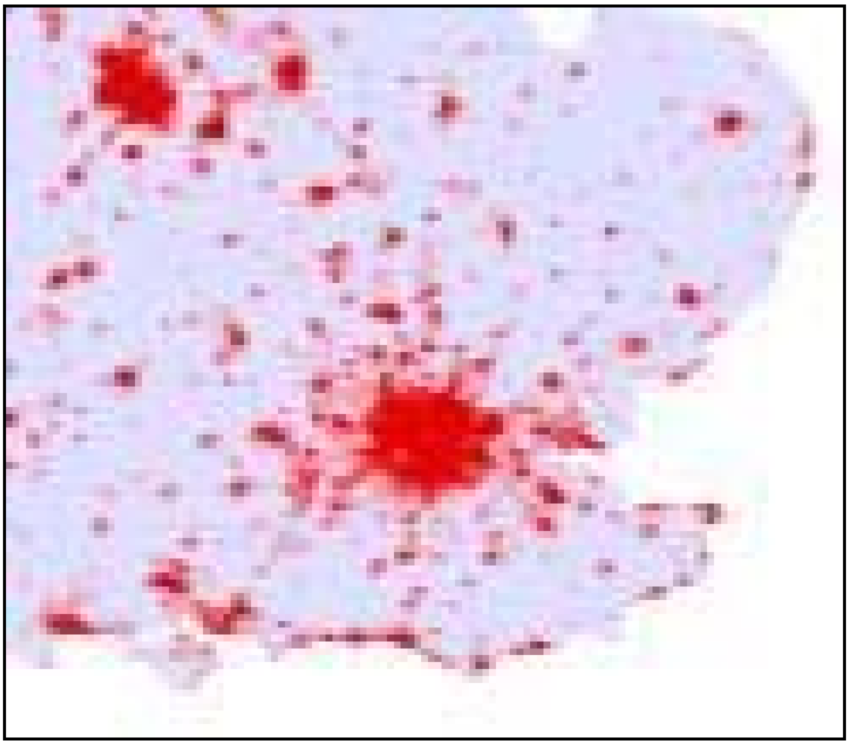
Good Practice Guidance
for Spatial Emissions Mapping

First Draft



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Cover page picture:
Fragment with the South East of the United Kingdom of Figure zza of this paper, illustrating how population density looks like with no focal mean applied. This grid could be used to weight the minor roads network as we assume that nearby population densities will determine road activity levels on minor roads.

DISCLAIMER

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Good Practice Guidance for Spatial Emissions Mapping

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Contents:

Glossary of Terms:

Focal mean:

IPPC: Integrated Pollution Prevention and Control.

LDV:

HDV:

LCPD: Large Combustion Plant Directive

LPS: Large Point Source. Point Sources that require reporting as defined in the UNECE reporting Guidelines.

NUTS:

Point Source: A site location to which emissions can be attributed. This includes Large and smaller point sources.

Road link:

Surrogate Spatial Dataset: a geographically resolved dataset of statistics by grid, link, point or boundary such as employment by region, population by administrative boundary or vehicle activity by road link.

1 Introduction

This chapter is to provide guidance on compiling spatial emissions datasets in order to submit data as required under the LRTAP Convention.

The sectoral guidance has been arranged grouping sectors that require similar mapping approaches and datasets. The current structure will be modified and integrated into the new Guidebook revisions during 2007/2008.

Gridded emissions are increasingly important because:

- Reported spatial emissions data is an important input for models used to assess atmospheric concentrations and deposition, as the spatial location of emissions determine to a greate extent their athomspheric dispersion patterns. The results of model assessments inform national and international policies used to improve the environment and human health.
- Reporting of spatial emissions is required under the Gothenburg Protocol for Parties to the LRTAP Convention.

2. REPORTING OBLIGATIONS FOR SPATIAL EMISSIONS

The UNECE/EMEP 2002 Emission reporting Guidelines provide details of the reporting requirements for spatial data (http://www.unece.org/env/eb/Air_Pollutionwithcover_15_ENG.pdf paragraphs 22 and 23.). These Guidelines are subject to revision in 2007 and was adopted by the TFEIP in November 2006. We have chosen to refer to the not yet adopted by the EMEP SB and the EB version of the Guidelines . Reporting is required for Large Point Sources represented by Latitude and Longditude references for the location of the point source and for Gridded sources using the EMEP 50x50km grid represented by x,y values for the centre of the grid.

The Guidelines gives guidance on e.g.:

- The EMEP 50 * 50 km grid
- The sectoral definitions for Gridded and Large Point sources
- Additional Large Point Source information requirements e.g. height class
- The required pollutants (Main pollutants, PM, Pb, Cd, Hg, PAHs, HCB, dioxins/furans)
- Years for reporting.

3. Definitions

EMEP grid

Please refer to **http://www.EMEP.int/grid/index.html** and Annex II

Large Point Source:

Large point sources (LPS) are defined as facilities[1] whose combined emissions, within the limited identifiable area of the site premises[1], exceed the pollutant emission thresholds identified below which have been extracted from the full list of pollutants in E-PRTR Regulation[2] (Annex II)[3] and listed in table 1B below.

Table D1 List of pollutants to be reported for a LPS if the applicable threshold value is exceeded based on thresholds specified in E-PRTR Regulation (Annex II)[4].

Pollutants/Subtances	Thresholds in kg/year
SO_2	150 000
NO_x	100 000
CO	500 000
NMVOC	100 000
NH_3	10 000
$PM_{2.5}$	50 000
PM_{10}	50 000
Pb	200
Cd	10
Hg	10
PAH	50
PCDD/F	0.0001
HCB	10

[1] As defined in Article 2 (4) & (5) of the E-PRTR Regulation, "(4) 'facility' means one or more installations on the same site that are operated by the same natural or legal person;(5) 'site' means the geographical location of the facility; ", EC Regulation 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and
amending Council Directives 91/689/EEC and 96/61/EC, OJ L33 of 4.2.2006, p. 1

[2] EC Regulation 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC, OJ L33 of 4.2.2006, p. 1

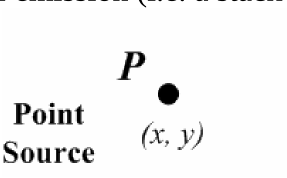
[3] As $PM_{2.5}$ is not specified in the E-PRTR regulation this has been added to the table 1B of these guidelines with the same threshold as for PM_{10}.

[4] EC Regulation 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC, OJ L33 of 4.2.2006, p. 1

Parties that do not report combustion process emissions under any other international or EU wide protocols or decisions may limit their criteria for Combustion Process LPS selection to > 300mw thermal capacity.

Point Sources

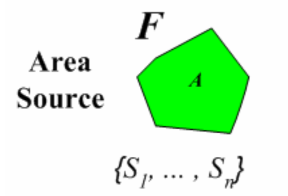
Point sources are represented by an x and y coordinate. This should represent the point of emission (i.e. a stack on an industrial site).



A point source is an emission source at a known location such as an industrial plant or a power station. Emissions from point sources represent sectors of a national inventory either fully (often for power stations where the sector is made up of large sites for which emissions reporting is mandatory) or in part (such as combustion in industry, for which only the large sites within the sector are required to report emissions).

Area Sources (Polygons)

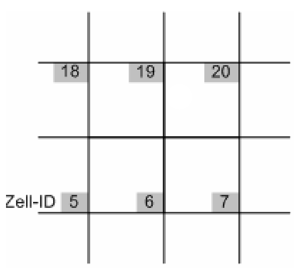
Area polygons are often used to represent data attributed to administrative boundaries. This can also include data collection boundaries, site boundaries and other non linear or regular geographical features.



Polygons can also be used to represent a regular grided set of features. Polygons whether regular (gridded or irregular) are vector (line) based features and are characterised by multiple x,y coordinates for each line defining an area.

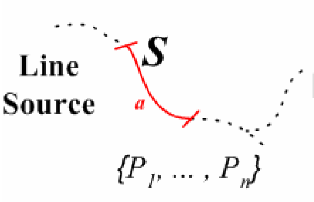
Area Sources (Grids)

Area sources can be represented in a regular grid of identically sized cells. The spatial aspects of grids are usually characterised by a geographical coordinates for the centre or corner of the grid and a definition of the size of each cell.



Grids are often used to harmonise datasets as point, line and polygon features can be converted to grids and then several different layers of information (emission sources) can easily be aggregated together (see 4.4 Combining different spatial features below).

Line Sources
Line sources are represented by vectors with a starting node and an end node specifying an x,y location for each.



Lines can be curved if the vector also has "vertices" WHAT IS THIS? attributed to it which provide additional x,y coordinates for sections of the line.

International air and sea traffic:

The following definitions apply to these reporting guidelines and are taken from chapters 3.5.1 and 3.6.1 of Volume 2 of the IPCC 2006 Guidelines.

International Shipping: Emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Includes emissions from journeys that depart in one country and arrive in a different country. Exclude consumption by fishing vessels .

International Aviation: Emissions from flights that depart in one country and arrive in a different country. Include take-offs and landings for these flight stages. Emissions from international military aviation can be included provided that the same definitional distinction is applied.

4. General Guidance

This section provides general guidance on the concepts and approaches to deriving and working with spatially resolved (e.g. sub-national) datasets. Please note that for modelling purposes, datasets with as high resolution as possible is preferable. Aggregation to the present EMEP 50x50 km grid could be done in the end, and further reference to the present EMEP grid is only made here due to the present Guidelines commitments.

Apart from a selection of detailed datasets, including some Countries detailed road transport networks and reported Large Point Source emissions data, most other nationally reported emissions datasets are based on national statistics and are not resolved spatially in a manner that could be readily aggregated to the required 50x50km EMEP grid. Where Parties inventories are compiled at a sub-national level these areas are usually too large to aggregate adequately to the EMEP 50x50km grids.

This presents the inventory compiler with a number of generic challenges that need to be resolved to produce spatial data accurately on the scales required including:

- **Finding key spatial data sources (Section 4.1)**
- **Gathering and working with point source data (Section 4.2)**.
- **Distributing national emissions using a number of different surrogate[5] spatial datasets (Section 4.3).**
- **Combining Spatial Features (Section 4.4):** Combining/aggregating surrogate data for different sectors available in different spatial forms (e.g. raster grids, polygons, lines) and resolving these forms to as high resolution as possible for possibly later aggregation to the appropriate 50x50km EMEP grid.
- **Converting between different Spatial Projections (Section 4.5).** Converting spatial data from different projection or co-ordinates into a standard co-ordinate and projection system for combination with other sectors and eventually conversion to the EMEP 50x50km grid.

4.1 Finding key spatial data sources

There are a number of different sources of spatial data. The first place to look should be national statistical centres such as demographic, economic, transport, regulatory, energy, regulating bodies and trade associations as these data are likely to be most up-to-date. Sometimes spatial datasets are maintained independently of their geographies. Statistics may be collected and stored with reference to regional or local government names while the information that defines the spatial boundaries of these areas (geographies) could be maintained in separate mapping datasets. Often a national body is responsible for the boundary datasets while specific statistics attributable to these boundaries will be available from elsewhere. In these cases the statistics will need to be joined to the boundary dataset using lookups and boundary IDs.

Where national data is unavailable or too time consuming to collect, a number of international datasets can be used.

4.1.1 NATIONAL DATASETS:

Population and employment.
Most countries will have spatial population and employment datasets based on administrative boundaries that can be used/combined to derive specific distributions or used as general default distributions where other methods are not feasible.

[5] A substitute: referring to a dataset that will give a proxy distribution of emissions but may not correlate directly to the real spatial patterns of emissions.

Gas distribution networks:
Information on gas supply by region or on a GIS bases is often available from energy departments gas suppliers or from national statistical centres. Even national information on the number of households with/without gas supply can be useful.

Agricultural data.
Most countries have agricultural census or survey data collected at a detailed spatial scale at administrative boundary level.

Road Network Information.
It is likely that many countries will hold national or commercial road network datasets. These can be used to help distribute road traffic emissions in combination with traffic intensity statistics for administrative boundaries or specific count points.

Rail.
"To be completed"

Airport activity data.
Many countries have detailed aircraft movement datasets as part of their national statistics. These can be used to distribute emissions from Landing and Take-Off (LOT) and from airside support vehicles to air port areas.

National shipping.
"To be completed"

Local Inventory data:
In some cases local inventory data can be used to improve the spatial distribution of emissions for transport and stationary sources. However, integration of this data with the nationally reported data and resolving emissions allocated to other areas can be time consuming and difficult to document. ACCORDING TO A SURVEY ZIG JUST MADE IN CONNECTION TO A ws ON LOCAL SCALES, FEW COUNTRIES DO

Large Point Source Information.
Regulation of large point sources is common in most Countries and reporting of regulated emissions through the Auhaus Convention and the OECD-PRTR, LCPD, EPER and E-PRTR established a requirement for regular point source emissions reporting. Regulators within Countries that are party to these protocols and directives will have publicly available records of reported emissions data. Alternative Large Point Source information sources can include:

- Trade Associations
- Operators
- Statistical energy and productivity publications (Capacity)

4.1.2 INTERNATIONAL DATASETS

There are a number of different international datasets that can be used to derive a countries spatial emissions.

INSPIRE

In the future the EU intends to provide access to spatial datasets through the INSPIRE programme http://eu-geoportal.jrc.it/gos

- A number of different geographical datasets will be available under this European Initiative.

Corine:

Provides processed satellite images showing different landcover classes that can be used to distribute emissions for different sectors. This data can be accessed from http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=823 or http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=950 and provides among the 45 different landcover the following of relevance to emissions mapping.

- Continuous urban fabric
- Discontinuous urban fabric
- Industrial or commercial units
- Road and rail networks and associated land
- Port areas
- Airports
- Mineral extraction sites
- Dump sites
- Construction sites
- Green urban areas
- Arable land
- Sport and leisure facilities

A number of these CORINE datasets can be used individually or in combination to generate spatial distributions for sectoral emissions.

Where CORINE or similar data is not available, satellite based landcover data can often be derived from raw images using the CORINE methodology. Expertise to support this can be found from REFERENCE NEEDED. MAYBE WWW.TEMIS.NL?

ICAO:

Airport statistics for major airports can be obtained from the ICAO website if country specific data are not available. see http://www.icaodata.com/Trial/WhatIsICAO.aspx

Eurostat:

Employment data is available from Eurostat at NUTS 3 level, split into three categories – services, industry and agriculture. Employment statistics are reported using the NACE classification system. see http://forum.europa.eu.int/irc/dsis/bmethods/info/data/new/classifications/nace_en.pdf

4.2 Gathering and working with point source data

There are a number of different types/forms of spatial dataset. Most will fall into one or other of the following categories outlined below.

Emissions for the point sources can be compiled using a number of different data sources and techniques. For convenience, the point source data can be divided into three groups:

1. Regulated point sources such as those regulated under the Integrated Pollution Control (IPC) or Integrated Pollution Prevention and Control (IPPC) regulatory regimes or where there is a requirement for centralized annual emissions reporting (e.g. for EPER/E-PRTR/the Large Combustion Plant (LCP) Directive)
2. Point sources that are regulated but for which there are no annual emissions reporting requirements (this is often smaller plants). For these sources emissions can be estimated based on centralized data on process type and information records associated with the original application for emission permits.
3. Point sources for sites or pollutants not reported or regulated. Emissions can be modeled by distributing national emission estimates over the known sources on the basis of capacity, pollutant correlations with reported data (e.g. particulate to PM10/PM2.5) or some other 'surrogate' statistic such as employment. Box x provides some examples of approached to deriving emissions for point sources in the absence of reported data.

Example 1: Estimating point Source Emissions for Sources/Pollutants that are not reported

Point source data are often not available for all processes even if the location of the emissions are known. Sources may not need to report emissions if these are below a specified reporting threshold or are not required to report. In some cases, datasets are not complete. Furthermore, some point sources are not regulated. In these cases, point source data is generated using national emission factors and some ‘surrogate’ activity statistic. Examples of approaches used are given below:

- Estimates of plant capacity, can be used to allocate the national emission estimate. This approach can be used, for example, for bread bakeries where estimates of the capacity of large mechanized bakeries can be made or gathered from national statistics or trade associations.
- Emission estimates for one (reported) pollutant can be used to weight the national emission estimate of another pollutant. For example, emissions of PM10 from certain coating processes can been estimated by allocating the national total to sites based on their share of the national VOC emission.
- Deriving point source estimates based on pollutant ratios can be used to fill gaps in reported emissions data. In some cases PM10/PM2.5 ratios can be established to estimate emissions for PM10 and PM2.5 for similar processes. Where no other

data is available other pollutants such as NOx and SO2 can be used to distribute other pollutant emissions.

- Assuming that all plants in a given sector have equal emissions. In a few cases where there are relatively few plants in a sector but no activity data can be derived, emissions can be assumed to be equal at all of the sites.

With the possible exception of using plant capacity, many of the approaches listed above will yield emission estimates which are subject to significant uncertainty. However, most of the emission estimates generated using these methods are, individually, relatively small and the generation of point source data by these means is judged better than mapping the emissions as area sources.

The derived point source dataset should be able to differentiate point source emissions into the relevant reporting sectors so that emissions can be reconciled with national totals for these sectors.

4.3 DISTRIBUTING NATIONAL EMISSIONS

In many cases (where emissions can not be calculated at a suitably small spatial scale or estimates are inconsistent with national estimates and statistics) national emission estimates will need to be distributed across the national spatial area using a surrogate spatial dataset.

Basic Principals:

The basic principals of distributing emissions presented in the formula below using a surrogate spatial dataset x:

$$emission_{ix} = emission_t \times \frac{value_{ix}}{\sum_{jx}^{ix} value}$$

Where :
Emission$_{ix}$: is the emissions attributed to a specific geographical feature (e.g. a gridcell or administrative boundary)within the spatial surrogate dataset x.
Emission$_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset.
Value$_{ix\text{ - }jx}$: are the surrogate data value of each of the specific geographical features within the spatial surrogate dataset x.

The following steps should be followed:

1. Determine the emission total to be distributed (**Emission$_{ix}$**) (either national total for sector or where a sector is represented by some large point sources; national total – sum of point sources).
2. Distribute that emission using the basic principals above using a suitable surrogate statistic (according to the detailed guidance by sector below).

This approach effectively shares out the national emissions according to the intensity of a chosen or derived spatially resolved statistic.

Example 2 Distribution of national emissions:

- to allocate SO2 emissions from residential combustion based on a gridded or administrative boundary (e.g. NUTS) spatial dataset of population density. However, emissions of SO2 may not correlate very well to population density in countries where a variety of different fuels are burned (e.g. city centres may burn predominantly gas and therefore produce very little SO2 emissions per head of population). Additional survey information and or energy supply data (e.g. metered gas supply) could be used to enhance the population based surrogate for residential emissions and achieve a better spatial correlation to “real” emissions.
- or to allocate national transport emissions to road links (road line maps) based on measured or modelled traffic flow, road type or road width information for each of the road links. Again, the closer the distribution attributes for each road link correlate to the actual emissions, the better. For example road width and road type only loosely relate to traffic emissions and provide a poor distribution method, being able to distinguish between the numbers of heavy goods vehicles and cars using different road links each year will improve the compilers ability to accurately allocate emissions.

Emissions at this point are likely to be in a number of different spatial forms including different sizes grids, polygons, lines and even point sources (where emissions are derived by allocating national estimates according to published capacity or employment information) determined by the spatial characteristics of the source data.

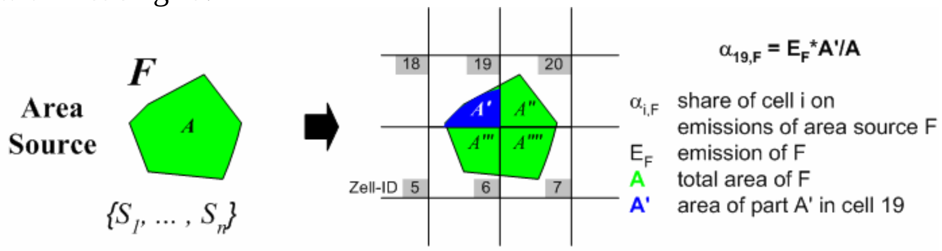
In many cases combinations of different spatial datasets will provide the best results for distributing emissions. For example, where traffic count/density information is not available basic road link information can be combined with population data to derive appropriate emission distribution datasets (see section 6.8 Road transport).

4.4 Combining different spatial features

Spatial emission data will need to be combined to form emission maps for totals and in order to derive the EMEP 50x50km grids. This is generally done by resolving the different spatial forms to a common grid so that different sectors can be aggregated. The common grid can either be the EMEP 50x50km grid or another grid based on national coordinates and or smaller cell sizes. The methodologies for converting the different forms to a common grid are outlined below. For line and area conversion to grids an intersect operation is needed. This intersects the boundaries of the polygon or the length of the line with the boundaries of the grid an creates a new set of features that are cut to the extent of each gridcell.

Area source (Polygons) to Grids

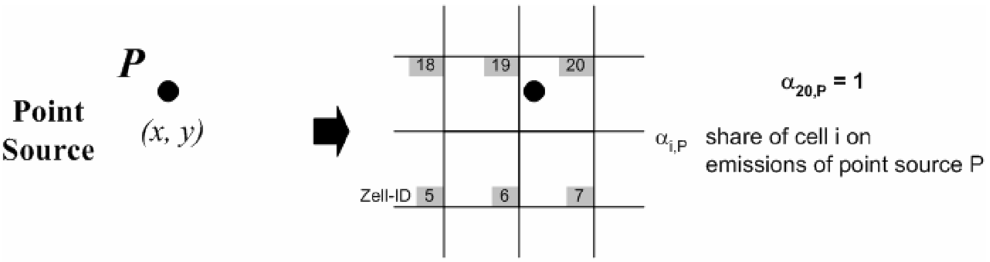
Intersecting the polygon with the grid will produce a dataset of polygons contained within each grid.



The fraction of the area of the new polygons can be used to distribute the emissions/surrogate statistics from the original polygon to the gridcells. Alternatively an emission rate/area can be applied to the new polygon area and that emission/surrogate statistic assigned to the gridcell.

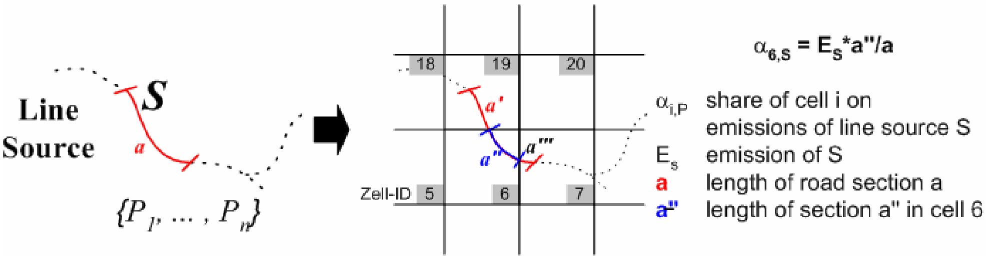
Point Sources to Grids

Point sources can be allocated directly to the grid within which they are contained by converting the x,y values to that of the coordinates used to georeference the grid or by intersecting the point with the grid.



Line Sources to Grids

Intersecting the line features with the grid will produce a dataset of shorter line lengths contained within each grid. The fraction of the original line length of the new line can be used to distribute the emissions/surrogate statistics from the original line to the gridcells. Alternatively an emission rate/unit of length can be applied to the new line length and that emission/surrogate statistic assigned to the gridcell.



4.5 CONVERTING BETWEEN DIFFERENT SPATIAL PROJECTIONS (E.G. GIS TO EMEP).

In a number of cases an inventory compiler may need to combine data from different spatial datasets and to eventually derive the 50x50kmEMEP grid a number of different spatial extents and datasets will need to be combined. Annex 1 presents the definition of the EMEP grid.

The Open Geospatial Consortium Inc. provides guidance and standards for Coordinate Transformation see http://www.opengeospatial.org/standards/ct . Much of this guidance and key variables

5. Setting priorities - working with Available resources and data

The following list of actions should be considered in order to define a spatial distribution project:

1. Use Key Source Analysis to identify to the most important sources, and give the most time to these.
2. Try to make use of existing spatial datasets and carefully consider the merits vs costs of extensive new surveying or data processing to derive new spatial datasets
3. Make use of GIS tools and skills to improve the usefulness of available data.
4. It is recommended to select the surrogate data that is judged to most closely represent the spatial emissions patterns and intensity. E.g. for combustion sources surrogate spatial datasets that most closely match the spatial patterns of fuel consumed by type should be chosen. In some cases specialized surrogate statistics can be derived from a number of different spatial surrogate datasets (e.g. Example 1).
5. Surrogate spatial datasets that are complete (cover the whole national area) should be preferred.
6. Issues relating to non disclosure may be encountered (at a sectoral or spatial level) that may impose barriers to acquiring data (e.g. population, agriculture, employment data). As only highly aggregated output data is needed for reporting, signing of non disclosure or confidentiality agreements or asking the data supplier to derive aggregated datasets may improve the accessibility of this data. It will be important that issues relating to this are identified and dealt with in consultation with the national statistical authority.

6. Sectoral Guidance

The sectoral guidance below provides methodological approaches by sector for distributing national emissions. Sectors have been grouped where similar spatial datasets apply. Generic methodology for dealing with point sources, in distributing national emissions over a surrogate spatial dataset, combining different spatial datasets (e.g. points and areas) and in generating the EMEP grid are included in the general guidance above.

Table xx taken from the 2007 Guidelines gives an overview of the required grid categories

Table xx GNFR sectors to be reported under the Convention of LRTAP

NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**
A_PublicPower	1 A 1 a	1 A 1 a Public Electricity and Heat Production
B_IndustrialComb	1 A 1 b	1 A 1 b Petroleum refining
	1 A 1 c	1 A 1 c Manufacture of Solid Fuels and Other Energy Industries
	1 A 2 a	1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel
	1 A 2 b	1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals
	1 A 2 c	1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals
	1 A 2 d	1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print
	1 A 2 e	1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco
	1 A 2 f i	1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other (Please specify in your IIR)
	1 A 5 a	1 A 5 a Other, Stationary (including Military)
C_SmallComb	1 A 4 a i	1 A 4 a i Commercial / Institutional: Stationary
	1 A 4 b i	1 A 4 b i Residential: Stationary plants
	1 A 4 c i	1 A 4 c i Agriculture/Forestry/Fishing: Stationary
D_IndProcess	2 A 1	2 A 1 Cement Production
	2 A 2	2 A 2 Lime Production
	2 A 3	2 A 3 Limestone and Dolomite Use
	2 A 4	2 A 4 Soda Ash Production and use
	2 A 5	2 A 5 Asphalt Roofing
	2 A 6	2 A 6 Road Paving with Asphalt
	2 A 7 a	2 A 7 a Quarrying and mining of minerals other than coal
	2 A 7 b	2 A 7 b Construction and demolition
	2 A 7 c	2A 7 c Storage, handling and transport
	2 A 7 d	2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)
	2 B 5 a	2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)
	2 B 5 b	2 B 5 b Storage, handling and transport (Please specify the sources included/excluded in the notes column to the right)
	2 B 1	2 B 1 Ammonia Production
	2 B 2	2 B 2 Nitric Acid Production
	2 B 3	2 B 3 Adipic Acid Production
	2 B 4	2 B 4 Carbide Production
	2 C 1	2 C 1 Iron and Steel Production
	2 C 2	2 C 2 Ferroalloys Production

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
	2 C 3	2 C 3 Aluminum Production
	2 C 5 a	2 C 5 a Copper Production
	2 C 5 b	2 C 5 b Lead Production
	2 C 5 c	2 C 5 c Nickel Production
	2 C 5 d	2 C 5 d Zinc Production
	2 C 5 e	2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)
	2 C 5 f	2 C 5 f Storage, handling and transport (Please specify the sources included/excluded in the notes column to the right)
	2 D 1	2 D 1 Pulp and Paper
	2 D 2	2 D 2 Food and Drink
	2 D 3	2 D 3 Wood processing
	2 E	2 E Production of POPs
	2 F	2 F Consumption of POPs and Heavy Metals (e.g. electrical and scientific equipment)
	2 G	2 G Other production, consumption, storage, transportation or handling of bulk products (Please specify the sources included/excluded in the notes column to the right)
E_Fugitive	1 B 1 a	1 B 1 a Fugitive emission from Solid Fuels: Coal Mining and Handling
	1 B 1 b	1 B 1 b Fugitive emission from Solid Fuels:Solid fuel transformation
	1 B 1 c	1 B c Other fugitive emissions from solid fuels
	1 B 2 a i	1 B 2 a i Exploration Production, Transport
	1 B 2 a iv	1 B 2 a iv Refining / Storage
	1 B 2 a v	1 B 2 a v Distribution of oil products
	1 B 2 a vi	1 B 2 a vi Geothermal energy extraction
	1 B 2 b	1 B 2 b Natural gas
	1 B 2 c	1 B 2 c Venting and flaring
F_Solvents	3 A 1	3 A 1 Decorative coating application
	3 A 2	3 A 2 Industrial coating application
	3 A 3	3 A 3 Other coating application (Please specify the sources included/excluded in the notes column to the right)
	3 B 1	3 B 1 Degreasing
	3 B 2	3 B 2 Dry cleaning
	3 C	3 C Chemical products
	3 D 1	3 D 1 Printing
	3 D 2	3 D 2 Domestic solvent use including fungicides
	3 D 3	3 D 3 Other product use
G_RoadRail	1 A 3 b i	1 A 3 b i Road Transport:, Passenger cars
	1 A 3 b ii	1 A 3 b ii Road Transport:, Light duty vehicles
	1 A 3 b iii	1 A 3 b iii Road Transport:, Heavy duty vehicles
	1 A 3 b iv	1 A 3 b iv Road Transport:, Mopeds & Motorcycles
	1 A 3 b v	1 A 3 b v Road Transport:, Gasoline evaporation
	1 A 3 b vi	1 A 3 b vi Road Transport:, Automobile tyre and brake wear
	1 A 3 b vii	1 A 3 b vii Road Transport:, Automobile road abrasion
	1 A 3 c	1 A 3 c Railways
H_NationalShips	1 A 3 d ii	1 A 3 d ii National Navigation (Shipping)
	1A 4 c iii	1A 4 c iii Agriculture/Forestry/Fishing: National Fishing
I_OffRoadMob	1 A 2 f ii	1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction: (Please specify in your IIR)
	1 A 3 e	1 A 3 e i Pipeline compressors
	1 A 4 a ii	1 A 4 a ii Commercial / Institutional: Mobile
	1 A 4 b ii	1 A 4 b ii Residential: Household and gardening (mobile)
	1 A 4 c ii	1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery
	1 A 5 b	1 A 5 b Other, Mobile (Including military, land based and recreational boats)
J_CivilTOL	1 A 3 a ii (i)	1 A 3 a ii (i) Civil Aviation (Domestic, LTO)

NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname
K_CivilCruse	1 A 3 a ii (ii)	1 A 3 a ii (ii) Civil Aviation (Domestic, Cruise)
L_OtherWasteDisp	6 A	6 A SOLID WASTE DISPOSAL ON LAND
	6 D	6 D OTHER WASTE
M_WasteWater	6 B	6 B WASTE-WATER HANDLING
N_WasteIncin	6 C a	6 C a Clinical Waste Incineration
	6 C b	6 C b Industrial Waste Incineration
	6 C c	6 C c Municipal Waste Incineration
	6 C d	6 C d Cremation
	6 C e	6 C e Small Scale Waste Burning
O_AgriLivestock	4 B 1 a	4 B 1 a Cattle Dairy
	4 B 1 b	4 B 1 b Cattle Non-Dairy
	4 B 13	4 B 13 Other
	4 B 2	4 B 2 Buffalo
	4 B 3	4 B 3 Sheep
	4 B 4	4 B 4 Goats
	4 B 6	4 B 6 Horses
	4 B 7	4 B 7 Mules and Asses
	4 B 8 a	4 B 8 Swine
	4 B 9 a	4 B 9 a Laying Hens
	4 B 9 b	4 B 9 b Broilers
	4 B 9 c	4 B 9 c Turkeys
	4 B 9 d	4 B 9 d Other Poultry
P_AgriOther	4 D 1	4 D 1 a Synthetic N-fertilizers
	4 D 2 a	4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products
	4 D 2 b	4 D 2 b Off-farm storage, handling and transport of bulk agricultural products
	4 D 2 c	4 D 2 c N-excretion on pasture range and paddock Unspecified (Please specify the sources included/excluded in the notes column to the right)
	4 G	4 G Agriculture OTHER
Q_AgriWastes	4 F	4 F FIELD BURNING OF AGRICULTURAL WASTES
R_ForestGrass	5 B	5 B FOREST AND GRASSLAND CONVERSION
S_Other	7 A	7 A OTHER (included in National Total for Entire Territory)
T_Natural	7 B	Other not included in National Total of the entire Territory (Please specify in your IIR)
	X	X (11 08 Volcanoes)

6.1 ENERGY PRODUCTION AND STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION (GNFR A_PUBLICPOWER AND B_INDUSTRIALCOMB)

TABLE 6.1.1 ACTIVITIES INCLUDED

- 1 A 1 a Public Electricity and Heat Production
- 1 A 1 b Petroleum refining
- 1 A 1 c Manufacture of Solid Fuels and Other Energy Industries
- 1 A 2 a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel
- 1 A 2 b Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals
- 1 A 2 c Stationary Combustion in Manufacturing Industries and Construction: Chemicals
- 1 A 2 d Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print
- 1 A 2 e Stationary Combustion in Manufacturing Industries and Construction: Food Processing, Beverages and Tobacco

- 1 A 2 f i Stationary Combustion in Manufacturing Industries and Construction: Other

??? 1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction **TO BE MOVET TO GNFR L_OFF-ROAD.**

- 1 A 5 a Other, Stationary (including Military)

6.1.1 GENERAL DESCRIPTION

This methodology includes the spatial mapping of emissions from industrial and non residential/commercial combustion sources including mobile non road sources. It includes dealing with Large Point Source information and area emissions.

6.1.2 ???SIMPLE METHODOLOGY???

QUESTION ABOUT SIMPLE AND MORE DETAILED METHODOLOGY: ISNT THE MORE AGGREGATED GNFR THE MORE SIMPLE??? Same question for all sectoral chapters

Source sectors will be spatially represented, depending on the pollutants and the availability of point source information, as either:

1. all point sources,
2. a combination of point sources (for the larger sites) and non point source emissions
3. or, purely non point source emissions

For any of the sectors in table 6.1, emissions can be distributed using reported point sources or surrogate spatial statistics or a combination of both depending on the availability of data.

Where a sector includes some point source data but not all emissions are covered by the point source dataset, remaining emissions (e.g. the national sector total – the sum of the point source emissions) should be distributed according to the “distribution of national emissions” as outlined in the general guidance above, using a suitable surrogate statistics.

Point Sources:
For deriving point source datasets see the “Gathering and working with point sources data” covered under the general guidance above.

Tier 1 Distributions using Land Cover:
Where employment or other more suitable data is not available a simpler and less accurate methods using land cover data can be used to derive industrial emissions based distributions. Weightings derived in the IMPRESAREO project **(**Dore, C. 2001) can be applied to the following landcover classes in the CORINE dataset to drive a suitable surrogate datasets:

Landcover Class	**Weighting**
Industry	1

Continuous urban fabric	0.2
Discontinuous urban fabric	0.01
Ports	0.05
Airports	0.05

Distributions using Employment:
Tier 2: Basic distributions can be derived using industrial sector employment statistics and the basic approach outlined above "distribution of national emissions" in the general guidance.

Tier 3: A more complex approach combining different datasets can be used where time and resources permit. In Example 3 below, national energy statistics by industry type have been used to apply specific energy intensity weightings to spatial employment datasets in order to derive a more realistic emissions distribution dataset.

Example 3: Deriving sector specific surrogate datasets

In the UK the following data sets are used to develop emissions distribution maps for Other industrial combustion, Miscellaneous industrial/commercial combustion, Public sector combustion and Agriculture stationary combustion:

- Office of National Statistics Inter-Departmental Business Register (IDBR) 2005 which provides detailed spatial data on employment at business unit level by Standard Industrial Classification (SIC) code; and
- DTI Energy Consumption in the UK data on industrial and commercial sector fuel usage for Coal, SSF, Oil and Gas for 2002. (DTI, undated report, Tables 4.6, 5.2 and 5.5)

The SIC codes in the IDBR database were aggregated and matched with the DTI energy datasets in order to calculate total employment by DTI energy sector and then used to derive UK average fuel intensity per employee by fuel type and industry type. These intensities could then be applied to employment distributions across the UK to make maps of implied fuel use by industry type and aggregated for the different emissions reporting sectors.

ASSUMPTIONS

Possible double counting in cells where point sources exist and emissions have been distributed based on surrogate statistics are minimal due to additional non regulated (non point source emissions occurring at point source locations).

DETAILED METHODOLOGY

To be added. SEE COMMENTS ABOVE

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

Pollutants that are dependant on the differentiation between different fuels will show high uncertainties for distributions based on data (e.g. employment) that can not reflect different spatial patterns of different fuel use. E.g. Spatial emissions of SO2 and PM10 from stationary combustion will not be well reflected if there is a diversity of fuel (e.g. coal and gas) used in different areas if the surrogate spatial datasets can not show this differentiation.
Distributing non road mobile sources (1 A 2 f ii Mobile Combustion in Manufacturing Industries and Construction) will be highly uncertain as emissions often occur in different places to employment. Emissions will be dependant on construction and maintenance activities that can be highly transient TO BE MOVET TO GNFR L_OFF-ROAD.

ADDITIONAL COMMENTS

Additional data such as gas supply, smoke control areas or other fuel supply information could be used to enhance the employment dataset to differentiate between different priority fuels in different areas. These datasets should be combined using GIS methods to derive a weighted spatial surrogate dataset.

Some Countries have also used surveys of boilers insurance documents in industry to build an accurate snapshot of combustion emissions by fuel type and size. However, undertaking suitable surveys can be resources intensive and can become quickly outdated.

REFERENCES

Dore, C.; Hayman, G.; Goodwin, J.; Winiwarter, W.; Steinnocher, K.; Ekstrand, S.; Olsson, B.; Bartzis, J.; Vlachogiannis, D.; Tamponi, M.: IMPRESAREO - Improving the Spatial Resolution of Air Emission Inventories Using Earth Observation DataWP 10000, Step by Step User Guide, ENV4-CT98-0752 (DG 12 - ESCY), 68 pp. + Annex, Dec. 2001

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6.2 Commercial Combustion

ACTIVITIES / SECTORS TO BE UPDATED ACCORDING TO GNFR

TABLE 6.2.1 ACTIVITIES INCLUDED

- 1 A 4 a i Commercial / Institutional: Stationary
- 1 A 4 a ii Commercial / Institutional: Mobile

GENERAL DESCRIPTION

This section includes the spatial mapping of emissions from stationary combustion in commercial installations. Typically these installations are in urban areas and includes small businesses and large public sector operations such as district heating, hospitals and government buildings.

Large point source data is likely to be minimal unless there are large district heating, or commercial/institutional heating plant included in the national inventory under sectoral 1A4a.

SIMPLE METHODOLOGY

First identify any relevant Large Point Sources with reported emissions or for which emissions can be estimated. Collection of public service and institutional fuel consumption data for large sites might be appropriate as this data is unlikely to be governed by commercial confidentiality.

Where large point sources are involved the guidance presented for large point sources under **Error! Reference source not found.**

Where a sector includes some point source data but not all emissions are covered by the point source dataset, remaining emissions (e.g. the national sector total – the sum of the point source emissions) should be distributed according to the methods given below in the simple methodology for area source distributions.

A number of different surrogate spatial datasets can be used for the distribution of non point emissions for Commercial sectors.

Employment statistics:
Spatial employment statistics for commercial and institutional employment categories can be used to distribute non point source emissions. This can be done using the distribution methods presented under the above. As with other combustion process emissions representing the allocation of different fuels used can make an important difference to the distributions. Therefore the integration of additional spatial data (e.g. gas distribution, known areas of fuel/smoke control) that helps to highlight any different spatial patterns for different fuel consumption will help to improve the

distribution dataset. Employment statistics can be used for the distribution of off road mobile emissions where other more specific data is not available.

Landcover:
Where Employment data is not available in an appropriate format, landcover data can be used to allocate emissions to the Continuous and Discontinuous urban fabric CORINE (or similar) classes for stationary and mobile sources.

Again the priority is to select or derive a dataset that most closely represents the spatial distribution and intensity of emissions. Ideally this will differentiate the use of different fuels in different regions.

ASSUMPTIONS

Possible double counting in cells where point sources exist and emissions have been distributed based on surrogate statistics are minimal due to additional non regulated (non point source) emissions occurring at point source locations.

DETAILED METHODOLOGY

To be added.. including the use of gas distribution datasets

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

Pollutants that are dependant on the differentiation between different fuels will show high uncertainties for distributions based on data (e.g. employment) that can not reflect different spatial patterns of different fuel use. E.g. Spatial emissions of SO2 and PM10 from stationary combustion will not be well reflected if there is a diversity of fuel (e.g. coal and gas) used in different areas if the surrogate spatial datasets can not show this differentiation.
Distributing non road mobile sources (1 A 4 a ii Commercial / Institutional: Mobile) will be highly uncertain as emissions are often occur in different places to employment. Emissions will be dependant on construction and maintenance activities that can be highly transient.
Improvement in national spatial statistics on gas supply to residential and commercial meters available nationally or reported internationally could improve the spatial distribution of fuel combustion for many non point source sectors.

ADDITIONAL COMMENTS

For commercial sectors additional data such as gas supply, smoke control areas could be used to enhance the employment dataset to differentiate between different priority fuels in different areas. These datasets should be combined using GIS methods to derive a weighted spatial surrogate dataset.

Some Countries have also used surveys of boilers insurance documents in commercial and institutional sectors to build an accurate snapshot of combustion emissions by fuel type and size. However, undertaking suitable surveys can be resources intensive and can become quickly outdated.

REFERENCES

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6.3 Residential

TABLE 6.3.1 ACTIVITIES INCLUDED

- 1 A 4 b i Residential: Stationary plants
- 1 A 4 b ii Residential: Household and gardening (mobile)

GENERAL DESCRIPTION

This section includes the spatial mapping of emissions from combustion in residential installations and mobile sources.

SIMPLE METHODOLOGY

Population or Household Density:
Spatial population or household census statistics can be used to distribute residential source emissions. Emissions can be distributed according to the population density or to the density of different classes of housing and the application of average energy consumption values for different housing classes. This should be done using the basic distribution methods presented under the 4.3 Distributing national emissions above.

For the distribution of household and gardening (mobile) emissions a similar approach can be used. Using Landcover (Urban/suburban classes) may help to improve the spatial patterns of household and gardening (mobile) emissions by removing allocations in city centers where use of mobile household and gardening equipment may be limited.

DETAILED METHODOLOGY

Development of spatial datasets that show spatial variation of different fuel types using gas network information will improve the emissions distributions for countries that have a diversity gas and solid/liquid residential fuels. This methodology is only appropriate for Countries that have a significant variation in fuel use for residential heating & cooking.

Integrating gas supply, with population data:
Where gas supply data is available this should be used:

1. to distribute emissions from gas consumption
2. to help remove emissions from other fuels allocated to areas with gas supply and allocate to areas where gas supply is low or zero.

Where no specific spatial gas supply data is available an approach highlighted by (Dore et al 2001) can be used to estimate gas supply distributions based on national statistics on the number of domestic connections to the gas network relative to the total number of households. (see Table 2.2 below).

Table 6.3.2- Domestic Connections to the Gas Network

Country	Households	Year	Households Connected	Year	Proportion connected	% in NG supply area	Comments
Austria	3,248,489	1998	1,207,000	1998	0.345	0.69	
Belgium	4,185,202	1998	2,303,000	1998	0.55	0.92	
Denmark	2,423,208	1999	289,000	1998	0.12	0.5	
Finland	2,340,000	1999	35,000	1997	0.15	0.33	Network only in south / south east
France	23,900,000	1998	9,590,000	1998	0.41	0.72	
Germany	37,532,000	1998	14,720,000	1998	0.42	0.93	
Greece	4,000,000	1999	8000	1999	0.2	0.5 (in 2006)	Only in Athens
Ireland	1,191,900	1997	322,000	1997	0.27	0.41	
Italy	21,642,350	1997	15,200,000	1998	0.696	0.86	
Luxembourg	144,300	1995					
Netherlands	6,692,000	1998	6,491,000	1997	0.97	0.99	
Portugal	3,083,000	1991	74,000	1998	0.026		
Spain	11,736,376	1991	3,271,000	1998	0.26	0.55	
Sweden	4,139,631	1996	52,000	1998	0.012		
UK	24,484,000	1999	19,897,000	1998	0.819	0.87	

Source: Country Picture,.Griffin and Fawcett (2000), Country Pictures, Energy and Environment Programme, ECI, University of Oxford

A distribution of gas supply can be derived based on the assumption that in areas of highest population densities the share of gas use is highest, and hence the use of other fuels reduced is reduced or excluded. This methodology assumes that gas networks (for the residential sector) will tend to be located in the most densely populated urban areas first. Obvious area restrictions should also be applied (e.g. from table yy above "Only Athens" indicates additional limitations to the spatial coverage of gas supply).

The grid cells with the highest densities that cumulatively equate to the percentage of the population with gas supply (e.g. for UK, the proportion connected is 81.9%) are considered to have the potential to use gas. Therefore, a grid can be developed based on population densities where we can identify the population that might potentially be using gas, and a grid showing population not using gas (see section XX for example).

The general objective should be to map different fuel uses differently and to derive the following surrogate spatial datasets to achieve a basic fuel differentiated map for the residential sector:

- **Map 1 (Gas):** Areas of gas supply or high population density assumed to be using gas.
- **Map 2 (Solid Fuels):** Areas of low population density (in countries with Gas supply) where gas is assumed not to be supplied????????. - to distribute emissions from consumption of solid fuels.
- **Map 3 (Liquid and other fuels):** All population densities – to distribute emissions from consumption of oil and other fuels.

The need for energy balance data for the domestic sector is crucial, in order to calculate the relative emission contributions from different types of fuel. It is worth noting that in this analysis, derived heat and electricity are not included in the energy balance as emissions from the use of such energy types is not directly attributable to the use of this energy. (However, the spatial location of households using such energy is important as it indicates that other fuel types are not being used).

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

As with other combustion process emissions representing the allocation of different fuels used can make an important difference to the distributions. Population density does not always correlate with emission density. Therefore, the integration of additional spatial data that helps to highlight any different spatial patterns for different fuel consumption will help to improve the distribution dataset. For SO2 and PMs in the residential sector the identification of areas burning predominantly solid and liquid fuels as opposed to natural gas will be important.

Improved approaches to distributing the combustion of bio-fuels (e.g. wood) will be important for many countries.

Improvement in national spatial statistics on gas supply to residential and commercial meters available nationally or reported internationally could improve the spatial distribution of fuel combustion for many non point source sectors.

ASSUMPTIONS

The simple methodology assumption that a linear relationship between emissions and population density exists,will be most realistic if a country has a uniform distribution of fuel use by type. Where there is a broad variation of fuel type use in different areas the accuracy of the simple method will be much lower.

The detailed methodology makes a number of assumptions about the distribution of gas supply (depending on the methods used) such as the relationship between population density and gas use that may not be appropriate. In addition it is assumed that the consumption of other fuels is related to the consumption of gas. In reality this relationship is much more complex, especially in the combustion of bio-fuels (e.g. wood) and in areas where there is a high proportion of localized use of coal and peat fuels.

ADDITIONAL COMMENTS:

None…

VERIFICATION PROCEDURES:

See general verification procedures under good practice above.

REFERENCES

Dore, C.; Hayman, G.; Goodwin, J.; Winiwarter, W.; Steinnocher, K.; Ekstrand, S.; Olsson, B.; Bartzis, J.; Vlachogiannis, D.; Tamponi, M.: IMPRESAREO - Improving the Spatial Resolution of Air Emission Inventories Using Earth Observation DataWP 10000, Step by Step User Guide, ENV4-CT98-0752 (DG 12 - ESCY), 68 pp. + Annex, Dec. 2001

Country Pictures,.Griffin and Fawcett (2000), Country Pictures, Energy and Environment Programme, ECI, University of Oxford

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6.4 Agricultural and Forestry Combustion

RABLE 6.4.1 ACTIVITIES INCLUDED

- 1 A 4 c i Agriculture/Forestry/Fishing: Stationary
- 1 A 4 c ii Agriculture/Forestry/Fishing: Off-road Vehicles and Other Machinery

6.4.1 GENERAL DESCRIPTION

This section includes the spatial distribution of combustion emissions from agricultural activities including heating, drying and mobile machinery. The distribution of emissions from livestock are excluded from this section but are included under Agriculture Livestock below.

Methods follow the general approach of distributing national totals using appropriate surrogate statistics.

6.4.2 SIMPLE METHODOLOGY

Employment or land cover data:

Agricultural and Forestry stationery and mobile combustion emissions can be distributed using either employment data for the agricultural and forestry sectors or "arable land" or "forest" land cover (or more appropriate dataset) using the basic distribution methods presented under the Section xx 4.2 Gathering and working with point source data above.

Where Land cover is used, emissions for agriculture and forestry should be split and distributed according to the relevant classes. Where this is not possible emissions should be distributed according to a combined land cover class for agriculture and forests or allocated to the dominant class e.g. "arable land" for countries where emissions from agricultural combustion dominate.

Where employment data is used care should be taken to ensure that the employment classes are representative of the national sector for Agriculture and Forestry. Employment statistics will often include the financial and administrative head offices (often located in cities) while energy statistics based national emissions from these "head offices" may be included under 1 A 4 a i Commercial / Institutional: Stationary. Care should be taken to ensure that the emissions are located where they occur.

ASSUMPTIONS

Agricultural and forestry work is transient and localized. Emissions distributed using land cover are likely to be more dilute than in reality.

The use of employment data will locate emissions at registered places or regions of work and may tend to focus emissions inappropriately to urbanized areas.

DETAILED METHODOLOGY

To be added…

ASSUMPTIONS

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

ADDITIONAL COMMENTS

The proposed approach of a uniform distribution across forestry / agricultural land cover is considered adequate for what is not generally a significant sector with respect to air emissions.

REFERENCES

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6.5 Industrial Processes and Fugitive Emissions

TABLE 6.5.2ACTIVITIES INCLUDED

- 2 A 1 Cement Production
- 2 A 2 Lime Production
- 2 A 3 Limestone and Dolomite Use
- 2 A 4 Soda Ash Production and use
- 2 A 5 Asphalt Roofing
- 2 A 6 Road Paving with Asphalt
- 2 A 7 a Quarrying and mining of minerals other than coal
- 2 A 7 b Construction and demolition
- 2A 7 c Storage, handling and transport
- 2 A 7 d Other Mineral products (Please specify the sources included/excluded in the notes column to the right)
- 2 B 5 a Other chemical industry (Please specify the sources included/excluded in the notes column to the right)
- 2 B 5 b Storage, handling and transport (Please specify the sources included/excluded in the notes column to the right)
- 2 B 1 Ammonia Production
- 2 B 2 Nitric Acid Production
- 2 B 3 Adipic Acid Production
- 2 B 4 Carbide Production
- 2 C 1 Iron and Steel Production
- 2 C 2 Ferroalloys Production
- 2 C 3 Aluminum Production
- 2 C 5 a Copper Production
- 2 C 5 b Lead Production
- 2 C 5 c Nickel Production
- 2 C 5 d Zinc Production
- 2 C 5 e Other metal production (Please specify the sources included/excluded in the notes column to the right)

- 2 C 5 f Storage, handling and transport (Please specify the sources included/excluded in the notes column to the right)
- 2 D 1 Pulp and Paper
- 2 D 2 Food and Drink
- 2 D 3 Wood processing
- 2 E Production of POPs
- 2 F Consumption of POPs and Heavy Metals (e.g. electricial and scientific equipment)
- 2 G Other production, consumption, storage, transportation or handling of bulk products (Please specify the sources included/excluded in the notes column to the right)

GENERAL DESCRIPTION

This methodology includes the spatial mapping of emissions from a wide range of industrial processes. It includes dealing with Large Point Source information and Area emissions.

Source sectors will be spatially represented, depending on the pollutants and the availability of point source information, as either:

1. all point sources (e.g. Aluminium production),
2. a combination of point sources (for the larger sites) and non point source emissions (e.g. Ferroalloys)
3. or, purely non point source emissions (where no regulated process or possibility to estimate point sources are available).

SIMPLE METHODOLOGY

As for the Industrial Combustion sector any of the above process sector emissions will need to be distributed using point sources (where data is available) and through applying surrogate spatial distributions to national totals.

A number of sectors will include some point source data and a remaining areas source component. The general guidance for dealing with point sources and distributing national totals should be followed and priority given to collecting relevant point source data and in identifying process specific spatial datasets.

Tire 1: Distribution using Land Cover:
Where employment or other more suitable data is not available a simpler and less accurate methods using land cover data can be used to derive industrial emissions based distributions for the total non point source component of industrial processes. Weightings derived in the IMPRESAREO project (Dore, C. 2001) can be applied to the following land cover classes in the CORINE dataset to drive a suitable surrogate datasets:

Landcover Class	Weighting
Industry	1
Continuous urban fabric	0.2

Discontinuous urban fabric	0.01
Ports	0.05
Airports	0.05

Tire 2: Employment[6] based approach:

The recommended default approach and surrogate spatial datasets for each NFR sector are presented in the table below. Where point source data is referred to please follow the general guidance under 4.2 Gathering and working with point source data and where surrogate spatial distribution datasets are required please follow the general guidance under 4.3 Distributing national emissions above.

Table 6.5.2 Allocating NFR sectors and employment distribution

NFR Sector	Approach ---------- Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
2 A 1 Cement Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of Cement)
2 A 2 Lime Production	Combine point sources data with surrogate distribution.	Some point sources	Employment (Manufacture of Lime)
2 A 3 Limestone and Dolomite Use	Combine point sources data with surrogate distribution.	Some chemical processes	Employment (Chemical, processes in wood, paper pulp, food, drink and other industries)
2 A 4 Soda Ash Production and use	Combine point sources data with surrogate distribution.	Some production processes	Employment (Chemical, processes in wood, paper pulp, food, drink and other industries)
2 A 5 Asphalt Roofing	Use surrogate spatial distribution	none	Population Density
2 A 6 Road Paving with Asphalt	Use surrogate spatial distribution	none	New or total Road Lengths
2 A 7 a Quarrying and mining of minerals other than coal	Use surrogate spatial distribution	none	Employment (non coal Mining & Quarrying)
2 A 7 b Construction and demolition	Use surrogate spatial distribution	none	Employment (Construction)
2A 7 c Storage, handling and transport	Use surrogate spatial distribution	none	Employment (Mineral Products)
2 A 7 d Other Mineral products	Use surrogate spatial distribution	none	Employment (Mineral Products)
2 B 5 a Other chemical industry	Combine point sources data with surrogate distribution.	Some production processes	Employment (Mineral Products)
2 B 5 b Storage, handling and transport	Combine point sources data with surrogate distribution.	Identification of some large production processes	Employment (Mineral Products)
2 B 1 Ammonia Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of fertilizers and nitrogen compounds)
2 B 2 Nitric Acid Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of other inorganic basic chemicals)
2 B 3 Adipic Acid Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of other inorganic basic chemicals)
2 B 4 Carbide Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of other inorganic basic chemicals)
2 C 1 Iron and Steel Production	Try to collect/estimate	Most or all plant	Employment (Manufacture of Iron & Steel)

[6] Some datasets recommended for distribution are not employment based as indicated with greyed cells.

NFR Sector	Approach -- Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
	emissions for all point sources for sector		
2 C 2 Ferroalloys Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of Ferroalloys)
2 C 3 Aluminum Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of Aluminum)
2 C 5 a Copper Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of Aluminum)
2 C 5 b Lead Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of Lead)
2 C 5 c Nickel Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of Nickel)
2 C 5 d Zinc Production	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of Zinc)
2 C 5 e Other metal production	Combine point sources data with surrogate distribution.	Some plant	Employment (Other metals manufacture)
2 C 5 f Storage, handling and transport	Combine point sources data with surrogate distribution.	Some plant	Employment (All metals manufacture)
2 D 1 Pulp and Paper	Combine point sources data with surrogate distribution.	Some plant	Employment (All paper, card manufacture)
2 D 2 Food and Drink	Combine point sources data with surrogate distribution.	Some plant	Employment (All food manufacture)
2 D 3 Wood processing	Combine point sources data with surrogate distribution.	Some plant	Employment (Manufacture of wood and wood products)
2 E Production of POPs	Try to collect/estimate emissions for all point sources for sector	Most or all plant	Employment (Manufacture of other organic basic chemicals)
2 F Consumption of POPs and Heavy Metals	Combine point sources data with surrogate distribution.	Some plant	Population density
2 G Other production, consumption, storage, transportation or handling of bulk products	Use surrogate spatial distribution	none	Employment from relevant industries

Where more appropriate surrogate spatial datasets (or combinations/refinements of those listed above) are available these should be used.

ASSUMPTIONS

Surrogate statistics used correlate with emissions for the given sector.

DETAILED METHODOLOGY

None..

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

The methodology above relies heavily on detailed sectoral employment data for surrogate spatial distributions. However, in many cases these are not specific to the processes producing emissions as emissions are likely to be highly specific to particular plants and processes. Employment data will also distribute emissions to locations that may have administrative or head office activities only where process emissions do not occur.

ADDITIONAL COMMENTS

Where only aggregated NFR emissions are available these can be distributed using aggregated employment statistics. However, aggregations of spatial statistics will decrease the accuracy of emissions distributions.

REFERENCES

BIBLIOGRAPHY

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6.6 Fugitive Emissions

Extraction and distribution of fossil fuels and geothermal energy

Regulated processes, energy industries, energy handbooks, and trade associations.

TABLE 6.6.1 ACTIVITIES INCLUDED

- 1 B 1 a Fugitive emission from Solid Fuels: Coal Mining and Handling
- 1 B 1 b Fugitive emission from Solid Fuels: Solid fuel transformation
- 1 B c Other fugitive emissions from solid fuels
- 1 B 2 a i Exploration Production, Transport

- 1 B 2 a iv Refining / Storage
- 1 B 2 a v Distribution of oil products
- 1 B 2 a vi Geothermal energy extraction
- 1 B 2 b Natural gas
- 1 B 2 c Venting and flaring

6.6.2 GENERAL DESCRIPTION

Fugitive emissions include those from exploration, extraction and distribution of fuels. Most emissions relate to the coal, oil and gas industry. A number of large fuel storage deports may be regulated and information on emissions or activities recorded by authorities or trade associations.

Source sectors will be spatially represented, depending on the pollutants and the availability of point source information, as either:

4. all point sources (e.g. Aluminium production),
5. a combination of point sources (for the larger sites) and non point source emissions (e.g. Ferroalloys)
6. or, purely non point source emissions (where no regulated process or possibility to estimate point sources are available).

6.6.3 SIMPLE METHODOLOGY

As for the Industrial Combustion sector any of the above process sector emissions will need to be distributed using point sources (where data is available) and through applying surrogate spatial distributions to national totals.

A number of sectors will include some point source data and a remaining areas source component. The general guidance for dealing with point sources and distributing national totals should be followed and priority given to collecting relevant point source data and in identifying process specific spatial datasets.

The recommended default approach (assuming no better country specific data is available) and surrogate spatial datasets for each NFR sector are presented in the table below. Where point source data is referred to please follow the general guidance under 4.2 Gathering and working with point source data and where surrogate spatial distribution datasets are required please follow the general guidance under 4.3 Distributing national emissions above.

Table 6.2.2

NFR Sector	Approach -- Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
1 B 1 a Fugitive emission from Solid Fuels: Coal Mining and Handling	Use surrogate spatial distribution	none	Employment (Coal Mining)
1 B 1 b Fugitive emission from Solid Fuels: Solid fuel transformation	Combine point sources data with surrogate distribution.	Some Plant data likely to be available	Employment (Mineral Products)
1 B c Other fugitive emissions from solid fuels	Use surrogate spatial distribution	none	Employment (Mineral Products)

NFR Sector	Approach ---- Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
1 B 2 a i Exploration Production, Transport	Combine point sources data with surrogate distribution.	Some Plant data likely to be available	Employment (Oil & Gas Employment)
1 B 2 a iv Refining / Storage	Try to collect/estimate emissions for all point sources for sector	Most plants	Employment (Manufacture of refined petroleum products)
1 B 2 a v Distribution of oil products	Combine point sources data with surrogate distribution.	Some Plant data likely to be available	Employment (Oil Employment)
1 B 2 a vi Geothermal energy extraction	Combine point sources data with surrogate distribution.	Some Plant data likely to be available	Statistics on geothermal energy extraction
1 B 2 b Natural gas	Use surrogate spatial distribution	none	Natural Gas distribution networks
1 B 2 c Venting and flaring	Try to collect/estimate emissions for all point sources for sector	Most plants	Employment (Manufacture of refined petroleum products)

ASSUMPTIONS

Surrogate statistics used correlate with emissions for the given sector.

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

The methodology above relies heavily on detailed sectoral employment data for surrogate spatial distributions. Employment data will also distribute emissions to locations that may have administrative or head office activities only where process emissions do not occur.

ADDITIONAL COMMENTS

Where only aggregated NFR emissions are available these can be distributed using aggregated employment statistics. However, aggregations of spatial statistics will decrease the accuracy of emissions distributions.

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6.7 Solvent Use

TABLE 6.7.1 ACTIVITIES INCLUDED

- 3 A 1 Decorative coating application
- 3 A 2 Industrial coating application
- 3 A 3 Other coating application
- 3 B 1 Degreasing
- 3 B 2 Dry cleaning
- 3 C Chemical products
- 3 D 1 Printing
- 3 D 2 Domestic solvent use including fungicides
- 3 D 3 Other product use

GENERAL DESCRIPTION

Emissions from solvent use will include industrial processes and domestics uses.

SIMPLE METHODOLOGY

A number of countries may have databases on the location and activities for a number of the industrial solvent users including sectors within 3 A 2 Industrial coating application such as vehicle and aircraft painting activities or for 3 B 2 Dry cleaning activities. Trade associations can also provide useful information on specific consumption of solvents in different industries.

The recommended default approach (assuming no better country specific data is available) and surrogate spatial datasets for each NFR sector are presented in the table below. Where point source data is referred to please follow the general guidance under 4.2 Gathering and working with point source data and where surrogate spatial distribution datasets are required please follow the general guidance under 4.3 Distributing national emissions above.

Table 6.7.2

NFR Sector	Approach ---------- Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
3 A 1 Decorative coating application	Use surrogate spatial distribution	none	Population Density
3 A 2 Industrial coating	Combine point sources	Some Plant data likely	Employment (for coatings industries

NFR Sector	Approach Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
application	data with surrogate distribution.	to be available	including metal packaging, vehicle refinishing, rolling mills, vehicle repair, wood coating etc)
3 A 3 Other coating application	Use surrogate spatial distribution	Some Plant data likely to be available	Employment (for coatings in the printing & packaging industry)
3 B 1 Degreasing	Combine point sources data with surrogate distribution.	Some Plant data likely to be available	Employment (from relevant manufacturing industries)
3 B 2 Dry cleaning	Try to collect/estimate emissions for all point sources for sector	Some Plant data likely to be available	Employment (dry cleaning)
3 C Chemical products	Combine point sources data with surrogate distribution.	Some Plant data likely to be available	Employment (Paint, ink, adhesive, leather, tire, rubber manufacture)
3 D 1 Printing	Use surrogate spatial distribution	none	Employment (newspaper and magazine industry)
3 D 2 Domestic solvent use including fungicides	Use surrogate spatial distribution	none	Population Density
3 D 3 Other product use	Use surrogate spatial distribution	none	Population Density

ASSUMPTIONS

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

ADDITIONAL COMMENTS

Where only aggregated NFR emissions are available these can be distributed using aggregated employment statistics. However, aggregations of spatial statistics will decrease the accuracy of emissions distributions.

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6.8 Road transport

Traffic counts or APMOSPHERE methods using population and average vehicle splits or traffic flow data.

TABLE 6.8.1 ACTIVITIES INCLUDED

- 1 A 3 b i Road Transport:, Passenger cars
- 1 A 3 b ii Road Transport:, Light duty vehicles
- 1 A 3 b iii Road Transport:, Heavy duty vehicles
- 1 A 3 b iv Road Transport:, Mopeds & Motorcycles
- 1 A 3 b v Road Transport:, Gasoline evaporation
- 1 A 3 b vi Road Transport:, Automobile tyre and brake wear
- 1 A 3 b vii Road Transport:, Automobile road abrasion

GENERAL DESCRIPTION

Emissions relate to the traffic flows and types of vehicles on the road network.

There are a number of approaches to mapping emissions that depend on the data available. These include:

- Distribution of emissions according to regional, local or link based traffic statistics (or traffic flows). Where possible these traffic flows should differentiate between different vehicle classes so that areas with high HDV traffic will show high emissions.
- Distribution of emissions according to road network information and modelled traffic intensity based on population density.

Methods using traffic flow statistics will provide the most accurate results and should be used where data is available.

For emissions from Evaporation and from brake and tire wear emissions can be distributed using and aggregated (for all vehicles) spatial surrogate dataset from those generated below.

SIMPLE METHODOLOGY

Using traffic flow statistics by vehicle class:
Where traffic flow statistics are available for road links or for regions that can be combined to form the EMEP 50x50km grids this data should be used. Spatial traffic flow statistics should be used that have a basic vehicle type split to enable appropriate emissions allocation for the key NFR reporting categories:

- 1 A 3 b i Road Transport: Passenger cars
- 1 A 3 b ii Road Transport: Light duty vehicles
- 1 A 3 b iii Road Transport: Heavy duty vehicles

- 1 A 3 b iv Road Transport: Mopeds & Motorcycles

The surrogate statistics may be available on a gridded, administrative boundary or link by link based spatial format. Whatever, the spatial form emission totals can be distributed using the basic “distributing national totals” approach given in the general guidance.

Assigning vehicle classes to road types:
Where traffic composition data (flows by vehicle type) are unavailable averaged composition % can be applied to total flow by road type based on national survey data or on data available in the COPERT III model (**Kouridis 2000)** or from the European MEET project.

Estimating emissions without traffic flow data:
Where appropriate traffic flow data are not available emission distributions can be generated using digital road maps and population density data using a method developed for the European APMOSPHERE project as indicated in Box AA below.

Example 4:

The emissions mapping approach uses a detailed European road network, which provides information on length of roads by type.– motorway, A roads, B roads and minor roads. For the purposes of this methodology, B roads and minor roads are classified together as minor roads.

The network must be *weighted* according to contribution to emissions (i.e. vehicle type and density).

The proposed approach is based on the assumption that population density is related to number of vehicles using different types of road network.

There are three steps in developing the road emission maps:

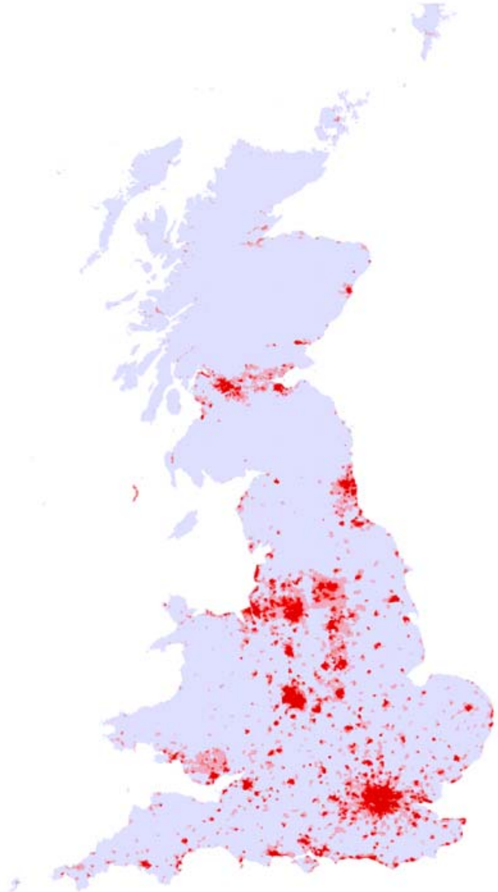
Step 1: generate weighted spatial datasets for three road type classes:
Each road type is assumed to have a different relationship with the close and more distant population depending on the type of road. For the APMOSPHERE project the following assumptions were made:

- Minor roads are assumed to be influenced most by densities of population (within a 5-10km radius).
- Major non motorway/highway roads are assumed to be influenced by populations from a wider catchment (30-40km radius)
- While Motorway/highway are assumed to be influenced by populations from an even larger catchment (40-50km radius).

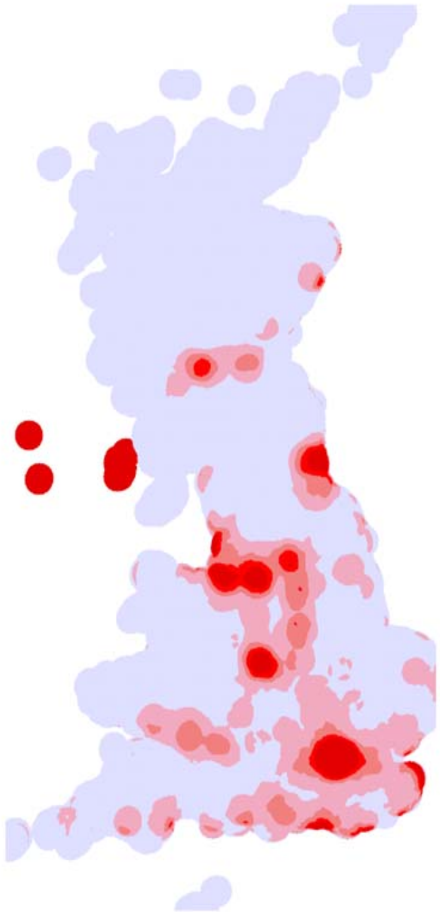
This influence of population density on road use can be modelled using a focal mean calculation using GIS tools. For each grid cell of the population grid, the mean value can be determined, based on the value of other grid cells in a given neighbourhood (in this case using the radius’ above around each grid cell). So a set radius of 20 km will mean that each grid cell is calculated based on the mean value of grid cells in this given radius.

The following figures illustrate how the population density grid changes based on the use of differing neighbourhood area size. Figure zza) illustrates what the UK population density looks like with no focal mean applied. This grid could be used to weight the minor roads network as we assume that nearby population densities will determine road activity levels on minor roads. Figure xxb) illustrates what the UK population density looks like using a 20 km radius. This illustrates our perceived understanding of population influence on A-road activity. Figure xxc illustrates the greater influence distance of population on motorways.

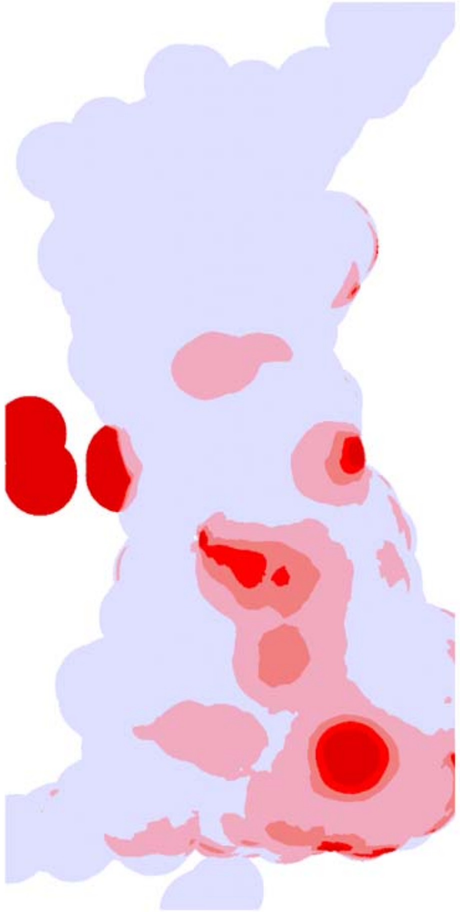
Figures zza-c Population Density Maps



zza) Focal Mean 0



zz7b) Focal Mean 20



zzc) Focal Mean 50

In addition an additional base load flow of traffic on motorways can be added to account for the national base load of traffic on even very rural parts of motorway stretches. This minimum load will be irrespective of the focal mean weightings. A base load calculated for the UK has been calculated to be 36% based on assessments of traffic flow on UK motorway roads (C J Dore 2004,)

Step 2: Attributing National emissions to the different road classes
The second step is to determine the proportion of the emission totals to allocate to the different road types.

The table below (Table 7a) gives an example of the UK profile and can be used where more specific COPERT III or country data is not available. This allows the percentage of emissions for each vehicle class to be allocated to each road type.

Tablexx Road Transport Emissions by Vehicle and Road Type

Road type	Cars	LDVs	HDVs	Motorcycles
Motorway	12%	13%	23%	5%
A road	52%	51%	41%	59%
Minor – built	26%	25%	23%	25%
Minor - non built	10%	11%	14%	11%

Step 3: Distributing emissions over the surrogate spatial datasets.
Once the national total emissions have been divided into their road class components these components can be distributes across the spatial datasets prepared in step 1 using the national emissions distribution approach given in the general guidance section.

ASSUMPTIONS

For the traffic flow based estimates it is assumed that the distribution of detailed vehicle age classes and driving conditions are uniform across the country and across the different road classes.

For the methods without traffic flow it is assumed that traffic density and therefore emissions is proportional to population density.

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

Neither of these methods take account of emissions in different (urban, rural, fast, slow driving conditions). Regions with a high or low urban component may therefore under or over estimate emission allocations because of differences in vehicle speed. Generally this issues is unlikely to affect the 50x50km emission maps.

ADDITIONAL COMMENTS

None.

REFERENCES

C J Dore 2004, Air Pollution Modelling for Support to Policy on Health and Environmental Risk in Europe (EVK2-2002-00577) Emission Mapping Methodology Progress Report (January 2004) C J Dore, S Pye and A Kent (AEA Technology). Project ofr the Commission.

Kouridis 2000. Chariton Kouridis, Leonidas Ntziachristos and Zissis Samaras, ETC/AE COPERT III Computer programme to calculate emissions from road transport - User manual, 27 Nov 2000, EEA (European Environment Agency) http://reports.eea.europa.eu/Technical_report_No_50/en

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6.9 Off road

6.9.1 Railways

ACTIVITIES INCLUDED

- 1 A 3 c Railways

GENERAL DESCRIPTION

Emission methods relate to the distribution of emissions from rail locomotives burning fossil fuels. Emissions will be located along the non electric rail networks.

Emissions from heating and electricity generation should be distributed using the approaches given above for commercial combustion.

SIMPLE METHODOLOGY

Maps of rail network can be used to distribute emissions to the appropriate 50x50km EMEP grids using the length of (non electric) network as a surrogate for emissions.

Where possible the non-electric lengths should be removed. WHAT DO YOU MEAN?

ASSUMPTIONS

Rail traffic density is uniform across the area. Regional effects of gradient and vehicle age/efficiency are not accounted for.

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

ADDITIONAL COMMENTS

Due to the lesser significance of this as a source, such inaccuracies are not considered to be particularly important at a 50x50km EMEP grid scale.

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6.10 Water transport

Lloyds shipping maps. ENTEC. EEA has a lot of the data…

ACTIVITIES INCLUDED

1 A 3 d ii National Navigation (Shipping)
1A 4 c iii Agriculture/Forestry/Fishing: National Fishing

GENERAL DESCRIPTION

Emissions from national navigation and fishing should be included. Mapping emissions from these sources has a high degree of uncertainty due to the transient and varied nature of the emission sources.

SIMPLE METHODOLOGY

National information on port arrivals, departures and destinations combined with geospatial data on shipping lanes or crude zoning around ports can be used to distribute emissions from National Navigation.

Where fish landing information is available by port this information can be used to distribute emissions to port areas or know fishing grounds.

Step 1: Use port arrival and destination (or fish landing) information to weight shipping routes or zones around ports (or where applicable and available fishing grounds).
Step 2: Distribute national totals across these routes or zones using the basic "distributing national emissions" approach given in the general guidance above.

ASSUMPTIONS

Emission distributions will need to make assumptions about the weighting of in port vs in transit emissions.
Emissions from fishing are likely to be associated with fishing grounds rather than port activities.

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

Improving the allocations to

ADDITIONAL COMMENTS

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6.11 Air transport

TABLE 6.11 ACTIVITIES INCLUDED

- 1 A 3 a ii (i) Civil Aviation (Domestic, LTO)

GENERAL DESCRIPTION

Emission methods relate to the distribution of emissions from aircraft take-off and landing are considered below. These methods are not appropriate for distributing emissions from cruise and LTO emissions from international aircraft flights should be excluded from the mapping as these are estimated centrally by EMEP.

Emissions from heating and electricity generation plant and mobile airside vehicles should be distributed using the approaches given above for commercial/industrial combustion.

SIMPLE METHODOLOGY

Where national emission estimates have been derived from aggregations of detailed aircraft/airport emission estimates then these detailed datasets should be used for the LTO component.

Alternatively national information on domestic aircraft movements by airport can be used to distribute emissions from Domestic Aviation Landing and Take Off to individual airports using the basic “distributing national emissions” approach given in the general guidance above.

Step 1: Create a dataset with domestic traffic movement data by airport with grid references or geospatial polygons of the airport areas weighting each airport according to the appropriate traffic movements. (Where possible additional weightings to take account of the average size of aircraft at each airport should be used. (e.g. Emission factor to aircraft size ratios)).

Step 2: Distribute national totals emission estimates across these routes or zones using the basic "distributing national emissions" approach given in the general guidance above.

ASSUMPTIONS

Size of aircraft typically used at different airports or different Landing and Takeoff profiles are not taken into account.

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

ADDITIONAL COMMENTS

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6.12 Waste treatment and disposal

TABLE 6.12.1 ACTIVITIES INCLUDED

- 6 A SOLID WASTE DISPOSAL ON LAND

- 6 B WASTE-WATER HANDLING
- 6 C a Clinical Waste Incineration
- 6 C b Industrial Waste Incineration
- 6 C c Municipal Waste Incineration
- 6 C d Cremation
- 6 C e Small Scale Waste Burning

GENERAL DESCRIPTION

Waste treatment and disposal includes a number of different sources that will be represented differently. Large waste disposal installations and incinerators are likely to be regulated and emissions are likely to be reported. Alternative point source data can often be obtained from relevant trade associations.

SIMPLE METHODOLOGY

The recommended default approach (assuming no better country specific data is available) and surrogate spatial datasets for each NFR sector are presented in the table below. Where point source data is referred to please follow the general guidance under section 4.2 Gathering and working with point source data and where surrogate spatial distribution datasets are required please follow the general guidance under 4.3 Distributing national emissions above.

Table 6.12.2

NFR Sector	Approach --- Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
6 A SOLID WASTE DISPOSAL ON LAND	Use surrogate spatial distribution	None	Where specific data on land application is not available use Landcover classes for Arable Land.
6 B WASTE-WATER HANDLING	Combine point sources data with surrogate distribution.	Some Wastewater treatment plant locations may be available from E-PRTR returns	Population density can be used to distribute emissions where point source data are unavailable.
6 C a Clinical Waste Incineration	Combine point sources data with surrogate distribution.	Some clinical incineration plant locations and emissions may be available from E-PRTR or other regulated process returns. Alternative information from Hospital data sources may provide additional point source datasets.	Population density can be used to distribute emissions where point source data are unavailable.
6 C b Industrial Waste Incineration	Combine point sources data with surrogate distribution.	Some industrial incineration plant locations and emissions may be available from E-PRTR or other regulated process returns.	Industrial employment in the waste industry can be used to distribute emissions where point source data are unavailable.
6 C c Municipal Waste Incineration	Combine point sources data with surrogate distribution.	Some industrial incineration plant locations and emissions may be available from E-PRTR or other regulated process returns.	Industrial employment in the waste industry can be used to distribute emissions where point source data are unavailable.

NFR Sector	Approach ---------- Description	Likelihood of Point Sources Data	Surrogate Spatial Distribution
6 C d Cremation	Combine point sources data with surrogate distribution.	Some Cremation plant locations and emissions may be available from E-PRTR or other regulated process returns. Alternative datasets can often be obtained from trade associations.	Population density can be used to distribute emissions where point source data are unavailable.
6 C e Small Scale Waste Burning	Use surrogate spatial distribution	none	Population density can be used to distribute emissions where point source data are unavailable. Where possible Landcover urban/suburban classes data can be used to create a

ASSUMPTIONS

Distributions based on employment and population will be very general approaches for allocating emissions that are likely to arise from much more localized areas.

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

TBA..

ADDITIONAL COMMENTS

Where possible local/regional knowledge and urban/rural masking should be used to improve on the basic population and employment based methods.

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6.13 Agriculture Arable land and Livestock

TABLE 6.13.1 ACTIVITIES INCLUDED

- 4 B 1 a Cattle Dairy
- 4 B 1 b Cattle Non-Dairy
- 4 B 2 Buffalo
- 4 B 3 Sheep
- 4 B 4 Goats
- 4 B 6 Horses
- 4 B 7 Mules and Asses
- 4 B 8 Swine
- 4 B 9 a Laying Hens
- 4 B 9 b Broilers
- 4 B 9 c Turkeys
- 4 B 9 d Other Poultry
- 4 D 1 a Synthetic N-fertilizers
- 4 D 2 a Farm-level agricultural operations including storage, handling and transport of agricultural products
- 4 D 2 b Off-farm storage, handling and transport of bulk agricultural products
- 4 D 2 c N-excretion on pasture range and paddock
- 4 G Agriculture OTHER
- 4 F FIELD BURNING OF AGRICULTURAL WASTES

GENERAL DESCRIPTION

Emissions include livestock and arable farming practices. Point source data is likely to be limited except for intensive livestock where EPER/E-PRTR reporting is required for some Parties.

Regional/local farming statistics are likely to be a key source of information. Where this data is not available other landcover/employment based datasets can be used.

SIMPLE METHODOLOGY

Livestock:
Where data is reported for regulated processes (e.g. E-PRTR/EPER) this should be used and combined with surrogate distribution techniques to distribute the remaining national emissions.

- **Livestock census/survey data:**
  Non point source emissions from livestock sectors can be distributed according to national spatial statistics from census and surveys. Data may need to be aggregated to larger areas to maintain anti disclosure commitments. Where possible, emissions should be allocated according to census data for each of the livestock classes. Where practical similar classes can be aggregated (e.g. Cattle can be grouped together).

- **Livestock employment data:**
  Where national spatial statistics from census and surveys are not available emissions can be distributed based on employment statistics. Many countries will have employment statistics broken down by broad livestock types. However when using these statistics care should be taken to account for possible over allocations to head/offices or market employment in urban areas that will distort the pattern of emissions and allocate too much emissions to urban areas.

Arable Farming Emissions:
Emissions from the arable sector will either be due to field burning, fertilizer application or from dust from storage, handling and transport of agricultural products (PM_{10}). CORINE land cover data can be used to distribute the emission total. It is proposed that all of the arable emission is distributed uniformly over appropriate arable land classification.

ASSUMPTIONS

Farming practices are regionally uniform.

DETAILED METHODOLOGY

None

WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENTS IN CURRENT METHODOLOGY

ADDITIONAL COMMENTS

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7. Verification/Validation????? procedures

Maps of the spatial distribution of atmospheric emissions are a key input to any air quality assessment. The reliability of emissions maps should be verified where possible to assess their appropriateness for use as input to models. Verification of spatial data involves comparison with independently derived data such as ambient monitoring results.

7.1 VERIFICATION BY MEASUREMENTS

Verification of ground level spatial emissions can be achieved by assessing the correlation of emissions from low level sources for 10km- 25km areas around monitoring stations with the measured average annual background or roadside concentrations at each station.

This method does require a higher spatial resolution that required for reporting and can be complex. Verification activities should consider the different component of atmospheric concentrations and how these might be influenced by near and more distant emission sources.

- Rural measurements will show contributions from relatively distant major point and area sources such as power stations or large conurbations. Measurements from monitoring sites well away from local sources provide good indications of the spatial variation of concentrations due to distant sources.
- Conurbation, city or roadside concentrations will provide the means to verify emissions from more local low level sources (having taken into account the likely impact of distant sources by applying a background component) in the surrounding 25 km2 area or nearby to major road links.

Figure 7.1 shows an example of the calibration of the area source NOx model to find the empirical relationship between area source emissions and measured annual average air concentrations at urban automatic monitoring sites. The modelled local emission contribution to overall annual mean NOx concentration (on the X axis) is compared with the measured NOx after removing the rural and point source contributions at each site (Y axis) (Stedman et al (2005).   The sites form two distinct clusters indicating a different relationship in inner conurbations and elsewhere but with strong relationships for each. 'Inner conurbations' includes Inner and Central London and central Birmingham and Manchester.

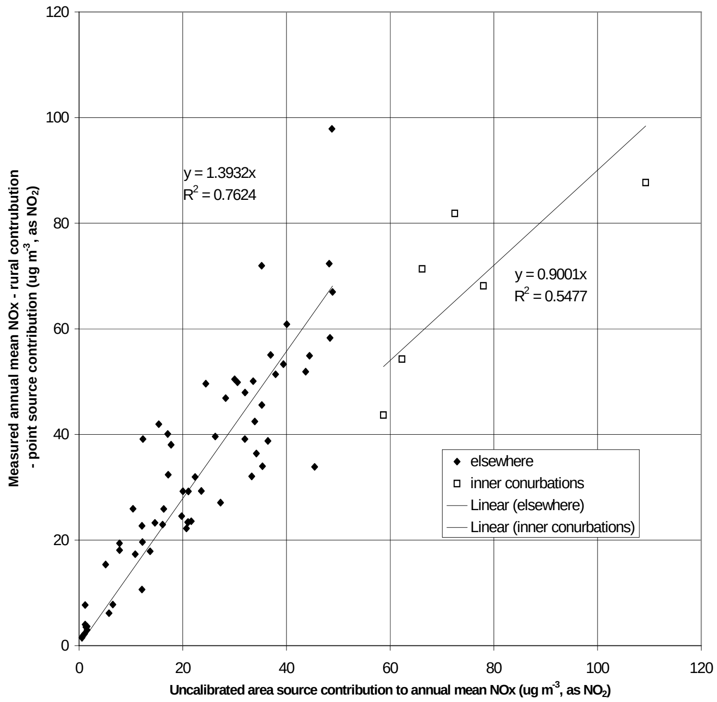

Figure 7.1 Calibration of area source NOx model (μg m-3, as NO2)

The verification of the spatial distribution of other pollutants can also be carried out using similar methods to those described above. Inventory verification for pollutants such as PM_{10} is, however, more problematic due to the diverse nature of PM_{10} and the range of sources of primary combustion, secondary and mechanically generated coarse particles.

References

Stedman J, Bush T, Vincent K, Kent A, Grice S and Abbot J (2005), UK air quality modelling for annual reporting 2003 on ambient air quality assessment under Council Directives 96/62/EC, 1999/30/EC and 2000/69/EC, Report to The Department for Environment, Food and Rural Affairs, Welsh Assembly Government, the Scottish Executive and the Department of the Environment for Northern Ireland

MAYBE we have to incude this somewhere: Notation Keys to be used when preparing submissions:

Table IC Notation Keys

Definition	**UNECE/EMEP Explanation**
Not estimated (NE)	Emissions occur but have not been estimated or reported
Included elsewhere (IE)	Emissions for this source are estimated and included in the inventory but not presented separately for this source The source where these emissions are included should be indicated.
Confidential information (C)	Emissions are aggregated and included elsewhere in the inventory because reporting at a disaggregated level could lead to the disclosure of confidential information

Not applicable (NA)	The source exists but relevant emissions are considered never to occur
Not occurring (NO)	An source or process does not exist within a country
Not Relevant **(NR)**	According to Para. 9 in the Emission Guidelines, Emission inventory reporting should cover all years from 1980 onwards, if data are available. However, "NR" (Not Relevant) is introduced to ease the reporting where emissions are not strictly required by the different Protocols. E.g. for some Parties emissions of NMVOC prior to 1988.

Annex I: Detailed description of the EMEP 50x50 km^2 grid

Content should include for example background material and technical definitions that underpin the EMEP grid for which reporting is required.

Many Parties enquire about conversion from GIS to EMEP grid basis. EMEP does not have such guidance on this issue at present – a small technical project to produce such guidance might be considered to cover this issue.

A map of the EMEP grid is given in **Error! Reference source not found.**.

The most updated description of the EMEP 50x50 km^2 grid together with useful programs, maps and files can also be found at the EMEP web site: *http://www.EMEP.int/grid/index.html* .

According to the definition given in the Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP): *"The geographical scope of EMEP means the area within which, coordinated by the international centres of EMEP, monitoring is carried out."* This definition has been referred to in all following protocols to the Convention. Since its adoption in 1984, as Parties have ratified or acceded to the EMEP Protocol, the geographical scope of EMEP has broadened.

The present EMEP grid domain is depicted in the figure at 50x50 km^2 resolution. The technical description of the grid can be found below. In addition, the following files with relevant information are available on the EMEP web site: http://www.EMEP.int/

Trans. f : Fortran code to convert from EMEP grid coordinates to geographical (longitude-latitude) coordinates.

EMEP grid. data : ASCII file which defines the geographical coordinates and area of each EMEP grid point.

Country_grid_fraction.txt: Text file defining the fraction (in percent) of grid cells belonging to a particular country. The file structure is EMEP country codes, EMEP grid x coordinate, EMEP grid y coordinate, fraction of country within grid cell (see Table 1 below)

Country_numbers.txt: Text file linking EMEP ISO codes to EMEP country codes and country names

The EMEP grid system is based on a polar-stereographic projection with real area at latitude 60^o N. The y-axis is oriented parallel to 32^o W defined as a negative longitude if west of Greenwich. The EMEP 50x50 km^2 domain includes 132x111 points (with x varying from 1 to 132 and y varying from 1 to 111).

For the **50x50 km² grid**, the latitude, ϕ, and longitude, λ, of any point (x, y) on the grid may be calculated as follows:

$$\phi = 90 - \frac{360}{\pi}\arctan\left[\frac{r}{M}\right]$$

$$\lambda = \lambda_0 + \frac{180}{\pi}\arctan\left[\frac{x - xpol}{ypol - y}\right]$$

in which: xpol = 8 (x coordinate of the North Pole)

ypol = 110 (y coordinate of the North Pole)

d = 50 km (grid length at 60^o N)

ϕ_0 = 60^o N = $\pi/3$ (defining latitude)

R = 6370 km (radius of earth)

M = R/d[1 + sin (ϕ_0)] = 237.73 (Number of grid distances between the North Pole and the equator)

r = $\sqrt{(x - xpol)^2 + (y - ypol)^2}$

λ_0 = -32 (32^o W)
(rotation angle, i.e. the longitude parallel to the y-axis)

The x and y coordinate in the EMEP grid of any given latitude and longitude can be found from:

$$x = xpol + M \tan\left[\frac{\pi}{4} - \frac{\phi}{2}\right]\sin(\lambda - \lambda_0)$$

$$y = ypol - M \tan\left[\frac{\pi}{4} - \frac{\phi}{2}\right]\cos(\lambda - \lambda_0)$$

It should be pointed out that x and y coordinates calculated with the equations above coincide with the grid-square **centre**. Thus, if a grid-square has its centre coordinates (x,y), the coordinates of its lower left and right corners are (x-0.5, y-0.5) and (x+0.5, y-0.5) respectively, and the coordinates (x,y) of its upper left and right corners are (x-0.5, y+0.5) and (x+0.5, y+0.5) respectively.

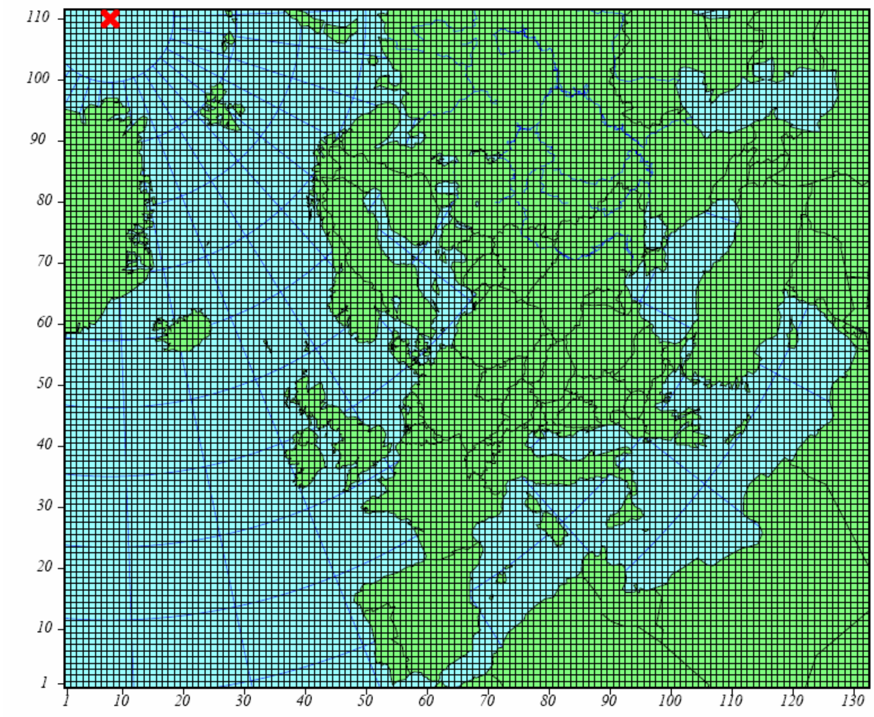

Figure I. Present extent of the EMEP 50x50km^{2}grid