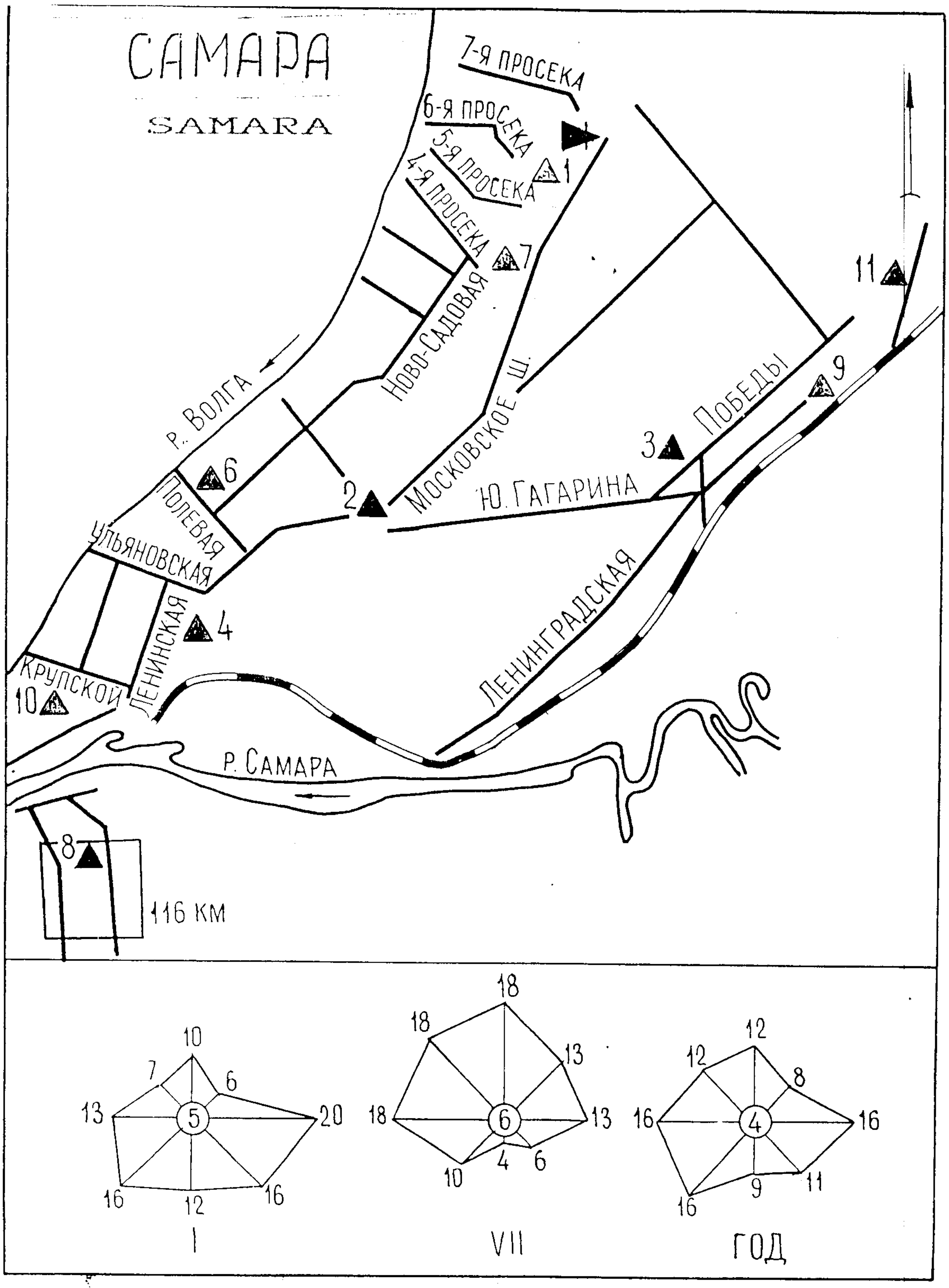
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	7	5	6	9	11	9	7	7	12	8	11	8	7
m s^{-1}	3.1	3.4	3.0	3.7	3.9	4.0	3.8	3.8	3.4	3.0	3.3	3.2	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	7	5	6	9	11	9	7	7	12	8	11	8	7
m s^{-1}	2.6	3.0	3.0	3.3	3.0	3.1	3.4	3.4	3.1	3.0	3.1	3.2	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})						
	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.9	97.0		-	
Domestic/space heating						
Industry and power plants	39.2	17.4	29.7		16.5	
Total	39.2	23.3	126.7		16.5	
Per capita (**kg**)	30.6	18.2	99.0		12.9	
Per km^2 (t)	84.1	50.0	271.9		35.4	

Annual emissions per source and totals in 1990 (kt a^{-1})						
	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.3	89.1	-	-	
Domestic/space heating						
Industry and power plants	31.8	17.4	23.3	35.4	11.3	0.0011
Total	31.8	21.7	112.4	35.4	11.3	
Per capita (**kg**)	25.2	17.2	89.1	28.1	9.0	
Per km^2 (t)	68.2	46.6	241.2	76.0	24.3	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***3***

Major (industrial) point sources
Naphtha-chemical enterprises are responsible for 50% of industrial emissions. Emissions basically come from low sources and are irregular.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity		
	Number of vehicles	Total traffic activity veh km a^{-1} x 10^9
Total		
of which:		
· passenger cars[4]	*2 484*	
· buses	*3 741*	
· freight traffic >3.5 t	*3 719*	

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

City/Conurbation		Annual consumption		Average Sulphur content (t)	
		1985	1990	1985	1990
Fuel oil low sulphur	(t a^{-1})	*240 306*	*34 684*	*2.97*	*2.7*
Fuel oil high sulphur	(t a^{-1})	*227 336*	*8 977*	*3.4*	*3.1*
Coal	(t a^{-1})	*168 835*	*67 432*	*0.46*	*0.5*
Wood	(t a^{-1})				
Natural/city gas	(10^6 m^3 a^{-1})	*1 169 100*	*2 683 823*		
Total	(t a^{-1})				

Local policies to reduce air pollution

Domestic/space heating: Natural gas is used more and more instead of coal and fuel oil.

VI. AIR QUALITY DATA

Monitoring network

10 Stations are operational (State Service for Observations and Control of Environmental Pollution Levels). Observations are made by the Samara Centre for Environmental Monitoring (Volga Region Administration for Hydrometeorology). MGO exercises general scientific and methodical guidance.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.1,2,6	No.1,2,6	No. 6	No. 6	No. 7	No. 7	No. 8	No. 8
Annual average			230	100	300	100	200	300	300	200
Winter average			217	127	220	130	270	230	250	130
Maximum (24 h)										
98 percentile (20 min)			510	390	580	390	470	860	580	470
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations are high. The city's concentration field is inhomogeneous. Concentrations change considerably from year to year. The WHO-AQG is likely to be exceeded on numerous days per year.

Winter smog classification	1990
Exceedance class[4]	*4*
Exposure class[4]	*4*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No.1,2,6	No.1,2,6	No. 2	No. 2	No. 7	No. 7	No. 8	No. 8
Annual average			33	27	30	30	50	50	40	40
Maximum (24 h)										
Maximum (20 min)			363	207	440	280	760	350	200	210
Number of days exceeding the WHO-AQG			1	0.3	1	0	3	1	0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported concentrations are relatively low compared to other cities in the former Soviet Union. The WHO-AQG is exceeded on a few days per year.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	7	7
Annual average	2	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		3
Annual average		0.04
Maximum monthly average		0.09
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO and Pb concentrations are low and do not exceed WHO-AQG standards in Samara.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station, the location of the meteorological station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

***City*:** Saratov[1]	***Country*:** Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	909 000 (1992)	***909 000 (1992)***
Total area	(km^2)		
Built-up area	(km^2)	386 (1991)	***386 (1991)***
Coordinates	(lat-/longitude)	51° 30' N 45° 55' E	

Major activities and development trends (1980-1990, 1990-2000)
Important industrial centre and traffic junction. River port, airport. Industry, among others: refineries, (petro)chemicals, food processing.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography*:** Sited on the right bank of the Volga River (Volgograd Reservoir). (river basin). *(-)*	Climate: Dfb (Köppen-Geiger) Meteorology: Wind velocity 0-1 m s^{-1}: 25%, calms: 9%.

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	5.6	5.4	7.2	6.1
precipitation (mm)				473.7
cloud cover (8^{-1})				6.1
wind speed (m s^{-1})	***4.7 (+)***	***4.7 (+)***	***4.5 (+)***	3.0
winter smog index	***21 (-)***	***19 (0)***	***22 (-)***	
summer smog index	***18 (0)***	***12 (0)***	***15 (0)***	
Station:				Saratov 51° 34' N 46° 02' E

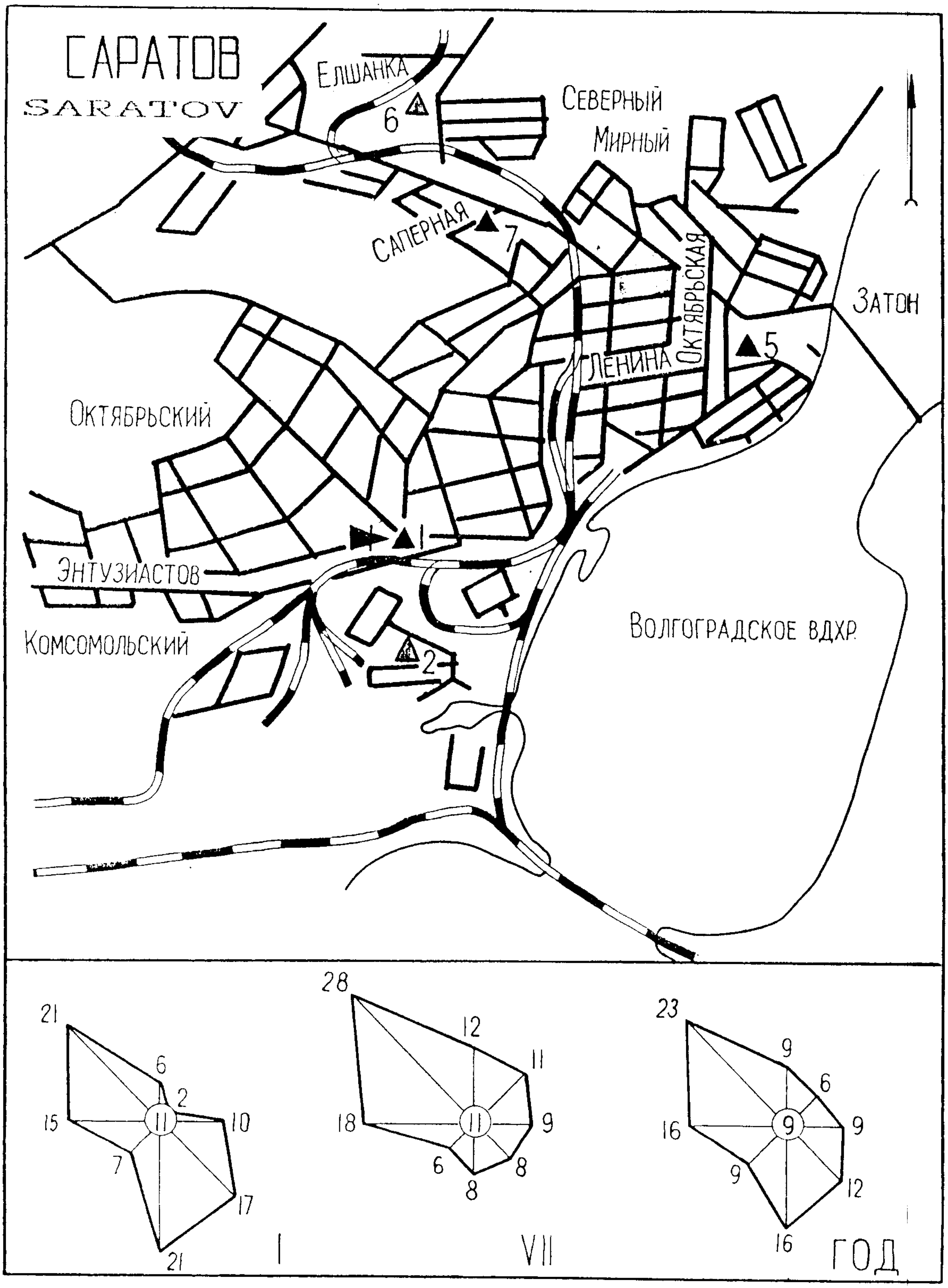
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	1	5	7	5	8	18	1	3	6	10	22	14	7
m s^{-1}	3.3	2.7	2.8	2.6	3.0	3.2	2.5	2.8	3.2	3.8	4.0	3.8	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	3	4	5	4	6	9	8	6	9	13	21	12	6
m s^{-1}	2.9	2.4	2.2	2.0	2.6	2.7	2.6	3.2	3.3	3.5	4.4	4.2	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	7.8	37.7			
Domestic/space heating						
Industry and power plants	19.9	12.3	18.4		5.0	
Total	19.9	20.1	56.1		5.0	
Per capita (**kg**)	21.7	21.9	61.1		5.5	
Per km^2 (**t**)	51.6	52.1	145.3		13.0	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	6.3	32.9	-		
Domestic/space heating						
Industry and power plants	16.0	12.9	11.8	49.7	7.3	0.023
Total	16.0	19.2	44.7	49.7	7.3	
Per capita (**kg**)	17.5	21.0	48.9	54.4	8.0	
Per km^2 (**t**)	41.5	49.7	115.8	128.8	18.9	

Emission class	1990
Winter smog emissions	*2*
Summer smog emissions	*3*

Major (industrial) point sources

Industrial enterprises are concentrated in the south and north-west districts of the city. Emissions basically come from low sources. Besides the emissions given in the Table, 566 t ammonia, 267 t benzol, and 63 t carbon bisulphide among others are also emitted.

IV. TRAFFIC DATA

Traffic

Traffic is responsible for 32% of total emissions.

Local policies to reduce air pollution

Industry: Development of industrial zones in the north-west and south parts of the city, relocation of existing enterprises from the central part of the city.

VI. AIR QUALITY DATA

Monitoring network

5 stations are operational (State Service for Observations and Control of Environmental Pollution Levels). Observations are made by the Samara Hydrometeorological Observatory. General guidance is provided by the Samara Centre for Observations of the Natural Environment, Volga Regional Administration for Hydrometeorology.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1, 7	No. 1, 7	No. 1	No. 1	No. 5	No. 5	No. 2	No. 2
Annual average		*13*	400	100	400	100	200	100	400	100
Winter average			350	190	350	230	220	120	350	220
Maximum (24 h)										
98 percentile (20 min)			1880	730	2220	760	1300	700	2040	700
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Although dust emissions show a slight upward trend, TSP concentrations have dropped dramatically. However, concentrations remain high and the WHO-AQG is likely to be exceeded.

Winter smog classification	1990
Exceedance class[4]	***2***
Exposure class[4]	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1, 7	No. 1, 7	No. 7	No. 7	No. 5	No. 5	No. 2	No. 2
Annual average			35	55	30	70	60	110	40	50
Maximum (24 h)										
Maximum (20 min)			680	730	750	400	530	580	740	410
Number of days exceeding the WHO-AQG			1	6	0	7	14	62	3	3
Number of days exceeding 2 x WHO-AQG			1	0	0	0	0	8	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations

Reported nitrogen dioxide concentrations are high and show an upward trend. Highest concentrations are observed at the traffic site. The WHO-AQG is exceeded on a few days per year in background areas and up to 60 days per year at the traffic site.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	6	6
Annual average	10	7
98 Percentile (20 min)	53	37

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		1
Annual average		0.0028
Maximum monthly average		0.0064

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	5	5
Annual average	1	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		1
Annual average		0.14
Maximum monthly average		0.28
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Reported CO and Pb concentrations are low and the WHO-AQGs are not likely to be exceeded.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station. The location of the meteorological station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

City: Setubal	***Country***: Portugal

I. GENERAL DATA

		City	Conurbation
Population	(number)	799 000	
Total area	(km^2)		
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	38° 31' N 8° 54' W	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Southern Europe ***Topography***: coastal ***(++)***	Climate: Csa (Köppen-Geiger) Meteorology:

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

VI. AIR QUALITY DATA

Winter smog classification	1990
Exceedance class	***1***
Exposure class[1]	***1***

1. Uncertain data.

***City*: Sevilla** | ***Country*: Spain**

I. GENERAL DATA

	City	Conurbation
Population (number)	720 000 (1990)	***780 000 (1990)***
Total area (km^2)	143 (1990)	***210 (1990)***
Built-up area (km^2)		
Co-ordinates (lat-/longitude)	37 ° 23' N 5° 59' E	

Major activities and development trends (1980-1990, 1990-2000)
Commercial, administration, agriculture and tourism.

Constituent municipalities: Sevilla, San Juan de Aznalfarache, Mairena del Alcor, Castilleja de la Cuesta, Camas.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: South Western Europe. 80 km distance from the sea.
Topography: Plain. Very little affected by the sea winds *(-)*.

Climate: (Csa)
Meteorology: Little precipitation, weak winds, calm.

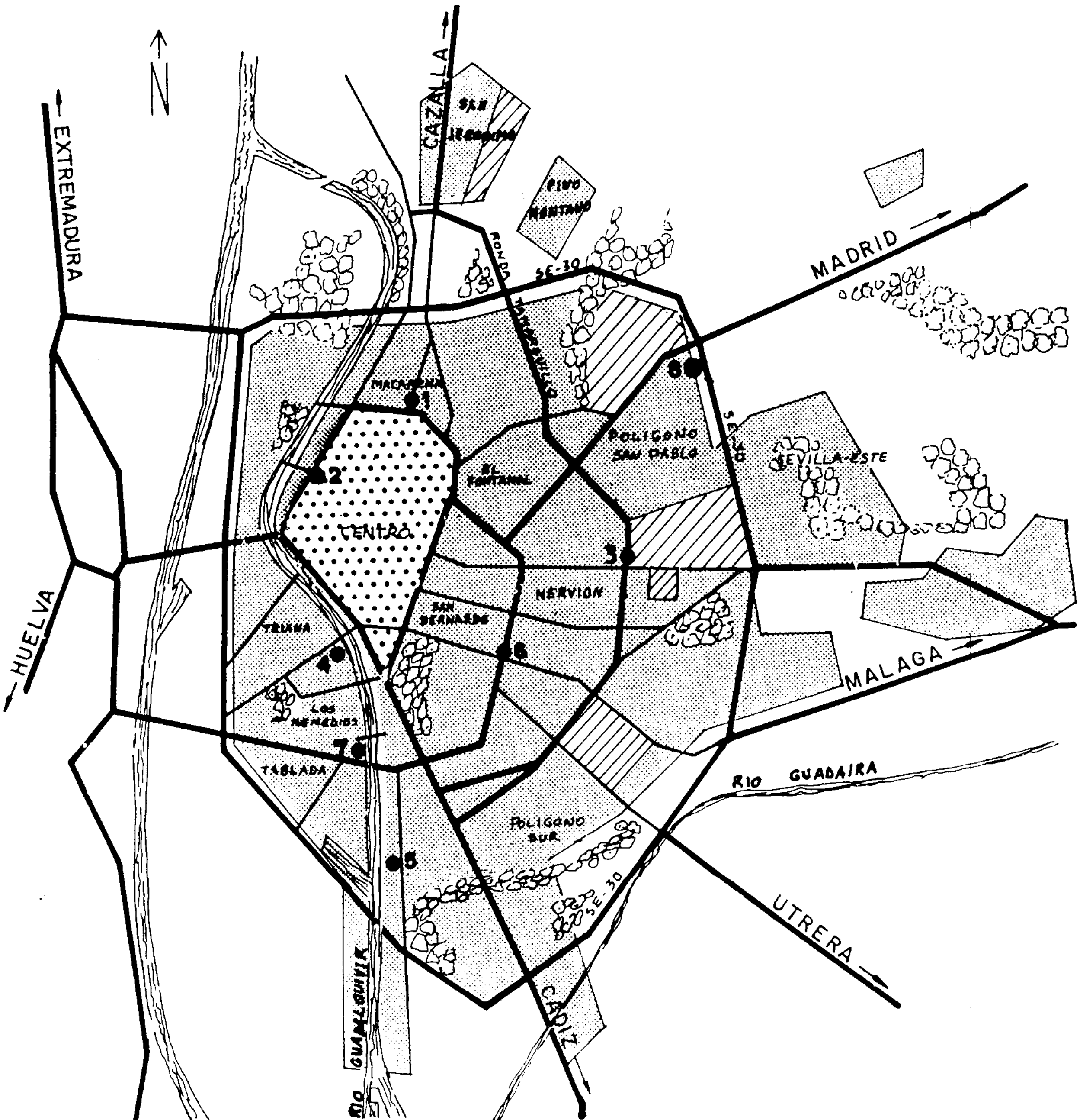
Averages	1980-1989	1985	1989
temperature (°C)	18.2	18.5	19.1
precipitation (mm)	540.3	599.3	888.3
cloud cover (8^{-1})			
wind speed (m s^{-1})	***2.61 (-)***	***2.9 (-)***	***2.5 (-)***
winter smog index	***3.0 (++)***	***1.8 (++)***	***0.0 (++)***
summer smog index	***93.1 (--)***	***104.8 (--)***	***108.4 (--)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	0.20	0.30	6.30	10.40	11.80	12.70	14.50
1990	Wind speed m s^{-1}	0.54	0.70	1.22	1.32	1.06	1.18	1.29
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	28.00	4.00	0.90	0.10	0.00	10.70	
	Wind speed m s^{-1}	1.60	1.78	1.73	0.60	--	<0.50	

City: Sevilla **Country**: Spain

Main topography, city morphology, industrial sources and monitoring network



City: Sevilla **Country**: Spain

Major (industrial) point sources
(see city map) Fertilising industries Naval activities Services industries Commercial city Aircraft industry

Local policies to reduce air pollution
Industry: The only energy generating station in the region is a hydroelectric station by the river Guaralqvivir, in a place called Alcalá del Rio, 15 km from Sevilla. **Traffic:** Infrastructure works have been done for the last years so that highways and bypasses have been made. The city centre does not suffer now from so much traffic, that is why the atmospheric quality has been improved. **Domestic/space heating**: Because of the climate there are very few heating systems using gas oil, coal or wood. Besides, for a better atmospheric quality, lots of generators are using natural gas. In order to get hot water for hospital uses, the energy source is natural gas, butane, propane or electricity.

VI. AIR QUALITY DATA

Monitoring network
The atmospheric surveillance network has 7 measuring stations for atmospheric quality and 1 for hydrological control. 1, 2, 5, 8 belong to the city of Sevilla; 3, 4 belong to the environment agency of Junta de Andalucia; 6 belong to the health services of Andalucia and 7 is for hydrological control and belongs to the city of Sevilla. Every day information about the environmental state of the day before is released to the media and an estimation for the current day.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	19__	1985	19__	1985	1992	1985	19__
Number of stations								2		
Annual average		*11*						9.0		
Winter average								9.8		
Maximum (24 h)								42.0		
98 percentile (24 h)								28		
Number of days exceeding the WHO-AQG								0		
Number of days exceeding 2 x WHO-AQG								0		

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

City: Sevilla **Country**: Spain

Particulate matter: TSP µg m⁻³	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	19__	1985	19__	1985	1992	1985	19__
Number of stations								2		
Annual average		1						66		
Winter average								69		
Maximum (24 h)								151		
98 percentile (24 h)								125		
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1992
Exceedance class	*0,5*
Exposure class[1]	*1*

NO_2 concentrations µg m⁻³	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	19__	1985	19__	1985	1992	1985	19__
Number of stations								2		
Annual average								52		
Maximum (24 h)								185.9		
Maximum (1 h)								430.0		
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

CO concentrations mg m⁻³	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		
Annual average		4.6
Maximum (8 h)		14.2
Number of days exceeding the WHO-AQG		3.0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data

City: Sheffield | **Country**: United Kingdom

I. GENERAL DATA

		City	Conurbation
Population	(number)	***528 000 (1986)***	
Total area	(km^2)		
Built-up area	(km^2)		***100***
Co-ordinates	(lat-/longitude)	53 ° 5 ' N 1 ° 5 ' W	

Major activities and development trends (1980-1990, 1990-2000)
Heavy industry, commerce.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Western Europe, Central UK, at a distance of 105 km from the North Sea.
Topography (siting):
Flanked by the Pennine Hills to the south west, to the north west. City is sited on the confluence of several small rivers *(-)*.

Climate: (Cfb)
Meteorology: Precipitation throughout the year. Prevailing wind is from south to west.

Averages	1980-1989	1985	1989
temperature (°C)	9.3	8.7	10.4
precipitation (mm)	503.3	516.1	766.2
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***4.1 (+)***	***3.8 (0)***	***4.1 (+)***
winter smog index	***9.3 (0)***	***11.8 (0)***	***8.3 (+)***
summer smog index	***3.1 (+)***	***0.2 (++)***	***7.3 (0)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

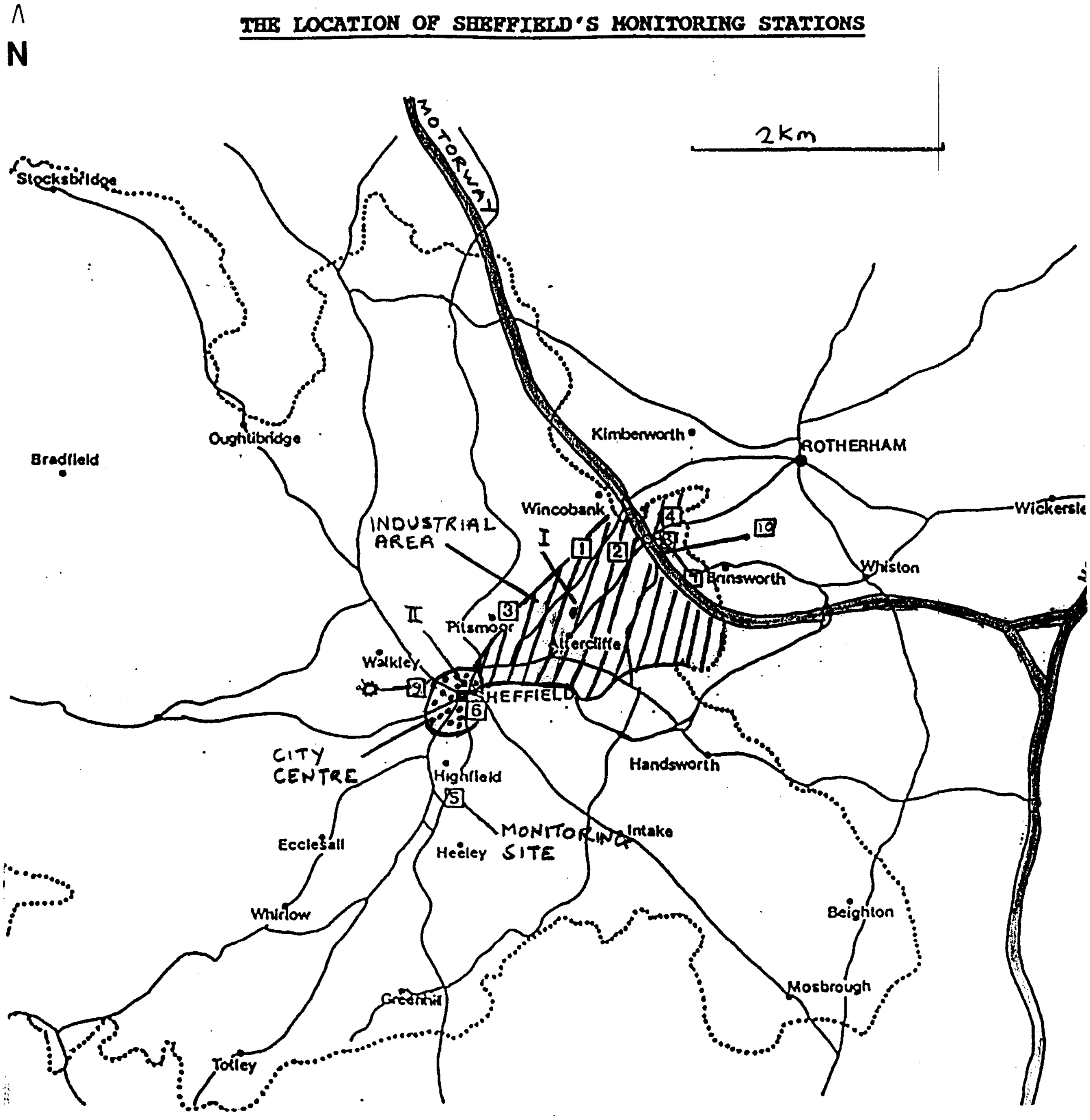
Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	4.11	3.78	3.24	4.13	4.60	9.04	12.4
1986	Wind speed $m\ s^{-1}$	4.1	3.9	3.4	3.08	2.8	3.1	3.8
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	13.09	10.89	15.16	10.63	7.94	0.95	
	Wind speed $m\ s^{-1}$	4.7	4.7	5.1	4.4	4.3		

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	0.1	7.3	8.5	2.5	2.0	6.5	7.9
1990	Wind speed $m\ s^{-1}$	0.7	2.6	2.8	2.9	1.8	1.9	2.7
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	9.2	17.9	6.9	11.2	19.5	0.5	
	Wind speed $m\ s^{-1}$	3.2	3.5	3.6	3.6	2.9		

City: Sheffield **Country**: United Kingdom

Main topography, city morphology, industrial sources and monitoring network



Scale 1 : ____________

City centre/Commercial area		City Centre Coordinate	★
Residential Area		Meteorological (Wind) Station	
Industrial Area		Air Quality Monitoring Point	
Woodlands/Parks/'Green' Areas		Major Industrial Point Source	
Water		Municipal Boundary	
Main Road		Motorway	

City: Sheffield **Country**: United Kingdom

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	*3*
Summer smog emissions[1]	*2*

Major (industrial) point sources

(see city map)
Iron and steel are major industries. Most of these producers are small scale with only a few large steel producers remaining. Almost all are situated to the north east of the city.

1 = 40 MW steam & boiler (coal fired) 30 m stack
11 = 49 MW refuse incinerator 75 m stack combined heat & power scheme.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity		1990
Conurbation	Number of vehicles	Total traffic activity veh km a^{-1}
Total of which: · passenger cars · buses · freight traffic >3.5 t	 327 368 250 452 13 253 57 474	x 10^9

Traffic

Road traffic entering city centre on weekdays (07.00-19.00 h):
1980: 278 644
1990: 327 368

New city centre road layout. Light rail transit system currently under construction.

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

The most commonly used fuel is natural gas. In the city centre some large establishments use heat from the CHP incinerator. Around 25 % of fuel used for domestic heating is solid smokeless fuel or coal. Sheffield is now all classed as a smoke control area.

Local policies to reduce air pollution

Industry:
No local schemes but active implementation of new national programme of air pollution control. Active promotion of CHP from municipal waste incineration. Consideration of local CHP scheme extension plus utilisation of landfill gas.

Traffic:
Local road policies to restrict through traffic from entering the city centre.
Pilot projects on bus priority schemes. Light rail transit lines under construction.

Domestic/space heating:
None specifically although local planning and development control policies favour non-/low-polluting systems.

City: Sheffield **Country**: United Kingdom

VI. AIR QUALITY DATA

Monitoring network
The local authority has responsibility for the monitoring sites. There are 3 sites with automatic monitors and 7 other monitoring sites. The UK government operates one site monitoring for breaches of EC NO_2 levels (No. 10 on map). The 3 automatic sites are used to inform the public of air pollution levels. The air alert scheme uses world health organisation figures to assess the risk to health.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	1991	1986	19__
Number of stations			1	1	1	1	1	1	1	1
Annual average		*41*	50	39	50	39	37	45	57	45
Winter average			49	28	49	28	35	54	58	37
Maximum (24 h)			158	76	158	76	113	282	157	85
98 percentile (24 h)			124	103	124	103	95	193	135	142
Number of days exceeding the WHO-AQG			4	0	4	0	0	0	9	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: $\mu g\ m^{-3}$Black smoke/TSP	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site TSP		Industrial site BS	
	1985	1991	1986	1991	1986	1991	1985	1992	1986	1991
Number of stations			1	1	1	1			1	1
Annual average		*14*	20	16	20	16		35	16	5.5
Winter average			25	11	25	11		38	19	4.5
Maximum (24 h)			165	33	165	33		174	96	25.6
98 percentile (24 h)			72	29	72	29		95	55	21
Number of days exceeding the WHO-AQG			0	0	0	0		2	0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0		0	0	0

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$
WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Winter smog classification	1992
Exceedance class	***1***
Exposure class[1]	***3***

City: Sheffield **Country**: United Kingdom

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	19__	1985	19__	1985	1991	1985	19__
Number of stations								3		
Annual average								67		
Maximum (24 h)								219		
Maximum (1 h)								364		
Number of days exceeding the WHO-AQG								4		
Number of days exceeding 2 x WHO-AQG								0		

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

O_3 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1992	1985	1992	1985	1992	1985	19__
Number of stations				1		1		1		
Annual average				41		41		42		
Summer average										
Maximum (1 h)				208		208		121		
Maximum (8 h)										
98 percentile (1 h)				101		101		82		
Number of days exceeding the WHO-AQG				0		0		0		
Number of days exceeding 2 x WHO-AQG				0		0				
Exceedance class				2						

WHO-AQG Ozone (1h max.) = 150 $\mu g\ m^{-3}$

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		
Annual average		0.9
Maximum (8 h)		9
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		
Annual average	1.09	0.18
Maximum monthly average	1.57	0.28
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Uncertain data

City: Sofia	*Country*: Bulgaria

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 127 000 (1986)	***1 300 000 (1990)***
Total area	(km^2)		***1 310 (1990)***
Built-up area	(km^2)	200 (1990)	
Co-ordinates	(lat-/longitude)	42° 42' N 24° 32' E	

Major activities and development trends (1980-1990, 1990-2000)
Municipalities in conurbation: Okuriste, Vazrajdane, Sredetz, Serdika, Triaditza, Lozenetz, Caervena, Svezda, Slatina, Poduene, Iskar, Vitosha, Nadejda, Studentska, Vraknitza, Krasna poliana, Krasmo selo, Mladost, Ovtcka kupel, Liulin, Kremikovtzi, Bankia.

Major activities:
An important commercial administrative and industrial centre. In Sofia are concentrated 74% of the ferrous metallurgy. 47% of the polygraphy, 17% of the electronics and electrical industries, machinery constructions and building materials manufacturing are also developed.
On the territory of Sofia are situated two powerful thermal stations and three heating stations.
A slight growth in Sofia is expected up to the year 2000.

II. TOPOGRAPHY AND CLIMATOLOGY

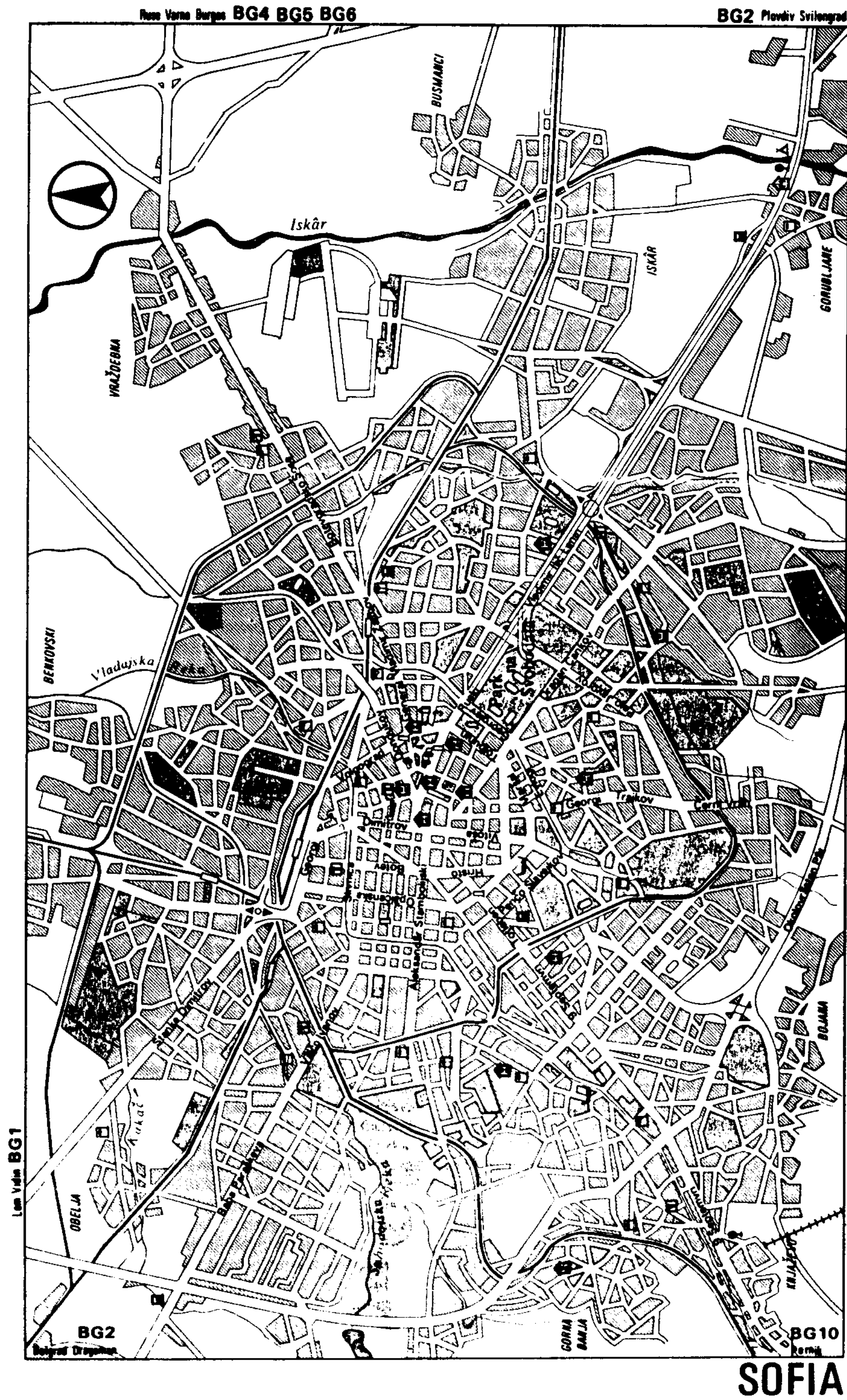
Region:	East Europe, on the Balkan peninsula.	Climate:	Temperate sea - temperate continental (Cfb)
Topography:	In the middle of Sofia valley. North: Stara Planina. South: Liulin, Vitosha, Lodevska mountains. 545-625 m above sea level ***(--)***.	Meteorology:	Rainfall during whole year. Average temp. (1990) = 10.9 °C.

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	1.0	0	0.1	11.2	0	0.2	0.4
	Wind speed $m\ s^{-1}$							
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	0	0	11.1	0.1	0	68.0	
	Wind speed $m\ s^{-1}$							

City: Sofia **Country**: Bulgaria

Main topography, city morphology, industrial sources and monitoring network



City: Sofia **Country**: Bulgaria

III. EMISSIONS

Annual emissions per source and totals in 1990 (Kt a^{-1})

Conurbation	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.004	0.014	0.83	0.023		
Domestic/space heating	10.10	0.36	10.68	17.96		
Industry and power plants	114.31	14.37	175.04	38.18		
Total	124.41	14.74	186.55	56.16		
Per capita (**kg**)						
Per km^2 (**kg**)						

Emission class	1990
Winter smog emissions	***5***
Summer smog emissions	***3***

Major (industrial) point sources

(see city map)

In the town area of Sofia are situated 2 thermal stations and 3 heating stations distributed evenly.
To the north-east (in the suburb): A big metallurgic plant
To the north-west of the city centre: A big pharmaceutical plant

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption		Average Sulphur content (%)	
		1985	1990	1985	1990
Fuel oil low sulphur	(t a^{-1})		53 682		0.9
Fuel oil high sulphur	(t a^{-1})		-		-
Coal	(t a^{-1})		170 286		2.3
Wood	(t a^{-1})		17 891		
Natural/city gas	(10^6 m^3 a^{-1})		10 530		
Total	(t a^{-1})				

Space/domestic heating: general remarks

Most of the houses in the town area of Sofia are heated from district heating centres. The rest of the houses in the town area and the houses in suburbs use coal, oil and wood for heating. Few of the houses use gas for heating.

Local policies to reduce air pollution

Industry and power plants:
The power plants change over from liquid and solid fuels to gas. Installation of equipment for purification.

Traffic:
Underground is under construction. Substitution of the pavement in order to reduce emissions. Enlargement of the electric transport network.

Domestic/space heating:
No measures taken.

City: Sofia **Country**: Bulgaria

VI. AIR QUALITY DATA

Monitoring network

There is in Sofia monitoring network for emission control with 18 points at present (January 1993) including 2 automatic stations (since 1993). Automatic stations measure the concentration of SO_2, O_3, NO, NO_2, H_2S, dust and meteorological data. Concentrations of SO_2, NO_2 and dust are measured by all other points and 14 of them measure also phenols, H_2S and lead (Pb). The information transmits to central control point. The whole network is subordinated to LIC to the Ministry of Environment.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations								3		
Annual average		*10*				56	25	30	6	31
Winter average									2	
Maximum (24 h)						240	20	400	25	400
98 percentile (24 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: Dust $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations										
Annual average		*19*				206	205	175	278	129
Winter average						288	190	178	290	123
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$
WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$
WHO-AQG PM_{10} (24h max.) = 70 $\mu g\ m^{-3}$

Winter smog classification	1992
Exceedance class[1]	*3*
Exposure class	*3*

City: Sofia **Country**: Bulgaria

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations										
Annual average						41	13	71		47
Maximum (24 h)							48			
Maximum (1 h)						261	75	333		371
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name	1	1
Annual average	2.5	0.4
Maximum monthly average	7	
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Uncertain data

City: St.Petersburg[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	4 948 000 (1987)	***4 948 000 (1987)***
Total area	(km^2)	627 (1991)	***627 (1991)***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	59° 55' N 30° 25' E	

Major activities and development trends (1980-1990, 1990-2000)
Second city of the Russian Federation. Important cultural and scientific centre. Russia's most important sea port to the Baltic Sea, international airport. Varied industry, among others: ship building, metallurgy, heavy engineering, building materials, chemicals.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Along the Neva River (mouth) which flows into the Finnish Bay (Baltic) (coastal). *(++)*

Climate: Dfb (Köppen-Geiger).
Meteorology: Surface inversions: 36%. Air stagnations: 8%

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	5.4	3.7	7.6	5.9
precipitation (mm)			624.0	679.1
cloud cover (8^{-1})				7.4
wind speed ($m\ s^{-1}$)	***2.6 (-)***	***2.2 (-)***	***2.2 (-)***	2.6
winter smog index[2]	***33 (-)***	***44 (-)***	***27 (-)***	
summer smog index	***7 (0)***	***33 (+)***	***10 (0)***	

Station: St. Petersburg 59° 58' N 30° 18' E

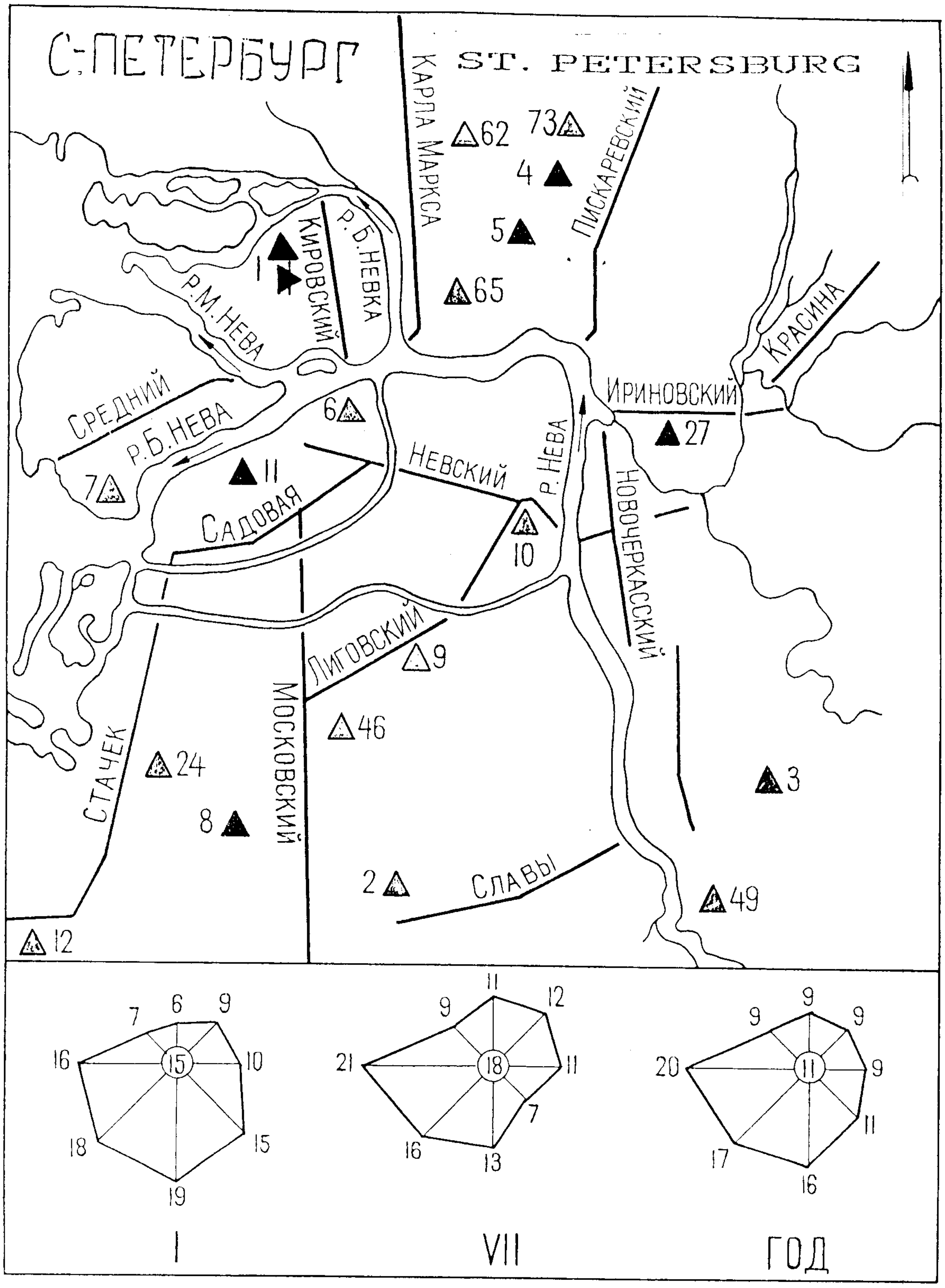
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	10	8	6	6	9	8	11	12	11	8	7	6
$m\ s^{-1}$	2.2	2.2	2.0	1.8	2.3	2.6	3.2	2.8	2.5	2.5	2.0	2.2	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	8	8	6	5	5	6	8	11	14	16	7	6	9
$m\ s^{-1}$	2.1	2.2	1.9	1.7	2.3	2.3	2.7	3.0	2.8	2.4	2.0	1.9	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	21.1	290.9		-	
Domestic/space heating						
Industry and power plants	73.6	46.7	41.2		46.1	
Total	73.6	67.8	332.1		46.1	
Per capita (**kg**)	14.9	13.7	67.1		9.3	
Per km² (**t**)	117.4	108.1	529.7		73.5	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	15.7	194.4	-	-	
Domestic/space heating						
Industry and power plants	62.7	41.8	29.7	5.6	34.6	0.0132
Total	62.7	57.5	224.1	5.6	34.6	
Per capita (**kg**)	12.7	11.6	45.3	1.1	7.0	
Per km² (**t**)	100.0	91.7	357.4	8.9	55.2	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***2***

Major (industrial) point sources

The prevailing heights of stacks are less than 50 m. Emissions from heat and power co-generation with high stacks make up 30% of industrial emissions. Industrial enterprises release in addition to those given in the Table many specific pollutants (phenol, ammonia, nitrogen chloride, benzo(a)pyrene). 26% of the gas-purification works in St.Petersburg work ineffectively or not at all, thus contributing to emissions. Industrial enterprises are found throughout the city, often in residential areas.

VI. AIR QUALITY DATA

Monitoring network

12 stations are operational (State Service for Observations and Control of Environmental Pollution Levels), another 5 stations belong to industrial enterprises or institutes. the 12 SSO stations function under the guidance of the Centre for Monitoring the Environment which is responsible for implementing the working programme and quality assurance.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 2, 8, 12		No. 8		No. 5		No. 1
Annual average		*7*		5		7		8		7
Winter average				6		7		12		9
Maximum (24 h) *calculated*				*61*		*100*		*86*		*101*
98 percentile (20 min)*				28		44		41		44
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0(*0*)		0(*0*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are low. The WHO-AQG is not likely to be exceeded.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 2, 3, 11	No. 2, 3, 11	No. 3	No. 3	No. 5	No. 5	No. 7	No. 7
Annual average		*16*	100	90	100	120	500	440	100	60
Winter average			78	70	67	67	270	333	100	33
Maximum (24 h)										
98 percentile (20 min)			390	444	390	540	1940	1730	390	280
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations are high, extremely high peak values are observed at the traffic site. The WHO-AQG is likely to be exceeded.

Winter smog classification	1990
Exceedance class[5]	***1***
Exposure class[5]	***2***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 2, 3, 8, 11	No. 2, 3, 8, 11	No. 8	No. 8	No. 10	No. 10	No. 1	No. 1
Annual average			30	58	30	70	70	80	40	50
Maximum (24 h)										
Maximum (20 min)			700	350	280	500	920	940	570	1240
Number of days exceeding the WHO-AQG			2	7	0	13	14	9	9	7
Number of days exceeding 2 x WHO-AQG			1	0	0	0	2	3	1	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations

Reported nitrogen dioxide concentrations are high and show an upward trend due to the increasing traffic intensity. The WHO-AQG is exceeded in all city areas.

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1991	1985	19__	1985	19__	1985	19__
Number of stations				No. 13						
No. Annual average				-						
Summer average				61						
Maximum (1 h)				200						
Maximum (8 h)										
98 percentile (1 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Ozone concentrations

Ozone was monitored for the first time in the summer of 1991 (July-September). Concentrations were monitored daily from 9.00 to 19.00 local time. Maximum concentrations were observed in July-August between 13.00 and 15.00. In the morning hours concentrations of ozone exceeded 30 µg m^3 and are likely to be related to "white nights". From these first monitoring efforts it seems that concentrations can exceed the WHO-AQG.

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	5	5
Annual average	0.6	4
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		10
Annual average		0.04
Maximum monthly average		0.10
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		2
Annual average		6
98 Percentile (20 min)		32

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		8
Annual average		0.0029
Maximum monthly average		0.0148

VII. EFFECTS

Effects of air pollution on health
According to 1988 data, in St.Petersburg the number of cases of respiratory diseases is 86% and that of malignant tumours 78% higher than the average in the cities of the former Soviet Union.

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1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. Less than 75% of the data available.
3. Not the named ODS station. The location of the meteorological station is shown on the map.
4. The location of the meteorological station is shown on the map.
5. Uncertain data.

***City*:** Stockholm	***Country*:** Sweden

I. GENERAL DATA

	City	Conurbation
Population (number)	***659 000 (1985)***	1 503 000
Total area (km²)	***188 (1985)***	
Built-up area (km²)		
Co-ordinates (lat-/longitude)	59° 20' N 18° 05' E	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: North Europe, close to the Baltic Sea, plain.
***Topography*:** Open landscape *(++)*

Climate: Semi-coastal climate (Dfb)
Meteorology: Precipitation during all seasons, prevailing wind direction: West to south.

Averages	1980-1989	1985	1989
temperature (°C)	6.1	4.1	7.8
precipitation (mm)	435	559.1	418.5
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.3 (0)***	***3.1 (0)***	***3.2 (0)***
winter smog index	***25.2 (-)***	***30.3 (-)***	***20.7 (-)***
summer smog index	***4.6 (+)***	***2.2 (+)***	***5.6 (+)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

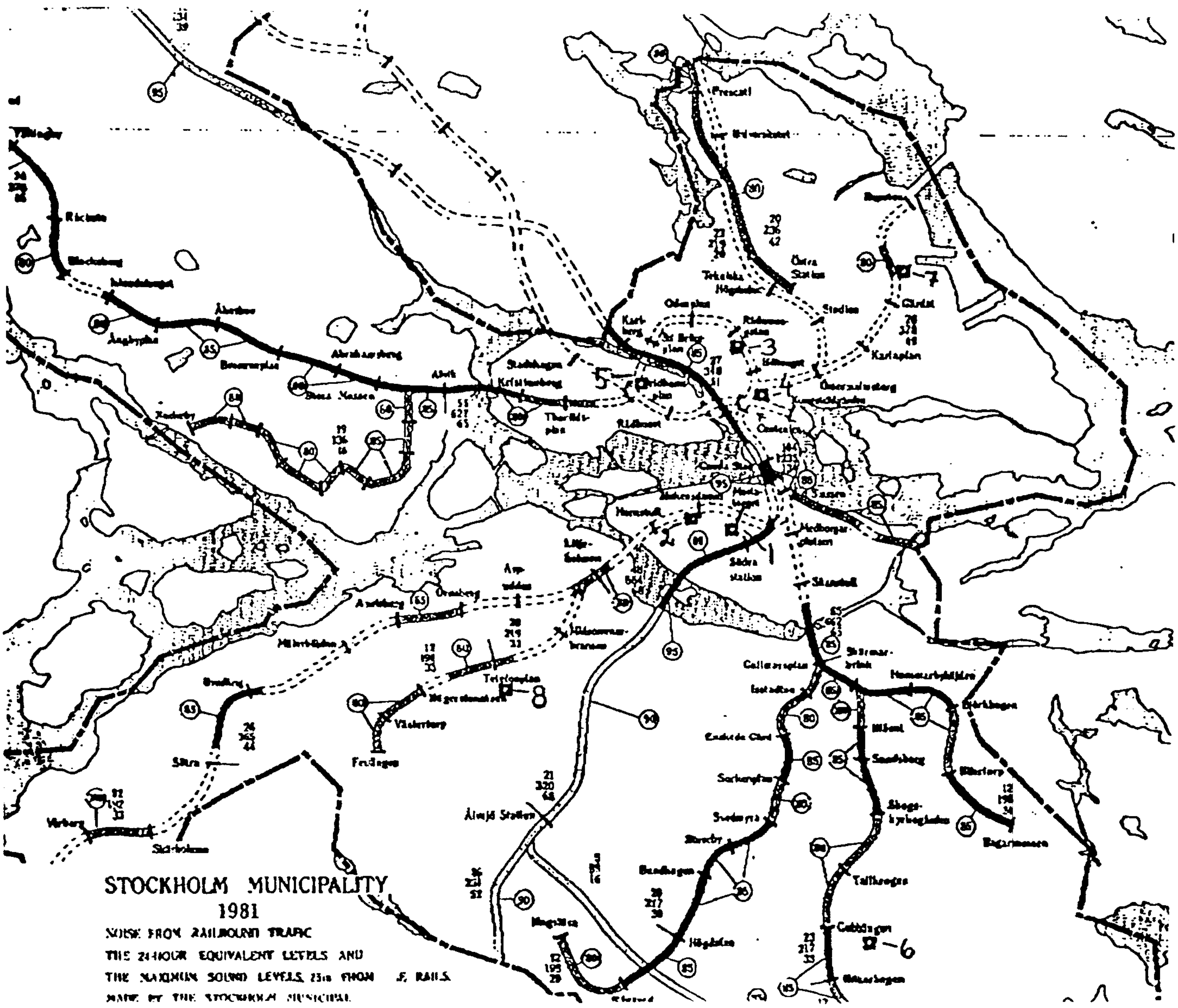
Direction (30° sectors)		**337.5-22.5**		**22.5-67.5**	**67.5-112.5**	**112.5-157.5**		**157.5 202.5**
Average windrose	Freq. %	13.1		11	8	7.8		15.2
1985	Wind speed m s^{-1}	3.3		3.2	3.3	3.6		3.5
Direction (30° sectors)		**202.5-247.5**		**247.5-292.5**		**292.5-337.5**	**Wind still**	
	Freq. %	16.4		17.8		10.8		
	Wind speed m s^{-1}	3.4		3.5		3.3		

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**337.5-22.5**		**22.5-67.5**	**67.5-112.5**	**112.5-157.5**		**157.5 202.5**
Average windrose	Freq. %	9.6		7.7	5.6	6.6		18.2
1990	Wind speed m s^{-1}	3.5		3.2	3.4	3.6		3.6
Direction (30° sectors)		**202.5-247.5**		**247.5-292.5**		**292.5-337.5**	**Wind still**	
	Freq. %	20.9		18.5		12.9		
	Wind speed m s^{-1}	4.0		4.1		3.4		

City: Stockholm **Country**: Sweden

Main topography, city morphology, industrial sources and monitoring network



City: Stockholm **Country**: Sweden

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.7	12	140	18		0.06
Domestic/space heating + Industry and power plants	17.3	7.2		2.4		
Total	18.0	19.2	140	20.4		
Per capita (**kg**)	27.4	29.1	212	31.0		
Per km^2 (**t**)	96.0	101.9	745	108.5		

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.1	8.6	66.5	12.4	0.4	0.015
Domestic/space heating + Industry and power plants	2.1	2.5		2.6		
Total	2.4	13.8	68.6	18.3		0.8
Per capita (**kg**)	3.5	20.1	100	26.7		
Per km^2 (**t**)	12.8	73.4	365	973.0		

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***3***

Major (industrial) point sources

(see city map)

IV. TRAFFIC DATA

Vehicle statistics and traffic activity			**Total annual consumption of fuel for traffic**		
	Number of vehicles 1992	Total traffic activity veh km a^{-1}		Consumption (t a^{-1}) 1985	1988
Total	297 958	3.1 x 10^9			
of which:					
· passenger cars	258 963		Diesel oil	72 300	75 800
· buses	1 042		Petrol/Gasoline	306 000	275 100
· freight traffic >3.5 t	28 249		LPG		

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption 1985	Annual consumption 1992	Average Sulphur content (t) 1985	Average Sulphur content (t) 1992
Fuel oil low sulphur	(t a^{-1})	320 000	250 000	-	250
Fuel oil high sulphur	(t a^{-1})	630 000	180 000	5 000	730
Coal	(t a^{-1})	150 000 - 200 000	150 000 - 200 000	-	-
Wood	(t a^{-1})	-	-	-	-
Natural/city gas	(10^6 m^3 a^{-1})	-	-	-	-
Total	(t a^{-1})	1 125 000	605 000	5000	980

City: Stockholm **Country**: Sweden

Local policies to reduce air pollution

Industry:
- There are very few big industries within Stockholm city

Traffic:
- Claim for using better diesel fuel.
- Plans for extended public transport in the 1990's
- Plans for building a motorway ring around the city centre in order to cut down the inner city traffic.
- National goals and Stockholm city goals for air pollutants.
- Reduce air pollution in Stockholm city by not allowing freight traffic (>3.5 t) that has high emissions (environmental zone)

Domestic/space heating:
- A number of big heat pumps are used for district heating.
- Less sulphur content in fuel and oil.

VI. AIR QUALITY DATA

Monitoring network

The environment and health protection administration has a network of 5 stations in the city (3 traffic stations, 1 city background, 1 industrial station) and 2 regional background stations.

Information for public: Newspaper Monday-Friday
Local radio Monday-Friday
Display on the office building

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1990	19__
Number of stations	1	1	1	1					1	1
Annual average	10	3.5 *(2)*	19	6.9	19	6.9			17	5.6
Winter average	12	4.1	25	8.6	25	8.6			23	8.1
Maximum (24 h)	83	24.1	140	54	140	54			114	26
98 percentile (24 h)	41	19	62	24	62	24			68	16
Number of days exceeding the WHO-AQG	0	0	2	0	0	0			0	0
Number of days exceeding 2 x WHO-AQG	0	0	0	0	0	0			0	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: PM10 (µg m^{-3})	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1993	1985	1993	1985	1992	1985	1990
Number of stations				1		1		1		
Annual average		*8*		17.7		17.7		34.1		
Winter average				15		15				
Maximum (24 h)				33.5		33.5		132.9		
98 percentile (24 h)				32		32		100		
Number of days exceeding the WHO-AQG				0		0		32		
Number of days exceeding 2 x WHO-AQG				0		0		0		

WHO-AQG PM10 (24h max.) = 70 µg m^{-3}

Winter smog classification	1990
Exceedance class	*1*
Exposure class[1]	*1*

City: Stockholm **Country**: Sweden

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	1	1	2	1	1	1	2	3	1	1
Annual average		9	33	29	33	29	56	44	30	18
Maximum (24 h)			103	79	103	79	119	105	81	54
Maximum (1 h)		89	207	171	207	171	187	199	140	98
Number of days exceeding the WHO-AQG		0	0	0	0	0	0	0	0	0
Number of days exceeding 2 x WHO-AQG		0	0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

O_3 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	1	1	1	1	1	1				
Annual average	28	59	47	47	47	47				
Summer average	34	65	68	55	68	55				
Maximum (1 h)	129	173	213	168	213	168				
Maximum (8 h)										
98 percentile (1 h)	70	116	152	108	152	108				
Number of days exceeding the WHO-AQG	0	0	0	0	0	0				
Number of days exceeding 2 x WHO-AQG	0	0	0	0	0	0				

WHO-AQG Ozone (1h max.) = 150 $\mu g\ m^{-3}$

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	sveav	4
Annual average	3.2	2.6
Maximum (8 h)		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		hornsg/sveav
Annual average		
Maximum monthly average		0.45
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

VII. Effects

Effects of air pollution on health

100 cases of cancer per year due to traffic (estimation)

Effects of air pollution on nature

Increased acidity in soils.
Mobility of metals in ground surface.
Effects on trees.
Critical load of nitrogen and sulphur is exceeded in the city.

Effects of air pollution on buildings/material

Extra costs within Stockholm approximately 200 million SKR per year compared to the surrounding countryside.

1. Uncertain data

City: Stuttgart	***Country***: Germany

I. GENERAL DATA

		City	Conurbation
Population	(number)	560 000	***580 000***
Total area	(km²)		***200 000***
Built-up area	(km²)		
Coordinates	(lat-/longitude)	48° 47' N 9° 12' E	

Major activities and development trends (1980-1990, 1990-2000)
Trading and industrial city. Traffic junction with inland harbour and airport.
Industries: electrotechnics, cars, heavy engineering, food processing.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, centre part of Baden-Württemberg.
Topography: river basin, valley **(--)**

Climate: Cfb
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	8.6	7.7	9.5
precipitation (mm)	599.6	693.8	557.6
wind speed (m s⁻¹)	***2.4 (-)***	***2.3 (-)***	***2.1 (--)***
winter smog index	***10.7 (0)***	***14.4 (0)***	***5.8 (+)***
summer smog index	***17.3 (0)***	***16.9 (0)***	***15.3 (0)***

Station: 10737 48° 47' N 9° 13' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network

VI. AIR QUALITY DATA [2]

SO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*8*				
Mean of stations in city background	1985 1989	2 2	48.5 22.4	338 74.5	228 57.5	23 0	5 0
Highest observed concentrations	1985 1989		56.7 24.0	384 76.0	272 62.0	28 0	8 0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

TSP concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Regional background	1990		*22*				
Mean of stations in city background	1985 1989	2 2	19.2 32.1	106 132	56 93	1 2	0 0
Highest observed concentrations	1985 1989		19.5 48.4	128 152	72 111	3 4	0 0

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Winter smog classification	1989
Exceedance class	***1***
Exposure class	***3***

NO_2 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (24 h)	Maximum (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG
Mean of stations in city background	1985 1989	2 2	48.6 58.1	177 183	250 280	2 1	0 0
Highest observed concentrations	1985 1989		58.1 57.9	183 218	280 353	2 2	0 0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Year	Number of stations	Annual average	Maximum (1 h)	98 percentile (1 h)	Number of days exceeding the WHO-AQG	2x WHO-AQG	*Exceedance class*
Mean of stations in city background	1985 1989	1 2	28.4 30.3	258 204	137 126	0 0	0 0	***2***
Highest observed concentrations	1985 1989		28.4 30.7	258 236	137 143	0 0	0 0	

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

1. Uncertain data.

2. EC-DGXI/B3 Air Pollution Information System (APIS).

City: Tallin	*Country*: Estonia

I. GENERAL DATA

	City	Conurbation
Population (number)	500 000	
Total area (km^2)		
Built-up area (km^2)		
Coordinates (lat-/longitude)	59° 22' N 24° 48' E	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Eastern Europe
Topography: coastal, plain *(++)*

Climate: Dfb (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	5.1	4.2	7.1
precipitation (mm)	587	702	683
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.5 (0)***	***3.4 (0)***	***3.6 (0)***
winter smog index	***21 (-)***	***23 (-)***	***13 (0)***
summer smog index	***4 (+)***	***1 (++)***	***5 (+)***

III. EMISSIONS

Annual emissions[1] per source and totals in 1990 ($kt\ a^{-1}$)

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic		10.3	98.0			
Domestic/space heating						
Industry and power plants	19.5	2.5	6.5		5.2	
Total						

Emission class	1990
Winter smog emissions[2]	***3***
Summer smog emissions[2]	***1***

VI. AIR QUALITY DATA

Annual average concentrations in 1990

City, 1 station (St. Petersburg Road)[1]:	Regional background:
SO_2 104 µg m^{-3}	SO_2 *5* µg m^{-3}
Dust 31 µg m^{-3}	TSP *13* µg m^{-3}
NO_2 17 µg m^{-3}	
CO 1.08 mg m^{-3}	

1. Environmental Report 3: Air Pollution in Estonia 1985-1990, Environment Data Centre, National Board of Waters and the Environment, Helsinki 1992.

2. Uncertain data.

City: The Hague	*Country*: Netherlands

I. GENERAL DATA

		City	Conurbation
Population	(number)	430 000	***654 000***
Total area	(km^2)	65	***151***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	52° 5' N 4° 16' E	

Major activities and development trends (1980-1990, 1990-2000)

Offices are the main source of employment in the Hague. There are some industrial activities, but no heavy industry. The situation in neighbouring cities is comparable. In the Hague the number of offices is still growing.

After years of a decreasing number of inhabitants the population is growing slightly again. The population in the suburbs has been growing and is still growing because of a larger supply of one-family dwellings.

II. TOPOGRAPHY AND CLIMATOLOGY

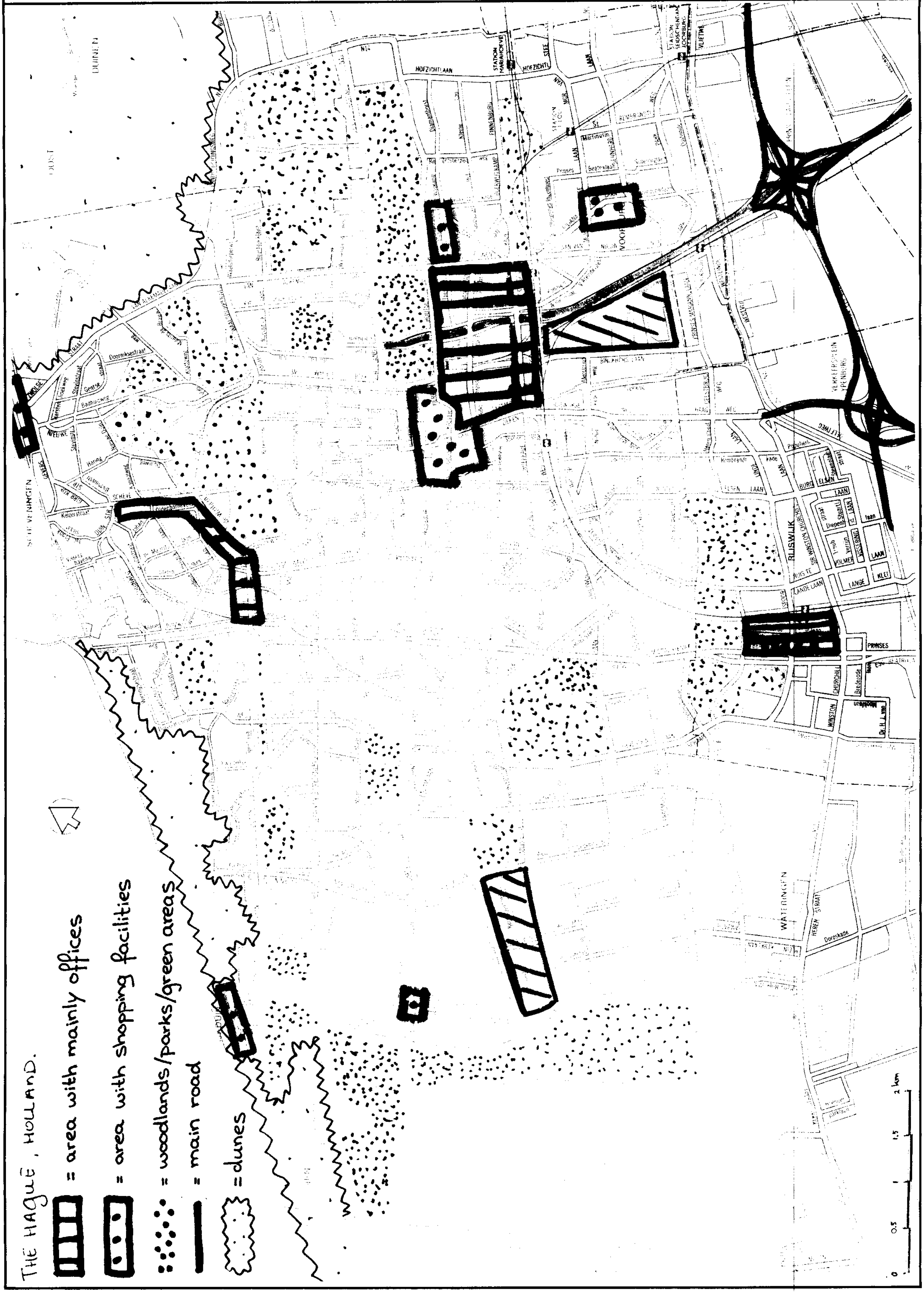
Region: western Europe, western part of the Netherlands
Topography: flat plain, coastal **(++)**

Climate: moderate coastal climate with precipitation during all seasons (Cfb)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	9.8	8.9	10.8
precipitation (mm)	645	782	671
wind speed ($m\ s^{-1}$)	***5.2 (++)***	***5.4 (++)***	***4.6 (+)***
winter smog index	***6.8 (+)***	***8.2 (+)***	***5.5 (+)***
summer smog index	***3.0 (+)***	***1.1 (++)***	***4.4 (+)***

Station: 06210 52° 11' N 4° 25' E

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Major (industrial) point sources

No major industry is present in the Hague.
For generating electricity 1 power plant is situated west of the city. The residual heat is used for a centralised urban heating system.

Emission class	1990
Winter smog emissions[1]	*1*
Summer smog emissions[1]	*2*

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles	Total traffic activity $x\ 10^9$ veh km a^{-1}
· passenger cars 1980	146 006	
· buses 1988		0.616
· freight traffic >3.5 t	23 001	

Traffic

Public transport primarily by tramway (1 288 x 10^9 veh km a^{-1}).

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

Natural gas is the usual fuel for domestic heating. The centralised urban heating system is mainly used by retail companies and big stores in the centre of the city and hardly for domestic heating.

Local policies to reduce air pollution

Industry:
Aim is to connect offices and industries to the centralised urban heating system as much as possible to reduce fuel consumption and produce less pollution.

Traffic:
Aim is to stabilise the number of cars driving in the city at the 1988 level using a Traffic Circulation Plan. Local air pollution by traffic has to be reduced to legal maxima.
Public transport is supposed to be doubled by 2005/2010.

Domestic/space heating:
Aim is to connect more houses to the centralised urban heating system. This will result in less pollution and energy saving.
The municipal energy service subsidises the purchase of new low-polluting equipment for heating of individual households.

VI. AIR QUALITY DATA

Monitoring network

1 station of the national monitoring network (LML) is situated in the city background and 1 station in the regional background.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations	1	1		1		1				
Annual average	21	12 *(9)*		16		16				
Winter average		16		20		20				
Maximum (24 h)	263	85		93		93				
98 percentile (24 h)	128	37		48		48				
Number of days exceeding the WHO-AQG		0		0		0				
Number of days exceeding 2 x WHO-AQG		0		0		0				

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Particulate matter: black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	19__	1985	19__	1985	19__	1985	19__
Number of stations		1								
Annual average		13 *(20)*								
Winter average		18								
Maximum (24 h)		57								
98 percentile (24 h)		42								
Number of days exceeding the WHO-AQG		0								
Number of days exceeding 2 x WHO-AQG		0								

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Winter smog classification	1990
Exceedance class	***0.5***
Exposure class[1]	***1***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations		1	1	1	1	1				
Annual average		38	45	42	45	42				
Maximum (24 h)		105	136	114	136	114				
Maximum (1 h)		197	220	233	220	233				
Number of days exceeding the WHO-AQG		0	0	0	0	0				
Number of days exceeding 2 x WHO-AQG		0	0	0	0	0				

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations		1		1		1				
Annual average		47		48		48				
Summer average		65		63		63				
Maximum (1 h)		301		314		314				
Maximum (8 h)		121		156		156				
98 percentile (1 h)		142		134		134				
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG		0		0		0				
Exceedance class				2						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

---

1. Uncertain data

City: Thessaloniki	***Country***: Greece

I. GENERAL DATA

		City	Conurbation
Population	(number)	969 000	
Total area	(km^2)		
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	40° 38' N 22° 58' E	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Southern Europe ***Topography***: coastal, hills ***(0)***	Climate: Csa (Köppen-Geiger) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	14.8	15.3	15.1
precipitation (mm)	455	422	498
cloud cover (8^{-1})			
wind speed (m s^{-1})	***2.9 (-)***	***2.5 (-)***	***2.5 (-)***
winter smog index	***15 (0)***	***13 (0)***	***20 (0)***
summer smog index	***79 (-)***	***90 (--)***	***75 (-)***

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***3***
Summer smog emissions[1]	***2***

1. Uncertain data.

City: Tirana	*Country*: Albania

I. GENERAL DATA

		City	Conurbation
Population	(number)	274 000 (1992)	***450 000 (1992)***
Total area	(km^2)	31 (1992)	61 (1992)
Built-up area	(km^2)	10 (1992)	***25 (1992)***
Coordinates	(lat-/longitude)	41° 20' N 19° 49' E	

Major activities and development trends (1980-1990, 1990-2000)

Capital. Important commercial, administrative and industrial centre. Timber, construction and food industries. Small airport is located in the north of the city.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Balkan region, Mediterranean (South Europe). ***Topography***: Coastal, hills ***(0)***	Climate: Csa (Köppen-Geiger) Meteorology: Frequent wind still periods

Local wind distribution (1985)

Direction	N	NE	E	SE	S	SW	W	NW	Calm
Frec. %	4.3	2.0	1.0	6.5	4.5	4.7	3.1	14.2	59.7
$m\ s^{-1}$	3.1	2.0	1.2	2.1	2.6	2.9	2.5	3.2	<0.5

Local wind distribution (1985)

Direction	N	NE	E	SE	S	SW	W	NW	Calm
Frec. %	4.5	2.3	1.0	7.5	1.8	3.2	2.4	13.6	63.6
$m\ s^{-1}$	2.8	2.9	1.4	2.6	2.2	2.6	2.5	3.7	<0.5

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***1***

Major (industrial) point sources
A power plant is located in the western part of the city. No incinerators are present.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity $veh\ km\ a^{-1}$
Total	13 291	x 10^9
of which:		
· passenger cars	7 773	
· buses	763	
· freight traffic >3.5 t	2 889	
. freight traffic <3.5 t	1 866	

Traffic
2 800 vehicles enter the city on weekdays. The total public annual transport activity is approximately 5 x 10^8 passenger km a^{-1} 41 km of main city roads (10-50 000 veh/day).

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

City/Conurbation		Annual consumption		Average Sulphur content (t)	
		1990	1992	1985	19__
Fuel oil low sulphur	($t\ a^{-1}$)	11 064	11 400	0.3	0.3
Fuel oil high sulphur	($t\ a^{-1}$)			4.0	4.0
Coal	($t\ a^{-1}$)	10 054	3 000		
Wood	($t\ a^{-1}$)	23 030	32 500		
Natural/city gas	($10^6\ m^3\ a^{-1}$)				
Total	($t\ a^{-1}$)				

Space/domestic heating: general remarks
No centralised urban heating system is present. A poor quality of coal is used. During recent years a large quantity of wood was used for space/domestic heating instead of coal.

VI. AIR QUALITY DATA

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			1	1	1	1				
Annual average		*4*	24	23	24	23				
Winter average			26	33	26	33				
Maximum (24 h)			112	88	112	88				
98 percentile (24 h)			-	-	-	-				
Number of days exceeding the WHO-AQG			0	0	0	0				
Number of days exceeding 2 x WHO-AQG			0	0	0	0				

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations
Concentrations are monitored 7 days per month. Concentrations show no clear trend. The WHO-AQG is likely to be breached in some years (e.g. 1988: max. 24h 130 µg m^{-3} and 1989 max. 24 h 160 µg m^{-3}).

Particulate matter: black smoke µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			1	1	1	1				
Annual average		*11*	67	85	67	85				
Winter average			66	107	66	107				
Maximum (24 h)			337	392	337	392				
98 percentile (24 h)			-	-	-	-				
Number of days exceeding the WHO-AQG			22	32	22	32				
Number of days exceeding 2 x WHO-AQG			2	5	2	5				

WHO-AQG black smoke (24h max.) = 125 µg m^{-3}

Suspended particulate concentrations
Concentrations are very high and showed no clear trend in the period 1985-1990. The WHO-AQG is breached on up to 90 days per year. Concentrations are likely to breach 2 x AQG on up to 25 days per year.

Winter smog classification	1990
Exceedance class	***2***
Exposure class[1]	***4***

1. Uncertain data.

***City*:** Togliatti[1]	***Country*:** Russian Federation

I. GENERAL DATA

		City		Conurbation
Population	(number)	670 000 (1992)		***670 000 (1992)***
Total area	(km^2)	301 (1991)		301 (1991)
Built-up area	(km^2)	54 (1992)		***54 (1992)***
Coordinates	(lat-/longitude)	53° 22' N 49° 24' E		

Major activities and development trends (1980-1990, 1990-2000)
Large industrial centre (Samara region), important river port. *Fast growing city, 1959: 72.000, 1970: 251.000, 1984: 576.000, 1992: 670.000 inhabitants.*

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
***Topography*:** Sited on the upper terrace of the left bank of the Volga (Samara Reservoir) (plain). *(+)*

Climate: Dfb (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	5.1	4.2	7.2	5.4
precipitation (mm)				492.2
cloud cover (8^{-1})				6.6
wind speed ($m\ s^{-1}$)	***2.6 (-)***	***2.8 (-)***	***2.4 (-)***	2.8
winter smog index	***42 (-)***	***53 (--)***	***37 (-)***	
summer smog index	***20 (0)***	***21 (0)***	***24 (0)***	

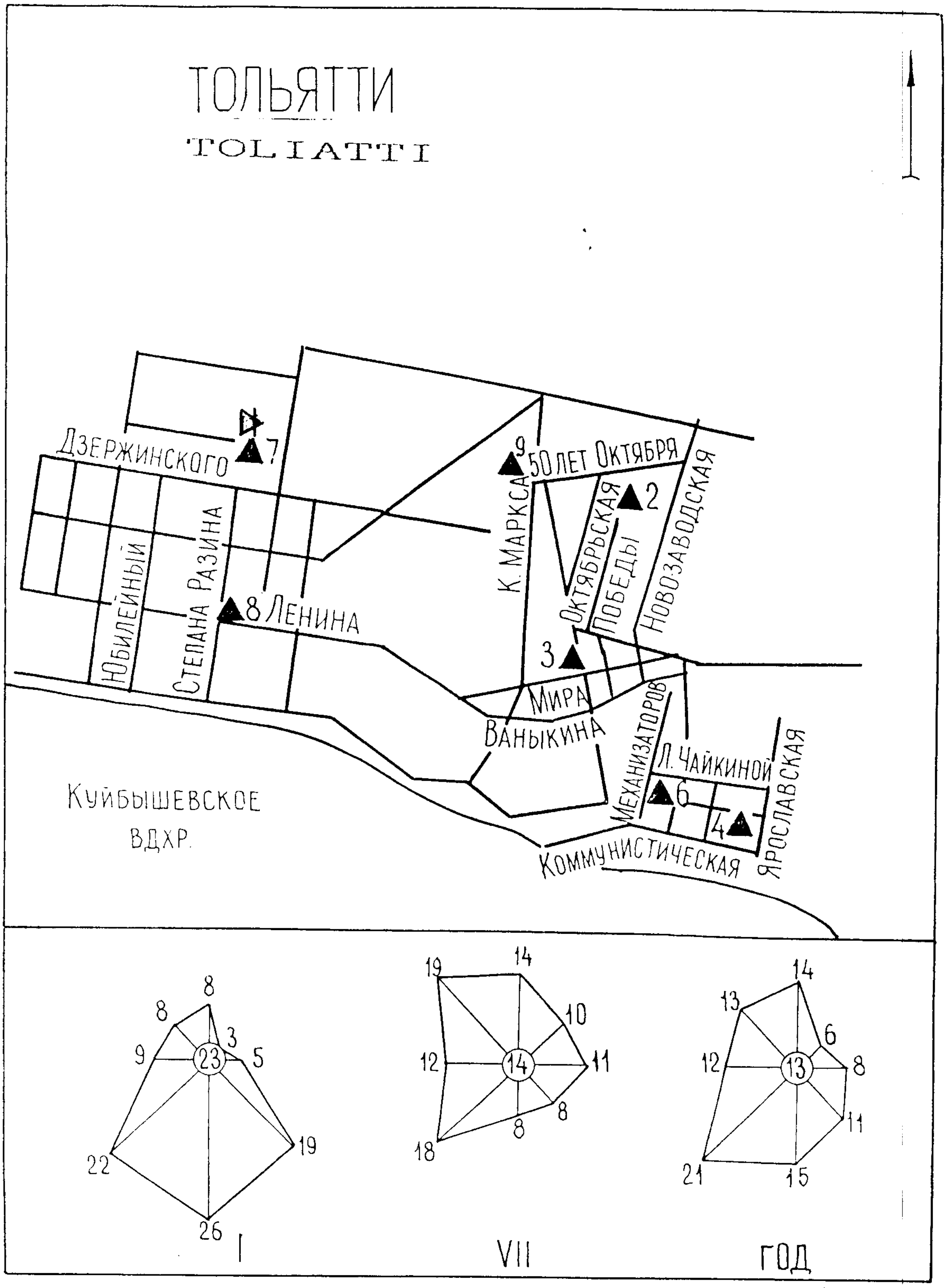
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	10	7	6	4	4	6	14	18	8	9	6	8	4
$m\ s^{-1}$	3.1	3.3	2.8	2.4	2.8	3.3	5.4	3.8	3.4	2.8	3.9	3.8	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	10	7	3	2	3	5	21	19	11	8	4	7	19
$m\ s^{-1}$	2.9	2.6	2.1	2.7	2.4	2.8	3.9	3.7	3.2	3.5	3.1	3.0	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	3.4	48.0			
Domestic/space heating						
Industry and power plants	15.8	40.1	25.4		24.3	
Total	15.8	43.5	73.4		24.3	
Per capita (**kg**)	25.2	69.4	117.1		38.8	
Per km^2 (**t**)	292.6	805.6	1 359.3		450.0	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	2.5	49.9	-	-	
Domestic/space heating						
Industry and power plants	10.4	39.3	19.5	9.8	18.8	0.0006
Total	10.4	41.8	69.4	9.8	18.8	
Per capita (**kg**)	16.0	64.4	106.9	15.1	29.0	
Per km^2 (**t**)	192.6	774.1	1 285.2	181.5	348.2	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***2***

Major (industrial) point sources

Besides the emissions given, 3 814 t ammonia among others are also emitted (fertilizer production). The industrial enterprises are concentrated in the north and north-east part of the city. Emissions basically come from low sources, only 3% of all sources have high stacks.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

City/conurbation	Number of vehicles	Total traffic activity veh km a^{-1}
Total	*39 821*	x 10^9
of which:		
· passenger cars	*28 072*	*90*
· buses	*2 859*	*950*
· freight traffic >3.5 t	*4 911*	*400*

Traffic

Length of roads with 10-50 000 vehicles per day: 112 km.

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating		Annual consumption 1985	Annual consumption 19__	Average Sulphur content (t) 1985	Average Sulphur content (t) 19__
Fuel oil low sulphur	(t a^{-1})				
Fuel oil high sulphur	(t a^{-1})	*930 000*			
Coal	(t a^{-1})	*3 754 000*			
Wood	(t a^{-1})				
Natural/city gas	(10^6 m^3 a^{-1})	*2 904 456*			
Total	(t a^{-1})				

VI. AIR QUALITY DATA

Monitoring network

7 Stations are operational (State Service for Observations and Control of Environmental Pollution Levels). Observations are made by the Togliatti Hydrometeorological Observatory. The general guidance is provided by the Samara Centre for Observations of the Natural Environment, Volga Region Administration on Hydrometeorology.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 4, 6	No. 4, 6	No. 4	No. 4	No. 3	No. 3	No. 2	No. 2
Annual average			300	200	400	200	200	200	200	200
Winter average			300	185	300	220	180	150	130	120
Maximum (24 h)										
98 percentile (20 min)			860	470	1250		470	780	470	780
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations are high, especially during the summer. The WHO-AQG is likely to be exceeded on numerous days.

Winter smog classification	1990
Exceedance class[4]	*3*
Exposure class[4]	*4*

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 4, 6	No. 4, 6	No. 4	No. 4	No. 3	No. 3	No. 2	No. 2
Annual average			40	45	50	40	60	50	40	50
Maximum (24 h)										
Maximum (20 min)			345	560	540	750	690	480	630	390
Number of days exceeding the WHO-AQG			3	3	6	3	17	1	2	7
Number of days exceeding 2 x WHO-AQG			0	0	0	0	1	0	0	0

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high. The WHO-AQG is exceeded in all city districts on a few days per year.

Formaldehyde concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	3	3
Annual average	6	18
98 Percentile (20 min)	37	54

Benzo(a)pyrene concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		74
Annual average		0.0006
Maximum monthly average		0.0027

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	3	3
Annual average	1	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		2
Annual average		0.24
Maximum monthly average		0.40
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. Not the named ODS station, the location of the meteorological station is shown on the map.
3. The location of the meteorological station is shown on the map.
4. Uncertain data.

***City*:** Toulouse	***Country*:** France

I. GENERAL DATA

		City		Conurbation
Population	(number)			***608 000 (1992)***
Total area	(km^2)			
Built-up area	(km^2)			***250 (1992)***
Coordinates	(lat-/longitude)	43° 37' N 1° 27' E		

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and industrial centre. Aircraft manufacturing, chemical industry. Airport.

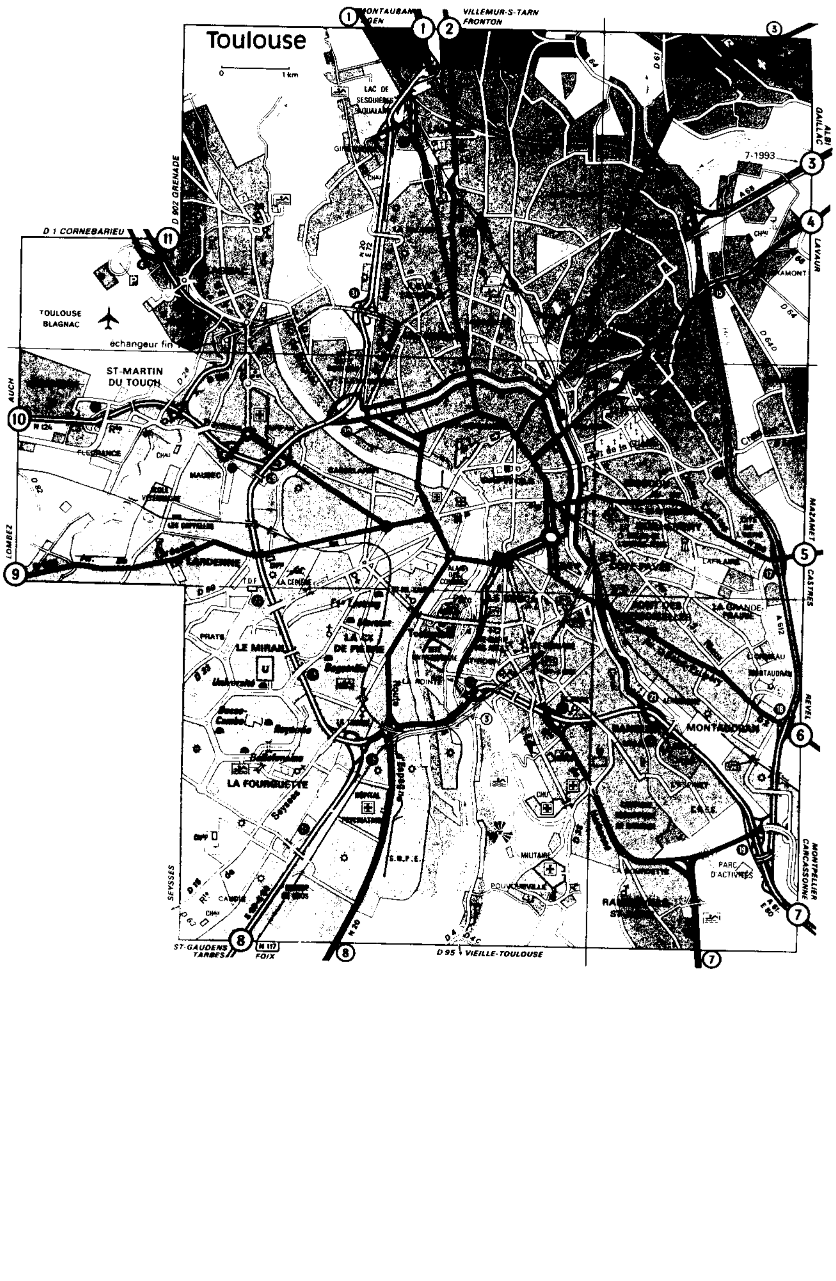
II. TOPOGRAPHY AND CLIMATOLOGY

Region: West Europe ***Topography*:** shallow river basin *(-)*	Climate: Cfb (Köppen-Geiger) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	12.9	12.3	13.5
precipitation (mm)	538	653	627
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.0 (-)***	***2.7 (-)***	***3.0 (-)***
winter smog index	***4 (+)***	***3 (++)***	***5 (+)***
summer smog index	***38 (-)***	***51 (-)***	***41 (-)***
Station:	Toulouse Blagnac 43° 38' N 01° 22' E		

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

Main topography, city morphology, industrial sources and monitoring network



VI. AIR QUALITY DATA [2]

Suspended particulate concentrations (µg m^{-3}) 1990	
1 station	
annual mean	14
24h maximum	126
days 24h >120	>0
WHO-AQG TSP (24h max.) = 120 µg m^{-3}	

Winter smog classification	1990
Exceedance class	*1*
Exposure class	*1*

Nitrogen dioxide concentrations (µg m^{-3}) 1990	
number of stations	4(5)
Maximum observed concentrations:	
annual mean	44
p 50 (1h)	30
24h maximum	129
p 98 (1h)	196
1h maximum	463
2 stations p98 >135	
WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}	

Ozone concentrations (µg m^{-3}) 1990	
1 station	
annual mean	39
p 98 (1h)	150
1h maximum	275
number of hours >150	166
WHO-AQG Ozone (1h max.) = 150 µg m^{-3}	
Exceedance class	*2*

Carbon monoxide concentrations/Lead concentrations

CO (mg m^{-3}) 1990		**Lead (µg m^{-3})**
number of stations	2(4)	
Maximum observed concentrations:		annual mean concentration in city centre
annual mean	3	
p 98 (1h)	14	1986: 1.5
1h maximum	78	1990: 0.9
WHO-AQG CO (8h max.) = 10 mg m^{-3}		**WHO-AQG Lead (annual average) = 0.5 µg m^{-3}**

1. Uncertain data.

2. Stroebel R. (ed), Air Quality in France, annual report 1990.

City: Tula[1]	*Country*: Russian Federation

I. GENERAL DATA

		City		Conurbation
Population	(number)	541 000 (1992)		***541 000 (1992)***
Total area	(km^2)	127 (1992)		***127 (1992)***
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	54° 11' N 37° 38' E		

Major activities and development trends (1980-1990, 1990-2000)
The conurbation includes the settlements Kosaya Gora, Mendeleevsky, Skuratovsky, Gorelki. Tula is an industrial city (ferrous metallurgy, heavy engineering).

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: Sited near Moscow along the Upa River. The central and most ancient part of the city lies on the left high bank of Upa River (shallow river basin). *(-)*	Climate: Dfb (Köppen-Geiger) Meteorology: wind velocity 0-1 m s^{-1}: 20%. Inversions (winter) low-level: (18-20%).

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	4.6	2.8	6.3	5.2
precipitation (mm)				573.5
cloud cover (8^{-1})				6.9
wind speed (m s^{-1})	***3.2 (0)***	***2.6 (-)***	***3.0 (-)***	3.4
winter smog index	***31 (-)***	***31 (-)***	***23 (-)***	
summer smog index	***9 (0)***	***10 (0)***	***15 (0)***	

Station: Kaluga 54° 34' N 36° 22' E

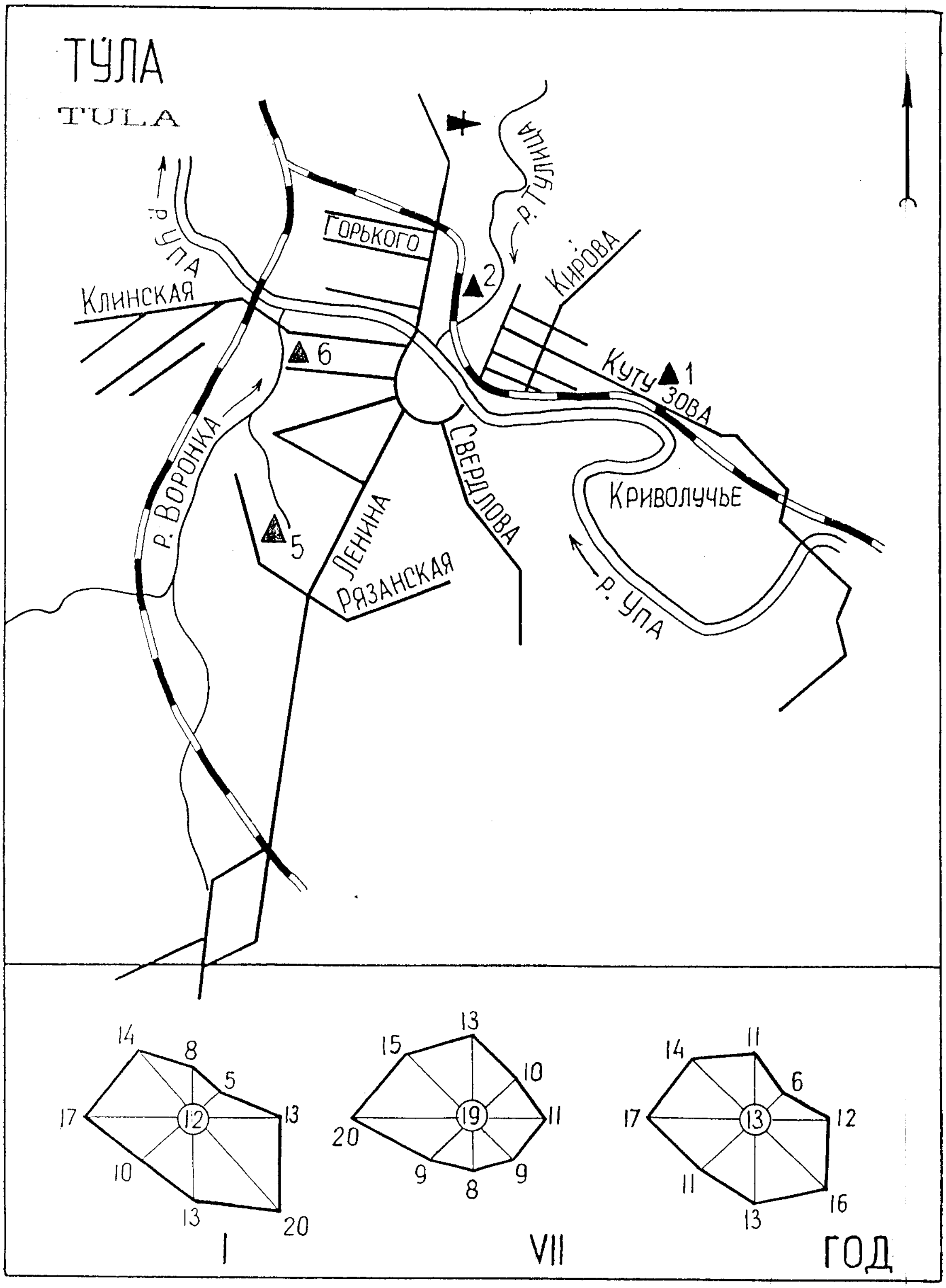
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	7	5	5	6	5	11	11	9	7	10	10	14	11
m s^{-1}	2.9	2.3	2.5	2.7	2.5	2.4	2.9	3.6	3.4	2.6	3.0	2.9	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	5	6	3	4	7	8	16	17	15	8	6	6
m s^{-1}	2.9	2.4	2.6	2.3	2.9	3.3	3.4	3.3	3.1	3.3	3.5	3.1	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	2.4	29.9		-	
Domestic/space heating						
Industry and power plants	9.6	4.4	108.0		10.1	
Total	9.6	6.8	137.9		10.1	
Per capita (**kg**)	17.8	12.6	256.3		18.8	
Per km² (t)	75.6	53.5	1 085.8		79.5	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	4.9	61.2		-	
Domestic/space heating						
Industry and power plants	11.0	4.7	110.5		11.8	0.0
Total	11.0	9.6	171.7		11.8	
Per capita (**kg**)	20.4	17.8	316.7		21.9	
Per km² (t)	86.6	75.6	1 352.0		92.9	

Emission class	1990
Winter smog emissions	*2*
Summer smog emissions[4]	*2*

Major (industrial) point sources

The basic contribution to industrial emissions (76%) is made by metallurgical plants. Heavy engineering and boiler-houses are also sources of air pollution. For 2% of more than 1000 sources of emissions, the stacks are higher than 50 m.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	*54 591*	x 10^9
of which:		
· passenger cars	*39 690*	
· buses	*2 049*	
· freight traffic >3.5 t	*8 324*	

Total annual consumption of fuel for traffic

	Consumption (10^3 l a^{-1})		Average Sulphur content (t)	
	1985	1989	1985	19__
Diesel oil		*45 528*		
Petrol/Gasoline		*29 879*		
LPG				

Traffic

Traffic is estimated to be responsible for 37% of total emissions.
Public transport: non-electrical: 575.3 million passenger km a^{-1}, electrical: 264.6 million passenger km a^{-1}.

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

Most houses are connected to district heating (natural gas). 1991 emissions of municipal heating plants: sulphur anhydrides 106 t, nitrogen oxides 545 t and carbon oxide 1970 t.

VI. AIR QUALITY DATA

Monitoring network

4 stations are operational (State Service for Observations and Control of Environmental Pollution Levels, Tula Centre for Observations of the Natural Environment, Administration for Hydrometeorology of the Central Chernozem Region). The methodical guidance of the network stations is exercised by A.I.Voeikov Main Geophysical Observatory (MGO) located in St.Petersburg.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 1, 5		No. 5		No. 6		No. 9
Annual average		*10*		2		2		2		2
Winter average				6		6		6		6
Maximum (24 h) *calculated*				*27*		*27*		*27*		*30*
98 percentile (20 min)*				12		12		12		13
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0(*0*)		0(*0*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day **WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}**

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are very low, the WHO-AQG is not exceeded.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1, 5	No. 1, 5	No. 1	No. 1	No. 6	No. 6	No. 9	No. 9
Annual average		*22*	100	70	100	80	100	70	100	410
Winter average			100	90	100	102		81	133	292
Maximum (24 h)										
98 percentile (20 min)			390	285	390	310	390	240	390	1640
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported dust concentrations (city background) are relatively low, near the lower limit of the monitor. At the industrial site TSP concentrations in 1990 were high with very high peak values. Here, the WHO-AQG is likely to be exceeded.

Winter smog classification	1990
Exceedance class[4]	*1*
Exposure class[4]	*2*

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1, 5	No. 1, 5	No.5	No. 5	No. 6	No. 6	No. 9	No. 9
Annual average			35	30	40	30	40	40	60	70
Maximum (24 h)										
Maximum (20 min)			200	305	210	280	240	510	800	1690
Number of days exceeding the WHO-AQG			0	0	0	0	0	3		16
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	2		13

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations in city background areas do not exceed the WHO-AQG. At the industrial site high peak values do occur and the WHO-AQG is exceeded on more than 10 days per year, even by a factor 2.

NH_3 concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	1	1
Annual average	100	20
98 Percentile (20 min)	390	120

Benzo(a)pyrene concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		1
Annual average		0.0015
Maximum monthly average		0.0040

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	6	6
Annual average	1	<1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 $mg\ m^{-3}$

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		19
Annual average		0.02
Maximum monthly average		0.04
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

Carbon monoxide concentrations/Lead concentrations
Reported concentrations of CO and Pb are low and do not exceed WHO-AQG standards.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station, the location of the meteorological station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

City: Turin	**Country**: Italy

I. GENERAL DATA

		City	Conurbation
Population	(number)	980 000 (1992)	***1 784 000 (1992)***
Total area	(km²)	120 (1992)	
Built-up area	(km²)		***100 (1992)***
Coordinates	(lat-/longitude)	45° 04' N 7° 40' E	

Major activities and development trends (1980-1990, 1990-2000)
Most important industrial city of Italy. Prime administrative and cultural city of Piedmont. Industry is located mainly in the SW and NW of the city (car and truck factory, metallurgy, chemicals).
The population of the city decreased from 1 200 000 to 980 000 in 1991. The population of the conurbation (52 municipalities) increased to 1 784 000.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Southern Europe, south of the Alps (30 km), fringe of the Po plain.
Topography: on plain (200 m a.s.l.) along Po river. ***(0)***

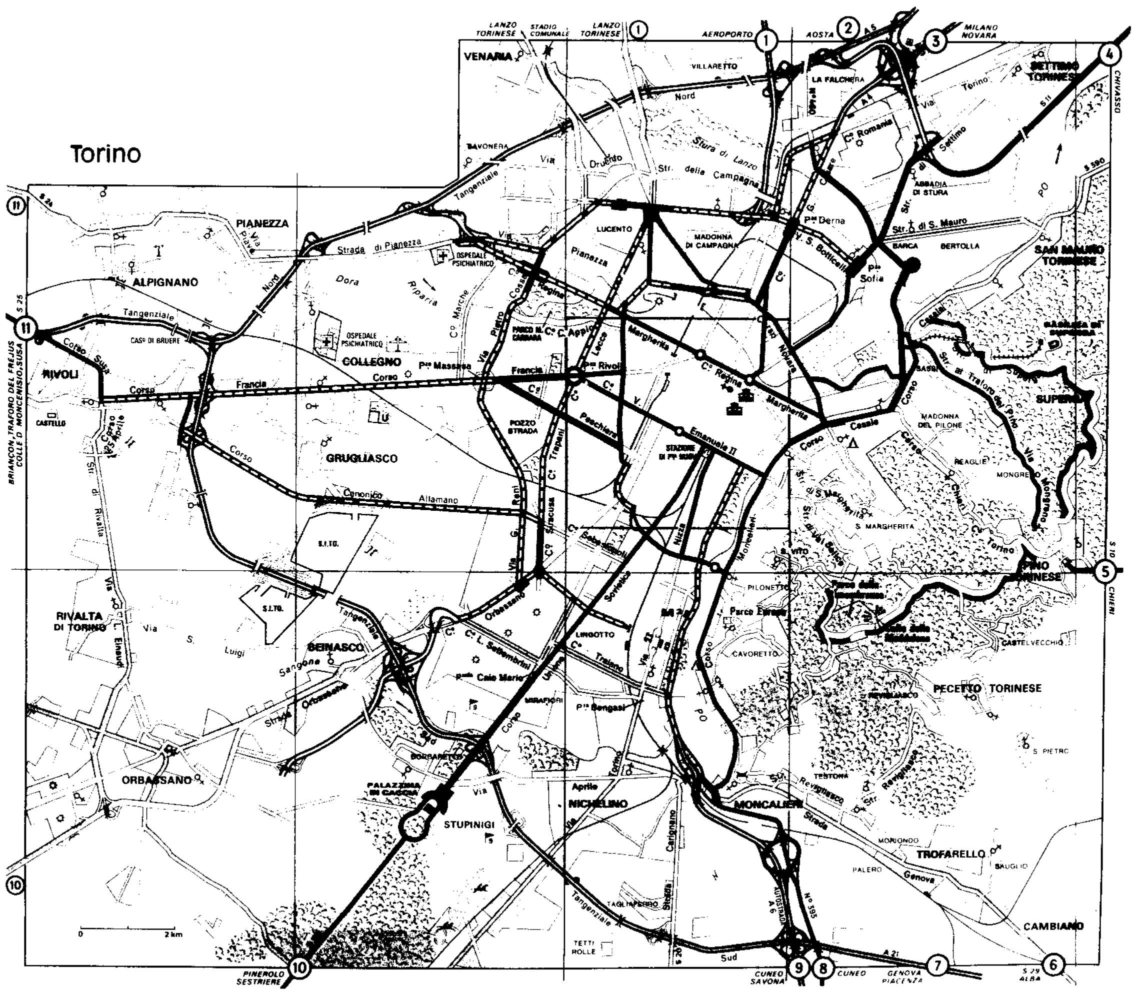
Climate: Cfb (Köppen-Geiger)
Meteorology: frequent calm periods

Averages	1980-1989	1985	1989
temperature (°C)	11.8	11.5	12.0
precipitation (mm)			
cloud cover (8^{-1})			
wind speed [1] ***($m\ s^{-1}$)***	***0.4 (--)***	***0.3 (--)***	***0.2 (--)***
winter smog index	***96 (--)***	***109 (++)***	***104 (++)***
summer smog index	***68 (-)***	***91 (--)***	***62 (-)***
Station:	Torino B.D.C 45° 02' N 07° 44' E		

Local wind distribution (1991)[2]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	9.2	14.7	16.4	7.3	2.6	2.2	3.7	16.1	3.7	0.8	1.62	1.56	19.7
$m\ s^{-1}$	0.98	1.44	1.39	1.23	1.45	1.52	1.5	1.4	1.26	1.79	2.7	1.1	0.19

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Emission class	1990
Winter smog emissions[3]	*4*
Summer smog emissions[3]	*4*

Major (industrial) point sources

(see city map)
1 Car factory
2 Power plant
3 Foundry
4 Industrial waste incinerator
5 Truck factory
6 Aircraft factory

IV. TRAFFIC DATA

Vehicle statistics and traffic activity			Total annual consumption of fuel for traffic				
	Number of vehicles	Total traffic activity		Consumption ($kt\ a^{-1}$)		Average Sulphur content (t)	
		veh km a^{-1}		1985	19__	1985	19__
Total	-	1.7×10^9					
of which:							
· passenger cars	589 000		Diesel oil				
· buses			Petrol/Gasoline	250			
· freight traffic >3.5 t			LPG				

Traffic

10% of cars are equipped with a catalytic converter. The average occupation of passenger cars is 1.2 persons per car. 330 000 cars enter Turin on weekdays during the morning rush hour (7.30 - 8.30 a.m.). Total non-electric public transport activity is about 580 x 10^6 passenger km a^{-1}. Total electric-powered public transport activity (trams) is 326 x 10^6 passenger km a^{-1}. Turin has 34 km of road with more than 50 000 cars daily and 350-400 km of road with 10 000-50 000 cars daily.

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

1992: 650 10^6 m^3 a^{-1} natural gas. 70% is heated by natural gas, about 10% by the central co-generation heating system, <20% by gas oil and <2% by coal.

Local policies to reduce air pollution

Traffic: City centre (24 km^2) is restricted to private traffic between 7.30 and 13.30. If alarm levels of pollution are exceeded, general restrictions to all traffic in the city are imposed.

VI. AIR QUALITY DATA

Monitoring network

Lab. Sanita Publica is responsible for operating the air quality monitoring network. If concentrations exceed certain levels, alert is given by the mayor on basis of 24 hours measurements. Information is diffused through televideo in the winter and in case of episodes through newspapers. There are also two private monitoring networks operational in Turin.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1991	1985	1991	1985	1991	1985	19__
Number of stations			1	1	1	1	-	-		
Annual average		*6*		55		55	72	41		
Winter average			115	76	115	76	89	61		
Maximum (24 h)			343	212	343	212	293	189		
98 percentile (24 h)			828	158	828	158	237	144		
Number of days exceeding the WHO-AQG			63	32	63	32	34	13		
Number of days exceeding 2 x WHO-AQG			9	0	9	0	4	0		

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

(Fluorescence) Concentrations are regarded representative for city background and traffic sites. City background figures for 1985 are based on the winter period only. SO_2 concentrations have dropped considerably during the last decade. In the beginning of the eighties daily average concentrations of 1000 µg m^{-3} and winter half-year averages of 400 µg m^{-3} were recorded, in recent years mean concentrations in winter are below 100 µg m^{-3} generally. During unfavourable conditions concentrations still exceed WHO-AQG guidelines (remark made from APIS data).

Particulate matter: TSP µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1987	1990
Number of stations			1(No. 3)	1(No. 3)	1(No. 3)	1(No. 3)	1	1	2	2
Annual average		*14*	168	155	168	155	177	144	<u>216</u>	227
Winter average										
Maximum (24 h)			538	398	538	398	584	434	<u>602</u>	727
98 percentile (24 h)			377	360	377	360	457	339	<u>445</u>	573
Number of days exceeding the WHO-AQG			218	185	218	185	223	156	<u>130</u>	278
Number of days exceeding 2 x WHO-AQG			50	44	50	44	64	34	<u>40</u>	122

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

(gravimetric) Suspended particulate concentrations are extremely high in Turin. Although the concentrations presented here suggest that concentrations have dropped other data sources (APIS) show that concentrations do not show a clear downward trend.

Winter smog classification	1990
Exceedance class	*2*
Exposure class	*4*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1986	1991	1986	1991	1986	1991	1985	19__
Number of stations			1	1	1	1	-	-		
Annual average			78	83	78	83	135			
Maximum (24 h)			180	142	180	142	277	229		
Maximum (1 h)			532	507	532	507	649	528		
Number of days exceeding the WHO-AQG			7	0	7	0	63	15		
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
(chemiluminescence). Concentrations are regarded representative for city background and traffic sites. Traffic site 1986: **only July and August.** NO_2 concentrations show an upward trend

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1991
Station number/name	1	1
Annual average	9.4	6
Maximum (8 h)	38.2	19.5
Number of days exceeding the WHO-AQG	142	42
Number of days exceeding 2 x WHO-AQG	7	1

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	background site	
	1985	1988
Station number/name	3	3
Annual average	1.5	1.05
Maximum monthly average	2.4	1.75
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO: (infrared). Pb: (atomic absorbtion)

1. Less than 75% of the data available.

2. Not the named ODS station. The location of the meteorological station is shown on the map.

3. Uncertain data.

City: Ufa[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 034 000 (1987)	***1 034 000 (1987)***
Total area	(km^2)	480 (1991)	***480 (1991)***
Built-up area	(km^2)		
Coordinates	(lat-/longitude)	54° 45' N 55° 58' E	

Major activities and development trends (1980-1990, 1990-2000)
Industrial and cultural centre. Railway junction, airport and river port. Industry: (petro)chemicals, heavy engineering.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe ***Topography***: Situated on the Pribelskaya Plain (west of Ural). The main part of the city is girded by Belaga and Ufa Rivers and stretches for 65 km to the north-east (river basin). *(-)*	Climate: Dfb (Köppen-Geiger) Meteorology: Wind velocity 0-1 m s^{-1}: 27%, surface inversions: 41%.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	2.7	2.5	4.7	3.5
precipitation (mm)				594.2
cloud cover (8^{-1})				6.4
wind speed (m s^{-1})	***3.5 (0)***	***3.8 (0)***	***3.4 (0)***	2.6
winter smog index[2]	***43 (-)***	***36 (-)***	***47 (--)***	
summer smog index	***21 (0)***	***10 (0)***	***35 (-)***	
Station:		Ufa	54° 45' N	56° 00' E

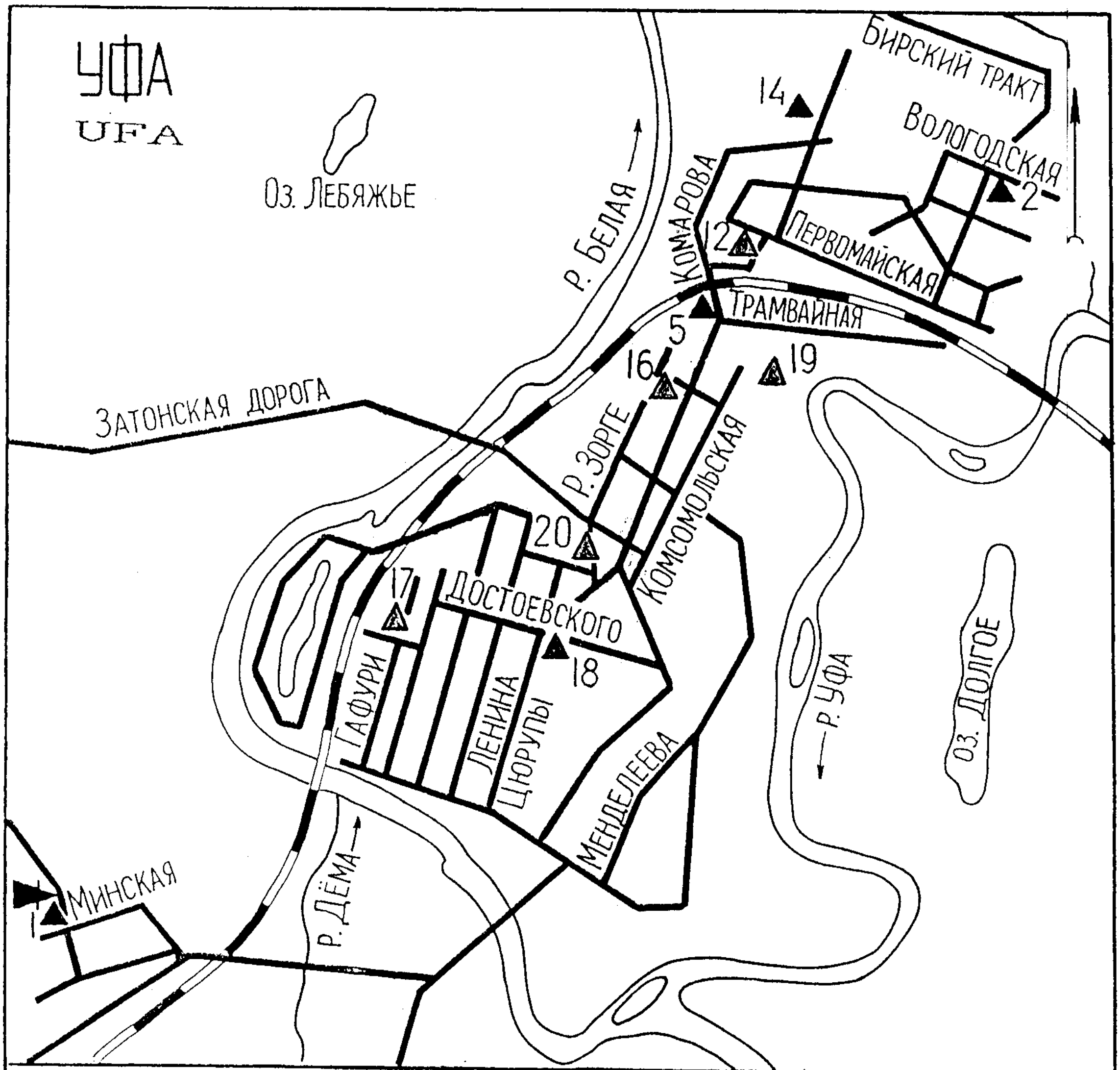
Local wind distribution (1985)[4]

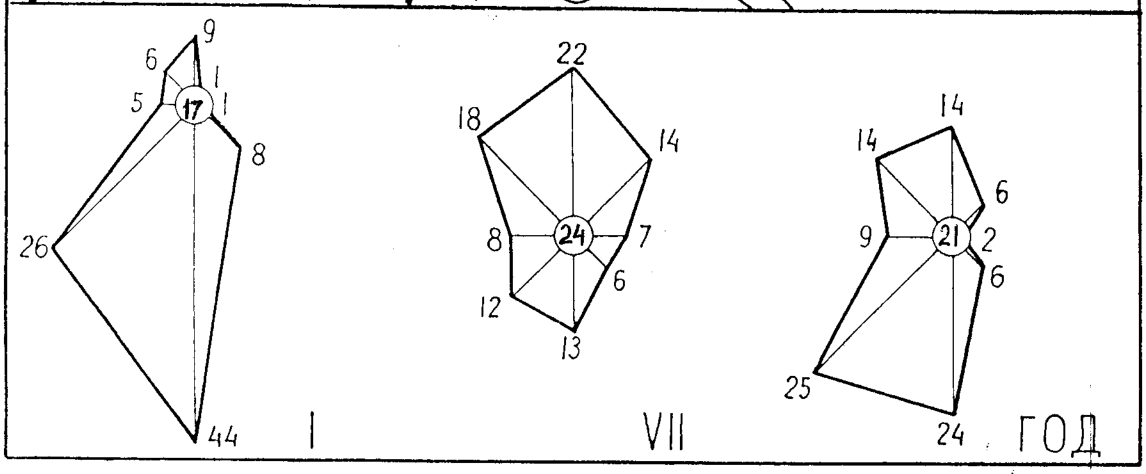
Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	11	5	3	1	2	3	25	15	11	10	7	7	23
m s^{-1}	3.2	3.2	3.7	2.5	2.6	2.9	4.2	4.1	3.8	4.3	4.3	4.2	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	5	2	3	1	4	11	28	16	11	5	8	6	8
m s^{-1}	2.3	1.8	1.9	2.0	2.1	2.2	3.8	3.0	3.2	3.8	3.0	2.2	

Main topography, city morphology, industrial sources and monitoring network





III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.8	85.9		-	
Domestic/space heating						
Industry and power plants	72.3	24.8	35.7		9.2	
Total	72.3	30.6	121.6		9.2	
Per capita (**kg**)	66.2	28.0	111.4		8.4	
Per km^2 (**t**)	150.6	63.8	253.3		19.2	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	9.7	92.7	-	-	
Domestic/space heating						
Industry and power plants	48.5	25.7	29.1	12.7	7.1	0.199
Total	48.5	35.4	121.8	12.7	7.1	
Per capita (**kg**)	44.4	32.4	111.5	11.6	6.0	
Per km^2 (**t**)	101.0	73.7	253.7	26.5	14.8	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***3***

Major (industrial) point sources

Most industry is located in the north part of the city. Also emitted into the atmosphere are 219 t of sulphuric acid, 647 t ammonia and 299 t hydrochloric acid.

VI. AIR QUALITY DATA

Monitoring network
9 Stations are operational (State Service for Observations and Control of Environmental Pollution Levels). The stations function under the guidance of Bashkortostan Administration for Hydrometeorology.

SO_2 concentrations	Mean of stations				Highest observed concentrations					
μg m^{-3}	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations		No. 1		No.5,18		No. 18		No. 2		No. 17
Annual average		10		15		20		10		10
Winter average		2		16		18		14		13
Maximum (24 h) *calculated*		*72*		*170*		*210*		*135*		*169*
98 percentile (20 min)*		39		80		100		60		70
Number of days exceeding the WHO-AQG (*+calc.*)		0(*0*)		0(*3*)		0(*4*)		0(*1*)		0(*2*)
Number of days exceeding 2 x WHO-AQG		0		0		0		0		0

* based on 20-minute values, sampled 3 times a day **WHO-AQG SO_2 (24h max.) = 125 μg m^{-3}**

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations are low, but compared to other cities in the former Soviet Union relatively high. The WHO-AQG is likely to be exceeded on one to a few days per year.

Particulate matter:	Mean of stations				Highest observed concentrations					
μg m^{-3}	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	No. 1	No. 1	No.5,18	No.5,18	No. 18	No. 18	No. 2	No. 2	No. 17	No. 17
Annual average	100	100	100	100	100	100	100	100	100	100
Winter average		83		106		83	82	98		16
Maximum (24 h)										
98 percentile (20 min)		390		490		390		600		390
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 μg m^{-3}

Suspended particulate concentrations
Reported concentrations are relatively low. The WHO-AQG is likely to be exceeded on a few days per year.

Winter smog classification	1990
Exceedance class[5]	***2***
Exposure class[5]	***3***

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	No. 1	No. 1	No.5,18	No.5,18	No. 5	No. 5	No. 2	No. 2	No. 17	No. 17
Annual average	40	10	45	40	40	40	30	50	50	30
Maximum (24 h)										
Maximum (20 min)	200	70	400	350	400	450	360	340	590	370
Number of days exceeding the WHO-AQG	0	0	1	6	1	10	1	2	1	0
Number of days exceeding 2 x WHO-AQG	0	0	0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high. The WHO-AQG is exceeded on 1-10 days per year, depending on the location. The traffic site is possibly also influenced by industrial emissions.

NH_3 concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		12
Annual average		20
98 Percentile (20 min)		102

Benzo(a)pyrene concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		17
Annual average		0.0027
Maximum monthly average		0.0085

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	2	2
Annual average	2	2
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 $mg\ m^{-3}$

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		14
Annual average		0.06
Maximum monthly average		0.12
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

Carbon monoxide concentrations/Lead concentrations
Reported CO and Pb concentrations are low and do not exceed WHO-AQG standards.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.
2. Less than 75% of the data available.
3. Not the named ODS station, the location of the meteorological station is shown on the map.
4. The location of the meteorological station is shown on the map.
5. Uncertain data.

City: Valencia	**Country**: Spain

I. GENERAL DATA

	City	Conurbation
Population (number)	717 000 (1990)	***753 000 (1990)***
Total area (km^2)	51 (1990)	135 (1990)
Built-up area (km^2)		***44 (1990)***
Co-ordinates (lat-/longitude)	39° 28' N 0° 22' E	

Major activities and development trends (1980-1990, 1990-2000)
Important commercial and economic city. The industrial activity is located in the port and surroundings and in Vara de Quart industrial site, south-west from city centre. In the 1981-1991 period, the Valencia population has increased 1.1%. The expected evolution for 2000 is stabilisation or a very little increase.

Constituent communities:
North: Benifaraig, Poble Nou, Carpesa, Cases d'Barcena, Mahuella, Massarrojos, Borbotó.
West: Benimamet, Beniferri.
South: Forn d'Alcedo, Castellar, Pinedo, El Saler, El Palmar, Perellonet, La Torre, Faitanar.

II. TOPOGRAPHY AND CLIMATOLOGY

Region / Topography	Climate
Region: Eastern Spain city on the shore, 350 km distance from Madrid. ***Topography***: Flat coastal plain *(++)*	Climate: (Csa) Meteorology: Precipitation mainly in autumn. Warm winters - hot and dry summer.

Averages	1980-1989	1985	1989
temperature (°C)	17	17.1	17.5
precipitation (mm)	451.4	560.3	920.9
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.0 (-)***	***2.9 (-)***	***2.9 (-)***
winter smog index	***7.6 (+)***	***7.0 (+)***	***0.6 (++)***
summer smog index	***70.0 (-)***	***76.4 (-)***	***69.1 (-)***

LOCAL WIND DISTRIBUTION (WIND ROSE) 39°28'48" N 0°22' W

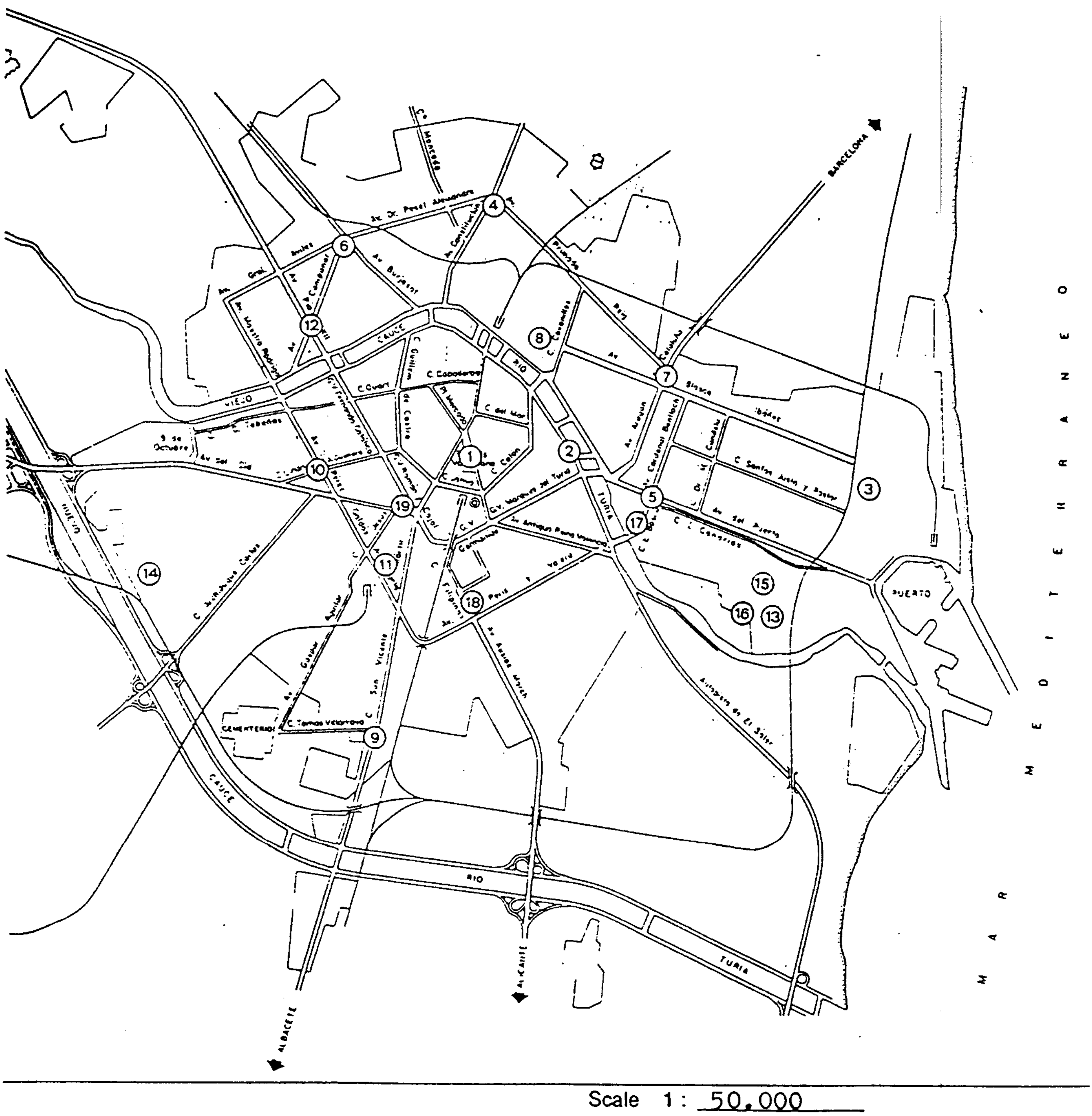
Direction (30° sectors)		**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	
Average windrose	Freq. %	1.4	5.3	5.2	0.8	0.5	8.8	16.2	2.7	
1985	Wind speed $m\ s^{-1}$	1.4	2.7	2.3	0.7	0.4	1.7	1.9	1.9	
Direction (30° sectors)		**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**Wind still**
	Freq. %	0.4	1.0	2.8	6.9	5.5	4.4	2.8	1.5	34.9
	Wind speed $m\ s^{-1}$	0.6	1.0	1.3	2.1	2.9	2.3	2.5	1.4	1.8

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	
Average windrose	Freq. %	4.3	7.7	8.0	1.8	3.7	7.8	14.5	5.4	
1992	Wind speed $m\ s^{-1}$	6.5	11.1	7.8	5.0	5.8	7.2	9.8	9.8	
Direction (30° sectors)		**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**	**Wind still**
	Freq. %	2.3	1.6	2.7	5.6	12.4	5.6	4.6	1.9	10.3
	Wind speed $m\ s^{-1}$	6.5	6.7	6.7	8.9	9.3	10.1	7.8	7.2	2.4

City: Valencia **Country**: Spain

Main topography, city morphology, industrial sources and monitoring network



Scale 1 : 50.000

City: Valencia **Country:** Spain

III. EMISSIONS

Annual emissions per source and totals in 1986 (kt·a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.543	2.022			1.873	0.068
Domestic/space heating	0.128	0.078			0.091	
Industry and power plants	1.024	0.329			0.177	
Total	1.695	2.429			2.141	
Per capita (**kg**)	2.3	3.2			2.8	
Per km^2 (**t**)	38.5	55.2			48.7	

Emission class	1990
Winter smog emissions[1]	***4***
Summer smog emissions	***2***

Major (industrial) point sources
(see city map) There are two industrial sites located west (Vara de Quart) and east (the port). These sites have no special pollution problems for the nearest built-up areas.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity			**Total annual consumption of fuel for traffic**				
	Number of vehicles	Total traffic activity veh km a^{-1}		Consumption (t a^{-1}) 1985	Consumption (t a^{-1}) 19__	Average Sulphur content (%) 1985	Average Sulphur content (%) 19__
Total		x 10^9					
of which:							
· passenger cars	257 335		Diesel oil	41 794		0.5	
· buses	943		Petrol/Gasoline	93 718		0.1	
· freight traffic >3.5 t	20 984		LPG				

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption 1985	Annual consumption 19__	Average Sulphur content (%) 1985	Average Sulphur content (%) 19__
Fuel oil low sulphur	(t a^{-1})			2.7	
Fuel oil high sulphur	(t a^{-1})			3.6	
Coal	(t a^{-1})			1.1	
Wood	(t a^{-1})				
Natural/city gas	(10^6 m^3 a^{-1})				
Total	(t a^{-1})				

Space/domestic heating: general remarks
The domestic heating emissions incidence is very low in the detected concentration levels, mainly because of the climate and the energy source used.

City: Valencia **Country**: Spain

Local policies to reduce air pollution
Industry: The new factories are located in industrial sites far from the city centre. **Traffic**: - Bypass now in use. - Electric energy transportation (trams, underground railway) - New buses - Bigger pedestrian area - More effective traffic lights system. **Domestic/space heating**: - More effective generators.

VI. AIR QUALITY DATA

Monitoring network
The surveillance network for the atmospheric pollution has a 14 stations manual network and a 5 remote stations (new) automatic network. The information is released to local press and other media, local and national authorities, and the EU.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations Traffic sites are used as city background stations for SO_2				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1986	1990	1985	1992	1985	1992	1985	1992	1985	1992
Number of stations			5	5			5	5	4	4
Annual average		*3*	46	37			56	46	58	38
Winter average			51	43			65	49	120	38
Maximum (24 h)			197	120			234	170	637	161
98 percentile (24 h)			137	76			155	86	169	117
Number of days exceeding the WHO-AQG			9	0			17	1	21	2
Number of days exceeding 2 x WHO-AQG									2	-

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: Black smoke $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site (10)		Industrial site (16)	
	1986	1990	1986	19	1985	19__	1986	1993	1986	1992
Number of stations			9	9			5	5	4	4
Annual average		*7*	54	43			111	70	48	37
Winter average			60	55			131	84	59	47
Maximum (24 h)			198	161			306	240	331	168
98 percentile (24 h)			143	121			213	158	175	118
Number of days exceeding the WHO-AQG			21	5			95	30	15	3
Number of days exceeding 2 x WHO-AQG			0	0			2	0	1	0

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$

Winter smog classification	1993
Exceedance class	*2*
Exposure class	*1*

City: Valencia **Country:** Spain

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City traffic		City background		Traffic site		Industrial site	
	1985	19__	1986	19__	1985	19__	1986	1992	1985	19__
Number of stations			3				3			
Annual average			82				101			
Maximum (24 h)			234				297			
Maximum (1 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1993
Station number/name	AC. MADRID (10)	
Annual average	1.7	
Maximum monthly average	2.4	
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Uncertain data

City: Vienna	**Country**: Austria

I. GENERAL DATA

		City	Conurbation
Population	(number)	***1 564 000 (1990)***	
Total area	(km^2)	415 (1990	
Built-up area	(km^2)	***190 (1990)***	
Co-ordinates	(lat-/longitude)	48 ° 12 ' N 16 ° 22 ' E	

Major activities and development trends (1980-1990, 1990-2000)
Business, Tourism.

Population still increasing.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe, on the north-eastern edge of the Alps, near the Pannonian Lowland.
Topography: On the gentle south-eastern slope between woodland and the city of Vienna in a low density built up area. ***(--)***

Climate: (Cfb)
Meteorology: Combination between urban and slight orographic influences of the hills of the Vienna woods.

Averages	1980-1989	1985	1989
temperature (°C)	10.2	9.5	11.2
precipitation (mm)	472.3	647.7	630.3
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.2 (0)***	***3.0 (-)***	***2.8 (-)***
winter smog index	***10.0 (0)***	***11.3 (0)***	***8.4 (+)***
summer smog index	***21.7 (0)***	***25.9 (-)***	***18.8 (0)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	4.3	4.4	3.3	5.3	9.8	7.4	2.1
1985	Wind speed $m\ s^{-1}$	2.0	1.4	1.2	2.0	3.1	3.3	2.2
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	2.1	6.3	26.8	14.9	6.9	6.4	
	Wind speed $m\ s^{-1}$	1.4	2.5	4.5	3.8	2.9	-	

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	4.3	4.2	2.9	5.1	9.3	6.4	2.6
1990	Wind speed $m\ s^{-1}$	2.3	1.6	1.3	1.7	3.0	3.0	2.0
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	2.3	7.2	28.3	13.1	6.1	8.2	
	Wind speed $m\ s^{-1}$	1.7	2.7	4.5	3.3	2.9	-	

City: Vienna **Country**: Austria

Main topography, city morphology, industrial sources and monitoring network

Siedlungsgebiete

Dichtbebautes Stadtgebiet mit städtischer Vielfalt: Mischung von Wohnungen, Gewerbebetrieben, Versorgungseinrichtungen, usw.

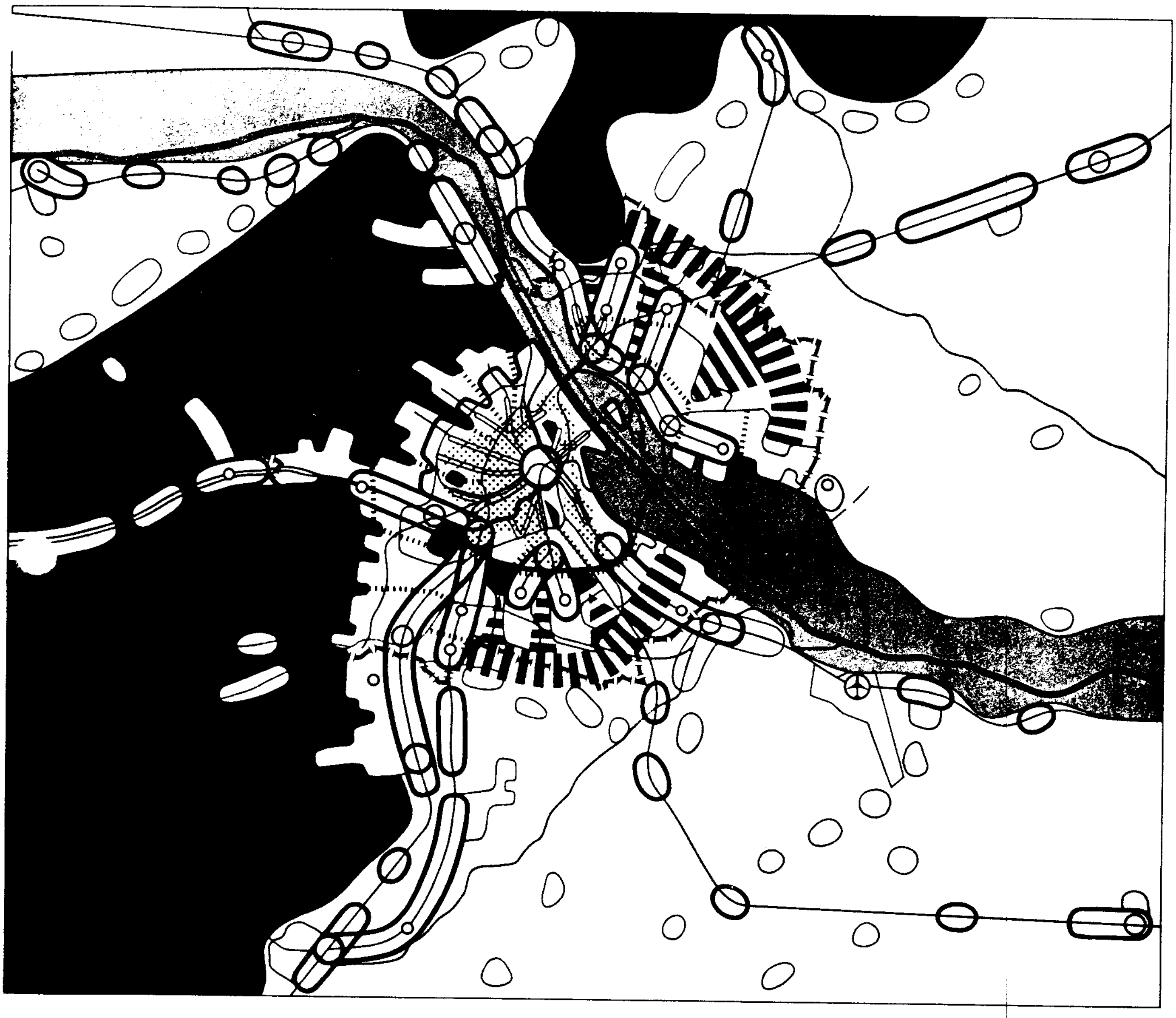
Siedlungsachse im Anschluß an das dichtbebaute Stadtgebiet mit baulichen Verdichtungsmöglichkeiten und angestrebter städtischer Vielfalt

Siedlungsgebiet

Flächen unter 2 ha sind nicht dargestellt

1 : 300 000

SCHEMA DER GRÜN- UND ERHOLUNGSGEBIETE



Donaubereich

Grüngürtel

Park, Grünanlage

Grünkeil

Grünzug

Verbesserung der Grünflächenversorgung

City: Vienna **Country**: Austria

III. EMISSIONS

Annual emissions per source and totals in 1985 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic						
Domestic/space heating						
Industry and power plants	3.62	5.80				
Total						
Per capita (**kg**)						
Per km^2 (**t**)						

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.68	24.70	77.16	23.23	0.84	
Domestic/space heating	1.82	0.89	19.14	1.39	0.39	
Industry and power plants	11.41	6.45	4.17	28.86	1.00	
Total	13.91	32.04	100.47	65.20	2.23	
Per capita (**kg**)	9.09	20.92	65.61	42.57	1.45	
Per km^2 (**t**)	34	77	242	157	5	

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions	***4***

Major (industrial) point sources

(see city map)

- 2 Electric power plants (oil/gas) 710 and 320 MW
- 1 Gas turbine power plant 150 MW
- 2 Incinerators for domestic waste 30 and 60 MW
- 1 Incinerator for hazardous waste and sewage sludge 40 MW
- 1 Oil refinery
  - Distillation cap. ca 40 000 t/d
  - Desulphurisation cap. ca 17 000 t/d
  - Power plant 180 MW (el)

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	667 850	ca. 5 x 10^9
of which:		
· passenger cars	559 382	
· buses	3 794	
· freight traffic >3.5 t	56 702	

Traffic

4 000 000 movements daily

- 37 % public traffic
- 37 % motorised individual traffic (1.2 passengers/vehicle)
- 26 % non-motorised individual traffic

City: Vienna **Country**: Austria

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks	
Natural gas	48.7 %
Oil	17.1 %
Coal, wood	18.2 %
Centralised urban heating system	13.2 %
Electricity	2.9 %

Local policies to reduce air pollution

Industry:
Use of natural gas instead of oil in the power plants, installation of detoxing-systems in the communal power plants.

Traffic:
Promotion of public traffic, restriction of individual traffic.

Domestic/space heating:
Promotion of centralised urban heating systems.

VI. AIR QUALITY DATA

Monitoring network

One network with 18 stations.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990-	1985	1990	1985	1990
Number of stations	-	2	7	10	1	1	1	1	1	1
Annual average	-	19 *(14)*	40	17	47	20	45	34	45	16
Winter average	-	-	62	35	78	47	63	41	65	25
Maximum (24 h)	-	100	235	95	460	140	-	80	260	70
98 percentile (24 h)	-	120	220	120	330	170	-	110	310	100
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Particulate matter: "Laskus kopf" $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations			2	3	2	3		2		
Annual average		27	112	40	117	46		41		
Winter average			122	55	128	63		56		
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG black smoke (24h max.) = 125 $\mu g\ m^{-3}$
WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$
WHO-AQG PM_{10} (24h max.) = 70 $\mu g\ m^{-3}$

City: Vienna **Country**: Austria

Winter smog classification	1990
Exceedance class	*2*
Exposure class	*2*

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations	-	1	-	2		1		1		1
Annual average	-	16	-	38		42		71		39
Maximum (24 h)		70		130		150		150		120
Maximum (1 h)										
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		11.MBA
Annual average		2.9
Maximum (8 h)		
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data

City: Vilnius	*Country*: Lithuania

I. GENERAL DATA

		City		Conurbation
Population	(number)	566 000 (1987)		566 000 (1987)
Total area	(km^2)			
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	54° 40' N 25° 19' E		

Major activities and development trends (1980-1990, 1990-2000)
Capital of Lithuania. Commercial, industrial and administrative centre.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Baltic, East Europe
Topography: river basin *(-)*

Climate: Dfb (Köppen-Geiger)
Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	5.6	4.5	8.1
precipitation (mm)		851	
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***3.5 (0)***	***3.1 (0)***	***2.9 (-)***
winter smog index	***20 (0)***	***18 (0)***	***18 (0)***
summer smog index	***6 (+)***	***7 (+)***	***8 (0)***

Station: Vilnius 54° 38' N 25° 17' E

III. EMISSIONS

Emission class	1990
Winter smog emissions[1]	***2***
Summer smog emissions[1]	***2***

Major (industrial) point sources[2]

1992

	Total (t)	power plant (Vilnius CHP) (t)
SO_2	188 204	15 774
NO_x	43 720	3 053
CO	98 931	-
CH	36 661	-
sol.part.	40 591	143
other	23 030	-

VI. AIR QUALITY DATA 1990[3]

Nitrogen dioxide concentrations (µg m^{-3})

average	maximum (20 min)	
30	270	
30	210	
20	180	
27	220	(mean)

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Lead concentrations (µg m^{-3})

average	maximum month
0.03	0.08
0.01	0.02

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

1. Uncertain data.
2. Energy and Environment in Estonia, Latvia and Lithuania (Riso-M-2943 (ed.2) (EN)).
3. Belyland M.E. (ed.), 1991, Annual report on the state of air pollution and harmful pollutant emissions to the cities and industrial centres of the Soviet Union, Air pollution, 1990, St. Petersburg, M.G.O.

City: Volgograd[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 007 000 (1992)	***1 007 000 (1992)***
Total area	(km^2)	440 (1991)	440 (1991)
Built-up area	(km^2)	220 (1992)	***220 (1992)***
Coordinates	(lat-/longitude)	48° 45' N 44° 30' E	

Major activities and development trends (1980-1990, 1990-2000)
One of the largest industrial, cultural and scientific centres of the Russian Federation, very important river port. Industry: refineries, blast furnaces, (ferrous) metallurgy, (petro)chemicals, cement, ship building.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Located on the right bank of the Volga River, extending over 10 kilometres (river basin). *(-)*

Climate: Bsk (Köppen-Geiger)
Meteorology: Wind velocity 0-1 m s^{-1}: 22%, surface inversions 39%, air stagnations 9%.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	7.6	5.3	8.6	7.9
precipitation (mm)				548.9
cloud cover (8^{-1})				5.9
wind speed (m s^{-1})	***5.6 (++)***	***5.8 (++)***	***5.0 (++)***	3.3
winter smog index[2]	***25 (-)***	***24 (-)***	***22 (-)***	
summer smog index	***26 (-)***	***22 (0)***	***31 (-)***	

Station: Volgograd 48° 41' N 44° 21' E

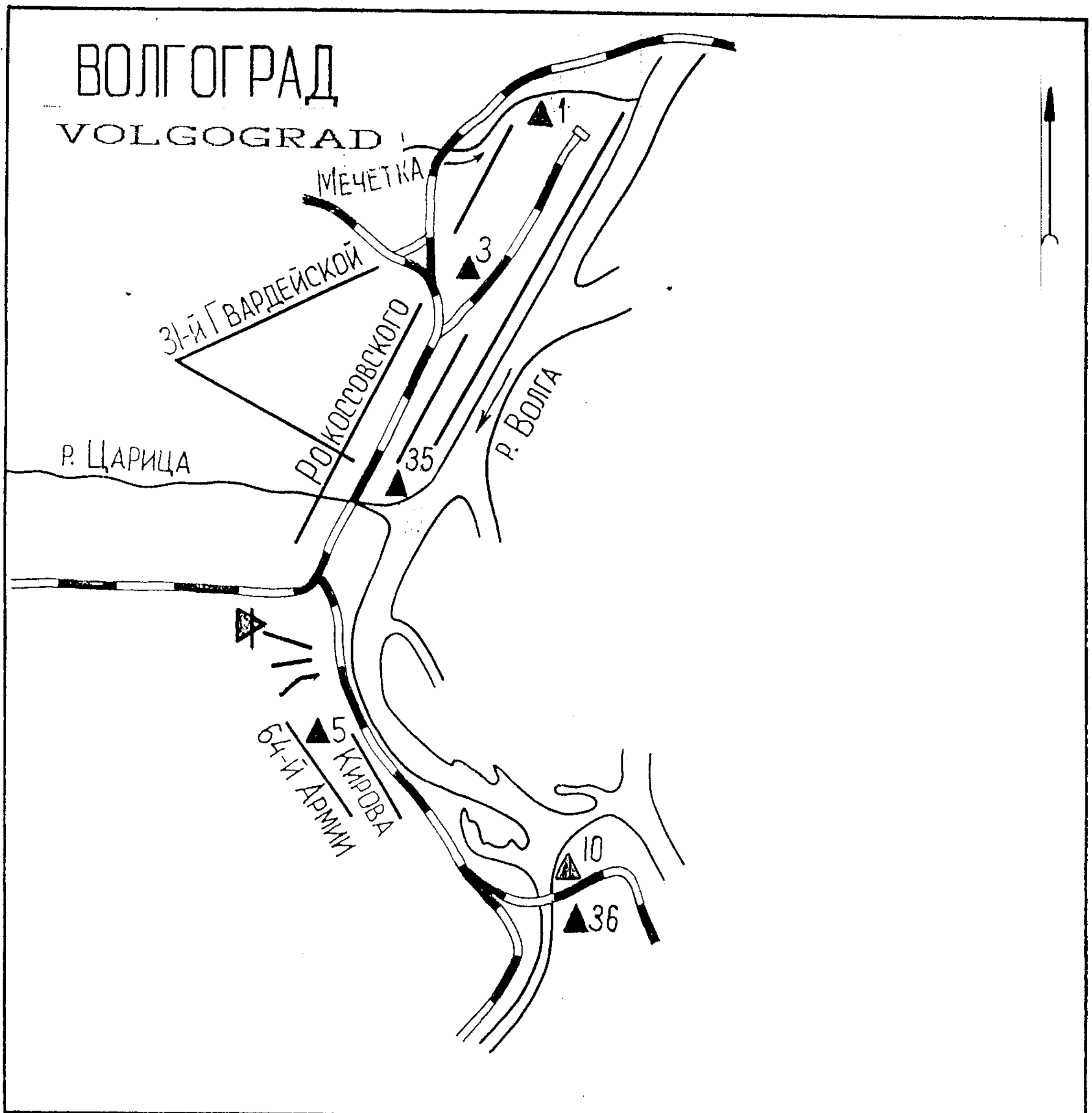
Local wind distribution (1985)[4]

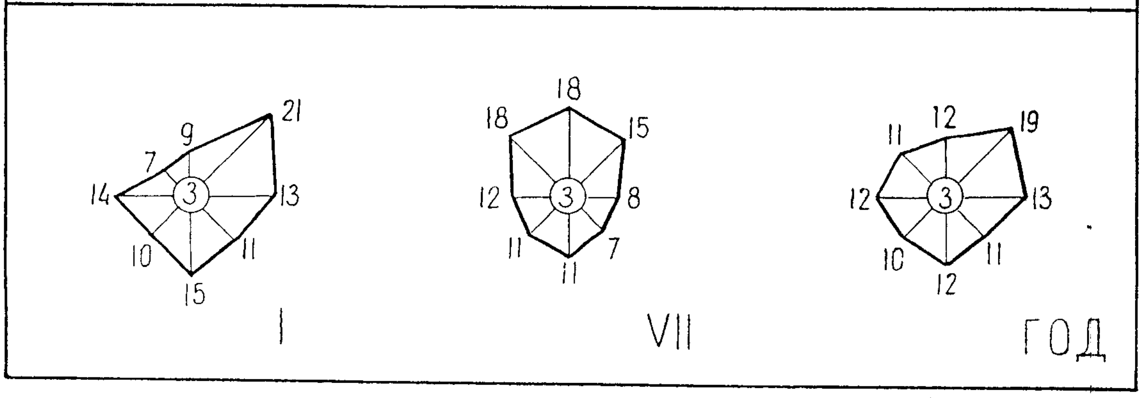
Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	3	5	10	9	9	9	4	4	10	19	9	9	20
m s^{-1}	3.5	4.1	3.8	3.7	3.8	4.0	3.5	4.6	5.1	5.5	4.4	4.0	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	6	3	3	9	6	7	7	5	15	18	12	9	8
m s^{-1}	3.4	2.8	3.0	2.2	2.8	3.0	???	3.4	4.9	4.7	3.8	3.8	

Main topography, city morphology, industrial sources and monitoring network





III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	6.0	91.3		-	
Domestic/space heating						
Industry and power plants	37.6	18.8	59.9		41.8	
Total	37.6	24.8	151.2		41.8	
Per capita (**kg**)	38.1	25.1	153.0		42.3	
Per km^2 (**t**)	170.9	112.7	687.3		190.0	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	6.0	91.3	-	-	
Domestic/space heating						
Industry and power plants	29.5	18.3	52.9	46.8	34.4	0.002
Total	29.5	24.3	144.2	46.8	34.4	
Per capita (**kg**)	29.6	24.4	146.0	46.9	34.5	
Per km^2 (**t**)	134.1	110.5	327.0	212.7	156.4	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***3***

Major (industrial) point sources

Most enterprises are located in the south of the city. In this part of the city industrial sewage is stored from which considerable emissions take place, especially during the summer. In addition to the emissions given in the Table, there are emitted: 696 t hydrogen fluoride, 460 t hydrogen bisulphide and 430 t ammonia.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles	Total traffic activity veh km a^{-1}
Total	187 000	1945 x 10^9
of which:		
· passenger cars	72 500	550 x 10^9
· buses	2 500	95 x 10^9
· freight traffic >3.5 t	112 000	900 x 10^9

Total annual consumption of fuel for traffic

	Consumption (kt a^{-1}) 1985	Consumption (kt a^{-1}) 1991	Average Sulphur content (t) 1985	Average Sulphur content (t) 1991
Diesel oil		55.0		0.2
Petrol/Gasoline		120.0		
LPG				

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating		Annual consumption		Average Sulphur content (t)	
		1985	1991	1985	1991
Fuel oil low sulphur	(t a^{-1})	*521 525*	*352 479*	*4 172*	*2 573*
Fuel oil high sulphur	(t a^{-1})	*241 932*	*196 965*	*6 484*	*3 939*
Coal	(t a^{-1})	*191 505*	*92 090*	*3 696*	*1 446*
Wood	(t a^{-1})	.	.	.	.
Natural/city gas	(10^6 m^3 a^{-1})	*1 196*	*1 503*	.	.
Total	(t a^{-1})			*14 652*	*7 958*

Space/domestic heating: general remarks

The sulphur load of the fuels used for combustion has dropped considerably, because of the increasing use of natural gas and lowering of the sulphur content of oil and coal.

Local policies to reduce air pollution

Industry: Building of a gas purification installation at a metallurgical enterprise is planned.

VI. AIR QUALITY DATA

Monitoring network

6 Stations are operational (State Service for Observations and Control of Environmental Pollution Levels, North-Caucasian Administration for Hydrometeorology). The network has been functioning since 1976.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 1,10,35		No. 10		No. 5		No. 36
Annual average		*9*		12		25		5		27
Winter average				25		59		9		64
Maximum (24 h) *calculated*				*160*		*270*		*67*		*325*
98 percentile (20 min)*				70		130		30		150
Number of days exceeding the WHO-AQG (*+calc.*)				1(*2*)		1(*8*)		0(*0*)		2(*10*)
Number of days exceeding 2 x WHO-AQG				0		0(≥1)		0		0(≥1)

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are high compared to concentrations monitored in other cities of the former Soviet Union. The WHO-AQG is exceeded in some city background areas and at the industrial site.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1,10,35	No. 1,10,35	No. 10	No. 10	No. 5	No. 5	No. 36	No. 36
Annual average		*19*	200	200	200	200	100	200	200	200
Winter average			334	153	167	192	133	91	267	228
Maximum (24 h)										
98 percentile (20 min)				670		470		470		470
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations
Reported TSP concentrations are high. Natural dust (semi-arid climate) increases dust levels. The WHO-AQG is likely to be exceeded on numerous days.

Winter smog classification	1990
Exceedance class[5]	***2***
Exposure class[5]	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1,10,35	No. 1,10,35	No. 35	No. 35	No. 5	No. 5	No. 36	No. 36
Annual average			33	47	30	60	30	50	40	50
Maximum (24 h)										
Maximum (20 min)			430	250	740	340	770	490	420	210
Number of days exceeding the WHO-AQG			2	0	7	1	4	2	1	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are high, annual means show an upward trend. Highest concentrations are observed in the city centre, near highways and in the south industrial sector (station 36). The WHO-AQG is exceeded.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name	1	1
Annual average	5	6
98 Percentile (20 min)		32

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		35
Annual average		0.0018
Maximum monthly average		0.0028

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	5	5
Annual average	2	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	City background	
	1985	1990
Station number/name		1
Annual average		0.03
Maximum monthly average		0.10
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO and Pb concentrations are low and do not exceed WHO-AQG standards.

VII. EFFECTS

Effects of air pollution on health
According to 1988 data, the number of cases of respiratory diseases is 30% higher than the average for the cities of the former Soviet Union.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station. The location of the meteorological station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Voronezh[1]	*Country*: Russian Federation

I. GENERAL DATA

		City	Conurbation
Population	(number)	958 000 (1992)	***958 000 (1992)***
Total area	(km^2)	430 (1986)	430 (1986)
Built-up area	(km^2)	53 (1992)	***53 (1992)***
Coordinates	(lat-/longitude)	51° 40' N 39° 13' E	

Major activities and development trends (1980-1990, 1990-2000)
Important industrial and cultural centre of the Russian Federation. Industry: (petro)chemicals, heavy engineering, building materials, food processing.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Sited on both banks of Voronezh River (river basin). *(-)*

Climate: Dfb (Köppen-Geiger)
Meteorology: Wind velocity 0-1 m s^{-1}: 29%, surface inversions: 26%, air stagnations: 10%.

Averages	1980-1988	1985	1989	1988[2]
temperature (°C)	6.3	5.3	7.6	6.1
precipitation (mm)				685.0
cloud cover (8^{-1})				6.6
wind speed (m s^{-1})	***3.8 (0)***	***4.2 (+)***	***3.4 (0)***	2.9
winter smog index	***31 (-)***	***30 (-)***	***33 (-)***	
summer smog index	***18 (0)***	***19 (0)***	***22 (0)***	

Station: Voronezh 51° 42' N 39° 10' E

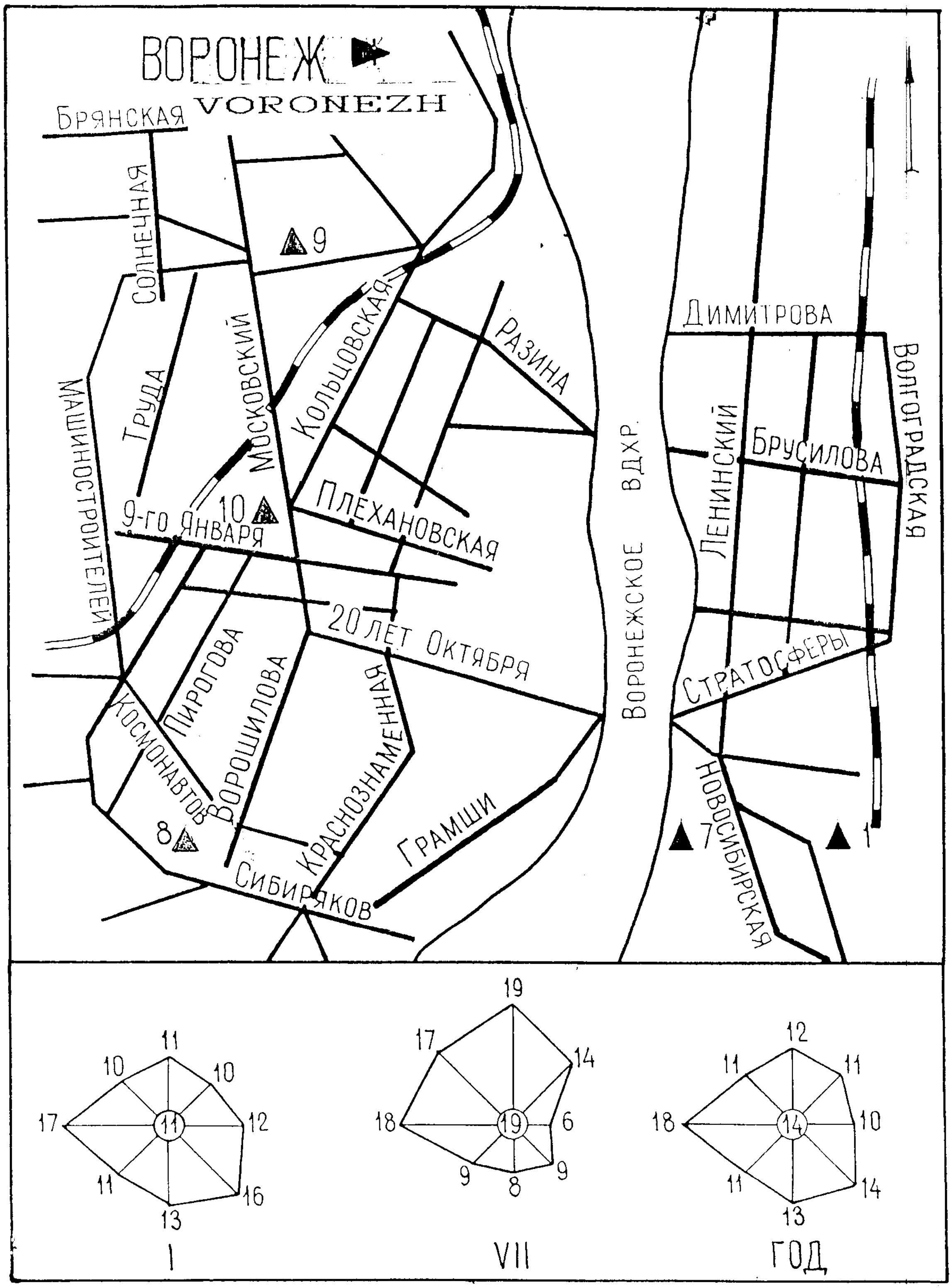
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	7	8	6	5	7	11	9	8	7	15	11	6	15
m s^{-1}	2.8	2.4	2.1	2.3	2.8	3.4	3.5	2.7	3.0	3.3	3.7	3.1	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	3	6	4	2	5	8	5	10	17	20	13	7	-
m s^{-1}	3.1	2.5	2.0	2.6	2.5	3.4	3.0	3.3	3.3	3.6	3.7	2.8	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	10.6	104.5		-	
Domestic/space heating						
Industry and power plants	9.5	4.0	8.6		12.2	
Total	9.5	14.6	113.1		12.2	
Per capita (**kg**)	10.9	16.7	129.7		14.0	
Per km^2 (**t**)	179.3	275.5	2 134.0		230.2	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	8.1	84.9	-	-	
Domestic/space heating						
Industry and power plants	8.7	4.3	6.6	5.3	10.8	0.001
Total	8.7	12.4	91.5	5.3	10.8	
Per capita (**kg**)	9.5	13.6	100.0	5.8	11.8	
Per km^2 (**t**)	164.2	234.0	1 726.4	100.0	203.8	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***1***

Major (industrial) point sources

Low emission sources prevail. Also emitted: ammonia (186 t), hydrogen fluoride (7 t). Most enterprises and power stations are located in the southern part of the city.

Local policies to reduce air pollution

Domestic/space heating: Houses are heated by small boiler-houses. Small boiler-houses are to be closed. The larger units will use gas as fuel.

VI. AIR QUALITY DATA

Monitoring network

5 stations are operational (State Service for Observations and Control of Environmental Pollution Levels). Stations function under the guidance of Centre for Monitoring the Environment, Administration on Hydrometeorology of the Central Chernozem Region (Kursk).

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 8,9,10		No. 9		No.1		No. 7
Annual average		*9*		5		6		5		7
Winter average				9		11		9		11
Maximum (24 h) *calculated*				*46*		*56*		*49*		*82*
98 percentile (20 min)*				23		28		24		38
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0(*0*)		0(*0*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

Reported sulphur dioxide concentrations are low. The WHO-AQG is not exceeded.

Particulate matter: µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 8, 9	No. 8, 9	No. 9	No. 9	No. 1	No. 1	No. 7	No. 7
Annual average		*21*	200	170	200	190	300	200	400	440
Winter average			209	176	200	193	283	178	383	378
Maximum (24 h)										
98 percentile (20 min)			470	520	470	550	580	592	940	1158
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations

Reported TSP concentrations are high, the WHO-AQG is likely to be exceeded.

Winter smog classification	1990
***Exceedance class*[4]**	*2*
***Exposure class*[4]**	*3*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 8, 9	No. 8, 9	No. 8	No. 8	No. 1	No. 1	No. 7	No. 7
Annual average			45	40	50	40	50	40	60	60
Maximum (24 h)										
Maximum (20 min)			290	255	360	290	350	320	300	220
Number of days exceeding the WHO-AQG			0	0	0	0	1	1	0	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are likely to exceed the WHO-AQG at the traffic site and possibly in the industrial district of the city.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	7	7
Annual average	8	10
98 Percentile (20 min)	31	27

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		7
Annual average		0.0023
Maximum monthly average		0.0041

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	1	1
Annual average	1	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		1
Annual average		0.06
Maximum monthly average		0.17
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
CO and Pb concentrations are low and WHO-AQG standards are not exceeded.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station, the location of the meteorological station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

City: Warsaw	*Country*: Poland

I. GENERAL DATA

		City	Conurbation
Population	(number)	1 653 000 (1985)	
Total area	(km^2)		
Built-up area	(km^2)		
Co-ordinates	(lat-/longitude)	52° 13' N 21° 01' E	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: ***Topography***: *(+)*	Climate: (Dfb) Meteorology:

Averages	1980-1989	1985	1989
temperature (°C)	7.7	7.1	9.5
precipitation (mm)	258	184.6	480.7
cloud cover (8^{-1})			
wind speed (m s^{-1})	***3.9 (0)***	***3.4 (0)***	***4.4 (+)***
winter smog index	***16.9 (0)***	***23.9 (-)***	***9.9 (0)***
summer smog index	***10.1 (0)***	***12.4 (0)***	***12.9 (0)***

III. EMISSIONS

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic						
Domestic/space heating						
Power plants	56.3	18.9			34.9 Combustion	
Total	59.3					
Per capita (**kg**)						
Per km^2 (**kg**)						

Emission class	1990
Winter smog emissions[1]	***3***
Summer smog emissions	***4***

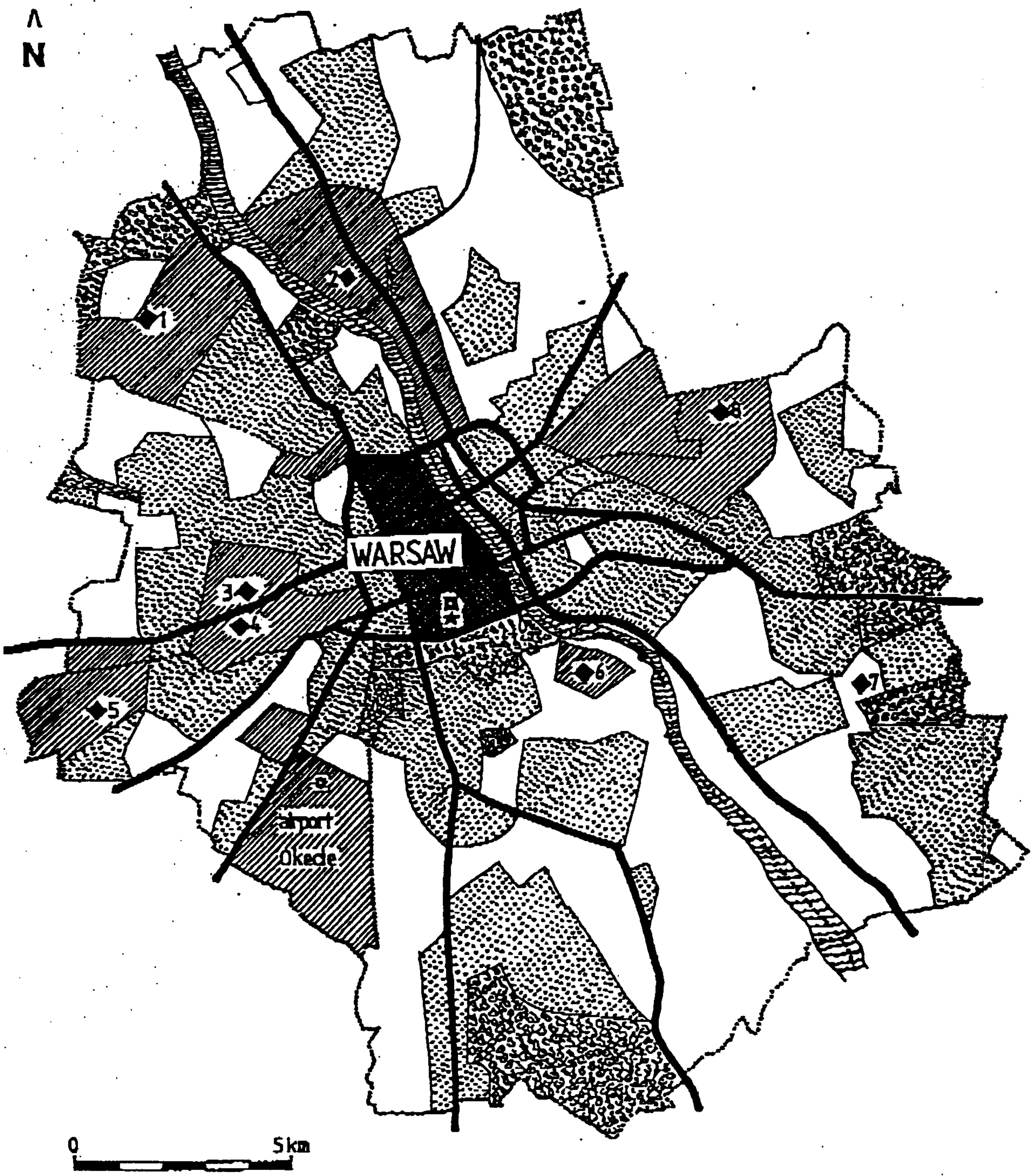
Major (industrial) point sources

(see city map)

1 Steel mill
2 Poker and heat generation plant (1 x 200 m, 2 x 100 m)
3 Mechanical works
4 Heat generation plant
5 Farm tractors factory
6 Poker and heat generation plant (120 m, 2 x 200 m)
7 Electronic factory (industrial power plant store 100 m)
8 Heat generation plant (220 m)

City: Warsaw **Country**: Poland

Main topography, city morphology, industrial sources and monitoring network



Scale 1 : ____________

City centre/Commercial area	City Centre Coordinate
Residential Area	Meteorological (Wind) Station
Industrial Area	Air Quality Monitoring Point
Woodlands/Parks/'Green' Areas	Major Industrial Point Source
Water	Municipal Boundary
Main Road	Motorway

City: Warsaw **Country**: Poland

IV. TRAFFIC DATA

Vehicle statistics and traffic activity	Number of vehicles	Total traffic activity veh km a^{-1}
Total		x 10^9
of which:	605 200	
· passenger cars	532 800	
· buses	4 400	
· freight traffic >3.5 t	49 200	

VI. AIR QUALITY DATA

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1992	1985	19__	1985	19__	1985	19__
Number of stations										
Annual average		*13*		30						
Winter average				43						
Maximum (24 h)				122						
98 percentile (24 h)				83						
Number of days exceeding the WHO-AQG				0						
Number of days exceeding 2 x WHO-AQG				0						

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Suspended particulate concentrations
Regional background concentration TSP in 1990: *24* µg m^{-3}

Winter smog classification	1992
Exceedance class	
Exposure class[1]	*1*

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1992	1985	19__	1985	19__	1985	19__
Number of stations										
Annual average				54						
Maximum (24 h)				175						
Maximum (1 h)										
Number of days exceeding the WHO-AQG				3						
Number of days exceeding 2 x WHO-AQG										

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

City: Warsaw **Country**: Poland

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1992	1985	19__	1985	19__	1985	19__
Number of stations										
Annual average				48						
Summer average				30						
Maximum (1 h)										
Maximum (24 h)				117						
98 percentile (1 h)				102						
Number of days exceeding the WHO-AQG				0						
Number of days exceeding 2 x WHO-AQG				0						
Exceedance class				*1*						

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		
Annual average		1 752
Maximum (24 h)		3 688
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

1. Uncertain data

City: Wroclaw	*Country*: Poland

I. GENERAL DATA

		City	Conurbation
Population	(number)	***664 000 (1988)***	
Total area	(km^2)		
Built-up area	(km^2)	***75***	
Coordinates	(lat-/longitude)	51° 05' N 17° 00' E	

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Central Europe ***Topography***: plain ***(+)***	Climate: Dfb (Köppen-Geiger) Meteorology:		
Averages	1980-1989	1985	1989
temperature (°C)	8.4	7.7	9.9
precipitation (mm)	289	168	437
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***2.8 (-)***	***2.8 (-)***	***2.8 (-)***
winter smog index	***18 (0)***	***22 (-)***	***11 (0)***
summer smog index	***17 (0)***	***14 (0)***	***18 (0)***

III. EMISSIONS

Emission class	1990
Winter smog emissions	
Summer smog emissions[1]	***2***

1. Uncertain data.

City: Yaroslavl[1]	*Country*: Russian Federation

I. GENERAL DATA

		City		Conurbation
Population	(number)	619 000 (1992)		***619 000 (1992)***
Total area	(km^2)	180 (1991)		***180 (1991)***
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	57° 34' N 39° 52' E		

Major activities and development trends (1980-1990, 1990-2000)
Industrial city, centre of ancient Russian architecture. Industry: (petro)chemicals, heavy engineering, food processing.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Situated on the central part of the Russian Plain. The city extends over 30 km along the Volga river (north-west to south-east). The width of the city is not more than 12 km. *(-)*

Climate: Dfb (Köppen-Geiger)
Meteorology: Wind velocity 0-1 m s^{-1}: 17%, surface inversions: 31%, air stagnations: 9%.

Averages	1980-1989	1985	1989	1988[2]
temperature (°C)	3.8	1.9	5.9	3.9
precipitation (mm)				565.9
cloud cover (8^{-1})				6.9
wind speed (m s^{-1})	***2.3 (-)***	***2.5 (-)***	***2.2 (-)***	4.6
winter smog index	***51 (--)***	***48 (--)***	***48 (--)***	
summer smog index	***16 (0)***	***11 (0)***	***24 (0)***	
Station:				Rostov 57° 12' N 39° 25' E

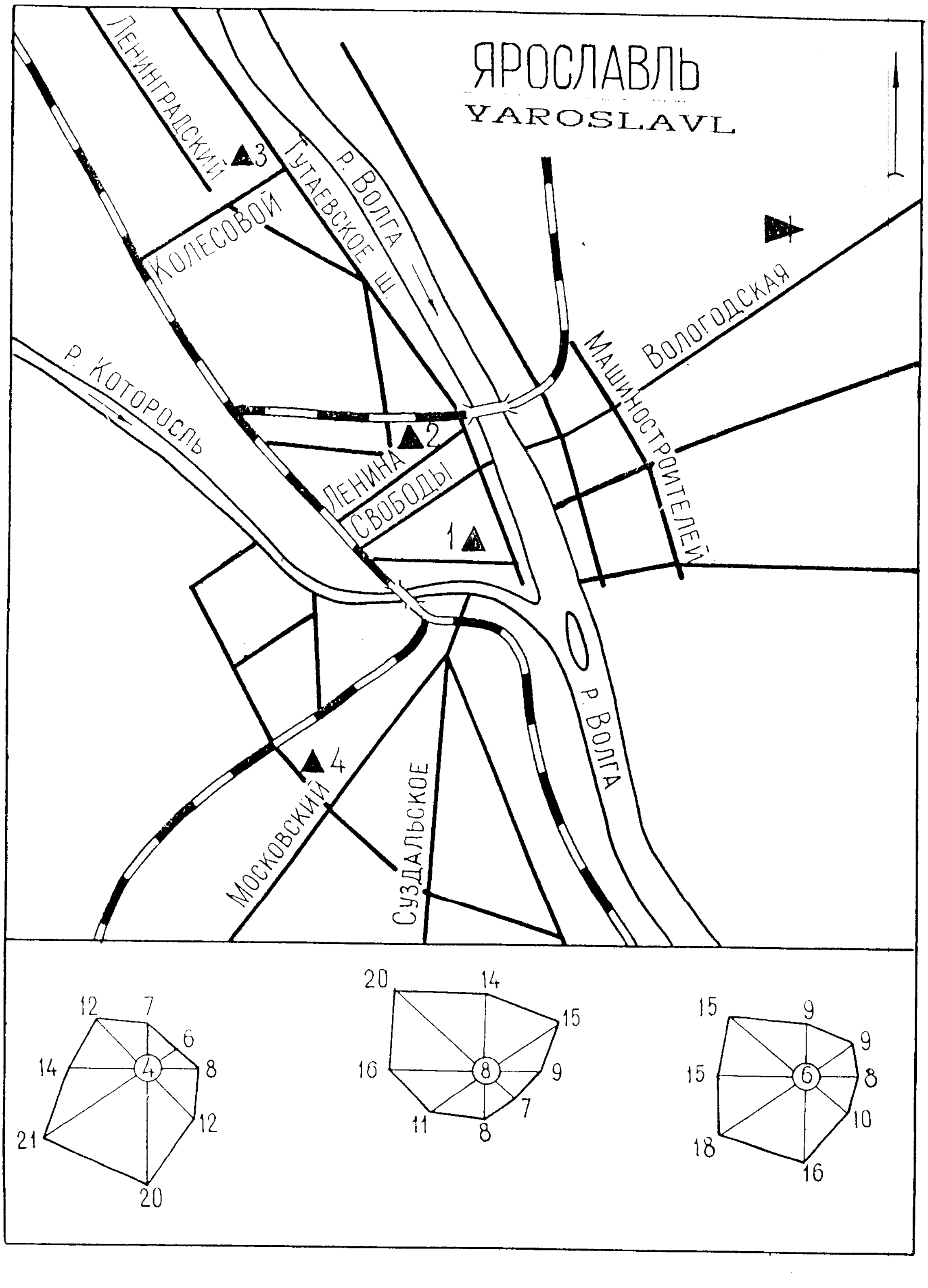
Local wind distribution (1985)[3]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	6	8	5	5	7	13	10	7	9	10	13	7	3
m s^{-1}	6.2	5.4	5.0	5.2	4.7	5.1	5.4	5.4	5.5	5.9	5.4	5.2	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4	6	6	4	8	11	11	8	11	10	12	9	2
m s^{-1}	4.5	4.2	3.8	4.3	4.6	4.4	4.8	5.1	4.8	5.4	5.5	5.2	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	2.9	41.6		-	
Domestic/space heating						
Industry and power plants	37.9	15.4	63.0		22.0	
Total	37.9	18.3	104.6		22.0	
Per capita (**kg**)	59.8	28.9	165.0		34.7	
Per km^2 (**t**)	210.6	101.7	581.1		122.2	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	2.9	41.6	-	-	
Domestic/space heating						
Industry and power plants	35.3	15.7	38.8	78.4	21.5	0.0026
Total	35.3	18.6	80.4	78.4	21.5	
Per capita (**kg**)	55.7	29.3	126.8	123.7	33.9	
Per km^2 (**t**)	196.1	103.3	446.7	435.6	119.4	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***4***

Major (industrial) point sources

The prevailing heights of stacks are lower than 20 m (70%). Industrial enterprises release many specific pollutants (sulphuric acid, hydrogen sulphide, carbon bisulphide, lead, benzo(a)pyrene).

VI. AIR QUALITY DATA

Monitoring network
4 Stations are operational (State Service for Observations and Control of Environmental Pollution Levels). The stations function under the guidance of the Nizhniy Novgorod Centre for Monitoring the Environment of the Upper Volga Region (Administration for Hydrometeorology).

SO_2 concentrations $\mu g/m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 1		No. 1		No. 3		No. 2
Annual average		*5*		2		2		3		6
Winter average				3		3		7		8
Maximum (24 h) *calculated*				*34*		*34*		*51*		*84*
98 percentile (20 min)*				14		14		21		37
Number of days exceeding the WHO-AQG (*+calc.*)				0(*0*)		0(*0*)		0(*0*)		0(*0*)
Number of days exceeding 2 x WHO-AQG				0		0		0		0

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 $\mu g/m^{-3}$

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations are very low, the WHO-AQG is not likely to be exceeded.

Particulate matter: $\mu g/m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1	No. 1	No. 1	No. 1	No. 3	No. 3	No. 2	No. 2
Annual average		*13*	100	100	100	100	100	100	100	200
Winter average			100	100	100	100	100	100	100	150
Maximum (24 h)										
98 percentile (20 min)			390	390	390	390	390	390	390	780
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Suspended particulate concentrations
Reported TSP concentrations are low (near lower limit of monitor).

Winter smog classification	1990
Exceedance class[4]	***4***
Exposure class[4]	***2***

NO_2 concentrations $\mu g/m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 1	No. 1	No. 1	No. 1	No. 3	No. 3	No. 2	No. 2
Annual average			40	10	40	10	40	10	50	20
Maximum (24 h)										
Maximum (20 min)			190	120	190	120	180	110	220	120
Number of days exceeding the WHO-AQG			1	0	1	0	0	0	1	0
Number of days exceeding 2 x WHO-AQG			0	0	0	0	0	0	0	0

WHO-AQG NO_2 (24h max.) = 150 $\mu g/m^{-3}$

Nitrogen dioxide concentrations
Reported Nitrogen dioxide concentrations are very low compared to concentrations monitored in other cities of the former Soviet Union. Still, the WHO-AQG is likely to be exceeded on one to a few days per year.

CO concentrations mg/m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	3	3
Annual average	1	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

B(a)P concentrations $\mu g/m^{-3}$	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		4
Annual average		0.0026
Maximum monthly average		0.0047
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

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1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Not the named ODS station, the location of the meteorological station is shown on the map.

3. The location of the meteorological station is shown on the map.

4. Uncertain data.

City: Zagreb	*Country*: Croatia

I. GENERAL DATA

		City		Conurbation
Population	(number)	707 000 (1992)		***954 000 (1992)***
Total area	(km^2)			1932
Built-up area	(km^2)			***80 (1992)***
Coordinates	(lat-/longitude)	45° 48' N 15 58' E		

Major activities and development trends (1980-1990, 1990-2000)
Capital of Croatia. Administrative, cultural and industrial centre. Chemical industry. In 1993, the conurbation area will be reduced to 1 298 km^2 (868 000 inhabitants).

II. TOPOGRAPHY AND CLIMATOLOGY

Region: Balkan (Central Europe)
Topography: river basin, mountains nearby (122-160 m a.s.l.) *(-)*

Climate: Cfb (Köppen-Geiger)
Meteorology: frequent inversions

Averages	1980-1989	1985	1989
temperature (°C)	9.9	10.1	11.0
precipitation (mm)	800	937	989
cloud cover (8^{-1})			
wind speed (m s^{-1})	***1.8 (--)***	***2.0 (--)***	***1.6 (--)***
winter smog index [1]	***22 (-)***	***13 (0)***	***29 (-)***
summer smog index	***44 (-)***	***47 (-)***	***40 (-)***

Station: Zagreb Pleso 45° 44' N 16° 09' E

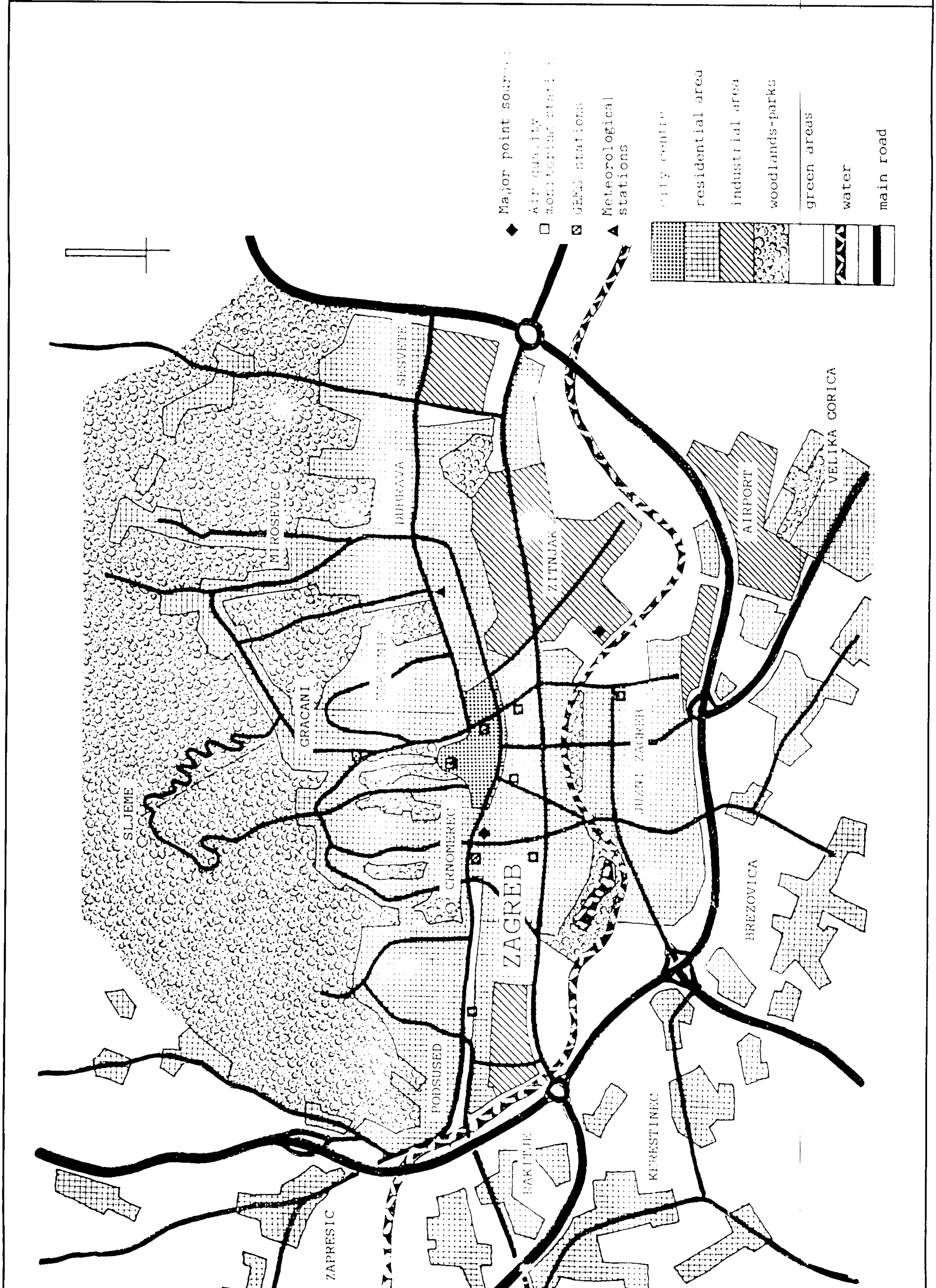
Local wind distribution (1985)[2]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	3.8	17.2	20.7	4.9	5.1	4.3	6.7	6.1	10.4	10.5	6.0	2.6	1.5
m s^{-1}	1.0	2.3	1.6	1.1	1.6	1.7	1.5	1.9	2.4	1.7	1.7	0.8	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	4.5	15.9	3.3	5.2	3.8	6.5	4.9	10.5	3.0	5.3	4.7	5.6	26.8
m s^{-1}	1.0	1.9	1.8	1.6	1.7	1.4	1.5	1.8	2.6	2.0	1.7	1.5	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	0.5	3.5	16.0	3.0	0.5	0.5
Domestic/space heating	2.8	1.3	7.2	1.2	1.2	
Industry and power plants	6.3	2.8	0.7	0.1	0.3	
Total	9.6	7.5	23.9	4.3	1.57	
Per capita (**kg**)	10.1	7.9	25.0	4.5	1.65	
Per km^2 (**t**)	120	94	299	59	20	

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***4***

Major (industrial) point sources

(see city map)
Combined heat-power stations in NW and SE of the city (2), stacks 200 m (total energy output 11654 TJ)
Chemical industry: solvents, herbicides, pigments, dyes, pharmaceuticals.

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

	Number of vehicles 1990	Total traffic activity veh km a^{-1}
Total	226 038	x 10^9
of which:		
· passenger cars	196 820	
· buses	1 076	
· freight traffic >3.5 t	23 908	

Total annual consumption of fuel for traffic

	Consumption (kt a^{-1}) 1985	Consumption (kt a^{-1}) 1990	Average Sulphur content (t) 1985	Average Sulphur content (t) 1990
Diesel oil	81.4	105.6	244	348
Petrol/Gasoline	98.1	135.0	30	74
LPG		4.0		2

Traffic

Public transport: buses and tramway. Very few cars are equipped with catalytic converters. Pb content petrol: 0.6 g/l. Traffic jams in rush hours.

V. SPACE/DOMESTIC HEATING

Total annual consumption of fuel for space/domestic heating

		Annual consumption		Average Sulphur content (percent)	
		1985	1988	1985	1988
Fuel oil low sulphur	(t a^{-1})		98 019		up to 2
Fuel oil high sulphur	(t a^{-1})		234 171		2-4
Coal	(t a^{-1})		120 772		0.5-3
Wood	(t a^{-1})		61 684		
Natural/city gas	(10^6 m^3 a^{-1})		530		
Total	(t a^{-1})				

Space/domestic heating: general remarks

1986 survey (2500 households, 1.2% of total)

26.5% connected to district or local heating plant
27.5% gas
2.5% liquid fuels
19% coal/wood
7% electricity

Local policies to reduce air pollution

Industry: Implemented: higher chimneys for power plants and other stationary sources, introduction of dust arrestors, gradual translocation of industry to outskirts of the city. Obligation to prepare environmental impact assessment for each new or reconstructed air pollution source and to use all available control measures. Clean air act and emission inventory are now being prepared as an instrument for planning measures.
Traffic: pedestrian zones, one-way traffic, detour for freight and transit traffic.
Domestic/space heating: Transition to the use of gas and district heating. Limitation of sulphur content of fuels to 1% (local decision, 1978).

VI. AIR QUALITY DATA

Monitoring network

Zagreb's Air Quality Monitoring Network consists of 9 stations to monitor sulphur dioxide and smoke, 3 stations to monitor TSP.

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			2	2	centre	centre				
Annual average		*13*	97	54	122	69			81	48
Winter average			146	63	193	79			136	59
Maximum (24 h)			334	180	460	260			321	207
98 percentile (24 h)			245	120	321	162			231	126
Number of days exceeding the WHO-AQG			93	8	146	15			85	4
Number of days exceeding 2 x WHO-AQG			12	1	24	1			2	0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Sulphur dioxide concentrations

(acidimetric) (GEMS-AIR stations) Concentrations show a downward trend, the WHO-AQG still is extensively breached at the industrial site and in the city centre.

Black smoke concentrations		
mean of 3 stations (suburb, centre and industrial)		
	1985	1990
annual average	43	23
winter average	71	32
maximum (24h)	272	158
98 p (24h)	211	87
number exc. AQG 1x	19	2
number exc. AQG 2x	1.7	0
WHO-AQG black smoke (24h max.) = 125 µg m^{-3}		

Particulate matter: TSP µg m^{-3}	**Observed concentrations**									
	Reg. background		Suburb		City centre		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	19__	1985	19__
Number of stations			1	1	centre	centre				
Annual average		*22*	120	67	136	146			95	
Winter average			133	85	154	152			121	
Maximum (24 h)			294	215	529	577			333	
98 percentile (24 h)			250	180	270	300			260	
Number of days exceeding the WHO-AQG			86	13	69	118			44	
Number of days exceeding 2 x WHO-AQG			7	0	4	8			4	

WHO-AQG TSP (24h max.) = 120 µg m^{-3}

Suspended particulate concentrations	
TSP:	Concentrations are high, and do not show a clear trend. The WHO-AQG is exceeded on numerous days.
Black smoke:	Concentrations show a downward trend, the WHO-AQG is still likely to be exceeded.

Winter smog classification	1990
Exceedance class	***2***
Exposure class[3]	***3***

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Suburb	City centre
	1985	1990
Station number/name		
Annual average	0.8	0.96
Maximum monthly average	1.3	1.46
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Lead concentrations
Pb is monitored only on weekdays. Concentrations are high (residential site). The WHO-AQG is likely to be exceeded, especially in the city centre and near busy streets.

1. Less than 75% of the data available.

2. The location of the meteorological station is shown on the map.

3. Uncertain data.

City: Zaporozhe[1]	*Country*: Ukraine

I. GENERAL DATA

		City		Conurbation
Population	(number)	895 000 (1992)		***895 000 (1992)***
Total area	(km^2)	318 (1991)		***318 (1991)***
Built-up area	(km^2)			
Coordinates	(lat-/longitude)	47° 50' N 35° 10' E		

Major activities and development trends (1980-1990, 1990-2000)
Important industrial centre of Ukraine. Industry: metallurgy (ferrous and non-ferrous), heavy engineering.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: East Europe
Topography: Sited along the Dnieper River. Main part of the city is located on the low left bank of the Dnieper (shallow river basin). ***(-)***

Climate: Bsk (Köppen-Geiger)
Meteorology: Surface inversions: 6%, low wind speed: 18%, air stagnations: 9%, (in summer at night 20%.

Averages	1980-1989	1985	1989	1988[3]
temperature (°C)	9.3	7.9	10.5	9.0
precipitation (mm)				615.5
cloud cover (8^{-1})				5.7
wind speed[2] ***($m\ s^{-1}$)***	***4.0 (+)***	***3.7 (0)***	***4.0 (+)***	1.8
winter smog index[2]	***20 (0)***	***26 (-)***	***15 (0)***	
summer smog index	***29 (-)***	***25 (-)***	***30 (-)***	

Station: Zaporozhe 47° 48' N 35° 15' E

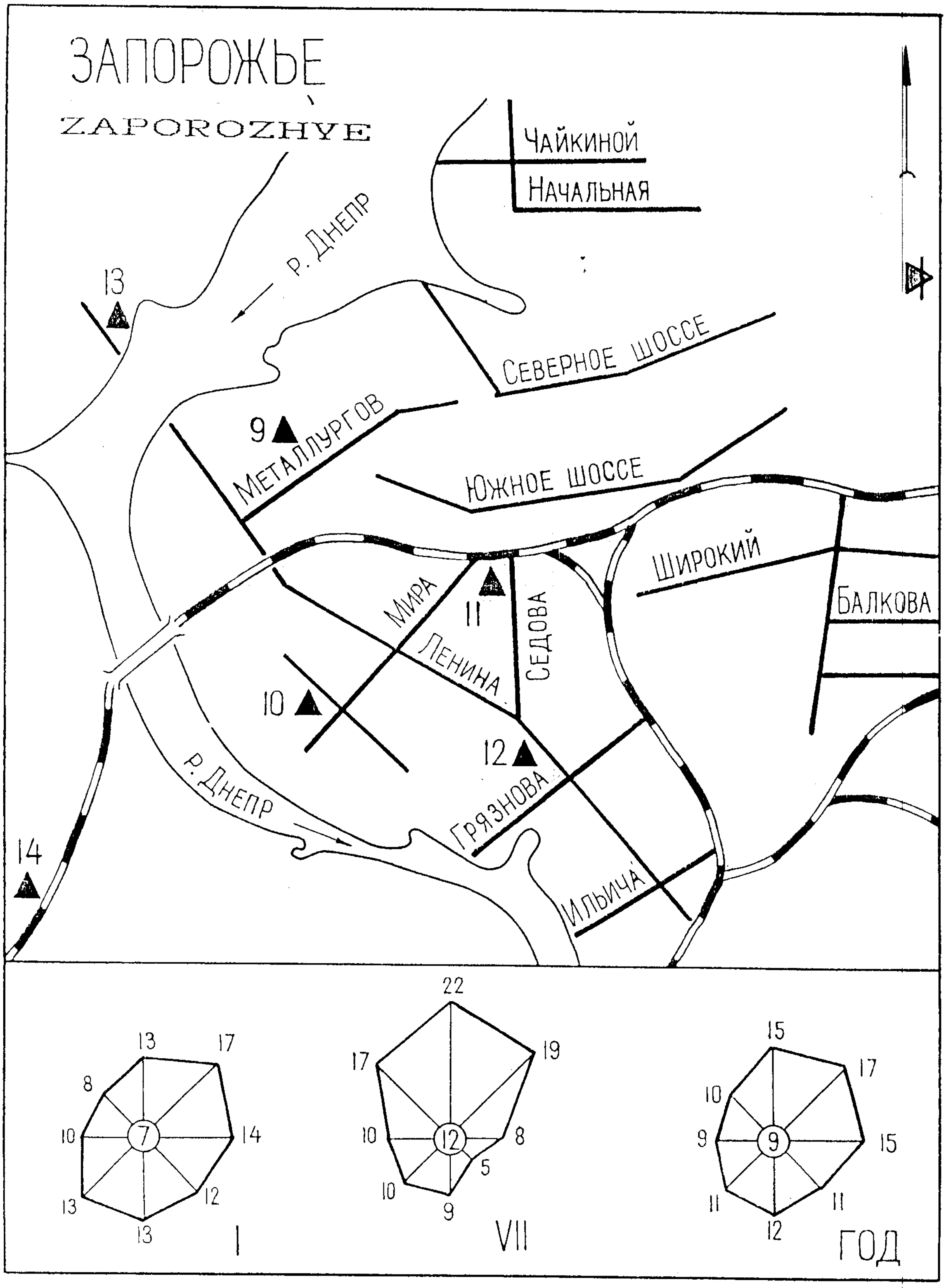
Local wind distribution (1985)[4]

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	11	9	7	7	7	10	9	9	8	8	11	8	12
$m\ s^{-1}$	2.6	2.4	2.4	2.6	3.3	3.4	1.8	2.0	2.2	2.3	2.5	2.5	

Local wind distribution (1990)

Direction	N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	calm
Frec. %	7	9	6	5	7	5	11	9	9	10	10	12	13
$m\ s^{-1}$	1.9	1.9	1.9	2.7	2.2	1.6	1.7	2.0	2.2	2.0	2.2	2.2	

Main topography, city morphology, industrial sources and monitoring network



III. EMISSIONS

Annual emissions per source and totals in 1988 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.3	82.1		-	
Domestic/space heating						
Industry and power plants	25.2	14.3	146.8		69.7	
Total	25.2	19.6	228.9		69.7	
Per capita (**kg**)	28.8	22.4	261.6		79.7	
Per km^2 (**t**)	79.3	61.6	719.8		219.2	

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	-	5.6	86.9		-	
Domestic/space heating						
Industry and power plants	24.9	14.4	139.2	3.5	58.6	0.0005
Total	24.9	20.0	226.1	3.5	58.6	
Per capita (**kg**)	28.1	22.6	255.5	4.0	66.2	
Per km^2 (**t**)	78.5	63.1	713.2	11.0	184.9	

Emission class	1990
Winter smog emissions	***3***
Summer smog emissions	***2***

Major (industrial) point sources

Low sources of emissions prevail. The industrial enterprises are located in the eastern part of the city. The basic contribution to industrial emissions (65%) is made by ferrous metallurgical plants. In addition to the emissions given in the Table: 244 t hydrogen sulphide, 125 t ammonia, 568 t hydrogen chloride, 16 t sulphuric acid, 305 t carbon bisulphide, 391 t fluoric compounds, 451 t chlorine and 16 t phenol.

VI. AIR QUALITY DATA

Monitoring network
6 stations are operational (State Service for monitoring the state of the natural environment in Ukraine). The Ukraine Centre for Radioactivity and Hydrometeorological Monitoring (State Committee of the Ukraine for Hydrometeorology) is in charge of methodology.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations				No. 9,13,14		No. 13		No. 10		No. 12
Annual average		*17*		22		24		25		28
Winter average				27		27		28		33
Maximum (24 h) *calculated*				*140*		*140*		*135*		*152*
98 percentile (20 min)*				80		80		80		90
Number of days exceeding the WHO-AQG (*+calc.*)				(*2*)		(*2*)		(*1*)		(*2*)
Number of days exceeding 2 x WHO-AQG										(*≥1*)

* based on 20-minute values, sampled 3 times a day

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations
Reported sulphur dioxide concentrations do not exceed the WHO-AQG. Highest concentrations are observed in the industrial area (station 12).

Particulate matter: $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 9,13,14	No. 9,13,14	No. 13	No. 13	No. 10	No. 10	No. 12	No. 12
Annual average		*36*	233	207	200	330	300	130	200	430
Winter average			200	187	150	280	230	180	220	330
Maximum (24 h)										
98 percentile (20 min)			905	790	780	970	890	580	470	1410
Number of days exceeding the WHO-AQG										
Number of days exceeding 2 x WHO-AQG										

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Suspended particulate concentrations
Reported TSP concentrations are high, especially at the industrial site and in the residential area in the north-western part of the city (station 13). The WHO-AQG is likely to be exceeded on numerous days per year.

Winter smog	1990
Exceedance class[5]	***2***
Exposure class[5]	***3***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	1990
Number of stations			No. 9,13,14	No. 9,13,14	No. 9	No. 9	No. 10	No. 10	No. 12	No. 12
Annual average			80	83	100	90	100	110	80	100
Maximum (24 h)										
Maximum (20 min)			643	427	800	430	730	530	780	490
Number of days exceeding the WHO-AQG						<u>51</u>		<u>52</u>		
Number of days exceeding 2 x WHO-AQG						<u>1</u>		<u>2</u>		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
Reported nitrogen dioxide concentrations are very high. The WHO-AQG is exceeded on numerous days at the traffic site and in some residential districts. In 1985 nitrogen dioxide concentrations were measured 2 times per day. WHO-AQG exceedances were not calculated for this year.

Formaldehyde concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name	11	11
Annual average	23	5
98 Percentile (20 min)	95	30

Benzo(a)pyrene concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		11
Annual average		0.0075
Maximum monthly average		0.0188

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name	10	10
Annual average	1	1
Maximum (8 h)		
Number of days exceeding the WHO-AQG	0	0
Number of days exceeding 2 x WHO-AQG	0	0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations µg m^{-3}	Highest observed concentrations	
	Industrial site	
	1985	1990
Station number/name		11
Annual average		0.10
Maximum monthly average		0.20
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 µg m^{-3}

Carbon monoxide concentrations/Lead concentrations
Reported CO and Pb concentrations are low and do not exceed WHO-AQG standards.

1. Figures and text printed in italics (except for concentration data) are provided by the city's contact person.

2. Less than 75% of the data available.

3. Not the named ODS station, the location of the meteorological station is shown on the map.

4. The location of the meteorological station is shown on the map.

5. Uncertain data.

City: Zaragoza	**Country**: Spain

I. GENERAL DATA

		City		Conurbation
Population	(number)	***599 000 (1990)***		
Total area	(km^2)			
Built-up area	(km^2)	***1 062 (1990)***		
Co-ordinates	(lat-/longitude)	41° 39' N 0° 54' E		

Major activities and development trends (1980-1990, 1990-2000)
Zaragoza is a commercial and administrative city. The industrial activity is located in industrial sites outside the city. Exceptionally, there are some small factories surrounded by buildings. Zaragoza has been the Spanish city that grew most for this century. In the 80's, there was an increase during the first 5 years and it was all the contrary during the last 4 years. Now the elder people are increasing and the babies are decreasing, so that the population is changing.

Municipalities in conurbation: Zaragoza, Cuarte, Cariñena, Tarazona, Borja, La Almunia de Doña Godina, Zuera, El Burgo de Ebro, Alfajarin, Fuentes de Ebro.

II. TOPOGRAPHY AND CLIMATOLOGY

Region: North Eastern Spain. Nexus between Cantabrico and Mediterranean.
Topography: 200 m high above the sea level. River Ebro crosses Zaragoza from north west to south east. Situated in the Ebro depression ***(-)***.

Climate: Mediterranean with continental tendencies (Bsh).
Meteorology: Little Precipitation, hard winters. Cold and dry winds from north (cierzo).

Averages	1980-1989	1985	1989
temperature (°C)	14.7	16.4	15.3
precipitation (mm)	273.4	227.3	302.9
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***4.8 (+)***	***4.7 (+)***	***4.0 (+)***
winter smog index[1]	***12.3 (0)***	***5.0 (+)***	***19.1 (0)***
summer smog index	***47.7 (-)***	***60.1 (-)***	***50.3 (-)***

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	1	0.7	4.2	13.3	8.2	0.5	0.8
1985	Wind speed $m\ s^{-1}$	1.5	1.1	4.1	3.7	4.9	1.1	1.9
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	1.1	3.8	11.2	35.2	4.2	15.8	
	Wind speed $m\ s^{-1}$	3	5.8	6.3	13.2	3.7	0.5	

LOCAL WIND DISTRIBUTION (WIND ROSE)

Direction (30° sectors)		**N 345-15**	**NNE 15-45**	**ENE 45-75**	**E 75-105**	**ESE 105-135**	**SSE 135-165**	**S 165-195**
Average windrose	Freq. %	0.9	1.5	1.8	10.8	10.8	0.7	0.8
1990	Wind speed $m\ s^{-1}$	1.1	2.1	2.4	3.0	6.0	0.9	1.4
Direction (30° sectors)		**SSW 195-225**	**WSW 225-255**	**W 255-285**	**WNW 285-325**	**NNW 315-345**	**Wind still**	
	Freq. %	1.1	3.9	10.5	34.6	6.3	16.3	
	Wind speed $m\ s^{-1}$	1.9	6.3	4.7	11.5	5.4	0.5	

City: Zaragoza **Country**: Spain

Main topography, city morphology, industrial sources and monitoring network

City: Zaragoza **Country**: Spain

III. EMISSIONS

Annual emissions per source and totals in 1990 (kt a^{-1})

	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	1.4	1.4	10.2	1.5	0.077	
Domestic/space heating	3.15	0.42	0.35	0.13	0.08	
Industry and power plants	0.26	1.13	0.08	0.002	0.7	
Total	4.81	2.95	10.63	1.632	0.857	
Per capita (**kg**)	8.1	5.0	17.9	2.7	1.4	
Per km^2 (**t**)	4.5	2.8	10.0	1.5	0.8	

Major (industrial) point sources

(see city map)
The factories are located in industrial sites, outside the city centre.
The most important industries in Zaragoza are: Paper, steel, agricultural products.

V. SPACE/DOMESTIC HEATING

Space/domestic heating: general remarks

In the city centre there are about 120 coal domestic heatings.

Local policies to reduce air pollution

Industry:
Main industries are far from the city centre, although there are some exceptions with houses surrounding factories.

Traffic:
Public transportation (buses and axis) has its own special roads. There is limited parking in several places of the city. There are fast roads, for not entering the city centre.

VI. AIR QUALITY DATA

Monitoring network

Zaragoza has an automatic network for atmospheric control. It is run by the environmental services and there are 7 stations; remote and mobile, spread all over the city (urban and industrial sites).

SO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	19__	1985	19__	1985	1992	1985	1992
Number of stations								3		1
Annual average		*3*						50		6
Winter average								55		6
Maximum (24 h)								165		12
98 percentile (24 h)								145		11
Number of days exceeding the WHO-AQG								7		0
Number of days exceeding 2 x WHO-AQG								0		0

WHO-AQG SO_2 (24h max.) = 125 µg m^{-3}

Suspended particulate concentrations

Regional background concentration TSP in 1990: *8* µg m^{-3}

Winter smog classification	1990
Exceedance class	*1*
Exposure class	*4*

City: Zaragoza **Country**: Spain

NO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	19__	1985	19__	1985	1992	1985	19..
Number of stations								3		2
Annual average								78		22
Maximum (24 h)								206		48
Maximum (1 h)										
Number of days exceeding the WHO-AQG								37		0
Number of days exceeding 2 x WHO-AQG								0		0

WHO-AQG NO_2 (24h max.) = 150 $\mu g\ m^{-3}$

CO concentrations $mg\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		Miguel Servet
Annual average		4
Maximum (8 h)		
Number of days exceeding the WHO-AQG		0
Number of days exceeding 2 x WHO-AQG		0

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Pb concentrations $\mu g\ m^{-3}$	Highest observed concentrations	
	Traffic site	
	1985	1992
Station number/name		Paraninfo
Annual average		1.72
Maximum monthly average		2.21
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG Lead (annual average) = 0.5 $\mu g\ m^{-3}$

1. Uncertain data

***City*:** Zurich	***Country*:** Switzerland

I. GENERAL DATA

		City	Conurbation
Population	(number)	356 000 (1991)	***356 000 (1991)***
Total area	(km^2)	92 (1991)	92 (1991)
Built-up area	(km^2)	24 (1991)	***24 (1991)***
Coordinates	(lat-/longitude)	47° 23' N 8° 33' E	

Major activities and development trends (1980-1990, 1990-2000)
Zurich is an important commercial centre (shopping, trade, banks). Mainly light industry (electrotechnical and paper) is concentrated in the middle west part of the city. The number of people in the industrial sector is declining, that of the commercial and trade sector is on the rise. The population has decreased from 440 000 in 1960 to 356 000 in 1990 but is more or less stable in recent years. The number of commuters entering the city on weekdays is about 130 000.
Although the number of inhabitants has decreased, the built-up area of Zurich has grown by 28% since 1970. Especially the area occupied with offices and parking lots has grown tremendously, 91% and 173% in the period 1970-1988 respectively. Residential areas are most important in absolute terms (38% of the total area in 1988). The proportion of built-up area in the city still rises and the increase was more than 10 percent in some districts in the period 1980-1987. The mean degree of urbanization in Zurich is 26% (city centre 80%).

II. TOPOGRAPHY AND CLIMATOLOGY

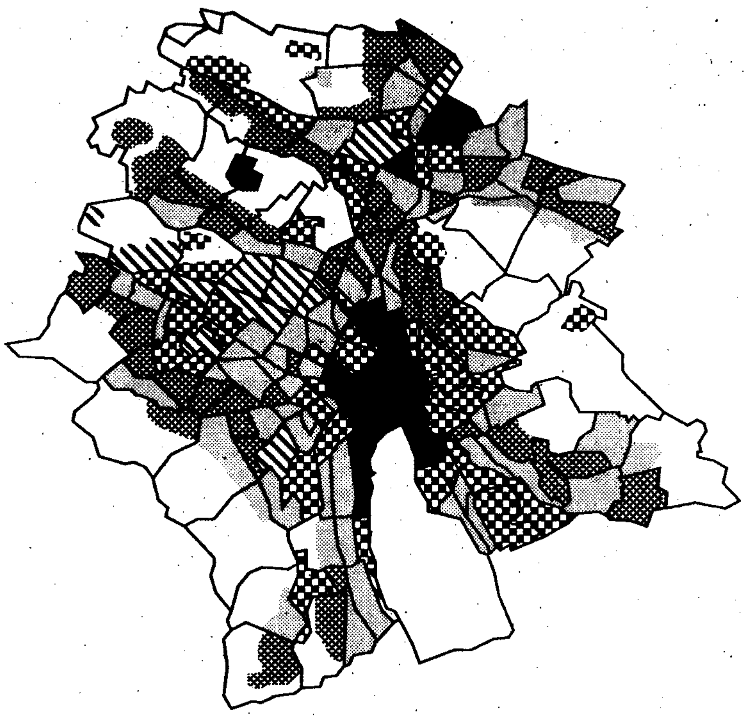
Region: West Europe
***Topography*:** Sited near lake Zurich in a NW-SW valley *(--)*

Climate: Cfb Maritime West coast climate.
Meteorology: Frequent diurnal inversions

Averages	1980-1989	1985	1989
temperature (°C)	8.9	8.6	9.6
precipitation (mm)	900	970	955
cloud cover (8^{-1})			
wind speed ($m\ s^{-1}$)	***1.9 (--)***	***2.0 (--)***	***1.8 (--)***
winter smog index	***10 (0)***	***8 (+)***	***8 (+)***
summer smog index	***18 (0)***	***19 (0)***	***11 (0)***

Station: Zürich 47° 23' N 8° 34' E

Main topography, city morphology, industrial sources and monitoring network



Wohngebiete, Wohnanteil über 80 % der Bruttogeschossfläche (BGF) [1]

Wohnmischgebiete, Wohnanteil 60 - 80 % der BGF

Mischgebiete, Wohnanteil unter 60 %, Lager und Produktionsanteil unter 40 % der BGF

Industrie und Gewerbegebiete, Lager und Produktionsanteil über 40 % der BGF

Citygebiete, Büro und Verkaufsanteil über 40 % der BGF

III. EMISSIONS

Annual emissions per source and totals in 1983 (t a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	160	2980	32080	3560	33	23
Domestic/space heating						
Industry and power plants						
Total	4050	4650	36640	4270	220	24
Per capita (**kg**)	11	13	101	12	1	0.1
Per km^2 (**t**)	174	200	1573	183	9	1.04

Annual emissions per source and totals in 1989 (t a^{-1})

City	SO_2	NO_x	CO	VOC	Particulate matter	Pb
Traffic	150	3520	15840	2510	23	13
Domestic/space heating	2660	1820	780	420	54	3
Industry and power plants	1030	510	120	70	66	1
Total	3840	5850	16730	2990	140	16
Per capita (**kg**)	11	16	47	8	0.4	0.05
Per km^2 (**t**)	165	251	718	128	6	0.69

Emission class	1990
Winter smog emissions	***2***
Summer smog emissions	***1***

Major (industrial) point sources

No major industrial point sources are present in Zurich. The biggest individual sources are two incinerators (676 t NO_x and 264 t SO_2 in 1990).

IV. TRAFFIC DATA

Vehicle statistics and traffic activity

City	Number of vehicles	Total traffic activity veh km a^{-1}
Total	-	1.6×10^9
of which:		
· passenger cars	141.000	1.358×10^9
· buses	-	-
· freight traffic >3.5 t	1951	74×10^9

Traffic

Traffic is growing in Zurich. The maximum capacity of main road network system has been reached. Total traffic activity has risen 25% in the period 1985-1990. The number of cars entering and going out of the city has risen annually 2.5% in the period 1986-1989. The public transport system is served by trams (199 km), buses and trolley buses (126 km) and `Quartier' buses (22 km). 306 million persons were transported in 1990 by the public transport system (225 million in 1983). 50% of all persons travel by PTS to the city (60% during rush hours).

Local policies to reduce air pollution
Industry: Emissions from combustion sources are checked every two years. Emission standards must be met, if not measures have to be taken to reduce emissions. For a number of industries, emission standards already have been laid down. The incinerator `Hagenholz' is being equipped with a catalytic converter and a gas-purification unit is being built. **Traffic**: Try to reduce car use by commuters through expanding the public transport network. In 1990 a new public traffic system (S-Bahn) was opened. Stimulating the use of bicycles (193 km of bicycle roads in use already). Experiments with dust collecting devices to reduce particle emissions from buses, use of low-sulphur diesel, experiments with combination fuels, e.g. diesel-oil emulsions reduce NO_2 emissions. Province and city will try to reduce freight traffic to the city by 10%. **Domestic/space heating**: Measures by forced replacement of oil and gas burners by Low-NO_x technology.

VI. AIR QUALITY DATA [1]

Monitoring network
4 Air quality monitoring are operational in Zurich. 2 stations are operated by the City's Health Inspectorate. 1 station is operated by the `canton' (province) and 1 by the federal government. Data is available from 1973 on for some components. In 1990, SO_2, NO_2, CO, O_3 and suspended particulates (+ Pb and Cd)were measured on a continuous basis (integration period 1 hour). Deposition of dust and heavy metals is measured on a 3-month basis at two stations.

SO_2 concentrations $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations			1	2	1	Kaser		Schi		
Annual average		*7*	50	15	50	18		28		
Winter average										
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG				0		0		0		
Number of days exceeding 2 x WHO-AQG				0		0		0		

WHO-AQG SO_2 (24h max.) = 125 $\mu g\ m^{-3}$

Sulphur dioxide concentrations
(UV fluorescence, continuously) SO_2 concentrations have dropped considerably during the last decade. This is due to the lowering of the sulphur content of heating fuels (about 50% since 1980) and the extensive use of natural gas. The 95 percentile varied between 35 and 68 $\mu g\ m^{-3}$ in 1990, the highest 24 hourly mean between 52 and 95 $\mu g\ m^{-3}$. Kaser = Kasernenhof, Schi = Schimmelstrasse.

Particulate matter: TSP $\mu g\ m^{-3}$	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations			Kaser	Kaser	Kaser	Kaser		Schi		
Annual average		*19*	50	38	50	38		71		
Winter average										
Maximum (24 h)										
98 percentile (24 h)										
Number of days exceeding the WHO-AQG								≥ 1		
Number of days exceeding 2 x WHO-AQG			0	0	0	0		0		

WHO-AQG TSP (24h max.) = 120 $\mu g\ m^{-3}$

Suspended particulate concentrations
Suspended particulate concentrations have dropped slightly during the last years. The annual mean in 1990 varied between 38 and 71 $\mu g\ m^{-3}$, the 95 percentile between 80 and 123 $\mu g\ m^{-3}$.

Winter smog classification	1990
Exceedance class	***0.5***
Exposure class[2]	***1***

NO_2 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations			1	2	1	Kaser		Schi		
Annual average			60	44	60	49		66		
Maximum (24 h)				98		109		141		
Maximum (1 h)										
Number of days exceeding the WHO-AQG			0	0	0	0		0		
Number of days exceeding 2 x WHO-AQG			0	0	0	0		0		

WHO-AQG NO_2 (24h max.) = 150 µg m^{-3}

Nitrogen dioxide concentrations
NO_2 concentrations seem to drop at 3% per year since the second half of the eighties at most stations. This drop follows the introduction of the catalytic converter for private cars and measures taken to reduce NO_x emissions from stationary sources. In 1990, the 95 percentile varied between 74 and 111 µg m^{-3}, the maximum 24 hourly mean between 87 and 141 µg m^{-3}.

O_3 concentrations µg m^{-3}	Mean of stations				Highest observed concentrations					
	Reg. background		City background		City background		Traffic site		Industrial site	
	1985	19__	1985	1990	1985	1990	1985	1990	1985	19__
Number of stations			Kaser	2	Kaser	Kaser		Stam		
Annual average			29	28 (1)	29	28				
Summer average				74 (1)		74				
Maximum (1 h)				190		186		175		
Maximum (8 h)										
98 percentile (1 h)				148		149		149		
Number of days exceeding the WHO-AQG				≥ 1		≥ 1				
Number of days exceeding 2 x WHO-AQG				0		0		0		

WHO-AQG Ozone (1h max.) = 150 µg m^{-3}

Ozone concentrations
Ozone concentrations do not show a clear trend in recent years. 98 percentiles (annual) varied between 115 and 149 µg m^{-3} in 1990, 1 hourly means between 134 and 193 µg m^{-3}. The Swiss national limit value (1h mean 120 µg m^{-3}) was breached 14 - 239 times depending on the station (N=4), the 98 percentile limit value of 100 µg m^{-3} was breached 2 - 4 times (N=4). Stam = Stampfenbachstrasse

CO concentrations mg m^{-3}	Highest observed concentrations	
	Traffic site	
	1985	1990
Station number/name		Schi
Annual average		
Maximum (8 h)		4.6 (24 h)
Number of days exceeding the WHO-AQG		
Number of days exceeding 2 x WHO-AQG		

WHO-AQG CO (8h max.) = 10 mg m^{-3}

Carbon monoxide concentrations
Carbon monoxide concentrations show a continuous downward trend.

VII. EFFECTS

Effects of air pollution on nature
Vitality of forest stands within the city boundaries has not changed significantly in the period 1985-1989. Deteriorating and improving forest stands are more or less in equilibrium. 39% of all stands is ill. Deciduous stands seem to suffer more than coniferous stands. About 19 500 trees are sited along city roads (`city trees'). Another approximately 40 000 trees are growing in the city's parks. 60% of all trees along roads is ill. On a yearly basis 1.5% of these trees have to be replaced. Illness is caused by different factors: maintenance of roads, water and nutrient deficits and stem damage.

1. Umwelt, Bericht 1990/91, Stadt Zürich, Gesundheits- und Wirtschaftsamt der Stadt Zürich.

2. Uncertain data.