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Atmospheric emissions of anthropogenic lead in Europe: improvements, updates, historical data and projections

Jozef M. Pacyna, Elisabeth G. Pacyna

36 pages with 10 tables

Abstract

This report provides estimates of lead emissions to the atmosphere in Europe, discriminated by country and by source category within each, country. Estimates of past lead emissions are provided for the years 1955, 1965, 1975, 1985, 1990 and 1995. Estimates for 1955–1990 have been improved relatively to earlier estimates for these years provided in 1996 for IIASA, using recently available data. Predictions of future lead emissions are provided for the year 2010. The methodology of estimating emissions is described.

Anthropogene, atmosphärische Bleiemissionen in Europa: verbesserte und aktualisierte sowie historische Daten und Prognosen in die Zukunft

Zusammenfassung

Dieser Bericht enthält Schätzungen über die nationalen Bleiemissionen der europäischen Länder in die Atmosphäre. Dabei wurden die verschiedenen Arten von Bleiemissionsquellen differenziert berücksichtigt. Die Schätzungen liegen für die Jahre 1955, 1965, 1975, 1985, 1990 und 1995 vor. Im Vergleich zu den Berechnungen der IIASA 1996 für die Jahre 1955–1990, wurden die Schätzungen in diesem Bericht aufgrund neuer, aktueller Dateninformationen deutlich verbessert. Vorhersagen für die zukünftigen Bleiemissionen in Europa wurden für das Jahr 2010 geschätzt. Zudem enthält der Bericht eine ausführliche Beschreibung über die den Schätzungen zugrunde liegenden Methode.

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1 INTRODUCTION

A project has been launched at the GKSS Research Centre to characterize the response of the natural environment of the cachtment of the Elbe river to pollution of lead, using various Pb emission scenarios. The project addresses two major questions in studying the chemical recovery of once polluted environment:

– how quick will be the response of Pb concentrations in the river due to changes of the emissions of the element, and
– how much time would it take in order to note significant changes of Pb concentrations in the river due to significant changes of the emissions.

Thus, the above questions can be re-defined in the following way: what time is needed to observe the beginning of the chemical recovery of Pb in the Elbe river due to emissions changes, and what time is needed for the degree of this recovery ewhich can be characterized as substantial.

As complete and accurate emission inventory of Pb as possible is needed to address the questions defined in the project. This report presents atmospheric emission estimates for Pb from anthropogenic sources in Europe, prepared within the GKSS project.

2 OBJECTIVES

The overall goal of the reported work was to update and evaluate historical, current, and future emissions of Pb from major source categories in individual European countries. The following source categories were regarded as major categories:

– stationary fuel combustion, including coal and oil combustion in utility, industrial, commercial, and residential boilers,
– non-ferrous metal manufacturing,
– road transport,
– iron and steel production,
– waste disposal, and
– other sources, primarily cement production.

In the next step, total national emission data should be spatially distributed on the basis of information provided by the project on the geographical location and individual emissions from point sources. Emissions from area sources, such as road transport and combustion of fuels in residential and commercial boilers should also be distributed on the basis of information on population density.

The following tasks have been agreed for the reported project at the project meeting in GKSS in July, 1998:

Task 1 An update of Pb emissions in Europe in 1955, 1965, 1975, 1985, and 1990.
Task 2: Estimation of Pb emissions in Europe in 1995.
Task 3: Allocation of the 1995 emissions of Pb into point and area source emissions.
Task 4: More accurate presentation of Pb emissions from sources in Germany and the Czech Republic.

In addition, the Consultants agreed to provide the Client with:

– estimates of emission scenarios for Pb in the year 2010, also reported here, and
– information on concentrations of Pb in the air measured at various stations in Europe. This information is not reported here but available in a report prepared by the Chemical Coordination Centre of the UN ECE European Monitoring and Evaluation Programme (EMEP).

3 METHODOLOGY OF WORK

The methodology of work will be described for each Task of the project separately.

3.1 Task I

In 1996 the Consultant carried out a project for the International Institute for Applied System Analysis (IIASA) on the Atmospheric Emissions of Heavy Metals in Europe. In this report anthropogenic emissions of As, Cd, Pb, and Zn in Europe have been estimated for the years 1955, 1960, 1965, 1970, 1975, 1980/1982, 1985/1987, and 1990/1991/1992/1993. Predictions for the years 2000, 2005 and 2010 have also been elaborated. The results of IIASA projects became the base for the update and improvement of the Pb emission estimates for the years: 1955, 1965, 1975, 1985, and 1990. It was decided that the 1980/1982 data in the IIASA report (Pacyna, 1996) will be regarded as the 1980 data in the current project, the 1985/1987 data as the 1985 data and the IIASA current data (1990/1991/1992/1993) as the 1990 data.

The details on the methodology of work within the IIASA project are available in the IIASA report (Pacyna, 1996). A summary of this work is presented below,

The results of two projects carried out at IIASA at the beginning of the 1990's were a primary source of information for preparing the emission estimates for the years 1955, 1965, 1975, and 1985. At the beginning of the 1990's IIASA contracted one of the authors (Jozef Pacyna) to assess the changes in emission factors for atmospheric Cd, Pb, and Zn from major source categories in Europe from 1950 through 1985. This assessment has been prepared in connection with the IIASA's project on the contamination of the Rhine river waters by various pollutants. The following tasks have been carried out in order to assess the changes of emission factors:

– review of progress made in developing industrial technologies between 1950 and 1985,
– review of advancement in emission control technologies, particularly dust control techniques, and
– review of current emission factors of Cd, Pb, and Zn with a view to their changes from the 1950's through 1985 due to the development of industrial technologies and control devices.

A set of emission factors for various time periods between 1950 and 1985 was proposed as an outcome of that project. Details are available from:

Pacyna J.M.: Emission Factors of Atmospheric Cd, Pb, and Zn for Major Source Categories in Europe in 1950 through 1985. The Norwegian Institute for Air Research, NILU Rept. OR 30/91, Lillestrøm, 1991.

The above mentioned emission factors were then used at IIASA together with various statistical data on the production of industrial goods and the consumption of raw materials in 13 countries around the Rhine river to estimate emissions of Cd, Pb, and Zn. The detailed description of methodologies used in these estimates is available from:

Anderberg S. and Stigliani W.: Atmospheric emissions of cadmium, lead, and zinc in Europe during the period 1955-1987, Internal report.

The results of the above estimates are presented in:

Olendrzynski K., Anderberg S., Bartnicki J., Pacyna J.M. and Stigliani W.: Atmospheric Emissions and Depositions of Cadmium, Lead and Zinc in Europe During the Period 1955-1987. The International Institute for Applied Systems Analysis. IIASA WP-95-35, Laxenburg, Austria.

The latter document contains estimates for all countries in Europe. The estimates for the countries other than "13 Rhine river countries" were obtained through scaling the 1982 estimates by Axenfeld et al. (1992) and another work by:

Pacyna J.M. and Munch J.: Atmospheric emissions of arsenic, cadmium, mercury and zinc in Europe in 1982. The Norwegian Institute for Air Research. NILU Rept. OR 17/88, Lillestrøm, 1988.

The results of the above mentioned works have been used to report Pb emissions in various European countries in 1955, 1965, 1975, and 1985. The national estimates were available for Sweden and the United Kingdom (from 1970) and the Netherlands, the former Federal Republic of Germany, and Norway (for 1980). The national data from the above mentioned countries were used in the project instead of the earlier IIASA's estimates.

In the next step, a listing of emissions from major point sources and area sources was prepared for each country in Europe. The 1980 listing prepared within the Dornier report was regarded as a basis for distribution of emissions among major point sources for earlier years. Some problems appeared in connection with preparing emission survey for major point sources in the years 1955 and 1965 as it was not always possible to obtain information when certain electric power plants, smelters, or cement plants started their production. In such cases information was sought through revision of emission surveys for other pollutants, particularly sulfur dioxide in various countries in Europe.

The 1990 emission data are based on the work prepared for IIASA in 1996 (Pacyna, 1996). It was recognized that the national data are probably the most accurate if they are prepared by national emission experts rather than by the experts working within international emission estimation fora. Therefore, the following steps were taken when searching for national emission estimates for 1990:

– review the progress of work on emission inventorying of heavy metals within the UN ECE Task Forces on Heavy Metals, and on Emission Inventories, the Oslo and Paris Commission (OSPAR) program on inputs of atmospheric heavy metals to the North Sea, the Helsinki Commission (HELCOM) pro gram on inputs of heavy metals to the Baltic Sea, the IGBP International Global Air Chemistry (IGAC) pro gram on Global Atmospheric Emission Activities (GElA), and the Arctic Monitoring and Assessment Programme (AMAP), and

– obtain supplementary national emission data through direct interactions with national experts in Europe, participating in various international fora.

Only some countries in Europe have had national estimates Pb emissions in 1990. The national emission data were available from the following countries:

- Austria: Abschätzung der Schwermetallemissionen in Österreich, Umweltbundesamt, UBE Rept.-95-108, Wien, 1995,
- the Czech Republic: data reported to the UN ECE Task Force on Heavy Metals,
- Denmark: data reported to the UN ECE Task Force on Heavy Metals, and to the PARCOM/ATMOS program,
- Finland: data reported to the UN ECE Task Force on Heavy Metals,
- Germany: Schwermetallemissionen in die Atmosphäre, TUV Rheinland, Köln, EP 10/93, 1993,
- the Netherlands: Emission inventory in the Netherlands. Emissions to air and water in 1992. The Ministry of Housing, Spatial Planning and the Environment, Directorate-General for the Environment, Gravenhage, Publ. No. 22, December 1994,
- Norway: Miljøgifter i Norge. Statensforurensningstilsyn (SFT), Rept. 92/103, Oslo, 1993,
- Poland: Report on Heavy Metals Emissions in Po land for 1990. The Institute for Ecology of Industrial Areas, Katowice, November 1993,
- Slovakia: Heavy Metals in Slovakia. Ministerstvo Zivotneho Prostredia Slovenskej Republiky, Bratislava, December 1994,
- Sweden: Heavy Metal Emissions to Air in Sweden in 1992. Swedish Environmental Protection Agency, Industrial Department, Stockholm, December 1993,
- Switzerland: Vom Menschen Verursachte Schadstoff- Emissionen in der Schweiz 1950–2010. Bundesamt für Umweltschutz, Schriftenreihe Umweltschutz No. 76, Bern,
- the United Kingdom: The UK Atmospheric Emissions of Metals and Halides 1970–1991. National Atmospheric Emissions Inventory. Department of Environment, London, September 1993.

The results of the national emission estimates in the countries mentioned above were accepted for further preparation of the 1990 emission survey for Pb in Europe.

The following approach was taken when assessing the Pb emissions for countries where no national emission data were available. The estimates of emissions for the Dutch project on the European Soil and Sea Quality due to Atmospheric Deposition (ESQUAD) were used. These estimates were verified by using them in simple model calculations of atmospheric deposition of Pb and comparing the estimated values with measurements. A good agreement has been obtained.

The detailed information on emission estimations for the ESQUAD project is available from:

Pacyna J.M.: Emission Inventory for Atmospheric Lead, Cadmium, and Copper in Europe. The University of Michigan, Department of Environmental and Industrial Health, Ann Arbor, MI, 1993.

Information on the ESQUAD project and final results of emission and deposition estimates within this program is available from:

The Impact of Atmospheric Deposition of Non-Acidifying Pollutants on the Quality of European Forest Soils and the North Sea. Main Report of the ESQUAD Project. Air and Energy Directorate of the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM), Den Haag, the Netherlands, 1994.

A listing of emission data for major point sources, as well as information on the amount of emissions from area sources was also prepared. A geographical location of point sources, information on source category type, and industrial technology was also inc1uded. This information was based on an earlier work for the Dornier report and was updated according to the changes of emissions within a given source category. A check of major point sources (location, production capacity, beginning of work, etc.) was made using information presented in the following documents:

International Lead and Zinc Study Group. World Directory: Lead and Zinc Mines and Primary Metallurgical Works, London, 1984,

International Lead and Zinc Study Group. World Directory: Secondary Lead Plants, London, 1985,

Non-Ferrous Metal Works of the World. 4th edition. Metal Bulletin Books Ltd., Worcester Park, England, 1986, and

Sulphur Emission from Large Point Sources in Europe. Swedish NGO Secretariat on Acid Rain. Gøteborg, 1994.

Information on the use and market of unleaded and low-leaded gasoline was obtained or verified (in the case of national emission data available) from data presented in the European Fuel Oxygenates Association (EFOA) Newsletter and through the exchange of data with the OCTEL Ltd. Company, the major producer of lead additives in Europe.

3.2 Task 2

During the last few years a number of national emission inventories for heavy metals have been carried out in several countries in Europe. This activity was primarily initiated by international agreements of emission reductions, particularly the agreements within the UN ECE Convention on Long-range Transboundary Air Pollutant Transport (LRTAP) protocol on emission reductions for heavy metals, OSPARCom, and HELCOM. National emission estimates from several countries were estimated by national emission experts. Some of these estimates have been reported to the UN ECE European Monitoring and Evaluation Programme (EMEP), some were published in technical report.

The activity within Task 2 was to receive as many as possible national emissions estimates because national estimates made by national emission experts are considered as more accurate than the estimates performed by international emission experts, such as the authors of the reported work. Obviously, some verification procedure is necessary in order to check the national data for their

completeness and comparability. On 30 November a letter requesting information on emissions of Pb was sent to 31 national experts. A copy of the letter and a list of national experts approached is enclosed in Annex 1. Similar letters were also send to:

– Dr. Wolfgang JockeI of TUV Rheinland E.V., Cologne, Germany,
– Mr. Jaroslav Fiala of the Czech Hydrometeorological Institute, Prague, the Czech Republic, and
– Mr. Pavel Jilek of the Ministry of the Environment of the Czech Republic, Prague, the Czech Republic.

The above mentioned experts from Germany and the Czech Republic were asked for more detailed information about the location of point sources of Pb emissions and the magnitude of emissions from these sources because of the specific needs of the whole project at GKSS (see Task 4).

Response to the above mentioned letter was very successful. As a result, the project obtained first hand information on emissions of Pb from a great number of authorities in various countries in Europe. The list of the countries which reported their national data to the reported project, and a reference for information is as follows:

I. Austria
Winiwarter, W. Emission of Cd. Hg and Pb in Austria in 1985, 1990 and 1995.
Austrian Research Centers, Seibersdorf, December 10, 1998.

II. Belarus

Kakareka, S., Estimation of lead emissions for Belarus in SNAP - source category. Belarusian National Academy of Sciences, Institute for Problems of Use of Natural Resources and Ecology, Minsk, December 30,1998, and

Belarusian Contribution to EMEP, Annual Report, 1996. Belarusian National Academy of Sciences, Meteorological Synthesizing Center – East, Minsk – Moscow, January 1997.

III. Bulgaria
Raykova, S. The EIbe catchment to Pb emission scenarios. Ministry of Environment and Water, Sofia, January 01, 1999, and

Syrakov, D. 1997 Annual Report on Bulgarian Contribution to EMEP. National Institute of Meteorology and Hydrology, Sofia, January 30, 1998.

IV. Czech Republic

Machalek, P. Emissions estimates data – HMs in Czech Republic (1990–1995). Czech Hydrometeorological Institute, Emission Inventory Section, Division of Air Quality Protection, Prague, January 28, 1999, and

CHI: Air Pollution in the Czech Republic in 1997. The Czech Hydrometeorological Institute (CHI), Air Quality Protection Department, Prague, 1998.

V. Denmark

Winther, M. The Danish Pb air emissions from the Danish CORINAIR 1997 inventory. Ministry of Environment and Energy, National Environmenta1 Research Institute. Department of Policy Analysis, Copenhagen, January 12, 1999 and January 28, 1999.

VI. Finland

Mukherjee, A.B. Emissions of Pb in Finland. University of Helsinki, Department of Environmental Protection, Helsinki, December 09, 1998.

VII. France

Fontelle, J.P. Heavy Metals emissions based on the 11 CORINAIR/MNECE/EMEP groups (take care of version SNAP 1997). CITEPA (Centere Interprofessionnel Technique D'Etudes De La Pollution Atmospherique), Paris, February 02, 1999.

VIII. Germany

JockeI, W., Hartje, J. Report on the Development of the Emissions of Heavy Metals in Germany 1985–1995. Umweltforschungsplan Des Bundesministers für UMWELT, Naturschutz und Reaktorsicherheit, Köln, July 1997, letter of JockeI, W. Environmental Protection/Air Pollution Control, Köln, December 02, 1998.

IX. Hungary

Kozak, K. Emissions of Pb in Hungary, 1980–1997. Ministry of Environment Republic of Hungary, Department of Environmental Development, Safety and Waste Management, Budapest, January 08, 1999.

X. Italy

Costa, P. Emission of Pb. CNR-Istituto Sull'Inquinamento Atmosferico, IIA-CNR, Universita della Calabria, Rende, December 03, 1998.

XI. Lithuania

Semlstoriute, D. Pb emissions in Lithuania. Ministry of the Environment, Environmental Quality Department, Air Division, Vilnius, December 16, 1998, and

Brazauskas, R. Pb emissions in Lithuania. Ministry of the Environment, Air Division of the Environmental Quality Department, Vilnius, January 19, 1999.

XII. The Netherlands

Berdowski, J.J.M. et al. Emissions to air for the Inventories of CORINAIR, EMEP and OSPARCOM 1990–1996. Ministry of Housing, Spatial Planning and the Environment, January 1998.

XIII. Poland

Mitosek, G. National annual total anthropogenic emissions of heavy metals 1990-1995. Institute of Environmental Protection, Air Protection Division, Warsaw, October 1997, and

Hlawiczka, S. Report on heavy metals emission in Poland for the year 1996. Institute for Ecology of Industrial Areas, Katowice, March 1998.

XIV. Slovenia

Rode, B. Heavy Metals emission estimations of Cd, Hg and Pb based on Technical Paper to the OSPARCOM-HELCOM UNECE Emission Inventory, 1990-1996. Ministry of the Environment and Physical Planning Hydrometeorological Institute of Slovenia, Ljubljane, December 29, 1998.

XV. Switzerland

Saxer, H.P. "Schriftenreihe Umwelt Nr. 256" of BUWAL, Emissions of Lead in Switzerland. 1950–2010. Swiss Agency for the Environment, Forests and Landscape, Section Biotechnology and Flux of Substances, Berne, January 05, 1999.

In addition to the information obtained from the above mentioned countries, national data from the authorities in the following countries were also available: Norway, Luxembourg and Slovakia.

Information on emissions of Pb in Croatia, Finland, Iceland, Italy, Latvia, Sweden and the United Kingdom has been obtained through the UN ECE EMEP.

The emission data received from national authorities have then been checked for completeness and comparability. The completeness of data regarded mainly the inclusion of all major source categories which may emit Pb to the atmosphere. No major omissions have been detected. All major source categories in all countries reporting the emission data were included in this reporting.

It is very difficult to verified the data obtained from national authorities in various countries in Europe. The following approach has been taken in the reported work. The information on emissions of Pb from various sources was brought together with the information on statistics on the production of industrial goods and/ or the consumption of raw materials and these two sets of data were used to calculate emission factors. Emission factors calculated in such a way were then compared with emission factors reported in the Joint EMEP/ CORINAIR Atmospheric Emission Inventory Guidebook (revised version, work in progress, 1999). For majority of the cases, emission factors estimated on the basis of national emission data reported to the project were within the range of emission factors proposed in the Guidebook. This check was a prove that the estimates from various countries are comparable and thus can be accepted for the reported project. Emission data for Italy and Finland reported to EMEP were accepted here instead of the data by Costa, and Mukherjee, respectively (mentioned above).

For Albania, Bosnia-Herzegovina, Estonia, Macedonia, Ukraina, and Yugoslavia the 1990 Pb emission estimates by Berdowski et al. (1997) were used as a basis for the assessment of the 1995 emissions.

Finally, the authors of the reported work have estimated the 1995 Pb emissions for Greece, Ireland, Moldova, Romania, Russia, and Spain. This has been done on the basis of emission factors adjusted specifically for these countries and information on statistical data on the production of industrial goods and the consumption of raw materials in 1995. For Portugal it was assumed that the 1990 emission data will also be relevant for 1995 as no major changes were noted for the activities generating the Pbb emissions to the atmosphere the this period.

3.3 Task 3

Emission data estimated for 1995 were then allocated into the point and area source emissions for further spatial distribution within the EMEP grid system. This allocation has been made on the basis on emission allocation in 1990 presented for the IIASA project. However, major revision has been made with respect to the existence of the 1990 point sources in 1995 and changes of production/ consumption magnitudes at these sources during the period from 1990 to 1995. Major changes in Eastern and Central Europe has been due to the change from centrally planned to market oriented economy in the Eastern and Central European countries. A number of industrial plants have been shut down due to economic problems, in some plants production of industrial goods have been significantly decreased. Implementation of environmental strategies for emission reduction also played a role in the decrease of emissions in Eastern and Central Europe, particularly towards the end of the period from 1990 through 1995. In can be suggested on the basis of discussions with Eastern European policy makers that about three quarters of the emission reduction in Eastern and Central Europe in the period from 1990 through 1995 was due to economic decline, while the rest due the installation of emission reduction equipment.

The decrease of Pb emissions from point sources in Western Europe is mainly due to the installation of more efficient emission control equipment in the period from 1990 through 1995.

Area source emissions of Pb include primarily emissions from combustion of gasoline, and emissions from combustion in stationary sources to produce heat. Again, the 1990 emission survey was taken as a base for the 1995 allocation taking into account information on population density and road network.

3.3 Task 4

Emissions from sources in Germany and the Czech Republic are the ones which should have the most important impact on the atmospheric deposition of Pb onto the surface of water of the EIbe river. Therefore, it was agreed at the beginning of the project that emissions from the sources in these countries should be given special attention with respect to the accuracy of emission estimates and completeness of sources included into the emission inventory.

In the case of Germany, the basis for presentation of the national emissions of Pb in 1995 is a work by JockeI and Hartje (1997) for the German Umweltbundesamt (the work presented earlier in this report). The report of this work is very detailed with respect to the methodology used to estimate the emission data, emission factors, and finally emission numbers for major and minor source categories. What is

missing, however, is a list of point sources indicating where these sources are located and how much of lead is emitted from each of them. This list has been prepared by authors of this report on the basis of their earlier works on emissions of heavy metals in Germany (e.g. Axenfeld et al., 1992, presented earlier in this report) and information on the impact of economic changes in former East Germany after the re-unification of Germany on the close-up of certain industrial plants and/ or reduction of the production of industrial goods in these plants.

Very similar comments can be made for emission inventorying for the Czech Republic. The basic report used in the reported work was the one by the staff of the Czech Hydrometeorological Institute (CHI) in Prague on Air Pollution in the Czech Republic in 1997 (CHI, 1998, presented earlier in this report). The CHI report provides a wealth of information on major sources of air pollution in the Czech Republic but not specifically for Pb. In contrary, information on Pb deposition in the country was very well covered in the report. In such situation, an important information on Pb emissions was received from the CHI Emission Inventory Section, in addition to the data reported in the above mentioned CHI national report.

3.5.1 Emission projections for the year 2010

Main purpose of this task was to present an emission projection for Pb in the year 2010. The starting point to this activity was an assessment on future emissions of heavy metals, prepared by J. Pacyna for IIASA (Pacyna, 1996). Major review of information on future emissions of air pollutants in the European countries has been made focusing on the collection of information on the amount of emission reductions planned in connection with various international agreements, as well as on technological and socio-economic factors considered by national experts when calculating these reductions. Major source of information for the review was the UN Economic Commission for Europe and its reviews on Strategies and Policies for Air Pollution Abatement, prepared under the Convention on Long-range Transboundary Air Pollution. Major focus in these reviews is on so-called protocol pollutants, such as SOx, NOx, and VOCs but occasionally information on heavy metals, particularly lead is also available. Therefore, it was possible to observe trends in general pollution reduction, seen from a given country prospective. Reduction of SOx emissions until the year 2010 are a result of not only introduction or improvement of emission control installations but also a result of changes in the production capacities. The SOx emission forecast can be regarded as an indication of a general trend of industrial air pollution decrease, particularly for new countries which were formed within the borders of the former Soviet Union and the former Yugoslavia. These countries, as well as other Central and Eastern European countries are often called as the countries with economies in transition. In addition, the information on the lead content in gasoline and its change can be obtained from these documents.

More information on the use of lead and indications for its changes has been obtained from the OECD document on:

Risk Reduction Monograph No. 1: Lead; Background and National Experience with Reducing Risk. Organisation for Economic Co-operation and Development, Environment Directorate, OCDE/GD (93) 67, Paris, 1993.

Further search for information on emission reductions lead has been carried out through revisions of various documents within the Oslo and Paris Commissions ministerial declaration on the protection of the North Sea against land-based pollutants, including lead and other heavy metals. This declaration was prepared at the Third International Conference on the Protection of the North Sea, held in the Hague in March 1990. For an agreed group of 17 substances, including lead, North Sea states should seek a reduction of 50% in atmospheric emissions (1985 base year) by 1999 at the latest, provided that the application of Best Available Technology (BAT), including the use of strict emission standards, enables the reduction. Similar declaration has been made for the Baltic Sea region by the Baltic Sea states.

Very thorough review of BAT techniques for reducing the emissions of heavy metals to the atmosphere has been prepared by the UN Task Force on Heavy Metal Emissions. This review has been made for all major source categories including:

- primary iron and steel industry,
- secondary iron and steel industry,
- primary non-ferrous metal industry,
- secondary non-ferrous metal industry,
- ferroalloy industry,
- chlor-alkali industry,
- glass industry,
- mining,
- municipal waste incineration,
- power production by fossil fuel combustion,
- gas cleaning, and
- fugitive emission control.

When using BAT in various types of industries, the information on the total emission of dust from each of the emission generation processes within a given industrial technology can be obtained, as well as an indication on the chemical composition of the emitted dust. The combination of these two parameters leads to the estimation of Pb emission factors when BAT is in place. This estimation has been completed for the major source categories considered in the IIASA's project (Pacyna, 1996). These BAT -related factors have been applied together with provisional information on future production capacities in various European countries to calculate future emissions. The results of these estimates were confronted with the international agreements on emission reductions in order to assess their possible implementation (or the implementation failure).

Information from the UN ECE Task Force on Emission Projections is now being used to assess the capacities and production plans in the ECE countries. The emission projections for the protocol pollutants (particularly SOx and NOx), are regarded as indicators for the projections of heavy metal emissions. It should be admitted that the Task Force on Emission Projections has been merged with the UN ECE Task Force on Emission Inventories. The information from the Task Force on Emission Projections is particularly important for the assessment of future emissions in the countries with economies in transition as it is the first-hand information from national experts in these countries. Equally important in this respect is also information from other fora of the UN ECB. For example, the UN ECE Report on the Fourth Session on the Senior Advisers to ECE Governments on

Environmental and Water Problems, Joint Working Group on Environment and Economics from 1994 addresses several of the issues of the environment and economy interactions in these countries, as well as interactions between privatization processes and the environment. This is a unique source of information for the project with respect to the realistic assessment of future emissions in the countries with economies in transition.

In the current project information on SOx emission trends from 1995 through 2010 has been used to assess emission trends for Pb from stationary combustion sources. It was difficult to obtain SOx emission trends for Finland and Norway. Therefore, the projections on Pb emissions from industrial sources in these countries have been presented on the basis of data from Denmark.

With respect to the Pb emissions from mobile sources, it was assumed that only unleaded gasoline will be used in Europe in the year 2010.

For some countries even national projections of Pb emissions are available. These countries include: Estonia, Lithuania, and Latvia.

3.6 Reporting of measured Pb concentrations in Europe

Additional task agreed within the reported project was to collect information on Pb concentrations in the air over Europe and in atmospheric deposition. This information shall prove useful in verifying the outcome of the models in the whole project.

There are not so many monitoring networks in Europe which measure atmospheric concentrations of Pb. The existing networks are within the OSPARCom and HELCOM Convention activities and the UN ECE LR T AP Convention. Any available data from these networks are being provided to the project Client, e.g. EMEP data reported within the UN ECE LRTAP by Berg et al. (1996), and CAMP data from the OSPARCom.

4 RESUL TS OF THE PROJECT

The results of emission estimates and/or assessments have been prepared for:

- country by country in Europe,
- category by category for each country in Europe,
- the years: 1955, 1965, 1975, 1985, 1990, 1995, and 2010,
- major point sources in each country, and
- areas sources in each country, including combustion in residential, commercial and industrial boilers, combustion of gasoline, and other sources.

These results, presented in a form of tables and listings, were delivered for spatial distribution within the EMEP grid system. Another copy has been sent to GKSS, the project Client.

Anthropogenic emissions of total Pb to the atmosphere in Europe during the period from 1955 through 2010 are presented in Table 1. The largest emissions of Pb in Europe were estimated for the

mid 1970's. Industrial development in Europe was very much progressing, however, emissions of pollutants generated due to this development were at the beginning to be controlled. First efficient electrostatic precipitators to capture dust emissions from industrial plants were installed in Western Europe at that time. Thus, an increase of Pb emissions in Europe prior to the mid 1970's can be accounted for the industrial development, while a continuous decrease after this period was mainly due to the installation of emission control equipment and increasing consumption of low-leaded and unleaded gasoline. In addition, quite dramatic decrease of the Pb emissions during the period from 1990 through 1995 has been due to general decline of economies in the countries in Central and Eastern Europe. In spite of that, the emission estimates presented in this work prove that indeed, lead can be a very good illustration of successful environmental strategies in work.

The Pb emissions projected for the year 2010 are less that 10 % of the maximum emissions of the element in the mid 1970's. The 2010 emission estimates presented here are 10 % lower than the estimates of projections for 2010 presented a few years ago to IIASA (Pacyna, 1996). This small difference is mostly due more accurate assumptions used in the reported work.

Concerning the Pb emissions in individual countries, Russian emissions contribute about one third to the total emissions in Europe. In 1995 Russia was followed on the top of the Pb emitting countries in Europe by Ukraine, Italy, Spain,, France the United Kingdom, and Yugoslavia (all with emissions above 1000 tonnes). Atmospheric emissions of Pb from various anthropogenic sources in individual countries in Europe in 1955, 1965, 1975, 1985, 1990, 1995, and 2010 are presented in Tables 2 through 8, respectively.

Emissions from combustion of gasoline have been the largest source of Pb emissions to the atmosphere in Europe during the period from 1955 through 1995, contributing with between 50 to 75 % to the total emissions. This contribution is expected to be about 60 % in the year 2010. Although only unleaded gasoline is assumed to be used in 2010, it should be realized that unleaded gasoline is defined as gasoline with no lead additives. However, gasoline contains a certain level of Pb ranging from 10 to 15 mg Pb/ liter due to the presence of Pb in the crude oil. This can be compared to 150 mg Pb/ liter added to low-leaded gasoline and about 400 mg Pb/ liter leaded gasoline.

Concerning the listing of Pb emissions from point sources, such listing has been prepared and reported for each individual country in Europe for 1955, 1965, 1975, 1985, 1990, 1995, and 2010. An example for Germany and the Czech Republic, the countries with special attention for this project, for the year 1995 is presented in Tables 9 and 10, respectively.

5 CONCLUDING REMARKS

Emissions inventories are never completely accurate, because unsurveyed or inadequately described sources are always present. Inventories are also never finished, because society moves ever on, building new sources of emissions, controlling the emissions of others, and ceasing the operation of still others. The estimates presented in the reported work express current vision on the past, actual, and future emissions of lead. They were estimated on the basis of information available from national experts in many European countries, and national and international organizations involved in collecting and using emission data.

Accuracy of emission estimates is a very important issue, however, very difficult to assess. On the basis of earlier emission estimates by the authors, their verification through the comparison with the independent calculations by other emission experts, and their applications in various dispersion models it can be proposed that the accuracy of current emissions of Pb is below 20 %. The historical emission estimates are less accurate than the current emission estimates due to the fact that there are larger limitations in obtaining reliable input data for the estimation of historical emissions. Even more limitations and inaccuracy exist when estimating the future emissions.

Verification of the reported emission data is clearly needed. Perhaps the easiest way to verify the historical and current emission estimates is through their applications in dispersion models. Air concentrations modeled on the basis of presented emission data can be compared with measurements carried out within various international and national pro grams in Europe.

A set of valuable data has been obtained during the performance of the reported project. These data are very relevant to various international activities in Europe aiming at the quantification of inputs of lead to the environment and eventually at recommending emission reduction policies and strategies.

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REFERENCES (other than those presented in the text of the report).

Berdowski J.J.M., Baas J., Bloos J.P.J., Visschedijk A.J.H. and P.Y.J. Zandweld (1997): The European Emission Inventory of Heavy Metals and Persistent Organic Pollutants. Umweltforschungsplan des Bundesministers fur Umwelt, Naturschutz und Reaktorsicherheit. Forschungsbericht 104 02 672/03. TNO Institute of Environmental Sciences, Energy Research and Process Innovation, Apeldoorn, the Netherlands.

Berg T., Hjellbrekke A–G, and J.E. Skjelmoen (1996): Heavy Metals and POPs within the ECE Region. EMEP/ CCC-Report 8/96. The Norwegian Institute for Air Research (NILU), Kjeller, Norway.

Pacyna J.M. (1996): Atmospheric Emissions of Heavy Metals in Europe (Improvements, Updates, Historical Data and Projections). A Final Report for the International Institute for Applied Systems Analysis (IIASA), Hagan, Norway.

Table 1: Anthropogenic emissions of Pb to the atmosphere in Europe during the period 1955–2010.

Country	1955	1965	1975	1985	1990	1995	2010
Albania	61.2	124.6	219.8	150.0	113.0	33.4	11.1
Austria	1892.5	2749.7	2618.6	790.0	215.4	39.3	33.7
Belarus	-(1)	-(1)	(1)	-(1)	- (1)	47.0	20.3
Belgium	3603.1	4789.1	4236.1	1490.0	577.0	435.0	105.8
Bos.-Herz.	- (2)	- (2)	-(2)	-(2)	-(2)	38.6	22.9
Bulgaria	705.3	1435.1	2531.4	1590.0	1397.0	297.5	102.7
Croatia	-(2)	-(2)	-(2)	-(2)	-(2)	286.0	144.6
CzechRep.	941.9 (3)	1525.8 (3)	2914.3 (3)	1170.0 (3)	577.6	376.6	116.2
Denmark	1101.0	1599.8	1523.5	300.0	163.2	16.2	11.9
Estonia	-(1)	-(1)	(1)	-(1)	-(1)	58.0	34.5
Finland	923.4	2056.1	2964.7	930.0	326.5	67.0	49.4
France	7377.6	12968.9	18862.5	8610.0	2987.0	1510.5	504.2
Germany	–	–	–	–	4074.0	624.0	328.7
FRG	9349.1	13583.8	12936.3	4617.0			
DDR	875.4	1386.3	3509.2	1870.0			
Greece	322.0	1066.6	1874.9	790.0	436.0	324.0	113.4
Hungary	268.3	545.9	962.9	666.0	604.0	153.7	63.4
Iceland	-	–	–	–	15.0	4.0	3.3
Ireland	439.3	523.2	518.1	390.0	213.0	85.2	50.8
Italy	2383.9	7897.4	13882.4	5490.0	2861.0	2174.0	561.5
Latvia	-(1)	-(1)	-(1)	-(1)	-(1)	10.3	4.4
Lithuania	-(1)	-(1)	-(1)	-(1)	-(1)	19.4	8.4
Luxembourg	315.4	457.4	416.9	160.0	100.0	29.8	13.3
Macedonia	- (2)	-(2)	-(2)	-(2)	-(2)	63.3	37.6
Moldavia	- (1)	-(1)	-(1)	-(1)	-(1)	23.0	13.7
Netherlands	1109.6	1956.2	2263.7	1341.6	266.0	152.0	71.9
Norway	598.3	1332.2	1920.8	412.0	162.3	28.4	27.7
Poland	2442.1	4225.8	6981.9	3000.0	1441.7	959.7	352.7
Portugal	88.0	291.6	512.6	390.0	209.0	209.0	46.3
Romania	519.0	1056.0	1862.6	1420.0	1423.0	937.5	419.0
Russia	14558.0 (1)	31150.5 (1)	54131.5 (1)	30500.0 (1)	30457 (1)	11000.0	4742.4
Slovakia	- (3)	- (3)	-(3)	-(3)	331.2	97.0	57.1
Slovenia	-(2)	-(2)	-(2)	-(2)	-(2)	195.0	51.6
Spain	1659.8	2705.9	6325.0	3620.0	2435.0	1826.0	1020.9
Sweden	851.0	1895.0	1600.0	950.0	365.0	37.8	36.6
Switzerland	423.0	941.9	1358.1	480.0	248.0	226.0	99.2
Ukraine	- (1)	-(1)	- (1)	- (1)	- (1)	3400.0	1910.2
U.K.	8841.7	10528.9	9140.3	8114.5	3795.1	1541.0	784.5
Yugoslavia	881.8 (2)	1794.2 (2)	3164.9 (2)	2340.0 (2)	2337.0 (2)	1065.0	632.2
Total	62531.7	110587.9	159233.0	81581.1	58130.0	28390.2	12608.1

1) former USSR
2) former Yugoslavia
3) former Czechoslovakia

Table 2: Anthropogenic emissions of Pb to the atmosphere in Europe in 1955.

Country	Stationary fuel combustion	Non-ferrous metal manufacturing	Iron & steel production	Waste disposal	Gasoline combustion	Cement production	Other sources	Total
Albania	4.3	10.4	–	-	45.3	1.2	–	61.2
Austria	56.8	113.6	75.6	–	1627.6	18.9	–	1892.5
Belgium	264.2	1812.0	510.0	1.3	981.0	34.3	0.3	3603.1
Bulgaria	35.3	324.4	14.1	–	324.4	7.1	–	705.3
Czechoslovakia	144.4	65.6	332.2	-	372.0	27.7	–	941.9
Denmark	44.0	–	22.1	44.0	979.9	11.0	–	1101.0
Finland	27.7	323.2	27.7	–	535.6	9.2	–	923.4
France	584.0	1034.0	1081.5	15.8	4579.0	83.2	0.1	7377.6
Germany, Fed. Rep.	1081.0	3800.0	1500.0	20.8	2774.0	146.0	27.3	9349.1
Germany, Dem. Rep.	324.1	194.0	213.4	–	115.0	28.9	–	875.4
Greece	6.4	6.4	3.3	–	299.5	6.4	–	322.0
Hungary	16.1	5.4	16.0	–	225.4	5.4	–	268.3
Iceland	-	–	–	–		-	–	–
Ireland	8.8	30.7	4.4	-	391.0	4.4	-	439.3
Italy	125.0	454.8	350.6	6.5	1365.0	82.0	–	2383.9
Luxembourg	3.8	1.1	266.6	0.4	42.0	1.5	-	315.4
Netherlands	165.8	212.6	98.1	13.3	611.0	8.8	–	1109.6
Norway	–	161.5	12.0	–	412.8	12.0	–	598.3
Poland	609.5	993.5	383.2	–	410.0	45.6	0.3	2442.1
Portugal	3.4	1.8	1.8	-	79.2	1.8	–	88.0
Romania	62.3	108.9	62.3	–	275.1	10.4	–	519.0
Spain	133.5	733.0	175.1	0.9	583.0	34.1	0.2	1659.8
Sweden	76.6	289.3	34.0	17.1	425.5	8.5	–	851.0
Switzerland	23.8	8.2.	25.8	3.7	344.0	17.5	–	423.0
United Kingdom	1000.0	947.3	931.2	4.9	3632.0	94.9	2231.4	8841.7
USSR (Europe)	630.4	1200.5	800.0	–	9085.0	60.8	2781.3	14558.0
Yugoslavia	35.3	379.2	26.4	–	432.1	8.8	–	881.8
Total	5466.5	13211.4	6967.4	128.7	30946.4	770.4	5040.9	62531.7

Table 3: Anthropogenic emissions of Pb to the atmosphere in Europe in 1965.

Country	Stationary fuel combustion	Non-ferrous metal manufacturing	Iron & steel production	Waste disposal	Gasoline combustion	Cement production	Other sources	Total
Albania	8.7	21.2	-	–	92.2	2.5	–	124.6
Austria	82.5	165.0	110.0	–	2364.7	27.5	–	2749.7
Belgium	174.7	1100.0	770.0	4.4	1622.0	43.1	1074.9	4789.1
Bulgaria	71.8	660.0	28.9	–	660.0	14.4	–	1435.1
Czechoslovakia	205.8	117.4	587.4	–	572.0	43.2	–	1525.8
Denmark	64.0	–	32.0	64.0	1423.8	16.0	–	1599.8
Finland	61.7	719.6	61.7	–	1192.5	20.6	–	2056.1
France	444.5	1648.4	1000.0	52.5	9119.0	163.5	541.0	12968.9
Germany, Fed. Rep.	732.6	3900.0	1500.0	69.3	5777.0	248.9	1356.0	13583.8
Germany, Dem. Rep.	342.6	264.3	312.7	–	420.0	46.7	-	1386.3
Greece	21.3	21.3	10.7	–	992.0	21.3	-	1066.6
Hungary	32.8	10.9	32.7	–	458.6	10.9	-	545.9
Iceland	–	-	-	–		–	–	–
Ireland	10.5	36.7	5.2	–	465.6	5.2	–	523.2
Italy	209.3	502.1	881.6	21.6	6135.0	147.5	0.3	7897.4
Luxembourg	4.0	1.8	362.4	1.4	86.0	1.5	0.3	457.4
Netherlands	137.6	392.4	234.6	44.4	1125.0	21.9	0.3	1956.2
Norway	–	359.8	26.6	–	919.2	26.6	–	1332.2
Poland	728.4	1066.2	701.6	–	1658.0	71.2	0.4	4225.8
Portugal	11.8	5.8	5.8	–	262.4	5.8	–	291.6
Romania	126.7	221.5	126.7	-	560.0	21.1	–	1056.0
Spain	128.9	837.3	393.4	2.9	1274.0	69.4	–	2705.9
Sweden	170.6	644.3	75.8	37.9	947.5	18.9	–	1895.0
Switzerland	20.7	6.6	35.8	12.1	836.0	30.7	–	941.9
United Kingdom	1569.5	665.8	1500.0	16.4	6251.0	124.1	402.1	10528.5
USSR (Europe)	1100.0	2700.0	1500.0	–	22597.0	175.2	3078.3	31150.5
Yugoslavia	71.8	771.5	53.8	–	879.2	17.9	–	1794.2
Total	6532.8	16839.9	10349.4	326.9	68689.7	1395.6	6453.3	110587.9

Table 4: Anthropogenic emissions of Pb to the atmosphere in Europe in 1975.

Country	Stationary fuel combustion	Non-ferrous metal manufacturing	Iron & steel production	Waste disposal	Gasoline combustion	Cement production	Other sources	Total
Albania	15.4	37.4	–	–	162.6	4.4	–	219.8
Austria	78.6	157.1	104.7	–	2252.0	26.2	–	2618.6
Belgium	82.1	651.5	542.0	14.7	2911.0	34.8	–	4236.1
Bulgaria	126.6	1164.4	50.7	–	1164.4	25.3	–	2531.4
Czechoslovakia	234.6	76.0	894.8	–	1641.4	67.9	–	2914.3
Denmark	60.9	–	30.6	60.9	1355.9	15.2	–	1523.5
Fin1and	88.9	1037.8	88.9	-	1719.5	29.6	–	2964.7
France	262.6	709.7	1092.1	89.8	16545.0	150.0	13.3	18862.5
Germany, Fed. Rep.	319.4	1570.9	1170.2	145.4	8362.0	169.2	1199.2	12936.3
Germany, Dem. Rep.	368.0	169.0	376.1	-	2518.0	78.1	–	3509.2
Greece	37.5	37.5	18.7	–	1743.7	37.5	–	1874.9
Hungary	57.8	19.2	57.9	–	808.8	19.2	–	962.9
Iceland	–	–	–	–		–	-	–
Ireland	10.4	36.2	5.2	–	461.1	5.2	–	518.1
Italy	240.5	302.9	1171.1	38.9	11956.0	172.7	0.3	13882.4
Luxembourg	7.9	0.8	215.4	2.1	189.0	1.7	–	416.9
Netherlands	19.5	6.0	233.1	90.0	1809.0	18.7	87.4	2263.7
Norway	–	518.6	38.4	-	1325.4	38.4	–	1920.8
Poland	786.6	1432.6	993.6	–	2846.0	135.1	788.0	6981.9
Portugal	20.4	10.3	10.3	-	461.3	10.3	–	512.6
Romania	223.5	391.1	223.5	-	987.2	37.3	–	1862.6
Spain	172.2	631.6	670.5	5.0	4724.0	121.7	–	6325.0
Sweden	13.0	250.0	50.0	20.0	1140.0	30.0	97.0	1600.0
Switzerland	12.0	6.0	22.4	25.5	1273.0	19.2	–	1358.1
United Kingdom	717.5	486.4	289.8	122.2	7424.8	99.6	–	9140.3
USSR (Europe)	2000.0	5000.0	2700.0	–	41872.0	296.9	2262.6	54131.5
Yugoslavia	126.6	1360.9	95.0	–	1550.8	31.6	–	3164.9
Total	6082.5	16063.9	11145.0	614.5	119203.5	1675.8	4447.8	159233.0

Table 5: Anthropogenic emissions of Pb to the atmosphere in Europe in 1985.

Country	Stationary fuel combustion	Non-ferrous metal manufacturing	Iron & steel production	Waste disposal	Gasoline combustion	Cement production	Other sources	Total
Albania	10.0	23.0	–	-	110.0	2.0	5.0	150.0
Austria	25.0	73.0	45.0	-	638.0	9.0	-	790.0
Belgium	41.5	195.4	117.1	14.7	1114.0	6.3	1.0	1490.0
Bulgaria	78.0	737.0	31.0	–	730.0	10.0	4.0	1590.0
Czechoslovakia	132.0	133.0	161.0	-	720.0	19.0	5.0	1170.0
Denmark	22.0	3.0	12.0	30.	230.0	3.0	–	300.0
Finland	34.0	403.0	29.0	–	460.0	3.0	1.0	930.0
France	167.0	911.0	215.0	86.0	7180.0	47.0	4.0	8610.0
Germany, Fed. Rep.	150.0	170.0	330.0	75.0	3400.0	192.0	300.0	4617.0
Germany, Dem. Rep.	185.0	222.0	52.0	–	1390.0	21.0	-	1870.0
Greece	30.0	27.0	6.0	–	700.0	23.0	4.0	790.0
Hungary	40.0	10.0	35.0	-	510.0	8.0	63.0	666.0
Iceland	-	–	-	–	–	–	–	-
Ireland	9.0	33.0	1.0	-	340.0	3.0	4.0	390.0
Italy	164.0	432.0	284.0	46.0	4490.0	74.0		5490.0
Luxembourg	2.0	–	35.0	2.0	120.0	1.0	–	160.0
Netherlands	4.2	1.7	63.4	56.1	1200.0	2.8	13.4	1341.6
Norway	–	25.0	15.0	2.0	365.0	3.0	2.0	412.0
Poland	287.0	1347.0	134.0	–	1200.0	29.0	3.0	3000.0
Portugal	14.0	8.0	6.0	-	350.0	11.0	1.0	390.0
Romania	134.0	240.0	141.0	–	880.0	25.0	–	1420.0
Spain	96.0	927.0	164.0	-	2380.0	53.0	–	3620.0
Sweden	13.0	110.0	50.0	25.0	750.0	2.0	–	950.0
Switzerland	8.0	-	3.0	–	460.0	7.0	2.0	480.0
United Kingdom	575.2	528.0	241.4	123.0	6555.5	91.4	-	8114.5
USSR (Europe)	1226.0	3002.0	1681.0	–	24440.0	148.0	3.0	30500.0
Yugoslavia	74.0	857.0	60.0	-	1330.0	16.0	3.0	2340.0
Total	3520.9	10418.1	3911.9	459.8	62042.5	809.5	418.4	81581.1

Table 6: Anthropogenic emissions of Pb to the atmosphere in Europe in 1990.

Country (Reference year)	Stationary fuel combustion	Non-ferrous metal manufacturing	Road transport	Iron and steel production	Wastes disposal	Other sources	Total	Remarks
Albania	4.0	23.0	86.0	-	–	–	113.0	JP/GEIA
Austria	35.8	9.3	159.0	6.6	0.3	4.4	215.4	Ntl.
Belgium	30.0	321.3	215.7	5.5	3.5	1.0	577.0	ESQ-JP
Bulgaria	78.0	577.0	730.0	2.0	–	10.0	1397.0	GEIA/JP
Czech Republic	205.1	108.6	247.5	15.0	0.1	1.3	577.6	Ntl.
Denmark	22.0	3.0	107.2	1.0	–	30.0*1	163.2	Ntl./JP
Fin1and	23.2	80.0	189.0	33.2	0.1	1.0	326.5	Ntl.
France	107.0	503.5	2306.0	14.7	55.1	0.7	2987.0	ESQ/GEIA
Germany, Fed. Rep.	30.0	110.0	1500.0	230.0	14.0	320.0	2204.0	Ntl.
Germany, Dem. Rep.	58.1	222.0	1390.0	4.0	8.0	187.9	1870.0	Ntl/JP
Greece	30.0	27.0	350.0	6.0	–	23.0	436.0	GEIA
Hungary	40.0	11.0	510.0	35.0	–	8.0	604.0	GEIA
Iceland	–	-	15.0	–	–	-	15.0	ESQ
Ireland	9.0	33.0	170.0	1.0	–	-	213.0	GEIA
Italy	164.0	432.0	2200.0	18.0	46.0	1.0	2861.0	GEIA
Luxembourg	2.0	–	60.0	35.0	2.0	1.0	100.0	GEIA
Netherlands	25.7	0.5	158.0	19.0	1.5	61.3	266.0	Ntl.
Norway	–	–	157.0	2.0	1.3	2.0	162.3	Ntl.
Poland	490.0	173.0	570.1	205.1	n.d.	3.5	1441.7	GEIA
Portugal	14.0	8.0	170.0	6.0	–	11.0	209.0	GEIA
Romania	137.0	240.0	880.0	141.0	–	25.0	1423.0	GEIA
Slovakia	54.9	21.4	96.8	145.5	1.7	10.9	331.2	Ntl.
Spain	91.0	927.0	1200.0	164.0	–	53.0	2435.0	GEIA
Sweden	11.0	32.0	309.0	12.0	1.0	–	365.0	Ntl.
Switzerland	8.0	–	230.0	3.0	–	7.0	248.0	GEIA
United Kingdom	585.4	529.8	2185.5	276.9	124.7	92.8	3795.1	Ntl.
USSR (Europe)	1226.0	3002.0	24400.0	1681.0	-	148.0	30457.0	GEIA
Yugoslavia	74.0	857.0	1330.0	60.0	–	16.0	2337.0	GEIA
Total	3555.2	8251.4	41921.8	3122.5	259.3	1019.8	58130.0	

n. d. = no data
* 1 = including waste disposal

Table 7: Anthropogenic emissions of Pb to the atmosphere in Europe in 1995.

Country	Stationary Fuel Combustion	Non-Ferrous Metal Manufacturing	Road Transport	Waste Disposal	Other Sources	Total	Remarks
Albania	2.1	1.2	29.8	0.3		33.4	Berdowski/Pacyna, 1995
Austria	8.2	6.4	17.8	0.3	0.3	39.3	National data, 1995
Belarus	7.3		9.3		22.7	47.0	National data, 1996
Belgium	71.4	18.2	246.0	39.7	17.1	435.0	National data, 1995
Bosnia-Herzegovina	0.2		30.0	0.4		38.6	Berdowski/Pacyna, 1995
Bu1garia	122.2		153.3	5.6	0.2	297.5	National data, 1995
Croatia	5.6		278.0		1.2	286.0	EMEP, 1995
						0.0	National data, 1995
Czech Republic	50.0	100.0	156.0			376.6	National data, 1996
Denmark	9.8		5.4		1.0	16.2	National data, 1995
Estonia	1.0		56.0		1.0	58.0	Berdowski/Pacyna, 1995
Finland	4.0	16.0	38.0	0.1	8.3	67.0	EMEP, 1995
France	142.9	82.2	1209.8	71.3		1510.5	National data, 1996
Germany	48.0	103	240.0	9.0	50.0	624.0	National data, 1995
	23.0	88.0	240.0	9.0	10.0	490.0	
	25.0	15.0			40.0	134.0	
Greece	22.0	20.0	260.0		17.0	324.0	Pacyna, 1995
Hungary	30.2	1.7	104.3	3.1		153.7	National data, 1995
Iceland			4.0			4.0	EMEP, 1995
Ireland	3.6	13.2	68.0			85.2	Pacyna, 1995
Italy	124.0	304.0	1672.0	60.0		2174.0	EMEP (1994)
Latvia	0.2		10.0		0.1	10.3	EMEP (1994)
Lithuania	2.8		16.4		0.2	19.4	National data, 1997
Luxembourg	2.0		5.0	2.0	15.8	29.8	National data, 1997
Macedonia	0.6	8.6	54.0	0.1		63.3	Berdowski/Pacyna, 1995
Moldova	3.6		19.4			23.0	Pacyna, 1995
The Netherlands	11.1	0.2	79.3	1.3	1.4	152.0	National data, 1995
Norway	1.8		26.6			28.4	National data, 1995
Poland	723.1	46.1	149.8	0.7		959.7	National data, 1996
Portugal	14.0	8.0	170.0		11.0	209.0	Pacyna, 1995
Romania	90.0	158.0	580.0		16.5	937.5	Pacyna, 1995
Russia	440.0	1080.0	8822.0		53.0	11000.0	Pacyna, 1995
Slovakia	19.0	7.0	26.0			97.0	Nationaldata, 1996
Slovenia	1.9		182.5		10.6	195.0	National data, 1996
Spain	68.0	695.0	900.0		40.0	1826.0	Pacyna, 1995
Sweden	1.8	2.5	30.0	0.5		37.8	EMEP, 1995
Switzerland	60.0	32.0	90.0	6.0	8.0	226.0	National data, 1995
Ukrainia	320.0		2332.0		8.0	3400.0	Berdowski/Pacyna, 1995
U.K	234.0	212.0	872.0	50.0	62.0	1541.0	EMEP, 1995
Yugoslavia	37.0	426.0	564.0		8.0	1065.0	Berdowski/Pacyna. 1995
TOTAL-EUROPE	2683.4	3341.3	19506.7	250.4	353.4	28390.2	

f. FRG: old states of Germany
f. DDR: new states of Germany

Table 8: Anthropogenic emissions of Pb to the atmosphere in Europe in 2010.

Country	Stationary Fuel Combustion	Non-Ferrous Metal Manufacturing	Road Transport	Iron & Steel Production	Waste Disposal	Other Sources	Total
Albania	2.1	1.2	7.5		0.3		11.1
Austria	6.1	4.7	17.8	4.7	0.2	0.2	33.7
Belarus	3.2		4.0	3.3		9.8	20.3
Belgium	20.4	18.2	44.1	3.7	2.4	17.0	105.8
Bosnia-Herzegovina	0.1		17.9	4.7	0.2		22.9
Bulgaria	45.2		51.1	1.2	5.0	0.2	102.7
Croatia	2.8		140.6	0.6		0.6	144.6
Czech Republic	50.0	31.5	20.5	4.4		9.8	116.2
Denmark	5.9		5.4			0.6	11.9
Estonia	0.6		33.3			0.6	34.5
Finland	2.4	9.6	31.9	0.4	0.1	5.0	49.4
France	61.0	82.2	324.9	4.3	31.4	0.4	504.2
Germany	15.9	59.8	156.9	42.1	4.0	50.0	328.7
Greece	22.0	20.0	49.4	5.0		17.0	113.4
Hungary	26.0	1.7	13.1	14.4	3.1	5.1	63.4
Iceland			3.3				3.3
Ireland	3.6	13.2	20.7	0.4		12.9	50.8
Italy	75.4	198.7	257.4	8.3	21.2	0.5	561.5
Latvia	0.1		4.3				4.4
Lithuania	1.2		7.1			0.1	8.4
Luxembourg	1.4		4.8	5.0	1.4	0.7	13.3
Macedonia	0.4	5.1	32.1				37.6
Moldova	2.1		11.6				13.7
The Netherlands	7.2	0.1	57.5	5.3	0.4	1.4	71.9
Norway	1.1		26.6				27.7
Poland	215.6	46.1	49.4	40.0		1.6	352.7
Portugal	9.8	5.6	19.0	4.2		7.7	46.3
Romania	90.0	158.0	38.9	93.0		39.1	419.0
Russia	189.7	465.6	3803.5	260.8		22.8	4742.4
Slovakia	13.3	4.9	7.4	31.5			57.1
Slovenia	0.5		48.3			2.8	51.6
Spain	68.0	648.9	156.4	114.8		32.8	1020.9
Sweden	1.5	2.1	30.0	2.6	0.4		36.6
Switzerland	7.8		81.7	2.9		6.8	99.2
Ukrainia	179.8		1310.2	415.8		4.4	1910.2
U.K	152.2	137.7	366.0	72.0	32.4	24.2	784.5
Yugoslavia	22.0	252.9	334.8	17.8		4.7	632.2
TOTAL - EUROPE	1306.4	2167.8	7589.4	1163.2	102.5	278.8	12608.1

Table 9: Anthropogenic emissions of Pb to the atmosphere, in tons per year, from point and area sources in old (former FRG) and new (former DDR) states of Germany in 1995.

Country code: 06 – **Former FRG** 1995

No.	Source name	Geographical position		Codes		Emission (ton/yr)
		Latitude	Longitude	Ind.	Instal.	Pb
	Baden-Wuerttemberg					
1	Altbach	48°47'	9°12'	11	11	0.1
2	Gaisburg	48°47'	9°12'	11	11	0.1
3	Heilbronn	49°08'	9°14'	11	11	0.1
4	Karlsruhe/Rheinhafen	49°00'	8°24'	11	11	0.1
5	Mannheim	49°30'	8°28'	11	11	0.2
6	Marbach	48°02'	8°28'	11	11	0.1
7	Münster	51°58'	7°37'	11	11	0.1
8	Walheim	50°24'	6°10'	11	11	0.1
	Bayern					
9	Arzberg	50°03'	12°12'	11	11	0.1
10	Aschaffenburg	49°58'	9°10'	11	11	0.1
11	Dettingen	50°02'	9°02'	11	11	0.1
12	Frauenaurach	49°27'	11°05'	11	11	0.1
12a	Gebersdorf	49°27'	11°05'	11	11	0.1
13	Ingolstadt	48°46'	11°27'	11	11	0.1
14	Irsching	48°46'	11°27'	11	11	0.1
15	München - Süd	48°08'	11°35'	11	11	0.1
16	München - Nord	48°08'	11°35'	11	11	0.1
17	Pleiting	48°40'	13°08'	11	11	0.1
18	Schwandorf	49°20'	12°07'	11	11	0.1
19	Zolling - Anglberg	47°51'	12°09'	11	11	0.1
	Bremen					
20	Bremen/Farge	53°05'	8°48'	11	11	0.1
21	Bremen/Hagenkraftwerk	53°05'	8°48'	11	11	0.1
22	Bremen/Hastedt	53°05'	8°48'	11	11	0.1
	Hamburg					
23	Hamburg/Hafen HKW	53°31'	10°03'	11	11	0.1
24	Hamburg/Neuhof	53°31'	10°03'	11	11	0.1
25	Hamburg/Tiefstack	53°31'	10°03'	11	11	0.1
26	Hamburg/Wedel	53°31'	10°03'	11	11	0.1
	Hessen					
27	Borken	51°03'	9°18'	11	11	0.1
28	Frankfurt	50°06'	8°41'	11	11	0.1
29	Frankfurt	50°06'	8°41'	11	11	0.1
30	Grosskrotzenburg/Staudinger	49°52'	8°39'	11	11	0.1
31	Kassel	51°18'	9°30'	11	11	0.1
32	Wölfersheim	50°23'	8°04'	11	11	0.1
33	Grosskrotzenburg/Staudinger	49°52'	8°39'	11	11	0.1
	Niedersachsen					
34	Afferde	52°23'	9°44'	11	11	0.1

Former FRG cont.:

No.	Source name	Geographical position		Codes		Emission (ton/yr)
		Latitude	Longitude	lnd.	lnstal.	Pb
35	Emden	53°23'	7°13'	11	**11**	0.1
36	Hallendorf	52°09'	9°58'	11	11	0.1
37	Hannover	52°23'	9°44'	11	11	0.1
38	Herrenhausen	52°20'	9°30'	11	**11**	0.1
39	Lahde/Heyden	52°22'	9°00'	11	11	0.1
40	Landesbergen/R.Frank	52°34'	9°07'	11	11	0.1
41	Mehrum	52°15'	10°30'	11	11	0.1
42	Offleben	52°14'	11°01'	11	11	0.1
43	Stade/Schilling	53°36'	9°28'	11	11	0.1
44	Wilhelmshaven	53°32'	8°07'	11	11	0.1
45	Wolfsburg	52°27'	10°49'	11	11	0.1
	Nordhein-Westfalen					
46	Alsdorf/Anna	50°53'	6°10'	11	11	0.1
47	Bochum	51°28'	7°11'	11	**11**	0.1
48	Datteln	51°39'	7°20'	11	11	0.1
49	Dortmund/Gustav Kneppen	51°32'	7°27'	11	11	0.1
50	Dortmund/Harpen	51°32'	7°27'	11	11	0.1
51	Düsseldorf/Flingeln	51°13'	6°47'	11	11	0.1
52	Düsseldorf/Lausward	51°13'	6°47'	11	11	0.1
53	Duisburg	51°25'	6°45'	11	11	0.1
54	Duisburg Ruhrort	51°25'	6°45'	11	11	0.1
55	Elverlingsen	50°44'	7°06'	11	11	0.1
56	Essen	51°27'	6°57'	11	11	0.1
57	Fortuna II & III	50°10'	8°20'	11	11	0.1
58	Frimmersdorf	51°12'	6°25'	11	11	0.3
59	Gelsenkirchen/Bismarck	51°30'	7°05'	11	11	0.1
60	Gelsenkirchen/Horst	51°30'	7°05'	11	11	0.1
61	Golden Bergwerk	50°44'	7°06'	11	11	0.1
62	Hambom	51°25'	6°45'	11	11	0.1
63	Herdecke/Cunowerk	51°24'	7°26'	11	11	0.1
64	Herne/GKW	51°32'	7°12'	11	11	0.1
65	Herne/Shamrock	51°32'	7°12'	11	11	0.1
66	Ibbenbüren	52°17'	7°44'	11	11	0.1
67	Köln	50°56'	6°57'	11	11	0.1
68	Krefeld-Verdingen	51°20'	6°32'	11	11	0.1
69	Leverkusen	51°02'	6°59'	11	11	0.1
70	Lünen/GK OST	51°37'	7°31'	11	11	0.1
71	Lünen/Kellermann	51°37'	7°31'	11	11	0.1
72	Marl	51°38'	7°06'	11	11	0.1
73	Marl	51°38'	7°06'	11	11	0.1
74	Marl	51°38'	7°06'	**11**	11	0.1
75	Möllen	51°30'	7°30'	11	11	0.1

Former FRG cont.:

No.	Source name	Geographical position		Codes		Emission (ton/yr)
		Latitude	Longitude	Ind.	Instal.	Pb
76	Neurath	51°04'	6°06'	11	11	0.2
77	Niederhaussem	50°09'	8°20'	11	11	0.3
78	Rauxel	51°30'	7°30'	11	11	0.1
79	Rheinpreussen	50°40'	7°10'	11	11	0.1
80	Schmehausen	51°00'	6°40'	11	11	0.1
81	Scholven	51°00'	6°40'	11	11	0.3
82	Siersdorf	51°25'	6°45'	11	11	0.1
83	Stockum/Gersteinwerk	51°38'	7°10'	11	11	0.2
84	Weltheim	52°20'	9°20'	11	11	0.1
85	Walsum	51°32'	6°41'	11	11	0.1
86	Weisweiler	50°55'	6°21'	11	11	0.2
87	Westerholt	50°50'	7°00'	11	11	0.1
88	Düsseldorf/Lauswand	51°13'	6°47'	11	11	0.1
89	Scholven F	51°20'	6°30'	11	11	0.1
	Rhein1and-Pfalz					
90	Ludwigshafen	49°29'	8°27'	11	11	0.1
91	Mainz	50°00'	8°16'	11	11	0.1
	Saarland					
92	Bexbach/St.Barbara	49°29'	7°16'	11	11	0.1
93	Endorf	49°19'	6°46'	11	11	0.2
94	Fürstenhausen/Fenne	49°15'	6°58'	11	11	0.1
95	Göttelborn/Weiher	49°15'	6°58'	11	11	0.1
96	Wehrden	51°42'	9°22'	11	11	0.1
	Schleswig-Holstein					
97	Brunsbüttel	53°54'	9°08'	11	11	0.1
98	Kiel-Förde	54°20'	10°08'	11	11	0.1
99	Lübeck	53°52'	10°40'	11	11	0.1
	West Berlin					
100	Charlottenburg	52°32'	13°25'	11	11	0.1
101	Lichterfelde	52°32'	13°25'	11	11	0.2
102	Moabit	52°32'	13°25'	11	11	0.1
103	Oberhavel	52°32'	13°25'	11	11	0.1
104	Reuter	52°32'	13°25'	11	11	0.1
105	Rudow	52°32'	13°25'	11	11	0.1
106	Wilmersdorf	52°32'	13°25'	11	11	0.1
107	Brezelius Metallhütten GmbH Binsfeldhammer	50°46'	6°14'	61	631	7.7
108	Brezelius Metallhütten GmbH Duisburg	51°25'	6°45'	61	631	5.4
109	Preussag-Boliden-Blei GmbH-Nordenham	53°32'	8°32'	61	631	12.2
110	Brezelius Metallhütten GmbH Duisburg	51°25'	6°45'	61	631	6.8
111	Preussag AG Metall-Harlingerrode	51°55'	10°30'	61	641	25.3
112	Metallhütte Carl Fahlbusch GmbH-Rastatt/Baden	48° 51'	8°13'	61	621	10.2

Former FRG cont.:

No.	Source name	Geographical position		Codes		Emission (ton/yr)
		Latitude	Longitude	Ind.	Instal.	Pb
113	Metallhütte Carl Fahlbusch GmbH-Baden/Wuerttemberg	48°51'	8°13'	61	621	10.2
114	Norddeutsche Affinerie AG-Hamburg	53°31'	10°03'	61	621	10.2
115	Thyssen AG	51°29'	6°43'	50	54	6.3
116	Thyssen AG	51°28'	6°43'	50	54	6.3
117	Thyssen AG	51°28'	6°45'	50	54	6.3
118	Thyssen AG	51°25	7°10'	50	54	6.3
119	Thyssen AG	51°31'	7°07'	50	54	6.3
120	Stahlwerke Roechling-Burbach GmbH	49°15'	6°50'	50	54	6.3
121	Ew Gesellschaft Maximillianshütte	49°29'	11°45'	50	54	6.3
122	Mannesmann AG	51°22'	6°42'	50	54	6.3
123	Stahlwerke Peine-Salzgitter AG	52°10'	10°24'	50	54	6.3
124	Stahlwerke Peine-Salzgitter AG	52°16'	10°13'	50	54	6.3
125	Kloeckner Werke AG	53°08'	8°41'	50	54	6.3
126	Estel Hüttenwerke	51°30'	7°25'	50	54	6.3
127	Hoesch Hüttenwerke	51°32'	7°29'	50	54	6.3
128	Krupp Stahl AG	51°23'	6°43'	50	54	6.3
129	AG Der Dillinger Hüttenwerke	49°21'	6°44	50	54	6.3
130	Neunkirchner Eisenwerke AG	49°21'	7°10	50	54	6.3
131	Duisburger Kupferhütte AG	51°25'	6°44'	50	54	6.3
132	Pont-A. Mousson	49°13'	7°02'	50	54	6.3
133	Kloeckner Werke AG	52°13'	8°03'	50	54	6.6
134	Bremerhaven	53°33'	8°35'	14	16	0.9
135	Bamberg	49°54'	10°54'	14	16	0.9
136	Hamburg	53° 31'	10°03'	14	16	0.9
137	Ingolstadt	48°46'	11°27'	14	16	0.9
138	Kiel	54°20'	10°08'	14	16	0.9
139	Krefeld	51°20'	6°32'	14	16	0.9
140	Marktoberdorf	47°47'	10°37'	14	16	0.9
141	Pinneberg	53°40'	9°49'	14	16	0.9
142	Wuppertal	51°15'	7°10'	14	16	0.9
143	Zirndorf	49°27'	10°58'	14	16	0.9
144	Ind.comm.resident combustion					11.3
145	Road Transport					240.0
146	Other Sources					10.0
	TOTAL					490.0

Country code: 07–**Former FRG** cont.:

No.	Source name	Geographical position		Codes		Emission (ton/yr)
		Latitude	Longitude	Ind.	Instal.	Pb
1	Boxberg	51°25'	14°34'	11	11	3.1
2	Hagenwerder	51°03'	14°47'	11	11	1.3
3	Lübbenau	51°57'	13°58'	11	11	1.0
4	Vetschau	51° 48'	14°06'	11	11	1.0
5	Thierbach	51°10'	12°29'	11	11	0.6
6	Lippendorf	51°11'	12°22'	11	11	0.4
7	Vockerode	51°50'	12°13'	11	11	0.3
8	Jänschwalde	51°51'	14°31'	11	11	3.0
9	Tratendorf	51°33'	14°25'	11	11	0.3
10	Hirschfelde	50°57'	14°54'	11	11	0.2
11	Harbke	52°12'	11°07'	11	11	0.1
12	Lauta	51°27'	14°06'	11	11	0.2
13	Zschornewitz	51°43'	12°24'	11	11	0.1
14	Sonstige	51°20'	12°25'	11	11	0.9
15	Schwarze Pumpe	51°32'	14°22'	11	11	0.9
16	Espenhain	51°10'	12°28'	11	11	0.1
17	Regis/Borna	51°06'	12°25'	11	11	0.1
18	Eisenhüttenstadt	52°20'	14°32'	50	52	13.5
19	Unterwellenborn	50°39'	11°25'	50	52	8.0
20	Brandenburg	52°25'	12°34'	50	54	13.5
21	Riesa	51°18'	13°18'	50	54	9.5
22	Henningsdorf	52°38'	13°13'	50	54	9.5
23	Veb. Kupfer u. Blechwalzwerk m. Niederkirchner-Ilsenburg	51°53'	10°41'	61	621	0.3
24	Hüttenkombinat Mansfeld-Hettstedt	51°39'	11°29'	61	621	0.8
25	Hüttenkombinat Mansfeld-Eisleben	51°32'	11°31'	61	621	0.8
26	Hüttenkombinat Mansfeld-Helbra	51°33'	11°28'	61	621	0.8
27	V.E.B. Bergbau u. Hütten-kombinat A. Funk-Freiberg	50°55'	13°20'	61	631,632	10.2
28	V.E.B. Bergbau u. Hütten-kombinat A. Funk-Freiberg	50°55'	13°20'	61	641,642	2.1
29	Ind.comm resident combustion					11.4
30	Other Sources					40.0
	TOTAL					134.0

Table 10: Anthropogenic emissions of Pb to the atmosphere, in tons per year, from point and area sources the Czech Republic in 1995.

Country code: 12A–**THE CZECH REPUBLIC**

No.	Source name	Geographical position		Codes		Emission (ton/yr)
		Latitude	Longitude	Ind.	Instal.	Pb
1	Pocerady	50°32'	13°35'	11	11	2.3
2	Ledive	50°31	13°33'	11	11	1.3
3	Tusimice	50°23'	13°20'	11	11	2.4
4	Prunerov	50°25'	13°16'	11	11	3.0
5	Brezova-Tisova	50°16'	12°41'	11	11	1.0
6	Vresova	50°09'	12°38'	11	11	0.5
7	Ervenice	50°35'	13°40'	11	11	0.1
8	Zaluzi	50°33'	13°45'	11	11	0.1
9	Melnik	50°33'	14°25'	11	11	2.3
10	Detmarovice	50°20'	14°20'	11	11	0.6
11	Ostrava	49°50'	18°15'	11	11	0.1
12	Karvina	49°50'	18°30'	11	11	0.1
13	Chvaletice	50°07'	14°36'	11	11	1.5
14	Porici	50°18'	14°35'	11	11	0.1
15	Hodonin	48°52'	17°10'	11	11	0.5
16	Novaky	49°39'	13°49'	11	11	1.2
17	Litvinov	50°30'	13°20'	11	11	0.3
18	Plzen	49°45'	13°25'	11	11	0.3
19	Olmucz lead works Olmucz n. Brno	49°13'	16°40'	61	631	47.0
20	Pribou lead works Pribou n. Prague	49°39'	13°49'	61	631	47.0
21	Kamenica remelting works-Jihlawa	49°24'	15°34'	61	632	3.0
22	Velvary remelting works-Velvary	49°24'	15°31'	61	632	3.0
23	Chomutov tube works-Chomutov	50°28'	13°26'	50	54	1.9
24	Poldi-Snop Kladno	50°10'	14°02'	50	54	11.1
25	Nova Huta Klementa Gottwalda-Kunice-Ostrawa	49°50'	18°15'	50	54	4.8
26	TZ Trinec/Ostrawa	49°50'	18°15'	50	54	28.4
27	Vitkovice/Ostrawa	49°50'	18°15'	50	54	10.1
28	Skoda/Pilzno	49°45'	13°25'	50	54	6.7
29	SZ Podbrezowa	49°45'	13°25'	50	54	3.8
30	ZDB Bohumin	49°45'	13°25'	50	54	3.8
31	Ind.comm. resident combustion					32.3
32	Waste Disposal					
33	Road Transport					156.0
34	Other Sources					
TOTAL						376.6

ANNEX 1

Deres *ref./Your ref.* Vår ref./Our ref.: Kjeller,
30 November, 1998

Dear Colleague:

Recently I became invo1ved in a study at the GKSS Research Centre in Geesthacht, Germany aiming at characterization of the response of the natural environment of the EIbe catchment to Pb emission scenarios. In other words, the study shall determine how quick and to what extent the Pb concentrations in the EIbe catchment will change due to any changes of emissions of the element in Europe. The project is sponsored by the German internal funds at GKSS and is coordinated by Dr. Hans von Storch and Dr. Wim Salomons, both of GKSS. My ro1e in the project is to support the study with information on current levels of Pb emissions in Europe and their historical developement from the 1950's.

While the survey of historica1 emissions of Pb in Europe is in its final stage, I am now quite concerned with as complete and accurate as possib1e data on emissions in the mid 1990's, regarded in the project as current emissions.

With this letter I wou1d like to ask you for help in providing me with the information on Pb emissions from sources in your country in the mid 1990's, let say for 1995. Obviously, any newer data, e.g. for 1996 will be highly appreciated.

I need total Pb emission data and if possible emission data on category by category basis with special focus on mobile sources, industrial processes, combustion of fuels in stationary sources, and waste disposal. In addition, if any data on emissions of Pb from point sources in your country are available (emission, location of the point source), they would be very appreciated.

I shall add that any data which I would receive from you will be used only for the above mentioned project. These data will be properly referred and an acknowledgement for your he1p will be included.

Thanking you in advance,

Yours sincerely,

J M. Pacyna

Jozef M. Pacyna
Senior scientist

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