Methodology development for the spatial distribution of the diffuse emissions in Europe

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Glossary

ACN - Address Coordinates in the Netherlands (URL: http://www.postcode.nl/index/204/2/0/4-position-xy-coordinates-database.html, 20.04.2010)

AMVER - Automated Mutual-Assistance Vessel Rescue System (URL: http://www.amver.com/, 20.04.2010)

APMOSPHERE - Air Pollution Modelling for Support to Policy on Health and Environmental Risk in Europe (URL: http://www.apmosphere.org/, 20.04.2010)

CAPRI - Common Agricultural Policy Regionalised Impact Modelling System (URL: http://www.capri-model.org/dokuwiki/doku.php?id=start, 20.04.2010)

CEH - Centre for Ecology and Hydrology (URL: http://www.ceh.ac.uk/sci_programmes/BioGeoChem/LandCoverMap2000.html, 07.07.2010)

CIESIN - Center for International Earth Science Information Network (URL: http://www.ciesin.columbia.edu/, 20.04.2011)

CLC2006: CORINE Land Cover 2006 raster data - version 13 (02/2010) (URL: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster , 01.06.2010)

CLC2000: CORINE Land Cover 2000 seamless vector data - version 13 (02/2010) (URL: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-seamless-vector-database-2, 01.06.2010)

CLRTAP - Convention on Long-range Transboundary Air Pollution (URL: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4, 01.06.2010)

COPERT - Computer Program to Calculate Emissions from Road Transport (URL: http://www.eea.europa.eu/publications/Technical_report_No_50/, 01.06.2010)

CRF - Common Reporting Format

Defra - Department for Environment Food and Rural Affairs (URL: http://www.defra.gov.uk/food-farm/animals/, 20.06.2011)

DG Environment - Directorate-General Environment of the European Commission (URL: http://ec.europa.eu/dgs/environment/index_en.htm, 01.06.2010)

DG TREN[1] **-** The Directorate-General for Mobility & Transport (URL: http://ec.europa.eu/transport/index_en.htm, 20.06.2011)

[1] DG TREN was splitt into DG MOVE and DG Ener.

DGUR – Degree of Urbanization (URL: http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/gisco/popups/references/Population%20Distribution%20-%20Demography 20.06.2011)

Dft - Department for Transport, UK (URL: http://www2.dft.gov.uk/pgr/statistics/, 20.06.2011)

DTI UK - Department of Trade and Industry - national statistics (URL: http://www.ukti.gov.uk/de_de/export.html?guid=none, 20.06.2011)

EAMA UK - European Automobile Manufacturers Association (URL: http://www.acea.be/index.php/country_profiles/detail/uk, 20.06.2011)

EDGAR - Emissions Database for Global Atmospheric Research (URL: http://edgar.jrc.ec.europa.eu/index.php, 20.06.2011)

EEA - European Environment Agency (URL: http://www.eea.europa.eu/, 20.06.2011)

EFISCEN - The European Forest Information Scenario Model (URL: http://www.efi.int/portal/, 20.06.2011)

EFTA - The European Free Trade Association (EFTA) (URL: http://www.efta.int, 20.06.2011)

EMEP - the Cooperative Program for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe (URL: http://www.emep.int/index.html, 20.06.2011)

E-PRTR - The European Pollutant Release and Transfer Register (E-PRTR) **(URL:** http://prtr.ec.europa.eu/, 01.06.2010)

ETC/ACC - European Topic Centre on Air and Climate Change (URL: http://www.eionet.eu.int, 01.06.2010)

EU - European Union (URL: http://www.europa.eu.int, 01.06.2010)

EUROSTAT - Statistical Office of the European Communities (URL: http://europa.eu.int/comm/EUROSTAT, 01.06.2010)

FAO - Food and Agriculture Organization of the United Nations (URL: http://www.fao.org/, 20.06.2011)

FAOSTAT - Food and Agriculture Organization of the United Nations (URL: http://faostat.fao.org/, 01.06.2010)

GAINS – The **G**reenhouse Gas and **A**ir Pollution **In**teractions and **S**ynergies (**GAINS**)-Model (URL: http://gains.iiasa.ac.at/index.php/home-page, 20.06.2011)

GDP - gross domestic product

GHG – Greenhouse Gases

GIAB - Geographical Information System for Agricultural Farms

GIS - Geographical information system

GISCO - Geographic Information System of the European Commission (URL: http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/gisco/introduction, 20.06.2011)

GISCO - Files to download for airports and ports (URL: http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/gisco/popups/references/transport_networks , 16.05.2011)

GLC - Global Land Cover (URL: http://ies.jrc.ec.europa.eu/global-land-cover-2000, 20.06.2011)

FAO GLIS - Global Livestock Information System (URL: http://www.fao.org/AG/againfo/resources/en/maps.html, 20.06.2011)

GPWv3 - Gridded Population of the World, version 3 (URL: www.ciesin.org, 20.06.2011)

GVA - Gross added value

HYDE - History Database of the Global Environment presents (gridded) time series of population and land use for the last 12,000 years (URL: http://www.hyde.org, 20.06.2011)

ICAO - International Civil Aviation Organisation (URL: http://www.icao.int/, 20.06.2011)

ICOADS - The International Comprehensive Ocean-Atmosphere Data Set Project (URL: http://www.ncdc.noaa.gov/oa/climate/coads/, 20.06.2011)

IDBR Database - Inter Departmental Business Register Database UK (URL: http://www.adls.ac.uk/, 20.06.2011)

IIASA - International Institute for Applied Systems Analysis (URL: http://www.iiasa.ac.at/, 20.6.2011)

IMPRESAREO - Improving the Spatial Resolution of Air Emissions Inventories Using Earth Observation Data (URL: http://www.epa.gov/ttn/chief/conference/ei18/session3/triacchini.pdf, 20.06.2011)

IPTS - The Institute for Prospective Technological Studies is one of the seven scientific institutes of the European Commission's Joint Research Centre (JRC) (URL: http://ipts.jrc.ec.europa.eu/, 20.06.2011)

JWEE - Joint Wood Energy Enquiry (URL: http://www.unece.org/timber/mis/energy/JWEE.htm 20.06.2011)

JRC – Joint Research Centre (URL: http://ec.europa.eu/dgs/jrc/index.cfm**,** 20.06.2010)

LAU2 – Local administrative unit (URL http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/nuts_nomenclature/local_administrative_units 20.06.2010))

LCP - Large Combustion Plant

LISA - National Job Information System and location register

LPG - Liquefied petroleum gas

LRTAP Convention - Long Range Transboundary Air Pollution (URL: http://www.unece.org/env/lrtap/welcome.html, 20.06.2010)

LTO - Landing and Take-Off circle

LTO domestic (EUROSTAT 2008) - Aircraft traffic data by main airport [AVIA_TF_ACA] (URL: http://appsso.EUROSTAT.ec.europa.eu/nui/show.do?dataset=avia_tf_aca&lang=en, 17.05.2011)

MRDS – Mineral Resource Data System (URL: http://tin.er.usgs.gov/mrds/, 20.06.2011)

NACE - Nomenclature Generale des Activites Economiques (fran.), Classification of Economic Activities in the European Community (URL: http://ec.europa.eu/competition/mergers/cases/index/nace_all.html, 20.06.2011)

NEC - National Emission Ceilings Directive (URL: http://ec.europa.eu/environment/air/pollutants/ceilings.htm, 20.06.2011)

NFR - Nomenclature For Reporting (URL: http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/, 20.06.2011)

NUTS - **N**ationales **U**nites **T**erritoriales **S**tatistiques (URL: http://europa.eu/legislation_summaries/regional_policy/management/g24218_fr.htm, 20.06.2011)

RAINS - Regional Air Pollution Information and Simulation model has been developed by International Institute for Applied Systems Analysis (IIASA) as a tool for the integrated assessment of alternative strategies to reduce acid deposition in Europe and Asia (URL: http://www.iiasa.ac.at/~rains/site-map.html, 20.06.2011)

REGIO Database - Regional statistics collected by the EUROSTAT (URL: http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/region_cities/regional_statistics/data/database, 20.06.2011)

RIVM - National Institute for Public Health and the Environment (URL: http://www.rivm.nl/en/, 20.06.2011)

SAGE Project - System for assessing Aviation's Global Emissions- (URL: http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/sage/, 20.06.2011)

SBI code - Standard Company Classification Code (URL: http://www.siccode.com/, 20.06.2011)

SEDAC - **S**ocio**e**conomic **D**ata and **A**pplications **C**enter (URL: http://sedac.ciesin.org/, 20.06.2011)

SIC - Standard Industrial Classification is a United States government system for classifying industries by a four - digit code (URL http://www.referenceforbusiness.com/encyclopedia/Sel-Str/Standard-Industrial-Classification-System-SIC.html, 20.06.2011))

SNAP - Selected Nomenclature of Air Pollution

SSF - solid smokeless fuel

TFEIP - Task Force on Emission Inventories and Projections (URL: http://www.tfeip-secretariat.org/, 16.05.2011)

TREMOVE - A policy assessment model, designed to study the effects of different transport and environment policies on the emissions from the transport sector (URL: http://www.tremove.org/, 20.06.2011)

TRANS-TOOLS - TOOLS for TRansport Forecasting ANd Scenario testing (URL: http://energy.jrc.ec.europa.eu/transtools/ , 20.06.2011)

UN ECE - the United Nations Economic Commission for Europe (URL: http://www.unece.org, 20.06.2011)

UNFCCC - The United Nations Framework Convention on Climate Change (URL: http://unfccc.int/2860.php, 20.06.2011)

UNCLOS - The United Nations Convention on the Law of the Sea (URL: http://www.un.org/Depts/los/index.htm, 20.06.2011)

US DOE - U.S. Department of Energy (URL: http://www.energy.gov/, 20.06.2011)

USGS - U.S. Geological Survey (URL: http://www.usgs.gov/, 20.06.2011)

VLIZ - Vlaams Instituut Voor de Zee / Flanders Marine Institute (URL: http://www.vliz.be, 20.06.2011)

VNF - Voies Navigables de France (URL: http://www.vnf.fr/vnf/home.vnf?action=vnf, 20.06.2011)

Glossary of Pollutants

CO - Carbon Monoxide

CO_2 - Carbon Dioxide

NH_3 - Ammonia

NO_x - Oxides of Nitrogen

PM10 – Fine Particulates, size 10 µm or less

SO_2 - Sulphur Dioxide

1. Introduction

This report describes the methodologies for spatial distribution of diffuse emissions in the framework of E-PRTR. The spatial allocations are compiled for the diffuse releases to air for key pollutants (NO_x, SO_2, PM10, CO and CO_2) from the following diffuse sources:

- Transport activities including road transport, domestic aviation, domestic and international shipping (NO_x, SO_2, PM10, CO and CO_2)
- Non-industrial combustion from commercial and residential stationary combustion (NO_x, SO_2, PM10, CO and CO_2)
- Industrial releases from sources not covered by the E-PRTR Regulation (NO_x, SO_2, PM10, CO and CO_2)
- Agricultural activities not covered by the E-PRTR Regulation (NH_3, PM10).

The methodology description includes the explanation of the selection of the distribution parameters, which are used for gridding of diffuse emissions for each pollutant and each sector.

The target spatial resolution is a 5 km x 5 km grid cell size for maps covering all EU27 Member states and the EFTA countries (Switzerland, Liechtenstein, Norway and Iceland) for the selected sectors and pollutants. The emissions data of pollutants NO_x, PM10, SO_2, CO and NH_3 are the officially submitted emission data sets to UNECE under the Convention on Long-range Transboundary Air Pollution (CLRTAP, 2010) and, for CO_2, the emissions gathered from the national submissions to the United Nations Framework Convention on Climate Change (UNFCCC, 2010).

One of the main challenges of this project is to quantify the shares of releases from diffuse sources from E-PRTR relevant sectors. A comparison of the emissions reported to CLRTAP and UNFCCC on one hand and to the E-PRTR data base on the other hand has been done to quantify the diffuse shares of the national totals. The considered emission source categories are structured in the NFR_08 (Nomenclature for reporting 2008) and CRF (common Reporting Format) sector structure as defined by the reporting obligations of CLRTAP and UNFCCC.

Emissions from anthropogenic sources are usually distinguished into point, line and area sources. Diffuse emissions are defined as emissions from sources excluding emissions from E-PRTR related facilities. Therefore diffuse emissions, for the purpose of this project, include typical diffuse sources (like transport a or agricultural activities) but also small industrial point sources which fall below the Annex I and Annex II capacity thresholds of the E-PRTR regulation.

All emission sources (activities) taken into account in this project are only handled as line and area sources for spatial allocation. The applied methodology for all types of emission sources including point sources is visualized in Figure 1 that includes all types of emission sources. The spatial mapping of emissions is divided into two main steps.

The **first step** is the allocation of national sector specific emissions to a regional level like NUTS3. The regionalization as shown in Figure 1 is performed using sector specific regional information. Examples

for regional information are the number of employees, traffic counting data or animal population. The **second step** is the distribution into a grid of 5 X 5 km, carried out on the basis of data sets that have been previously regionalized. The final results of the spatial gridding are the annual emission values per grid cell derived using geospatial referenced data sets (as land use, road and river networks, etc.).

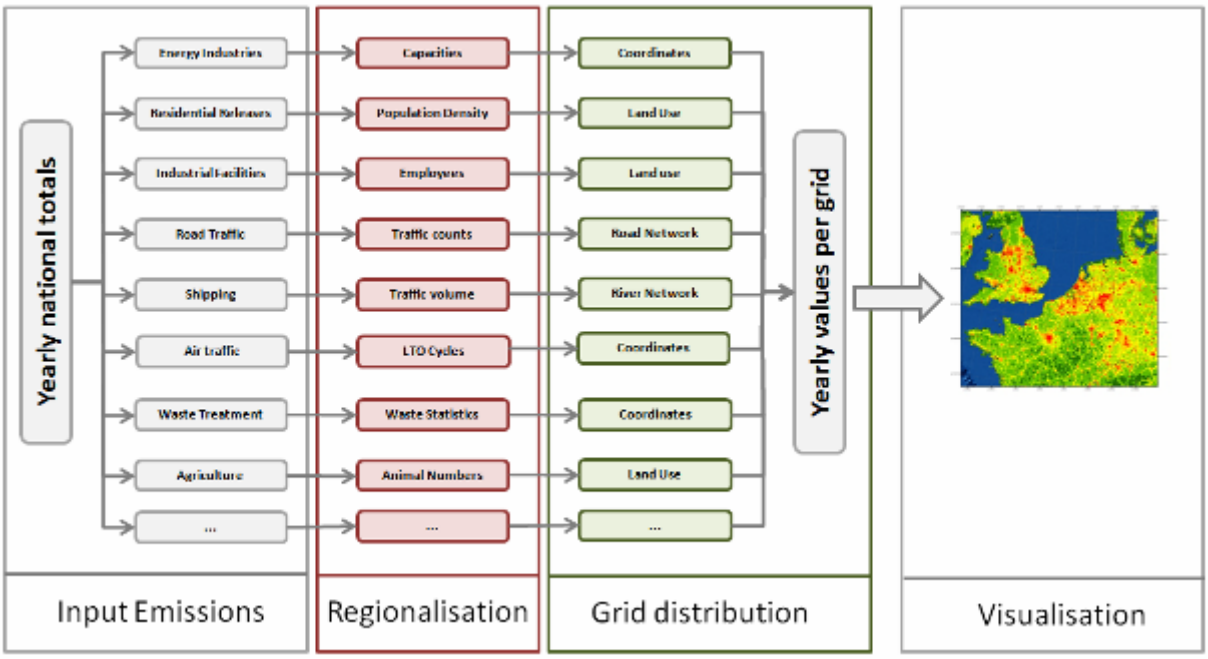

Figure 1: General methodology for the spatial distribution of emissions

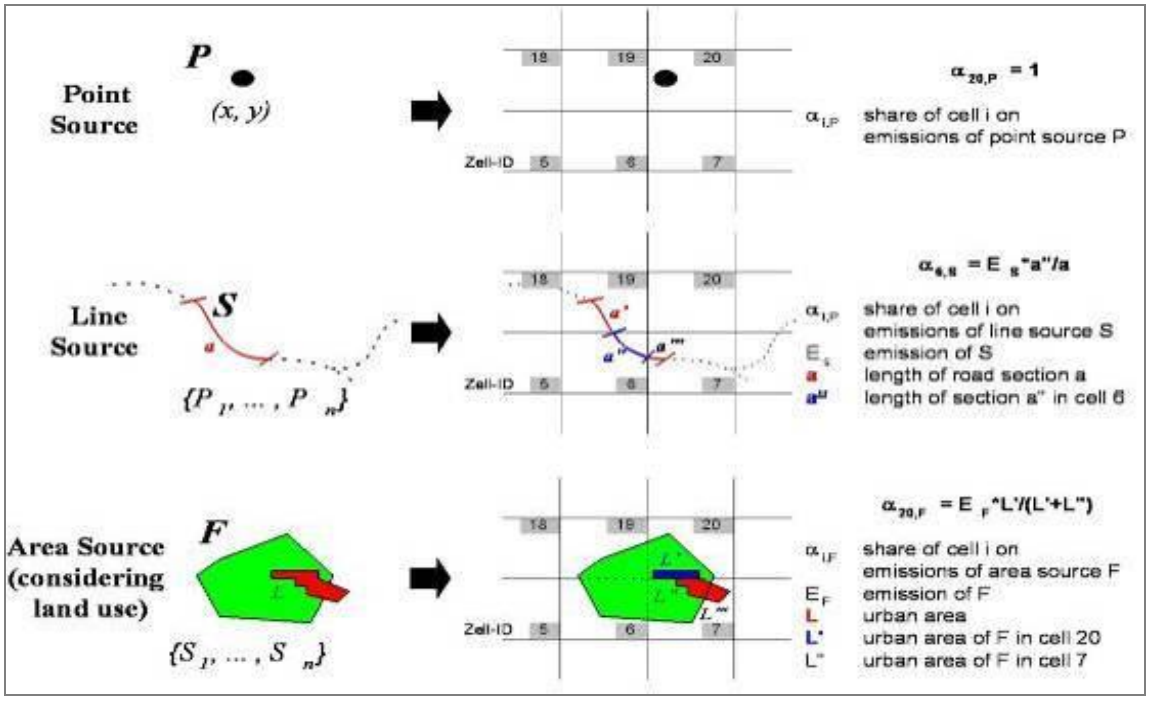

Figure 2: Geospatial referencing of distribution parameters (Wickert, 2001)

Figure 2 explains the geospatial referencing of the various point, line and area sources. Point sources are allocated to one grid cell using the coordinates of the facilities (point sources). The line sources cover more than one grid cell and therefore their shares for each grid cell have to be calculated before the spatial allocation can be performed. In order to distribute the area sources , similar to what has been done for the line sources, the shares for each concerning grid cell are derived and thus performing the spatial allocation of national totals. The final step is the visualization of the source of pollution and annual pollution releases on sector specific maps.

2. Subtraction Methodology

A methodology have been designed for subtracting "The European Pollutant Release and Transfer Register (E-PRTR)" emissions from the national totals officially reported by Member States to CLRTAP and UNFCCC.

The methodology has been initially developed on the basis of the work carried out for the report "Releases to air from diffuse sources in E-PRTR" (ETC/ACC, 2007) and the "E-PRTR Review Report 2009 on the 2007 E-PRTR dataset ETC/ACC Technical Paper 2009/15" (Mareckova et al., 2009) that linked the classification of industrial sectors (NFR-08) with the E-PRTR specific sector. In a second step, an alternative concept for subtraction of emissions reported to E-PRTR from national totals reported to CLRTAP and UNFCCC has been tested. In a last step the best available subtraction methodology have analyzed to determine which one to apply in this project.

2.1. Problem description

The aim is to describe an approach to identify the diffuse shares of the national emissions reported to the "Convention on Long-Range Transboundary Air Pollution (CLRTAP, 2010)" and the "United Nations Framework Convention on Climate Change (UNFCCC, 2010)" which are not covered by the reporting to E-PRTR Register.

The following key definitions are used in this report:

- **National Totals:** The submissions to CLRTAP and UNFCCC are representing the national totals which include both diffuse and non-diffuse emissions. The submissions by countries to the CLRTAP Convention are the reference for the pollutants CO, NO_x, SO_2, PM10, NH_3 and the submissions to the UNFCCC Convention are the reference for CO_2 emission releases.
- **Diffuse emissions:** emissions released by facilities or other anthropogenic activities not reported to E-PRTR. In particular:
    1. Releases from industrial sectors not reported to the E-PRTR (not considered in Annex I of the E-PRTR Regulation, having capacities below Annex I thresholds or releasing emissions below the substance threshold established in Annex II to the E-PRTR Regulation).
    2. Transport: on road-, shipping and domestic aviation activities.
    3. Combustion activities, including residential, commercial and industrial combustion facilities below 50 MW.
    4. All agricultural activities not covered by the E-PRTR regulation (excluding releases from E-PRTR activity 7a “Installations for the intensive rearing of poultry or pigs” above the capacity threshold defined in Annex I)

Transport activities are not covered by the E-PRTR Regulation and the emissions from these sectors are considered as diffuse emissions.

Activities 1 (Energy sectors), 3 (Mineral industry) and 4 (Chemical industry) contain activities partly covered by the E-PRTR Regulation. The emissions from these E-PRTR main sectors, defined in Annex I of the E-PRTR regulation, are considered as point-source releases when reported to the E-PRTR Regulation, while the remaining emissions from these activities are considered as diffuse emissions. Therefore a methodology to distinguish the point-source releases (covered by E-PRTR Regulation) and diffuse releases needs to be developed.

In principal it is assumed that:

- Aggregated emissions of CLRTAP and UNFCCC emissions are larger than E-PRTR emissions;
- This is valid for any level of aggregation of the data when comparing equivalent sector categories.

However, the total or sector specific E-PRTR emissions of some countries exceed the emissions officially reported by the same countries to CLRTAP or to UNFCCC (Mareckova et al., 2009)[2]

Thus, it is necessary to develop an approach which leads to a minimum of inconsistencies for the calculation of diffuse emissions for affected sectors and countries (industry and agriculture).

2.2. Methods applied by countries

Some European countries (e.g. NL or UK) already apply methods to identify sector specific shares of diffuse emissions. However, the national approaches for calculating diffuse emissions cannot easily be adapted on European scale. On the one hand due to the difference between the reporting guidelines of CLRTAP/UNFCCC and the E-PRTR and on the other hand because the E-PRTR source definitions do not consider the distinction between energy- and process-related emissions from industrial activities. The analysis of the 2008 emission data from CLRTAP/UNFCCC and E-PRTR revealed that the inconsistencies within a country are lower than the inconsistencies between different countries. The conclusion of the comparison of CLRTAP/UNFCCC and the E-PRTR sector allocations therefore is that a national subtraction approach is not transferable to the European level without major adaption.

2.3. Assessment of different subtraction strategies

Different strategies were assessed while developing a subtraction methodology. Firstly the different categorizations used for reporting requirements to the E-PRTR, the CLRTAP, and the UNFCCC reporting systems, respectively, have been analyzed. The systems to categorize activities used by the different inventory systems are:

- E-PRTR (2010): categorization of 9 main activities (first level) and several sub-activities (second level) according to Annex 1 of the E-PRTR regulation
- E-PRTR (2010) categorization of activities using NACE codes (as economic statistics)
- CLRTAP (2010): standardized categorization called Nomenclature for Reporting (NFR)
- UNFCCC (2010): standardized categorization called IPCC Common Reporting Format (CRF).

[2]To compare emissions by sector a mapping of activities to find equivalencies between NFR and E-PRTR Annex 1 categorisation have been developed

While CRF and NFR are rather comparable, the E-PRTR categorizations are significantly different. Therefore, based on the results of the EE-FI project 2009[3], a correlation table has been compiled. The purpose of the spreadsheet developed in the EE-FI project 2009 was the compilation of a common relationship between the following kinds of source categorization:

- Statistical Classification of Economic Activities in the European Community - NACE
- Selected Nomenclature for sources of Air Pollution - SNAP
- Common Reporting Format - CRF
- Nomenclature for Reporting - NFR
- Sector categorization from **G**reenhouse Gas and **A**ir Pollution **In**teractions and **S**ynergies (**GAINS**)-Model[4]
- E-PRTR main sub-activity level.

A further correlation of NFR sectors to E-PRTR main sub-activity level sectors has been prepared in the context of this project. The modification mainly aimed at reducing the relation between categories in the different systems from 'one to many' to 'one to one', meaning that each category of each system has a unique equivalent in the other reporting system and vice versa. The modification also completed the table to ensure that any NFR sector is assigned to a specific E-PRTR sub-activity.

Based on this correlation of activities (link NFR/CRF - E-PRTR) several subtraction approaches were tested by using official submitted data sets (mainly from 2007) to prepare the finally applied subtraction methodology. Details on the alternatives which were finally not chosen are described in chapter 2.8.

The method which was finally selected is known as ‘ABC Method'. For this approach the point source relevant NFR sectors are classified into three different groups and subtracted separately. The E-PRTR main activity levels as well as the NFR sectors were allocated to these three groups:

- “Energy Industries (A)”,
- “Industry (B)” and
- “Agricultural Industry (C)”.

The result of the ABC approach is a considerable reduction of the inconsistencies (cases where the emissions reported to E-PRTR are higher than the CLRTAP/UNFCCC national totals).

As result of the comparison and analysis of the developed approaches and in order to reduce the inconsistencies, the numbers of activity groups have been aggregated into two different groups abolishing the distinction between energy industries and other industries which was leading to most of the inconsistencies within the ABC Method. As a consequence, these two parts are subtracted together. The results, these two groups, namely “A-B” and “C”, are summarized in Table 1. The share of

[3]Available from the TFEIP-website: “A look-up spreadsheet for different reporting formats” can be found on the under the URL: http://www.tfeip-secretariat.org/documents/10-05-cyprus/3c_NACE_ SNAP_CRF_NFR _GAINSRAINS_draft.xls

[4] See for detailed description: http://gains.iiasa.ac.at/gains/EUR/index.login?logout=1

the negative values for the results of the subtraction according to the AB-C methodology is about 11%. The principal workflow is shown in Figure 3 and Figure 4, distinguished into different approaches for industrial and agricultural activities.

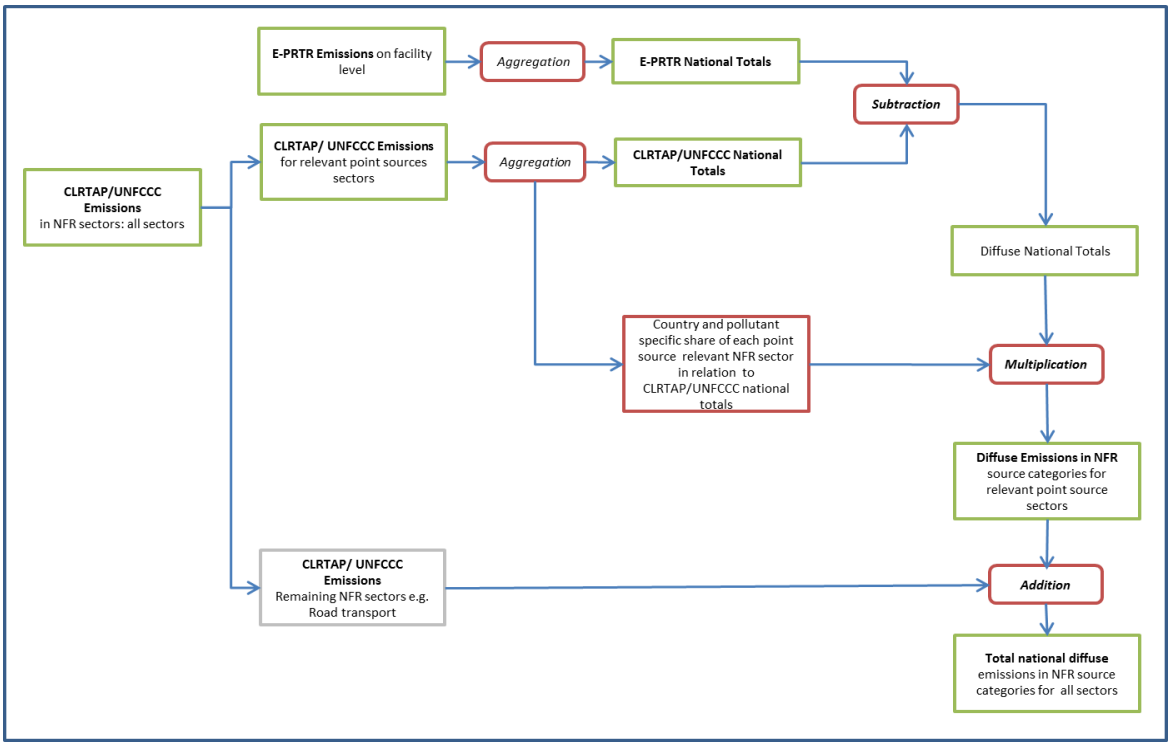

Figure 3: Principal work flow of the applied subtraction methodology (A-B, C-Method)

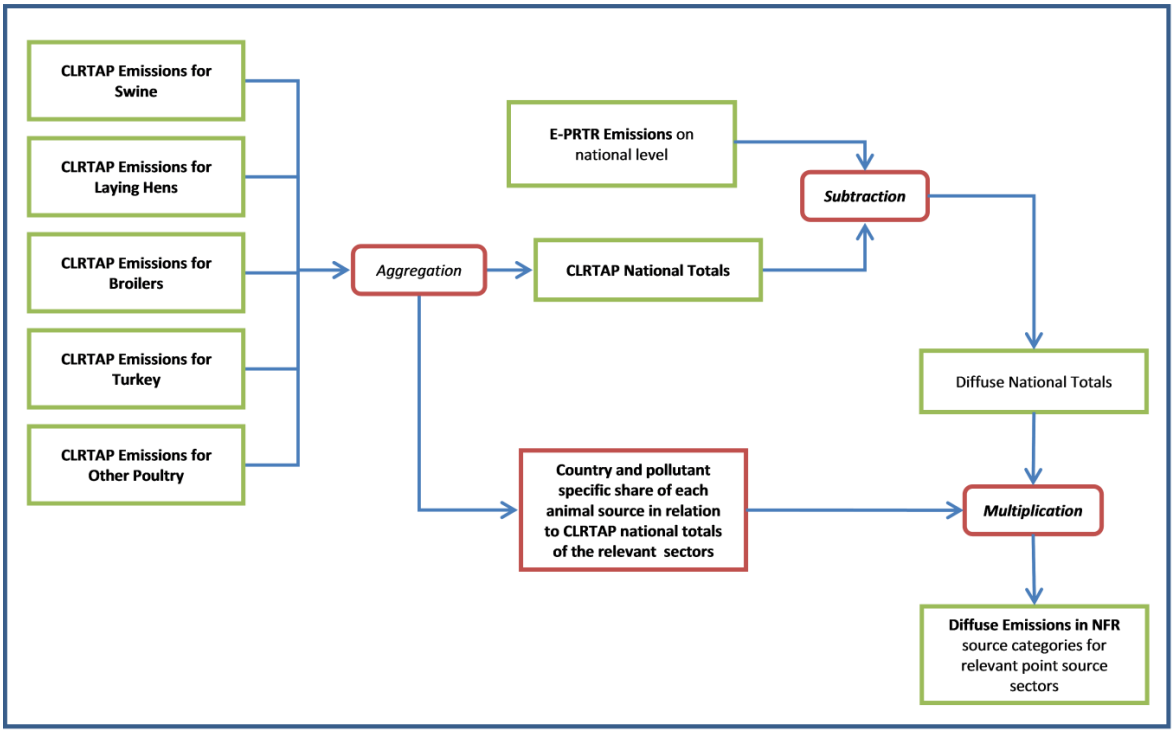

Figure 4: Principal work flow of the applied subtraction methodology for the agricultural sector

2.4. Applied Subtraction Methodology

The emission values from E-PRTR sectors have to be prepared and subtracted from the national totals from CLRTAP and UNFCCC for the related activity groups.

An overview of the main steps is given below:

1. **Assignment of activities**: the applied method starts basically with the categorization of the necessary sectors and the identification of E-PRTR related emission source categories from CLRTAP and from UNFCCC. (For CO_2, it is assumed that all emissions from biomass combustion activities are included within the national totals reported to the E-PRTR system for the year 2008.)
2. **Summarization**: The second step is the distinction of the categorized sectors from E-PRTR, CLRTAP and UNFCCC into the mentioned three classes (A, B and C). Additionally, in this step it is also necessary to calculate the shares of each NFR/CRF sector in relation to the national totals. The calculation of the shares is necessary for the reallocation of the total subtraction result into the original NFR/CRF sectors.
3. **Subtraction**: The next step is the calculation of the diffuse emissions for each pollutant and country. Here the subtraction of E-PRTR national values from CLRTAP national totals and UNFCCC national totals is carried out. When subtracting CO_2 emissions, the country specific reporting practice of biomass related information is considered.
4. **Reallocation of the remaining emissions**: the last step is the re-allocation of the remaining diffuse emissions after the subtraction process, to the initial NFR/CRF sectors in order to compile the gridded data sets on NFR/CRF sector level. The detailed description of the reallocation procedure is given in chapter 2.5.4.

Handling of remaining inconsistencies

The remaining inconsistencies for countries occurred where the E-PRTR emissions exceed the UNFCCC/CLRTAP submissions. They have been solved by calculation of diffuse emissions for the concerned countries on base of a consistent methodology.

Inconsistency is defined here not only by a resulting negative value when subtracting E-PRTR values from CLRTAP/UNFCCC ones but also when the resulting value represents a very low percentage of the total national emissions for the concerned sector. Therefore pollutant specific thresholds have been defined. This means that for all countries where the remaining values are negative or below the defined pollutant specific threshold in relation to the total amount, a recalculation of the diffuse parts is necessary.

2.5. Results

The result of the applied subtraction methodology is shown below for each country.

2.5.1. Categorization of different sectors into diffuse and non-diffuse sources

The transport and residential/commercial combustion sectors are not covered by the E-PRTR regulation and defined as diffuse sources. All agricultural emissions, except for the NFR sectors 4B8 Swine and 4B9 Poultry, covered by the E-PRTR Regulation, are defined as diffuse sources.

Table 1 gives an overview of the relevant diffuse sectors which are not covered by E-PRTR. All sectors with only contain diffuse sources are indicated as "D" in table 1. Table 1 presents all NFR categories with the following corresponding categories:

- A – E-PRTR point source relevant: covered mainly by E-PRTR sources
- B – E-PRTR point source relevant:

  covered by E-PRTR sources but also including diffuse sources (below E-PRTR reporting threshold)
- C – E-PRTR relevant like industrial facilities(B), but only agricultural installations
- D – Diffuse sources, which are not covered by E-PRTR

Table 1 shows the defined and applied assignment of the NFR source categories to E-PRTR main activity sectors.

Table 1: Classification of NFR emission source categories into diffuse and non-diffuse sectors

NFR08	Sector Name	Category	E-PRTR	E-PRTR Name
1A1a	Public Electricity and Heat Production	A	1c	Thermal power stations and other combustion installations (>50 MW)
1A1b	Petroleum refining	A	1a	Mineral oil and gas refineries
1A1c	Manufacture of Solid Fuels and Other Energy Industries	B	1c, 1b, 1f	Thermal power stations and other combustion installations (>50 MW), Installations for gasification and liquefaction, Installations for the manufacture of coal products and solid smokeless fuel
1A2a	Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel	B	2	Production and processing of metals
1A2b	Stationary Combustion in Manufacturing Industries and Construction: Non-ferrous Metals	B	2e	Installations for non-ferrous metals
1A2c	Stationary Combustion in Manufacturing Industries and Construction: Chemicals	B	4	Chemical industry
1A2d	Stationary Combustion in Manufacturing Industries and Construction: Pulp, Paper and Print	B	6	Paper and wood producing plants
1A2e	Stationary Comb. in Manufact. Ind. and Constr.: Food Processing, Beverages and Tobacco	B	8	Animal and vegetable products from the food and beverage sector
1A2fi	Stationary Combustion in Manufacturing Industries and Construction: Other	B	2, 3	Production and processing of metals Mineral industry
1A2fii	Mobile Combustion in Manufact. Industries & Constr.	D		
1A3ai(i)	International Aviation (LTO)	D		
1A3aii(i)	Civil Aviation (Domestic, LTO)	D		
1A3bi	Road Transport:, Passenger cars	D		
1A3bii	Road Transport:, Light duty vehicles	D		
1A3biii	Road Transport:, Heavy duty vehicles	D		
1A3biv	Road Transport:, Mopeds & Motorcycles	D		
1A3bv	Road Transport:, Gasoline evaporation	D		
1A3bvi	Road Transport:, Automobile tyre and brake wear	D		
1A3bvii	Road Transport:, Automobile road abrasion	D		

NFR08	Sector Name	Category	E-PRTR	E-PRTR Name
1A3c	Railways	D		
1A3di(i)	International maritime Navigation	D		
1A3di(ii)	International inland waterways	D		
1A3dii	National Navigation (Shipping)	D		
1A3e	Pipeline compressors	D		
1A4ai	Commercial / Institutional: Stationary	D		
1A4aii	Commercial / Institutional: Mobile	D		
1A4bi	Residential: Stationary plants	D		
1A4bii	Residential: Household and gardening (mobile)	D		
1A4ci	Agriculture/Forestry/Fishing: Stationary	D		
1A4cii	Agric./Forestry/Fish.: Off-road Veh. & Oth.Mach.	D		
1A4ciii	Agriculture/Forestry/Fishing: National Fishing	D		
1A5a	Other, Stationary (including Military)	D		
1A5b	Oth. mobile (Incl. military, land based & recr.boats).	D		
1B1a	Fugitive emission from Solid Fuels: Coal Mining and Handling	B	1f	Installations for the manufacture of coal products and solid smokeless fuel
1B1b	Fugitive emission from Solid Fuels: Solid fuel trans-formation	B	1d	Coke ovens
1B1c	Other fugitive emissions from solid fuels	B	1f	Installations for the manufacture of coal products and solid smokeless fuel
1B2ai	Exploration Production, Transport	B	1	Energy Industries
1B2aiv	Refining / Storage	B	1a	Mineral oil and gas refineries
1B2av	Distribution of oil products	D		
1B2avi	Geothermal energy extraction	B	1c	Thermal power stations & other combustion install.
1B2b	Natural gas	B	1a	Metal ore roasting or sintering installations
1B2c	Venting and flaring	B	1a	Mineral oil and gas refineries
2A1	Cement Production	B	3ci	Installations for the production of cement clinker
2A2	Lime Production	B	3cii	Installations for the production of lime in rotary kilns
2A3	Limestone and Dolomite Use	B	3f	Installations for melting mineral substances, including the production of mineral fibres
2A4	Soda Ash Production and use	B	3f	Installations for melting mineral substances, including the production of mineral fibres
2A5	Asphalt Roofing	D		
2A6	Road Paving with Asphalt	D		
2A7a	Quarrying and mining of minerals other than coal	B	3b	Opencast mining and quarrying
2A7b	Construction and demolition	D		
2A7c	Storage, handling and transport of mineral products	B	3	Mineral industry
2A7d	Other Mineral products	B	3	Mineral industry
2B1	Ammonia Production	B	4bi	Chemical installations for the production on an industrial scale of basic inorganic chemicals: gases
2B2	Nitric Acid Production	B	4bii	Chemical installations for the production on an industrial scale of basic inorganic chemicals: acids
2B3	Adipic Acid Production	B	4bii	
2B4	Carbide Production	B	4bv	Chemical installations for the production on an industrial scale of basic inorganic chemicals: non-metals, metal-oxides.
2B5a	Other chemical industry	B	4	Chemical industry
2B5b	Storage, handling and transport of chemical products	B	4b	Chemical installations for the production on an industrial scale of basic inorganic chemicals
2C1	Iron and Steel Production	B	2a, 2b, 2c	Metal ore roasting or sintering installations, Installations for the production of pig iron or steel inc. continuous casting, Installations for the processing of ferrous metals
2C2	Ferroalloys Production	B	2c	Installations for the processing of ferrous metals
2C3	Aluminum Production	B	2c	
2C5a	Copper Production	B	2ei	For the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes
2C5b	Lead Production	B	2ei	
2C5c	Nickel Production	B	2ei	
2C5d	Zinc Production	B	2ei	
2C5e	Other metal production	B	2ei	
2C5f	Storage, handling and transport of metal products	B	2ei	
2D1	Pulp and Paper	B	6a, 6b	Industrial plants for the production of pulp from timber or similar fibrous materials, Industrial plants for the production of paper and board and other primary wood products
2D2	Food and Drink	B	8	Animal and vegetable products from the food and beverage sector
2D3	Wood processing	B	6b	Industrial plants for the production of paper and board and other primary wood products
2G	Other production, consumption, storage, transporta-tion or handling of bulk products	B	2,3, 9	Prod. & proc. of metals, Mineral industry, Other act.
3A1	Decorative coating application	D		

NFR08	Sector Name	Category	E-PRTR	E-PRTR Name
3A2	Industrial coating application	B	9c	Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating
3A3	Other coating application	B	9c	
3B1	Degreasing	B	9c	
3B2	Dry cleaning	D		
3C	Chemical products	B	9c	Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating
3D1	Printing	B	9c	
3D2	Domestic solvent use including fungicides	D		
3D3	Other product use	B	9c	Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating
4B13	Other	D		
4B1a	Cattle Dairy	D		
4B1b	Cattle Non-Dairy	D		
4B2	Buffalo	D		
4B3	Sheep	D		
4B4	Goats	D		
4B6	Horses	D		
4B7	Mules and Asses	D		
4B8	Swine	C	7a	Installations for the intensive rearing of poultry or pigs
4B9a	Laying Hens	C	7a	
4B9b	Broilers	C	7a	
4B9c	Turkeys	C	7a	
4B9d	Other Poultry	C	7a	
4D1a	Synthetic N-fertilizers	D		
4D2a	Farm-level agriculture operations incl. storage, handling and transport of agriculture Products	D		
4D2b	Off-farm storage, handl.& transp. of bulk agric. Prod.	D		
4D2c	N-excretion on pasture range and paddock Unspec.	D		
4F	Field burning of agricultural wastes	D		
4G	Agriculture, other	D		
6A	Solid waste disposal on land	D		
6B	Waste-water handling	D		
6Ca	Clinical Waste Incineration	D		
6Cb	Industrial Waste Incineration	A	5b	Installations for the incineration of non-hazardous waste
6Cc	Municipal Waste Incineration	A	5b	
6Cd	Cremation	D		
6Ce	Small Scale Waste Burning	D		
6D	Other Waste	D		
7A	Other (included in National Total for Entire Territory)	D		

The categorization of emission sources presented in table 1 is the basis for calculating the diffuse emissions of E-PRTR relevant sectors.

However, the reported CO_2 emissions need further distinction according to E-PRTR ANNEX 2 of the "Background information on Member States' positions and situation" on biomass. There are three cases concerning the biomass reporting practice for **2007**:

- Countries reported total quantities of CO_2 including biomass
- Countries reported total quantities of CO_2 excluding biomass
- Countries did not provide informationon CO_2emission from biomass

For countries, where no information according the reporting practice concerning biomass related CO_2 emissions to the E-PRTR system is available, it is assumed that the reported emissions include biomass related CO_2 emissions. The categorization of country specific reporting practices is shown for 2007 in Table 2

For **2008**, the reporting practice is unclear. Only few countries delivered data for CO_2 excluding biomass related CO_2 emissions explicitly on facility level and if delivered, not for all facilities within these countries. Thus for2008 have been assumed that the CO_2 emissions reported to the E-PRTR system include biomass related CO_2 emissions. The subtraction of CO_2 emission data from the UNFCCC datasets was conducted on base of this assumption.

Table 2: Reporting of biomass related CO_2 in the EU27 and EFTA4 countries in 2007 [5]

Country	E-PRTR including biomass CO_2	E-PRTR excluding biomass CO_2
Austria		X
Belgium	X	
Bulgaria	X	
Cyprus		X
Czech Republic		X
Denmark	X	
Estonia		X
Finland		X
France	X	
Germany		X
Greece		X
Hungary		X
Iceland	X	
Ireland	X	
Italy		X
Latvia	X	
Liechtenstein	X	
Lithuania	X	
Luxembourg	X	
Malta	X	
Netherlands	X	
Norway	X	
Poland	X	
Portugal		X
Romania	X	
Slovakia	X	
Slovenia	X	
Spain	X	
Sweden	X	
Schwitzerland	X	
United Kingdom	X	

2.5.2. Data aggregation

The result of the aggregation of the E-PRTR source relevant emissions and the national total emissions reported to CLRTAP and UNFCCC into the groups A, B and C is shown in Table 3. The emissions reported to E-PRTR are also summarized to categories A, B and C.

The categories A and B are combined at this stage, however for the reallocation to the national totals, the A-category related sectors has not been taken into account. The reason is that the sectors Public Electricity and Heat Production (NFR 1A1a), Petroleum refining (NFR 1A1b), Industrial Waste Incineration (NFR 6Cb) and Municipal Waste Incineration (6Cc) are assumed to be almost completely covered by emissions from E-PRTR facilities. The result of the reallocation is shares of the relevant

[5] For countries, where no information available have been assumed that the national total emissions include biomass related CO_2 emissions.

sectors in relation to the national totals. These shares are used for reallocation of the aggregated emissions after the subtraction process. They are derived by dividing sector related emissions with the point source related national total emissions from of all sectors. The resulting shares are shown in Table 3 exemplified for Germany.

Table 3: CLRTAP (2010) and UNFCCC (2010) emissions categorized in A_B and C on country level

Country	Category	Year	Unit	CO	NH_3	NO_x	PM10	SO_x	CO_2
Austria	A_B	2008	kt	163	1	40	9	15	51244
	C	2008	kt	0	16	1	0	0	
Belgium	A_B	2008	kt	412	2	82	13	80	66165
	C	2008	kt	0	26	0	2	0	
Bulgaria	A_B	2008	kt	36	2	94	13	699	47220
	C	2008	kt	0	14	0	0	0	
Switzerland	A_B	2008	kt	27	0	18	6	8	16500
	C	2008	kt	0	10	0	2	0	
Cyprus	A_B	2008	kt	4	0	9	3	21	5959
	C	2008	kt	0	3	0	0	0	
Czech Republic	A_B	2008	kt	141	0	127	10	145	94145
	C	2008	kt	0	21	0	1	0	
Germany	A_B	2008	kt	1505	14	507	86	420	575697
	C	2008	kt	0	166	0	13	0	
Denmark	A_B	2008	kt	28	1	52	3	13	37891
	C	2008	kt	0	31	0	5	0	
Estonia	A_B	2008	kt	31	0	15	11	68	15674
	C	2008	kt	0	2	0	0	0	
Spain	A_B	2008	kt	701	13	440	36	430	205210
	C	2008	kt	0	87	0	17	0	
Finland	A_B	2008	kt	61	1	73	14	63	66100
	C	2008	kt	0	9	0	1	0	
France	A_B	2008	kt	1631	6	233	108	302	178795
	C	2008	kt	0	211	0	13	0	
United Kingdom	A_B	2008	kt	575	6	499	43	412	309430
	C	2008	kt	0	50	0	10	0	
Greece	A_B	2008	kt	82	0	169	0	404	76391
	C	2008	kt	0	14	0	0	0	
Hungary	A_B	2008	kt	62	1	49	8	53	33349
	C	2008	kt	0	34	0	0	0	
Ireland	A_B	2008	kt	19	0	40	7	34	23116
	C	2008	kt	0	8	0	0	0	
Iceland	A_B	2008	kt	1		5		72	2118
	C	2008	kt	0		0		0	
Italy	A_B	2008	kt	751	0	264	56	230	267567
	C	2008	kt	0	68	0	13	0	
Liechtenstein	A_B	2008	kt	0	0	0	0	0	39
	C	2008	kt	0	0	0	0	0	
Lithuania	A_B	2008	kt	15	0	15	3	18	10123
	C	2008	kt	0	9	0	0	0	

Country	Category	Year	Unit	CO	NH_3	NO_x	PM10	SO_x	CO_2
Luxembourg	A_B	2008	kt	2	0	6	0	1	3540
	C	2008	kt	0	1	0	0	0	
Latvia	A_B	2008	kt	18	0	13	2	2	4622
	C	2008	kt	0	3	0	0	0	
Malta	A_B	2008	kt	0	0	5	1	11	2078
	C	2008	kt	0	1	0	0	0	
Netherlands	A_B	2008	kt	157	2	72	11	47	108829
	C	2008	kt	0	47	0	8	0	
Norway	A_B	2008	kt	35	1	61	10	15	29286
	C	2008	kt	0	0	0	0	0	
Poland	A_B	2008	kt	150	1	393	85	758	240565
	C	2008	kt	0	90	0	9	0	
Portugal	A_B	2008	kt	88	4	112	70	103	42759
	C	2008	kt	0	9	0	0	0	
Romania	A_B	2008	kt	256	1	141	29	552	80361
	C	2008	kt	0	75	0	6	0	
Sweden	A_B	2008	kt	82	4	44	15	28	42013
	C	2008	kt	0	8	0	2	0	
Slovenia	A_B	2008	kt	4	0	16	2	12	10434
	C	2008	kt	0	4	0	0	0	
Slovakia	A_B	2008	kt	139	0	33	3	65	28185
	C	2008	kt	0	7	0	0	0	

Exemplarily for Germany, the fractions of the national total emissions for the categories A and B are shown in Table 4. These are representing the contribution of the NFR sectors to the national total (as shown in Table 3 for the A_B category) for each pollutant.

Table 4: Contribution of relevant NFR/CRF sectors to the national total emissions for Germany

Country	NFR/CRF	Year	Category	CO	NO_X	PM10	SO_2	CO_2
Germany	1 A 1 a	2008	A	9.8%	54.7%	11.3%	48.2%	60.3%
Germany	1 A 1 b	2008	A	0.1%	4.1%	1.4%	11.6%	3.8%
Germany	1 A 1 c	2008	B	0.6%	2.7%	0.5%	3.5%	2.3%
Germany	1 A 2 a	2008	B	39.2%	0.0%	0.1%	0.0%	2.0%
Germany	1 A 2 b	2008	B	0.0%	0.2%	0.0%	0.1%	0.0%
Germany	1 A 2 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 A 2 d	2008	B	0.0%	0.0%	0.0%	0.0%	0.5%
Germany	1 A 2 e	2008	B	0.0%	0.0%	0.0%	0.1%	0.0%
Germany	1 A 2 f i	2008	B	10.9%	16.7%	4.2%	10.6%	16.8%
Germany	1 B 1 a	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 B 1 b	2008	B	0.5%	0.0%	0.5%	0.1%	0.0%

Country	NFR/CRF	Year	Category	CO	NO_X	PM10	SO_2	CO_2
Germany	1 B 1 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 B 2 a i	2008	B	0.0%	0.0%	0.0%	0.0%	0.3%
Germany	1 B 2 a iv	2008	B	0.0%	0.0%	0.0%	1.7%	0.0%
Germany	1 B 2 a v	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 B 2 b	2008	B	0.0%	0.0%	0.0%	2.2%	0.0%
Germany	1 B 2 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 1	2008	B	0.0%	8.4%	2.6%	1.4%	2.3%
Germany	2 A 2	2008	B	0.0%	1.9%	0.2%	0.1%	1.0%
Germany	2 A 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 4	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 7 a	2008	B	0.0%	0.0%	0.0%	0.0%	0.2%
Germany	2 A 7 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 7 d	2008	B	0.0%	3.0%	1.7%	2.5%	0.0%
Germany	2 B 1	2008	B	0.0%	0.6%	0.0%	0.0%	0.7%
Germany	2 B 2	2008	B	0.0%	5.2%	0.0%	0.0%	0.0%
Germany	2 B 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 B 4	2008	B	0.0%	0.0%	0.1%	0.0%	0.0%
Germany	2 B 5 a	2008	B	0.1%	0.0%	0.5%	7.1%	1.8%
Germany	2 B 5 b	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 C 1	2008	B	31.5%	6.0%	29.7%	8.4%	7.5%
Germany	2 C 2	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 C 3	2008	B	7.2%	0.0%	1.9%	1.3%	0.1%
Germany	2 C 5 a	2008	B	0.0%	0.0%	0.1%	0.2%	0.0%
Germany	2 C 5 b	2008	B	0.0%	0.0%	0.0%	0.1%	0.0%
Germany	2 C 5 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 C 5 d	2008	B	0.0%	0.0%	0.0%	0.1%	0.0%
Germany	2 C 5 e	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 C 5 f	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 D 1	2008	B	0.0%	0.3%	1.6%	0.3%	0.0%
Germany	2 D 2	2008	B	0.0%	0.0%	0.4%	0.0%	0.0%
Germany	2 D 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 E	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%

Country	NFR/CRF	Year	Category	CO	NO_X	PM10	SO_2	CO_2
Germany	2 G	2008	B	0.0%	0.0%	43.0%	0.0%	0.0%
Germany	3 A 1	2008	B	0.0%	0.0%	0.0%	0.0%	0.2%
Germany	3 A 2	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 A 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 B 1	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 B 2	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 C	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 D 5	2008	B	0.0%	0.0%	0.0%	0.0%	0.2%
Germany	6 C b	2008	A	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	6 C c	2008	A	0.0%	0.0%	0.0%	0.0%	0.0%

2.5.3. Subtraction

For the E-PRTR relevant sectors shown in table 1 (groups A, B and C), the emissions from E-PRTR facilities are subtracted from the national totals of the categories A and B. An additional subtraction for category C also is carried out.

The biomass related CO_2 emissions are reported in memo items[6] to UNFCCC. For 2008 only few countries delivered data for CO_2 excluding biomass sources on facility level to the E-PRTR. It is assumed that the CO_2 emissions reported to the E-PRTR system include both biomass and non-biomass related CO_2 emissions. The subtraction of CO_2 emission data from the UNFCCC datasets was performed on the basis of this assumption.

The resulting shares of diffuse emissions for all pollutants and countries are shown in table 5. This share expresses the relation of national totals without distinction into the two categories A-B and C. The use of fractions of the total is more useful than showing the absolute differences, because inference of the relative magnitude of remaining diffuse emissions is obvious. Moreover, assessment and comparison of country specific differences is more transparent.

In table 5 country- and pollutant-specific inconsistencies are indicated. This is the case either for the negative values, or where no values in the data sets which have been reported to E-PRTR, CLRTAP or UNFCCC are provided, or if values below a defined pollutant specific threshold are found. The pollutant specific thresholds are defined as follows:

- SO_2: No pollutant specific threshold is defined above 0%, because it is assumed that all SO_2 emissions are mainly caused by large point sources.
- PM10: Pollutant specific threshold for PM10 is defined at 10%.The PM10 share is expected to be this high since the European average diffuse share is about 63% of the national total (see also table 5).

[6] The memo items in the UNFCCC submissions, like biomass activities, are not included in the national total for CO_2, but listed separately and therefore called memo items.

- NO_x: Pollutant specific threshold for NO_x is defined at 5% because the relative differences for e.g. Czech Republic, France and Slovakia are much lower than diffuse shares of the other countries and the average European diffuse share is at 27%
- NH_3: Pollutant specific threshold for NH_3 is defined at 10%. The NH_3 share is expected to be this high since the European average diffuse share is about 75% of the national total (see also table 5).
- CO: No pollutant specific threshold is defined above 0%, because it is assumed that all CO emissions are mainly caused by large point sources.
- CO_2: No pollutant specific threshold is defined above 0%, because it is assumed that all CO_2 emissions are mainly caused by large point sources (e.g. for the EU27 about 63% of the CO_2 emissions are only caused by the CRF sector 1A1a Public Electricity and Heat Production).

Table 5: Results of the subtraction process

Country	Year	Unit	CO	NH_3	NO_X	PM10	SO_X	CO_2
Austria	**2008**	%	-484.1	81.7	-358.2	90.5	49.9	40.5
Belgium	**2008**	%	2.1	85.9	15.1	64.3	9.1	22.6
Bulgaria	**2008**	%	-7.7	57.5	13.1	-40.8	-6.6	29.7
Switzerland	**2008**	%	63.7	33.9	70.1	100	41.5	52.6
Cyprus	**2008**	%	15.6	29.0	0.8	4.8	8.9	8.3
Czech Republic	**2008**	%	11.7	70.0	3.0	48.7	3.7	15.1
Germany	**2008**	%	36.2	91.5	25.9	84.6	36.7	19.9
Denmark	**2008**	%	78.4	96.4	46.0	66.7	4.1	49.8
Estonia	**2008**	%	43.8	76.1	17.4	54.4	16.1	19.7
Greece	**2008**	%	41.6	98.3	4.0		8.7	11.5
Spain	**2008**	%	46.8	61.6	7.3	53.9	8.8	27.6
Finland	**2008**	%	-80.7	78.5	16.4	83.4	30.2	8.2
France	**2008**	%	86.6	91.4	5.2	94.7	5.5	21.3
Hungary	**2008**	%	46.6	68.7	43.6	94.0	70.1	21.2
Ireland	**2008**	%	83.4	84.3	14.3	88.5	8.8	16.5
Iceland	**2008**	%	-2,359.5		100		83.4	-145.6
Italy	**2008**	%	64.6	0.6	64.8	93.6	76.7	67.9
Liechtenstein	**2008**	%	100	100	100	100	100	100
Lithuania	**2008**	%	58.9	60.5	44.7	70.1	11.8	37.3
Luxembourg	**2008**	%	-381.3	100	36.3		42.6	40.6
Latvia	**2008**	%	100	82.2	70.0	26.6	61.4	87.6
Malta	**2008**	%	100	100	-2.5	12.5	2.4	3.1
Netherlands	**2008**	%	11.8	93.9	16.7	80.9	6.0	18.4
Norway	**2008**	%	94.2	-13.9	75.3	48.1	3.9	56.0
Poland	**2008**	%	-239.9	92.0	25.7	67.5	26.9	23.0
Portugal	**2008**	%	56.9	45.3	34.7	93.2	34.1	35.0
Romania	**2008**	%	55.0	68.8	14.3	20.8	10.8	24.2
Sweden	**2008**	%	51.3	77.6	34.9	72.0	46.1	-13.8
Slovenia	**2008**	%	-350.2	83.1	8.5	80.4	30.2	24.5
Slovakia	**2008**	%	5.9	88.2	1.2	100	3.2	11.9
United Kingdom	**2008**	%	37.8	74.9	12.5	68.7	8.2	16.5

Notation to Table 5 :
- *100% e.g. means that no E-PRTR emissions were available (yellow marked)*
- *No value e.g. PM10 for Greece, means no CLRTAP emission was available (blue marked)*
- *Negative values (identified inconsistencies) (red marked) Reallocation*

The remaining diffuse national total emissions are reallocated to the specific NFR or CRF sectors, respectively. Results from the subtraction process are calculated for the merged category A-B and also for the category C. The shares of the CRF/NFR sectors, which are classified as A category, are not further taken into account in the reallocation process. The reallocation is performed by using the

shares which were derived in the aggregation process (step 2). The omitted sectors (Category A) in the reallocation process are the following:

- 1A1a Public Electricity and Heat Production (Energy transformation),
- 1A1b Petroleum refining,
- 6Cb Industrial Waste Incineration and
- 6Cc Municipal Waste Incineration.

The disaggregation of the remaining diffuse emissions is performed by using their contributions of E-PRTR relevant sectors to the national totals. The shares of the sectors classified as A category are omitted. In Table 6 only category B sectors are listed.

Table 6: Shares of diffuse emissions which are considered for the reallocation process (Germany)

Country	NFR09/CRF	Year	Category	CO	NO_x	PM10	SO_2	CO_2
Germany	1 A 1 c	2008	B	0.6%	6.5%	0.6%	8.9%	6.5%
Germany	1 A 2 a	2008	B	43.5%	0.0%	0.1%	0.0%	5.5%
Germany	1 A 2 b	2008	B	0.0%	0.6%	0.0%	0.2%	0.1%
Germany	1 A 2 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 A 2 d	2008	B	0.0%	0.0%	0.0%	0.0%	1.5%
Germany	1 A 2 e	2008	B	0.0%	0.1%	0.0%	0.4%	0.1%
Germany	1 A 2 fi	2008	B	12.1%	40.5%	4.8%	26.5%	46.7%
Germany	1 B 1 a	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 B 1 b	2008	B	0.6%	0.0%	0.6%	0.2%	0.0%
Germany	1 B 1 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 B 2 a i	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 B 2 a v	2008	B	0.0%	0.0%	0.0%	4.2%	0.0%
Germany	1 B 2 a vi	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	1 B 2 b	2008	B	0.0%	0.0%	0.0%	5.5%	0.7%
Germany	1 B 2 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 1	2008	B	0.0%	11.2%	3.0%	3.5%	6.5%
Germany	2 A 2	2008	B	0.0%	4.5%	0.2%	0.3%	2.7%
Germany	2 A 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 4	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 7 a	2008	B	0.0%	0.0%	0.0%	0.0%	0.5%
Germany	2 A 7 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 A 7 d	2008	B	0.0%	7.3%	2.0%	6.3%	0.0%
Germany	2 B 1	2008	B	0.0%	1.5%	0.0%	0.0%	2.0%
Germany	2 B 2	2008	B	0.0%	12.5%	0.0%	0.0%	0.0%
Germany	2 B 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 B 4	2008	B	0.0%	0.0%	0.1%	0.0%	0.0%
Germany	2 B 5 a	2008	B	0.1%	0.0%	0.6%	17.9%	5.0%
Germany	2 B 5 b	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%

Country	NFR09/CRF	Year	Category	CO	NO_x	PM10	SO_2	CO_2
Germany	2 C 1	2008	B	35.0%	14.6%	34.0%	21.1%	20.9%
Germany	2 C 2	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 C 3	2008	B	8.0%	0.0%	2.2%	3.2%	0.4%
Germany	2 C 5 a	2008	B	0.0%	0.0%	0.1%	0.6%	0.0%
Germany	2 C 5 b	2008	B	0.0%	0.0%	0.0%	0.3%	0.0%
Germany	2 C 5 c	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 C 5 d	2008	B	0.0%	0.0%	0.0%	0.3%	0.0%
Germany	2 C 5 e	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 C 5 f	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 D 1	2008	B	0.0%	0.8%	1.9%	0.7%	0.0%
Germany	2 D 2	2008	B	0.0%	0.0%	0.5%	0.0%	0.0%
Germany	2 D 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2 E	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	2G	2008	B	0.0%	0.0%	49.2%	0.0%	0.0%
Germany	3 A 1	2008	B	0.0%	0.0%	0.0%	0.0%	0.4%
Germany	3 A 2	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 A 3	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 B 1	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 B 2	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 C	2008	B	0.0%	0.0%	0.0%	0.0%	0.0%
Germany	3 D 1	2008	B	0.0%	0.0%	0.0%	0.0%	0.5%

2.6.Calculation of emissions for identified inconsistencies

After performing the subtraction process inconsistenciesin the case of some countries are found. That means especially that the emissions reported to the E-PRTR system were higher than the national totals reported to CLRTAP or UNFCCC, respectively, or were above the defined pollutant specific thresholds. It is assumed, however, that also in these countries diffuse emissions which are not covered by the E-PRTR system can be found.

Therefore a methodology to overcome these inconsistencies has been developed. The following premise is the starting point of this methodology and subsequent gap filling calculations:

- Countries' diffuse shares are similar when the economic and climate profiles also are similar.

This gap-filling exercise is described in detail for the following countries:

- Countries and pollutants with negative diffuse emissions e.g. Italy, Luxembourg, Poland and Slovenia
- Countries with no emissions reported to E-PRTR or CLRTAP (UNFCCC CO_2 is available for all relevant countries) e.g. Greece, Liechtenstein, Malta and Slovakia
- Countries with small amounts of remaining diffuse emissions, according to the pollutant specific thresholds e.g. Czech Republic, France, Slovakia and Sweden.

The gap filling is done by using emission values from similar countries or country groups. The country specific and the country group specific diffuse emission shares are derived on the basis of the results of the subtraction method for those countries and pollutants where no inconsistencies occur.

The criteria for identifying similar countries are:

- country with a similar population density
- similar Gross Added Value (GVA)
- similar climate zones

The similarities are mainly based on GVA by considering the main contributing economic branches. The advantage of using the GVA as an indicator instead of GDP is that the GVA excludes information on imports and exports, consumption, wages and taxes. Similarities for some countries are shown in Table 7.

Table 7: Examples for identification of similar countries

Country which requiring gap filling	Similar/Reference countries
Bulgaria	Romania, Poland
Cyprus	Malta, Greece
Finland	Sweden
Luxembourg	Belgium
Slovenia	Slovakia, Czech Republic

2.7. Summary and Conclusion

The national submissions to CLRTAP (2010) and UNFCCC (2010) include diffuse and non-diffuse emissions; the E-PRTR submissions only include non-diffuse emissions.

- The CLRTAP data set is the base for CO, NO_x, SO_2, PM10, and NH_3 emissions
- The UNFCCC data set is the base for CO_2 emissions

The main step of the subtraction procedure is the identification of E-PRTR emission categories which are related to CLRTAP and UNFCCC reporting categories. The CLRTAP (NFR) and UNFCCC sectors (CRF) have been categorized as follows:

A – EPRTR point source relevant: covered mainly by point sources

B – EPRTR point source relevant: covered by point sources and diffuse sources

C – EPRTR point source relevant: like B, but only agricultural installations

D – Diffuse emissions sources, not point source relevant in relation to E-PRTR.

The spatial distribution of category D emissions can be done only without further pre-processing. Emissions of all other categories are treated in the applied subtraction approach.

The country specific reporting practice of biomass related activities is accounted for in order to correctly subtracting the CO_2 emissions reported in both systems. Some countries (facilities, respectively) include the biomass related activities into the national totals reported to E-PRTR while other

countries exclude the biomass CO_2 in the submissions to the E-PRTR. For 2008 only few countries delivered data for CO_2 excluding biomass sources on facility level. Therefore, it is assumed that the CO_2 emissions reported to the E-PRTR system include biomass and non-biomass related CO_2 emissions. The subtraction of CO_2 emission data from the UNFCCC datasets was carried out based on this assumption.

Prior to the application of the subtraction method the emission data are aggregated to national values. In this process the category A and B emissions are combined to one national value, while category C emissions from agricultural industrial sources are treated separately. The emission from the three reporting systems E-PRTR, CLRTAP and UNFCCC, respectively, all categorized and aggregated to the classes A, B and C are used for subtracting E-PRTR emissions from the aggregated country specific emissions reported to CLRTAP/UNFCCC.

The results of the applied subtraction methodology are representing the diffuse shares of national total emissions. The results are indicating several countries where the total amounts of the E-PRTR emission exceed the national reference totals from CLRTAP/UNFCCC. The category B and C emissions of countries where no inconsistencies are found are reallocated to the NFR sector structure using the shares from the aggregation step, while the shares from sectors which are assigned to category A are omitted. A gap filling method has been developed for countries where the E-PRTR emissions are higher than the CLRTAP/UNFCCC national totals. It is applied when compiling diffuse emissions. Country specific inconsistencies have been identified using defined pollutant specific thresholds (c.f. Chapter 2.5.3):

- for SO_2, CO and CO_2 no threshold is defined (0%),
- for NO_x a 5% threshold is defined and
- for NH_3 and PM10, a 10% threshold is defined.

The calculation of the diffuse emissions for countries, where inconsistencies were identified, is conducted using emission data from similar countries or group of countries where no inconsistencies exist after the subtraction process. The selection of similar countries is applied on the basis of the gross added value (GVA) by comparing country specific economic branches.

A higher resolution of sectors within the subtraction process leads to much higher inconsistencies. The presented results describe the situation for 2007. The analysis for 2008 with updated data sets leads in some cases to different respectively better results.

2.8. Alternative subtraction approaches

Four optional subtraction approaches are tested:

1. Subtraction on E-PRTR main sub-activity level
2. Subtraction on E-PRTR main activity level
3. ABC Method (distinguishing different groups of sectors)
4. Subtraction on economic activity (NACE) level

Brief descriptions of this optional subtraction approaches are given in the following sub-chapters.

2.8.1. Method 1: Subtraction on the E-PRTR main sub-activity level

This method describes the subtraction based on the main sub-activity level, the second hierarchy level of the E-PRTR source categories.

The emission releases reported to E-PRTR for each of the sub-activities were subtracted from the sector-equivalents of CLRTAP and UNFCCC by using the predefined assignment of activities.

This approach showed many negative values of the resulting diffuse emissions. This is assumed inconsistent according to the above mentioned premise that any value on the sector specific level in the CLRTAP/UNFCCC data set should be higher than in the corresponding E-PRTR category level. The numbers of negative values can be used as an indicator for the level of inconsistency. Compared to the total number of sectors (100%) the application of this approach is resulting in 49% negative values.

2.8.2. Method 2: Subtraction on the E-PRTR main activity level

This approach is based on the subtraction of E-PRTR source categories called main activity (first hierarchy level of Annex 1 of the E-PRTR Regulation which includes 9 different groups). The main activity is a higher aggregated level compared to the sub-activity level, without distinction into subsectors and is also available from the E-PRTR data base reported by the countries. The correlation of E-PRTR main activity level to the NFR/CRF categorization is without conflicts by using the assignment of activities as described above (c.f. Chapter 2.3). The results from the subtraction on the main activity level indicated fewer inconsistencies than found using the method 1 (c.f. Chapter 2.8.1). Compared to the total number of sectors (100%) the share of negative values for the main activity level approach is about 28%.

2.8.3. Method 3: ABC Method (categorization of sectors)

The third method applied is the “ABC-Method”. For this approach the point source relevant NFR sectors are classified into three different categories and subtracted separately. The E-PRTR main activity levels as well as the NFR sectors were allocated to these three categories: “Energy Industries (A)”, “Industry (B)” and “Agricultural Industry (C)”. The outcome of the application of the ABC approach is a share of negative values of about 17% compared to the total number of sectors (100%).

Further analysis showed that, when applying the ABC method, most of the inconsistencies could be traced back to the distinction between energy industries and other industries. In order to minimise these inconsistencies these two categories A and B are subtracted together (c.f. chapter 2.5) by setting up the group AB. In group C “Agricultural industry” inconsistencies were found to be lowest. The results of the application of the subtraction based on the two groups AB and C are listed in table 5. The outcome of the application of the AB-C approach is a share of negative values of about 11% compared to the total number of sectors (100%).

2.8.4. Method 4: Subtraction on Economic activity (NACE) level

The fourth optional method is the subtraction based on the main economic activity levels (NACE level). The main classification of E-PRTR is based on the industrial activity classification laid down in Annex 1 of the E-PRTR Regulation. For each facility included in the E-PRTR dataset the main economic

activity for each facility under the form of the NACE code on 4-digit level, revision 2.0 (NACErev2.0) is also reported.[7] CLRTAP/UNFCCC data are not related to the economic activity but only to the NFR and CRF categories, respectively. It is not possible to make a clear assignment of the economic activity (NACE Rev2) to NFR categories. Therefore the [CLRTAP/UNFCCC]-[E-PRTR]-subtraction can be made on an aggregated level only.

For applying this approach the E-PRTR main activity levels and the NFR sectors were allocated to these eight main categories: “Mining and extraction (A)”, “Energy Industries (B)”, “Pulp & paper & wood (C)”, “Food & Drink (D)”, “Agriculture (E)“, “Chemical industry (F)“, “Cement, lime and mineral industry (G)” and “Metal industry (H)“.

Applicationof this approach showed many negative values in the resulting diffuse emissions.This is assumed to be inconsistent according to the above mentioned premise that any value on the sector specific level in the CLRTAP/UNFCCC data set should be higher than in the corresponding E-PRTR category level. Compared to the total number of sectors (100%) the share of negative values resulting from application of the “Economic activity (NACE) level” approach is about 28%.

The percentage of negative values is useful as an indicator of the level of inconsistency resulting from application of different subtraction approaches.

[7] ETC/ACC, ETC/SCP (2010); E-PRTR Review Report 2009 on the 2007 E-PRTR dataset ETC/ACC - Technical Paper 2009/15 [URL: http://air-climate.eionet.europa.eu/reports/ETCACC_TP_2009_15_E-PRTR_data_rev2009_waste_air, 25.01.2011]

3. Gridding methodology for diffuse industrial releases

3.1. Sector description

Diffuse emission releases here are defined as emissions from sources excluding releases from E-PRTR related facilities. This comprises industrial releases from industrial facilities not covered by the E-PRTR Regulation and its Annexes:

- not-Annex-1 facilities => Annex-1 facilities below the activity thresholds or
- releases not reported to E-PRTR since they were below the substance specific threshold as defined in Annex 2 to the E-PRTR Regulation.

Industrial emissions are subdivided mainly in two sectors:

- Energy ("Combustion (stationary)" and "Fugitive emissions from fuels (fuel production)")
- Industrial processes ("Production and processing of metals (ferrous and non-ferrous)", Mineral industry (non-metallic)", "Chemical industry", "Paper and wood production and processing industry", "Other (Non-energy use of fuels, solvent use, pretreatment or dyeing of fibres and textiles, tanning of hides and skins, production of carbon or electro-graphite)")

Some of these sectors are dominated by E-PRTR related point sources, and therefore omitted as diffusive one. They are fulfilled by the sectors[8]:

- Public Electricity and Heat Production (Energy transformation) (NFR/CRF 1A1a)
- Petroleum refining (NFR/CRF 1A1b)
- Industrial Waste Incineration (NFR/CRF 6Cb) and
- Municipal Waste Incineration (NFR/CRF 6Cc)

The industrial related NFR-sectors which contain mainly diffuse industrial emissions are described in Chapter 3.8.

Pollutants covered

The following pollutants are taken into account: NO_x, PM10, SO_2, CO and CO_2

[8] see table 1 sectors as allocated to category A

3.2. Emission data input

The input emission data used for the spatial distribution of diffuse industrial releases are from the following datasets:

- National emissions of CO_2 available from the EEA-website for 2008 (EEA/UNFCCC v.11, 2010)[9]
- Convention on Long-Range Transboundary Air Pollution (EEA/CLRTAP v.10, 2010)[10]

The national totals for the concerned pollutants from industrial facilities have been obtained from these two references. To obtain the diffuse part of the country specific emissions, not covered by the E-PRTR regulation, the subtraction methodology, as described in chapter 2, is applied. The diffuse dust emissions from construction and demolition activities as well as storage, handling and transport activities of industrial products are only taken into account if they are reported by the countries.

The country specific reporting situation on diffuse dust emissions from industrial activities is shown in Table 44, chapter 16.

3.3. Applied methodology

Diffuse industrial releases are spatially distributed according to the different proxy data and then gridded to be shown as map layers. The basic principle of distributing emissions is presented in the formula below using a surrogate spatial dataset (EEA, 2009):

$$emission_{i,x} = emission_t \times \frac{value_{i,x}}{\sum_i value_{i,x}}$$

where:

- ***i****:* is a specific geographic feature;
  here: administrative areas (NUTS 3), 5 km x 5 km grid cell;
- ***x***: is a sector that is characterized by the surrogate dataset (x).
- ***emission****$_{i,x}$:* is the emission attributed to a specific geographical feature i (e.g. a grid, line, point or administrative boundary) within the spatial surrogate dataset x;
  here: emission value attributed to each administrative area (NUTS 3 region) or each 5 km x 5 km grid cell;

[9] EEA: UNFCCC - v. 11 2010 (United Nations Framework Convention on Climate Change) (URL: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-4)

[10] CLRTAP_NFR09_GF_v10 (Convention on Long-range Transboundary Air Pollution) (URL: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4, 05.08.2010)

- ***emission***$_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset;
  here: the diffuse industrial emissions are distributed within each EU27 and EFTA4 Member state;

- ***value***$_{i,x}$ - are the surrogate data value (e.g. traffic volume) for each geographical feature within the spatial surrogate dataset x.
  here: the surrogate date are e.g. number of employees divided by activity branches, "Industrial or Commercial units" CORINE land cover class (e.g. the share of the employees by activity branches in each NUTS 3 region or 5 km x 5 km grid cell related to the national total of the employees by activity branches).

The specific geographic feature in this case is the lowest level of the administrative units (e.g. NUTS 3), the polygon and the grid level.

The use of surrogate data (proxy variables) allows determining the share of annual emissions that have to be attributed to each cell. The proxy data are correlated with the emission source sectors and defined by means of:

- geographical resolved statistical information
- land cover/land use data and
- different indexes derived from emission sources.

The methodology of the spatial distribution of the diffuse part of industrial emissions contains two main steps:

1. **Regionalization of national emission releases**
   - Regionalization aims to allocate the share of the national total emissions for each pollutant to NUTS 3 level using the following underlying parameters and steps:
     i. Number of economically active persons (available on NUTS 3 level) and the number of employees distinguished by specific branches (available on NUTS 2 level [11]);
     ii. Calculation of the point source densities on regional level: it is assumed that areas with higher facility densities are characterized by higher diffuse emissions;
     iii. Regionalization of the diffuse releases from industrial activities on NUTS 3 level based on the number of employees by relevant industrial activities and the facility densities.

[11] The number of economic active persons was applied for allocation of the branch specific employee numbers to NUTS3 level for specific sectors

2. **Gridding**
   - Allocation of the emission values on NUTS 3 to each polygon/grid cell according to the defined 5 km x 5 km grid using the following underlying parameters and steps:
     i. Land cover types (CLC2000/2006, 2010);
     ii. Calculation of the share of different land cover types in each grid cell/polygon (e.g. "Industrial or commercial units" – CLC2000/2006 (2010));
     iii. Calculation of emission values for each grid cell/polygon based on the combination of the applied proxy data.

3.4. Emissions and proxy data sets

Table 8 shows the emission values of the different pollutants for each industrial sector. The amount of all emissions from releases to air in the EU27 + EFTA4 countries is also presented.

Table 8: Diffuse industrial releases in relation to the total emissions for the considered pollutants

Sector	Sector_Code	Sector_Name	Emissions in 2008				
	[NFR/CRF]	[NFR/CRF]	CO_2 [kt]	NO_x [t]	SO_2 [t]	PM10 [t]	CO [t]
			UNFCCC	CLRTAP			
Energy	1 A	Combustion	472,009	545,612	632,894	145,456	1,216,750
	1 B	Fugitive Emissions from Fuels	13,567	8,426	146,113	25,611	20,807
Industrial processes	2 A	Mineral industry	89,764	28,219	39,502	142,868	46,847
	2 B	Chemical industry	24,625	38,957	59,787	10,627	44,233
	2 C	Metal industry	66,307	27,087	75,068	80,081	927,432
	2 D	Other production industry	116	9,676	12,126	30,535	6,374
	2 G	Other	1,376	187	3,779	34,320	1,438
	Sum		667,764	658,163	969,269	469,497	2,263,882
All reported emissions from EU27 + EFTA countries			**4,743,992**	**13,844,818**	**7,638,468**	**2,426,902**	**29,399,783**

The spatial distribution and the obtaining of grid cells for each pollutant are based on the emissions presented in Table 9 and the following proxy data sets:

- Employment data,
- Land use data (CLC2000/2006 "1.2.1. Industrial or commercial units"),
- Point source data.

Table 9 lists the main proxy variables used for spatial distribution of the diffuse part of industrial releases.

Table 9: Proxy data sets used for the spatial distribution of industrial emissions

Sector	Proxy Dataset	Data Source	Release Year	Extend
Industry	Employment data	EUROSTAT	2008	EU 27 + EFTA4
	Land use data	CORINE Land Cover Switzerland (CLC90), CLC2000, CLC2006	1990, 2000, 2006	EU 27 + EFTA4
	Point source data	E-PRTR data set	2010	EU 27+ EFTA4

The applied proxy data sets for each industrial related NFR-sector are shown in **chapter 3.8**.

Activity data as proxy for the regional distribution of the diffuse industrial releases

Diffuse emission releases here are defined as emissions from sources excluding releases from E-PRTR related facilities. This comprises industrial releases from industrial facilities not covered by the E-PRTR Regulation:

- not-Annex-1 facilities => Annex-1 facilities below the activity thresholds or
- Releases not reported to E-PRTR since they were below the substance specific threshold as defined in Annex 2 of the E-PRTR Regulation.

For the spatial distribution of diffuse industrial releases on regional level an approach based on employment data and activity data (amount of produced goods or used raw materials) on facility level was checked. **The activity data for the different source categories** are gathered from the following data bases:

- Metal Producers of the World Directory 2009 (Thompson et al., 2008)
- Directory of copper mines and plants 2008 to 2013 (International Copper Study Group, 2009)
- IEA GHG CO_2 Emissions Database (IEA, 2009)
- Industrial Minerals Directory (Vanson & Thomson, 2007)
- World Mining Directory (Moreno & Ash, 1998)
- Global Cement Directory 2007-2008 (McCaffery et al., 2010)

The availability of point source data on facility level in the different countries is presented in Table 10. On base of the available activity data on facility level it was analysed that the share of facilities which are below the Annex I thresholds are negligible. Thus on base of the assumption that industrial emissions are more likely located in areas with higher industrial activity independent if they are covered by the E-PRTR regulation or not, the density of E-PRTR sources was applied as an additional proxy data for the regionalisation of diffuse industrial releases.

Table 10: Availability of point source activity data on national level

ID	Country	Metal Producers Directory (2008)	Industrial Minerals Directory (2008)	World Mining Directory (1996)	ICSG Copper (2009)	IEA GHG CO_2 emissions database (2009)	USGS_mines (2010) (Point source location)
1	Austria	x	x			x	x
2	Belgium	x	x	x	x	x	x
3	Bulgaria	x	x		x	x	x
4	Cyprus		x	x	x		x
5	Czech Republic	x	x	x		x	x
6	Denmark		x			x	x
7	Estonia	x					x
8	Finland	x	x	x	x	x	x
9	France	x	x	x		x	x
10	Germany	x	x	x	x	x	x
11	Greece	x	x	x	x	x	x
12	Hungary	x	x			x	x
13	Iceland						x
14	Ireland			x		x	x
15	Italy	x	x	x	x	x	x
16	Latvia	x					x
17	Liechtenstein						x
18	Lithuania						x
19	Luxembourg	x	x	x		x	x
20	Malta					x	x
21	Netherlands	x	x			x	x
22	Norway	x	x	x	x	x	x
23	Poland	x	x	x	x	x	x
24	Portugal	x	x	x	x	x	x
25	Romania		x		x	x	x
26	Slovakia	x	x		x	x	x
27	Slovenia	x				x	x
28	Spain	x	x	x	x	x	x
29	Sweden	x	x	x	x	x	x
30	Schwitzerland	x	x	x		x	x
31	United Kingdom	x	x	x		x	x

3.5. Existing gridding methods and applied proxy data sets

The main criterion to select proxy data for the industrial sector was the availability of data. There are different gridding methodologies using different distribution parameters. The main methodologies are described and assessed below.

IMPRESAREO approach

Emissions from diffuse/area industrial sources can be mapped using the methodology set out in Improving the Spatial Resolution of Air Emission Inventories Using Earth Observation Data - IMPRESAREO (Dore et al., 2004), using weighted land cover categories. Weightings are applied to different land cover classes based on the emission density typically present. The weightings are set out in Table 11.

Table 11: IMPRESAREO weightings (Dore et al., 2004)

Land cover class	Weighting
Industry	1
Continuous urban fabric	0.2
Discontinuous urban fabric	0.01
Ports	0.05
Airports	0.05

Based on this weighting profile, the majority of emissions from diffuse industrial sources are located in land cover areas classified as industry. The limitation of this approach is the assumption that the industrial land coverage giving an accurate representation of the industrial related air pollutant releases. In addition, emissions (which typically arise from point sources) are diluted across an area.

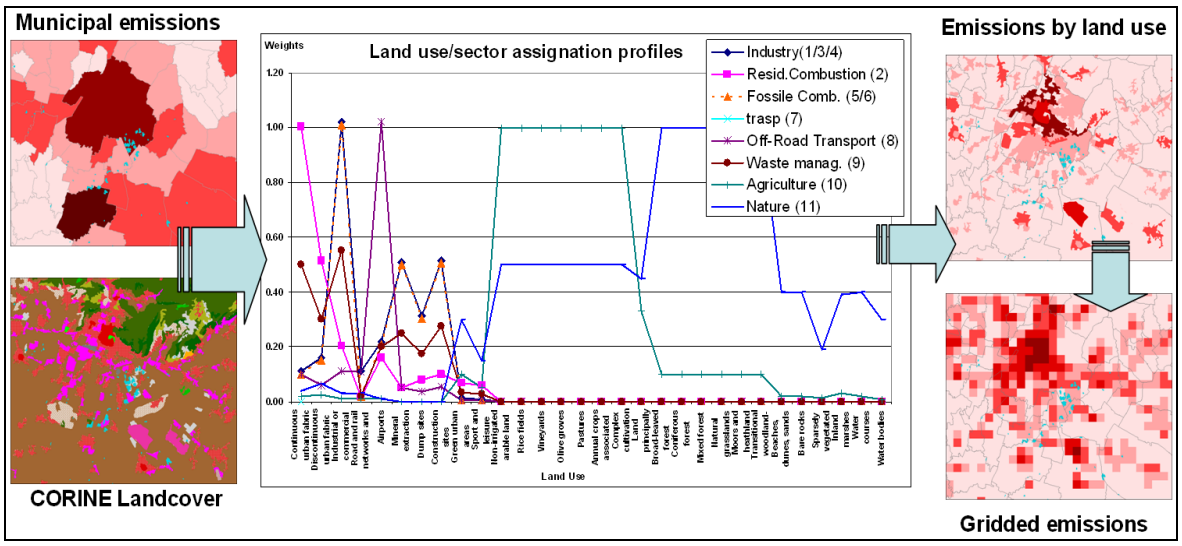

Figure 5: The gridding scheme based on land use assignation profiles (Triancchini et al., 2008)

Following the concept of applying land use assignation profiles as weighting factors for distributing diffuse emissions, the releases are directly related to spatial pattern and intensity of anthropogenic activities.

UK approach

In the UK the following data sets are used to develop emission 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* which provides detailed spatial data on employment at business unit level by Standard Industrial Classification (SIC) code;

- *DTI Energy Consumption in the UK data* on industrial and commercial sector fuel usage for coal, solid smokeless fuel (SSF), oil and gas for 2002 (DTI, 2002: Tables 4.6, 5.2 and 5.5).

The SIC codes in the Inter-Departmental Business Register (IDBR) database were aggregated and matched with the DTI energy data sets in order to calculate total employment by DTI energy sector. This data set is applied to derive the UK average fuel intensity per employee distinguished by fuel type and industry type. The fuel intensities have been applied to the employment distribution across the UK for creating maps of implied fuel use differentiated by industry type. In a last step these have been aggregated for the different industrial sectors (EMEP/EEA Emission Inventory Guidebook, 2009), (Bush et al., 2008).

NL approach

To spatially distribute the national emissions, the Emission Register of Netherlands has a spatial allocation available for each emission source. Individually reported emissions with a known geographic location, are subtracted from the national total emissions for the specific industrial sector. The rest of the emissions are divided as diffuse emissions according to the number of employees per facility in each relevant sector. Each sector is defined by its own NACE code - (PRTR Netherlands, 2010). Table 12 shows the main characteristics of the described gridding methodologies.

Table 12: Available methodologies for the spatial distribution of diffuse industrial emissions

Methodology	Advantage	Disadvantage
Method of land use assignation profiles (IMPRESAREO) (Dore et al., 2004)	High resolution (1 km x 1 km grid cell) emission distributions based on weighted land cover categories; Available proxy data; Can be applied at the national and regional level.	It relies on the industrial land coverage giving an accurate representation of this industry; Large amount of data; Requires EU-wide datasets;
NAEI Emission Mapping Methodology 2006 (UK) (Bush et al., 2008)	High resolution (1 km x 1 km grid cell) emission distributions based on detailed employment and fuel use data.	No central database with energy statistics (fuel use data) on regional level for all European countries.
Spatial allocation of diffuse industrial emissions - The Emission Register project (PRTR Netherlands, 2010)	High resolution (5 km x 5 km grid cell) emission distributions based on detailed employment data.	This method is not detailed enough to be used on the local scale and is too detailed for the European scale.
E-PRTR Methodology (this report)	Available land cover data; Available data of employees by source activity: High resolution (5 km x 5 km grid cell) emission distribution maps.	No central database available with activity data for all related industrial sectors, all pollutants and all countries. Large amount of data; Requires EU-wide datasets;

3.6. Applied models

For spatial distribution of the diffuse share of industrial releases no models have been applied.

3.7. Conclusion and results

On base of the developed methodology are compiled high-resolution (5 km x 5 km grid cell) emission maps of diffuse industrial air emissions. Spatial distributed CO_2 emissions for Europe is shown in Figure 6 as an example.

The methodology applied is based on different spatial distribution parameters, especially the proxy data sets "employees by activity source", "point source densities" and "land use classes" which are available for the whole area of EU27 and EFTA 4 countries.

The main proxy data for the regionalization of diffuse industrial releases to air are the employment numbers by activity branches. The advantage of using these data sets is the free accessibility from EUROSTAT 2008[12] for all considered countries.

However, employment statistics often related to the financial and administrative head offices (often located near urban agglomerations). But care must be taken to ensure that the emissions are located where they occur. The use of employment data locate emissions at registered places or regions of work and may tend to focus emissions inappropriately to urban areas. Thus point source densities on regional level have been applied as additional proxy data for the regionalization of diffuse industrial emissions. This based on the assumption that areas with higher facility densities are characterized by higher industrial emissions levels. Point source densities on NUTS 3 level are calculated for the EU27 plus EFTA 4 countries.

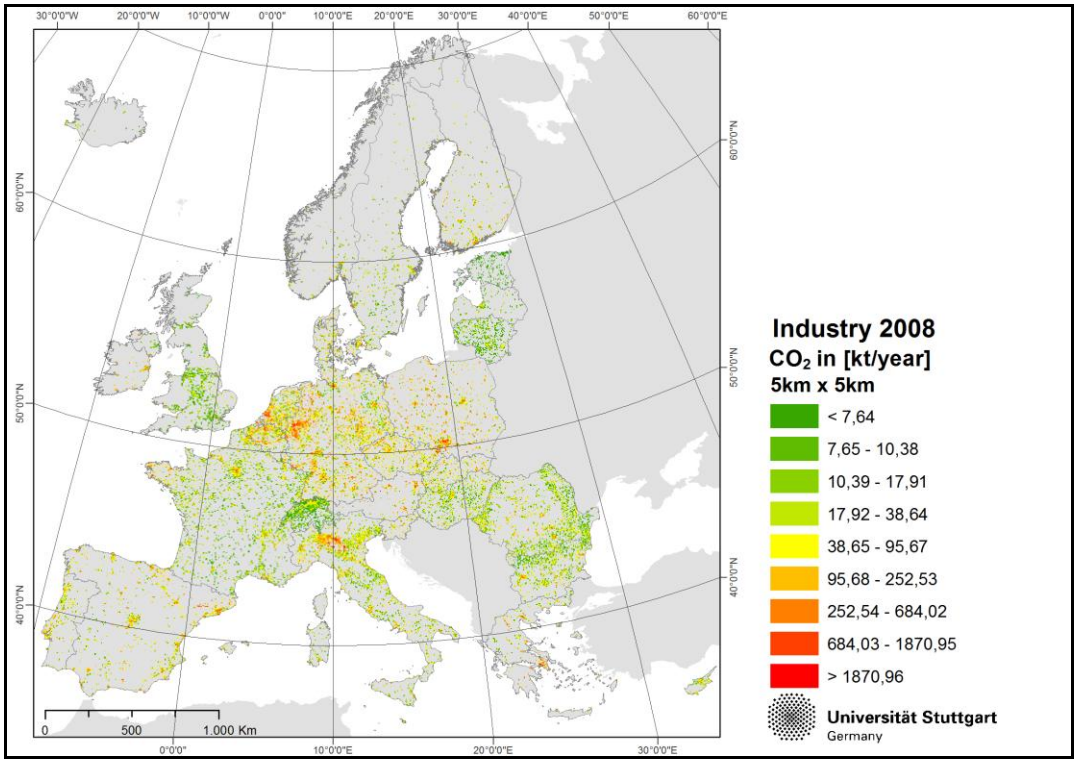

Figure 6: Example for CO_2 diffuse releases from industrial sources in Europe for the year 2008

[12] EUROSTAT data (URL: http://appsso.EUROSTAT.ec.europa.eu/nui/show.do?dataset=sbs_r_nuts03&lang=en, 15.12.2010)

3.8. Proxy data allocation to NFR – Sectors concerning diffuse industrial releases

Table 13: Allocation of E-PRTR sectors to NFR08 sectors and Proxy data

E-PRTR Sektor	NFR08	NFR08_Name	Proxy for Regionalization
Energy	1 A 1 c	**Manufacture of Solid Fuels and Other Energy Industries**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of coke oven products); Point source density (E-PRTR, 2010)
Energy	1 A 2 a	**Stationary Combustion in Manufacturing Industries - Iron & steel**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of basic iron and steel and of ferroalloys); Point source density (E-PRTR, 2010)
Energy	1 A 2 b	**Stationary Combustion in Manufacturing Industries - Non-ferrous metals**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of basic precious and other non-ferrous metals; Point source density (E-PRTR, 2010)
Energy	1 A 2 c	**Stationary Combustion in Manufacturing Industries – Chemicals**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of chemicals and chemical products); Point source density (E-PRTR, 2010)
Energy	1 A 2 d	**Stationary Combustion in Manufacturing Industries - Pulp, paper and print**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of paper and paper products); Point source density (E-PRTR, 2010)
Energy	1 A 2 e	**Stationary Comb. in Manufacturing Industries and Construction - Food processing, beverages and tobacco**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of food products; of beverages; of tobacco products); Point source density (E-PRTR, 2010)
Energy	1 A 2 f i	**Stationary Combustion in Manufacturing Industries: Combustion in cement, lime, asphalt, glass, mineral wool, bricks and tiles, fine ceramic material; combustion in boilers, gas turbines and stationary engines; plaster furnaces; other furnaces; enamel production; other processes with contact**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other non-metallic mineral products; of glass & glass products; of other porcelain & ceramic products; of cement, lime & plaster; of central heating radiators and boilers; of industrial ashes); Point source density (E-PRTR, 2010)
Energy	1 B 1 a	**Fugitive emission from Solid Fuels: Coal Mining and handling**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Mining of coal and lignite); Point source density (E-PRTR, 2010)

E-PRTR Sektor	NFR08	NFR08_Name	Proxy for Regionalization
Energy	1 B 1 b	**Fugitive emission from Solid Fuels: Solid fuel transformation**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Electric power generation, transmission and distribution; Manufacture of coke oven products); Point source density (E-PRTR, 2010)
Energy	1 B 1 c	**Other fugitive emissions from solid fuels**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of coke oven products); Point source density (E-PRTR, 2010)
Energy	1 B 2 a i	**Exploration, Production, Transport**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of gas; distribution of gaseous fuels through mains; Manufacture of refined petroleum products); Point source density (E-PRTR, 2010)
Energy	1 B 2 a iv	**Refining / Storage**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of refined petroleum products); Point source density (E-PRTR, 2010)
Energy	1 B 2 a v	**Distribution of oil products**	
Energy	1 B 2 b	**Natural gas**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of gas; distribution of gaseous fuels through mains); Point source density (E-PRTR, 2010)
Energy	1 B 2 c	**Venting and flaring**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of gas; distribution of gaseous fuels through mains; of refined petroleum products); Point source density (E-PRTR, 2010)
Energy	1 B 3	**Other fugitive emissions from geothermal energy production, peat and other energy extraction not included in 1 B 2**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Production of electricity); Point source density (E-PRTR, 2010)
Mineral industry	2 A 1	**Cement Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of cement); Point source density (E-PRTR, 2010)
Mineral industry	2 A 2	**Lime Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of lime and plaster); Point source density (E-PRTR, 2010)
Mineral industry	2 A 3	**Limestone and Dolomite Use**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of paper and paper products; Manufacture of cement, lime and plaster; Manufacture of abrasive products and non-metallic mineral products; Manufacture of basic iron and steel and of ferro-alloys); Point source density (E-PRTR, 2010)
Mineral industry	2 A 4	**Soda Ash Production and use**	

E-PRTR Sektor	NFR08	NFR08_Name	Proxy for Regionalization
Mineral industry	2 A 5	**Asphalt Roofing**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Construction of roads and motorways); Point source density (E-PRTR, 2010)
Mineral industry	2 A 6	**Road Paving with Asphalt**	
Mineral industry	2 A 7 a	**Quarrying and mining of minerals other than coal**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Extraction of crude petroleum and natural gas; Mining of metal ores; Other mining and quarrying; Mining support service activities); Point source density (E-PRTR, 2010)
Mineral industry	2 A 7 b	**Construction and demolition**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Construction); Point source density (E-PRTR, 2010)
Mineral industry	2 A 7 c	**Storage, handling and transport of mineral product**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other non-metallic mineral prod.); Point source density (E-PRTR, 2010)
Mineral industry	2 A 7 d	**Other Mineral products**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other non-metallic mineral products); Point source density (E-PRTR, 2010)
Chemical industry	2 B 1	**Ammonia Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms); Point source density (E-PRTR, 2010)
Chemical industry	2 B 2	**Nitric Acid Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other inorganic basic chemicals); Point source density (E-PRTR, 2010)
Chemical industry	2 B 3	**Adipic Acid Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other inorganic basic chemicals); Point source density (E-PRTR, 2010)
Chemical industry	2 B 4	**Carbide Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other inorganic basic chemicals); Point source density (E-PRTR, 2010)
Chemical industry	2 B 5 a	**Other chemical industry**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other chemical products n.e.c.); Point source density (E-PRTR, 2010)

E-PRTR Sektor	NFR08	NFR08_Name	Proxy for Regionalization
Chemical industry	2 B 5 b	**Storage, handling and transport of chemical products**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of other non-metallic mineral products); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 1	**Iron and Steel Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of basic iron and steel and of ferro-alloys); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 2	**Ferroalloys Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of basic iron and steel and of ferro-alloys); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 3	**Aluminum Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Aluminium production); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 5 a	**Copper Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Copper production); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 5 b	**Lead Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Lead, zinc and tin production); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 5 c	**Nickel Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Other non-ferrous metal production); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 5 d	**Zinc Production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Other non-ferrous metal production); Point source density (E-PRTR, 2010)
Production and processing of metals	2 C 5 e	**Other metal production**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Other non-ferrous metal production); Point source density (E-PRTR, 2010)
Paper and wood production and processing	2 C 5 f	**Storage, handling and transport of metal products**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of basic metals); Point source density (E-PRTR, 2010)
Paper and wood production and processing	2 D 1	**Pulp and Paper**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Manufacture of pulp and paper products); Point source density (E-PRTR, 2010)

E-PRTR Sektor	NFR08	NFR08_Name	Proxy for Regionalization
Animal and vegetable products from the food and beverage sector	2 D 2	**Food and Drink**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Food and drink); Point source density (E-PRTR, 2010)
Paper and wood production and processing	2 D 3	**Wood processing**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (Wood processing); Point source density (E-PRTR, 2010)
Other activities	2 G	**Other production, consumption, storage, transportation or handling of bulk products**	Number of employees by economic activities (EUROSTAT Employment statistics, 2008) (relevant industries); Point source density (E-PRTR, 2010)

4. Gridding methodology of the non-industrial combustion

4.1. Sector description

This sector considers non-industrial (stationary) combustion processes such as residential activities in households and in institutional and commercial buildings (e.g. heating and cooking with fireplaces, stoves, cookers and small boilers), having a thermal capacity equal or lower than 50 MW. The related NFR/CRF codes are commercial and institutional stationary plants (NFR 1A4ai) and residential stationary plants (NFR 1A4bi).

Pollutants covered

The following pollutants are taken into account: NO_x, PM10, SO_2, CO and CO_2.

4.2. Emission data input

The input emission data used for the spatial distribution of residential combustion are provided by the following datasets:

- National emissions of CO_2 available from the EEA-website for 2008 (EEA/UNFCCC v.11, 2010)[13]
- National emissions reported to "Convention on Long-Range Transboundary Air Pollution (EEA/CLRTAP v.10, 2010)"[14]

Intermediate calculations are conducted to differentiate the 'emissions per fuel type' before the spatial distribution of the national total emissions for the concerned pollutants.

Intermediate calculation of fuel specific emissions for residential stationary plants (1A4bi)
The country specific LRTAP data do not provide fuel specific emissions but only sector total emissions. Therefore an intermediate calculation approach is necessary for compiling fuel specific emissions from sector residential stationary plants (1A4bi).
Country specific **fuel splits** (available from the UNFCCC) combined with country-, fuel- and pollutant-specific **emission factors** from the GAINS[15] database are used to calculate the fuel-specific emissions from residential combustion. Thus, the emission data of each pollutant and each fuel type is calculated by the multiplication of these two parameters.

In summary this intermediate calculation follows 4 steps:

[13] The emission data originate from http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-4 (downloaded at 12th July 2010, Version 11)

[14] The emission data originate from: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4 (downloaded at 12th July 2010, Version 2010 for 2007)

[15] The Emission Factor from the GAINS (Greenhouse Gas - Air Pollution Interactions and Synergies) database from reference year 2005 (update every 5 years) depends on the pollutant under consideration, emissions in country, activity level in a given sector, abatement technology and more parameters described in documentation by Amann et al. (2004).

1. Obtaining of fuel splits (UNFCCC) and emission factors for each pollutant (GAINS)

2. Obtaining of calculated emissions per pollutant per fuel type by multiplication of both parameters

3. Calculation of percentages per pollutant per fuel type using the calculated values

4. Calculation of percentages of the national totals as reported by countries to CLRTAP and UNFCCC to obtain consistent values

Figure 7 shows the calculated pollutant specific fuel shares for Germany in the year 2007.

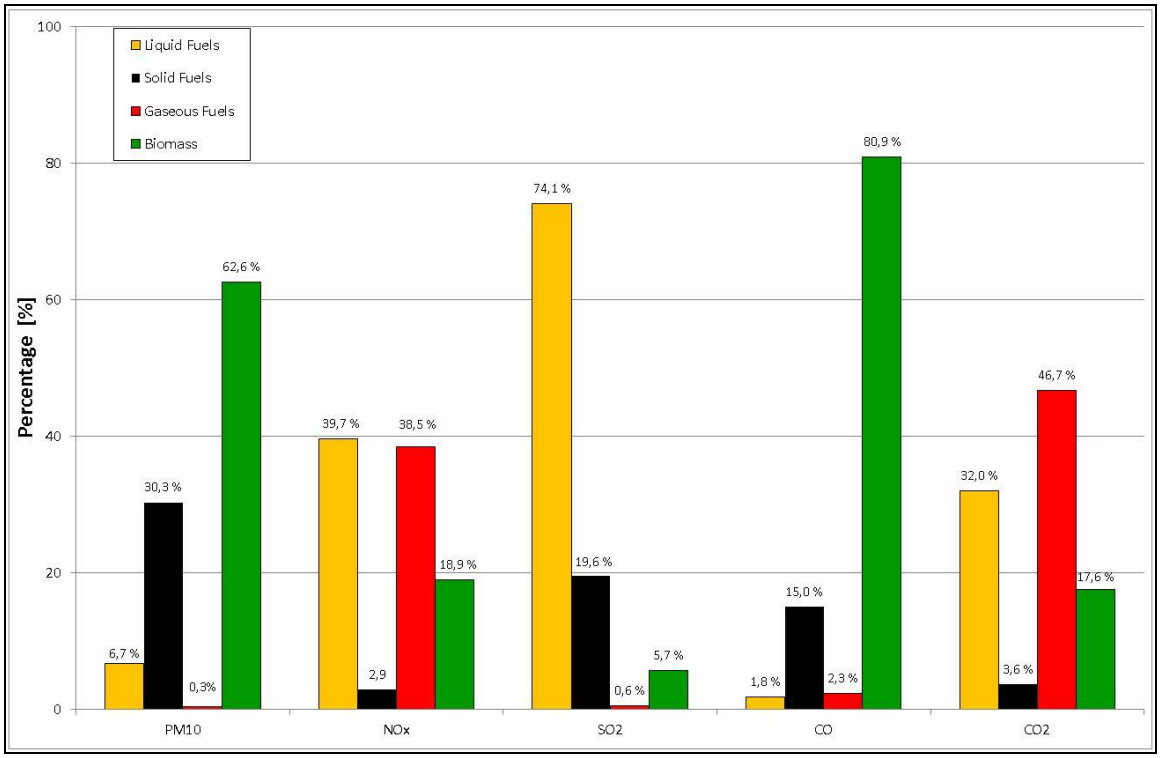

Figure 7: Share pollutant specific emissions distinguished by different fuel types for Germany

For commercial and institutional stationary plants (1A4ai), the emissions are allocated directly to administrative units and grids, without considering the fuel specific shares. Assuming, that there is no difference between emissions from urban and rural areas, then it is not necessary to distinguish the emission into different fuel type.

4.3. Applied methodology

The emissions from commercial combustion processes are spatially disaggregated to administrative units and grid cells, assuming a correlation with the number of employees. The emissions from residential combustion processes resolved to pollutant specific fuel splits are spatially disaggregated to administrative units and grid cells, assuming a correlation with the population density. The basic principle of distributing emissions is presented in the formula below using a surrogate spatial dataset (EEA, 2009):

$$emission_{i,x} = emission_t \times \frac{value_{i,x}}{\sum_i value_{i,x}}$$

where:

- ***i:*** is a specific geographic feature;
  here: e.g. a 5km x 5km grid, or administrative unit at NUTS 3 level
- ***x***: is a sector that is characterized by the surrogate dataset (x).
- ***emission*** $_{i,x}$***:*** is the emission attributed to a specific geographical feature i within the spatial surrogate dataset x;
- here: emission of residential combustion in determined administrative area (NUTS 3 region) or grid cell (5km x 5km)
- ***emission*** $_t$: is the total national emission for a sector t to be distributed across the national area using the (x) surrogate spatial dataset;
  here: the national total emission of residential or commercial combustion for each pollutant; reported to CLRTAP and UNFCCC
- ***value*** $_{i,x}$ - are the surrogate data values (e.g. population density) for each specific geographical feature within the spatial surrogate dataset x;
  here: typical surrogate data are e.g. the share of the population density or share of the number of employees in each NUTS 3 region or 5 km x 5 km grid cell related to the national total or NUTS3 region

Spatial distribution and gridding

For the spatial distribution of the emissions from sector 1A4ai (commercial) has been generated one map. For the spatial distribution of the emissions from the sector 1A4bi (residential combustion) have been generated three different fuel specific maps.

The methodology for the spatial distribution of emissions from residential and commercial activities contains two main steps:

1. **Regionalization of national totals**

   - The number of employees (EUROSTAT[16] data for 1A4ai on NUTS3 level) and the population data (EUROSTAT 2008[17] data set for 1A4bi) have been used for the regionalization of the diffuse releases from residential combustion activities.

   Additionally information on wood consumption has been introduced using a supply function which reflects the assumption that the use of wood will be more likely close to forest land use areas. The following formula: **0.3 x (POP NUTS3 / POP Total) + 0.7 x (Forest Area NUTS3 / Forest**

[16] EUROSTAT Economically active persons 2008 (URL: http://appsso.EUROSTAT.ec.europa.eu/nui/show.do?dataset=lfst_r_lfp3pop&lang=en , 07.07.2010)

[17] EUROSTAT Population 2008 - on NUTS3 level (URL: http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/product_details/dataset?p_product_code=DEMO_R_PJANAGGR3, 07.07.2010)

Area Total). A factor was calculated which expresses the significant role of the forest proximity in each administrative unit. The factors 0.3 and 0.7 are based on expert judgement and previous calculations.

2. Gridding

- The allocation of emissions regionalized on NUTS 3 level to a 5 km x 5 km grid cell resolution have been done by the following steps:
    - Gridding population data per grid cell 5km x 5km
    - The gridded population data has been intersected with land use data used to allocate the regionalized NUTS3 emissions from commercial combustion (1A4ai) into a grid of 5km x 5km
    - Applying the information on the degree of urbanisation (DGUR 2001) (GISCO, 2010)[18] in order to classify the gridded population into **three urbanisation categories** for residential combustion (1A4bi): "**A**" – densely (refers to a set of closely related local units, each one of which having a density greater than 500 inhabitants per km^2, and the total population of which being of at least 50 000 inhabitants), "**B**" - intermediate (refers to a set of closely related local units that do not pertain to a densely populated area, each one of which having density greater than 100 inhabitants per km^2, and where the total population is at least of 50 000 inhabitants or it refers to a set that is adjacent to a highly populated area and "**C**"- thinly populated areas (refers to a set of closely related local units that are not part of a densely populated area, or of an intermediate area).
    - Apply weighting factors for each fuel type and urbanisation category in order to allocate the emissions for residential combustion (1A4bi) within each grid cell
    - Calculation of emission values for each grid cell/polygon based on the combination of the applied proxy data.

This procedure delivers for each pollutant four different maps:

a) 1A4ai for Commercial and institutional stationary plants (unique distribution)

b) 1A4bi for Residential combustion plants – wood usage

c) 1A4bi for Residential combustion plants – gas usage

d) 1A4bi for Residential combustion plants – oil and coal usage

a) A European map of emissions from commercial and institutional plants based on the number of economically active persons on NUTS 3 level (EUROSTAT Economically active persons,

[18] EUROSTAT-GISCO – The Degree of Urbanisation (DGUR) classifies 2001 European census communes into three urbanisation categories: densely, intermediate or thinly populated areas (URL: http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/gisco/popups/references/Population%20Distribution%20-%20Demography, 07.07.2010)

2008) and gridded population data (Gallego, 2010). The gridded population data are reclassified into 9 CORINE Land Cover classes as defined in the following table. Thus, the emissions are allocated not only to industrial areas, but also everywhere where population is likely to occur. The fuel split is not considered here.

Table 14: CORINE LAND COVER Nomenclature - Aggregation levels (Gallego, 2010)

Group class	CORINE Class	Label
1	111	Continuous urban fabric
2	112	Discontinuous urban fabric
3	121, 133, 14	Other urban
4	122-124, 131-132	Low population artificial
5	21, 22, 23	Agriculture
6	241-243	Heterogeneous
7	244, 31	Forest
8	32	Natural vegetation
9	33,4,5	Bare land, wetland and water

b) A European map of emissions by population using wood as fuel type is based on population density in a grid resolution of 100m x 100m from Gallego (2010). The population density grid combines information on population per commune (LAU2) using the CORINE Land Cover Classes as defined in Table 14 and LUCAS (Land Use and Cover Area frame Statistical survey) systems. The main usage of wood is still in rural areas. Therefore the emissions are spatially re-distributed within the grid cells following the assumption that in densely populated regions, the average wood consumption is about half of the amount used in thinly populated regions (Denier van der Gon et al., 2010). In order to develop a relationship between the level of wood consumption dependent from different population densities, a **weighting factor scheme of 2:1.5:1** is applied for thinly, intermediate and densely populated areas. This is a rough estimation which taken into account the wood use in rural areas which is not covered by any statistical data.

c) A European map of emissions by population using gas as fuel type is based on population density in a grid resolution of 100m x 100m (Gallego, 2010). The distribution of population density is based on information about population per commune in combination with CLC Classes as defined in Table 14. Generally, the gas consumption tends to be located in the most densely populated urban areas. A share of households connected to gas installations in densely populated areas is assumed three times higher than those in thinly populated areas. A **weighting factor scheme of 3:2: 1** is applied for densely, intermediate and thinly populated areas. Figure 8 shows a correlation of households with gas connections in relation to the population density in different European countries.

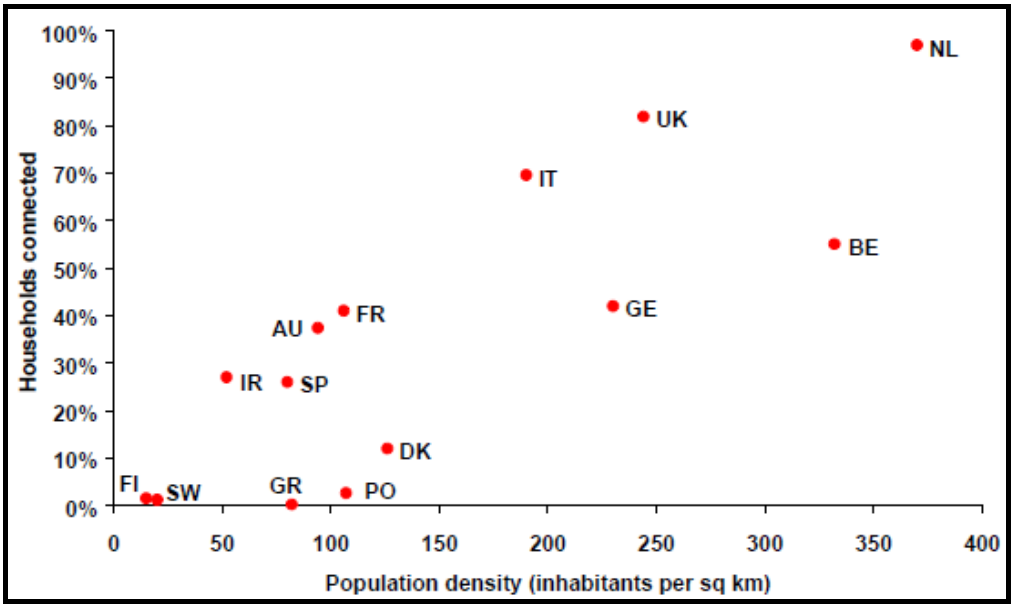

Figure 8: Population density and household connected to natural gas (Griffin, 2000)

d) A European map of emissions from applying oil and coal related fuel types based on population density in a grid resolution of 100m x 100m (Gallego, 2010). The population density is allocated to 9 CORINE Land Cover classes as described in Table 14. It is assumed that oil and coal related fuels are used nearly equal in rural and urban areas. Therefore the allocation of the emissions to grid cells is correlated to the overall population density as proxy data.

4.4. Emissions and proxy data sets

Table 15 shows the emissions of the different pollutants distinguished by fuel for the residential combustion sector.

Table 15: Pollutant specific emissions from the residential and commercial combustion sector

Sector	Sector_Code	Sector_Name	Fuel type	Emissions in 2008				
	[NFR[1]/ CRF[2]]	[NFR/CRF]		CO_2 [kt]	NO_x [t]	SO_2 [t]	PM10 [t]	CO [t]
				UNFCCC	CLRTAP			
Residential combustion	1A4ai	Commercial Institutional: Stationary	Not applied	155,044	202,388	92,676	18,266	265,710
	1A4bi	Residential: Stationary plants	Wood	138,791	7,269	149,380	468,426	5,993,854
			Gas	262,070	265,592	8,054	808	131,822
			Oil & Coal	181,219	217,256	269,127	156,717	1,508,683
	Sum			737,124	692,506	519,237	644,217	7,900,070
All reported emissions from EU27 + EFTA4 countries				**4,743,992**	**13,844,818**	**7,638,468**	**2,426,902**	**29,399,783**

As proxy data sets have been applied the following data bases:

- Derived gridded population data set (JRC gridded population + urbanization degree applied to the 5x5km^2 grid) (EEA/JRC, 2010)
- Derived wood usage of the population (JRC gridded population + urbanization degree + wood supply applied to the 5x5km^2 grid) (EEA/JRC, 2010)
- Number of employees (EUROSTAT Economically active persons, 2008) applied to the 5x5km^2 grid

Table 16 lists the proxy data which are used for the spatial distribution of the emissions from residential combustion activities distinguished by fuel use.

Table 16: Proxy data sets applied for the residential and commercial combustion sector

Sector	NFR08	NFR08_Name	Fuel type	Proxy Dataset	Data Source	Release Year	Extend

Sector	NFR08	NFR08_Name	Fuel type	Proxy Dataset	Data Source	Release Year	Extend
Residential and commercial combustion	1A4ai	Commercial Institutional: Stationary	all	**Number of employees** allocated to specific land use categories	EUROSTAT JRC	2008	EU 27 + EFTA4
				Land use			
	1A4bi	Residential: Stationary plants	Wood	**Population density** distinguished into three urbanisation areas: A; densely populated area B; intermediate pop. area C: thinly pop. area Weighting factors for A : B : C 1 : 1.5 : 2	EUROSTAT JRC population EUROSTAT-GISCO CORINE Land Cover Switzerland (CLC90), CLC2000, CLC2006	2008 & 2006 & 2001	
				Land use			
			Gas	**Population density** distinguished into three urbanisation areas: A; densely populated area B; intermediate pop. area C: thinly pop. area Weighting factors for A : B : C 3 : 2 : 1			
				Land use			
			Oil & Coal	**Population density** distinguished into three urbanisation areas: A; densely populated area B; intermediate pop. area C: thinly pop. area Weighting factors for A : B : C 1 : 1 : 1			
				Land use			

4.5. Existing gridding methods and applied proxy data sets

The main selection criteria for the applied proxy data for the spatial resolution of emissions from residential combustion activities were availability and consistency of data. However it shall be noticed that other country specific and European scale methodologies exist for gridding using different distribution parameters; few are briefly described below.

UK approach:

Distributions of emissions related to domestic gas, coal, oil and smokeless solid fuel use were compiled for the UK for 2007 using the results of modelling domestic fuel use within Great Britain for the 2004. Gas consumption related emissions from the residential combustion sector have been gener-

ated on base of a combination of data sets from DTI (Energy Consumption in the UK) and BRE (regional data on the numbers of households using different fuels) (Bush et al., 2008) with a 1km x 1km resolution of:

- Geographic household distribution, derived from the 2001 UK Census
- Distribution of households connected to gas, the number of gas customers
- Amount of gas used per km^2 for 2005
- Regional data on the numbers of households using different fuels

For the spatial distribution of emissions caused by other fuels than gas, it has been assumed that:

- Coal is burnt exclusively outside Smoke Control Areas
- Oil is burnt outside the biggest cities (of greater than 250,000 populations) but inside the smaller cities in grid squares where exists residual demand
- Smokeless solid fuels (SSF, coke, anthracite, peat) are burnt exclusively within smoke control areas
- Wood consumption[19] is assumed to have the same spatial distribution as coal

NL approach

In the Netherlands the Emission Register of Netherlands has a spatial allocated data set for each emission source available. The emissions from residential combustion are allocated according to population data, number of employees per business, number of households and a detailed map of locations of different house types. Additionally fairly accurate information available about gas network connection, which is even in "remote" rural areas and data about how much natural gas is used by different types of dwellings.

This information originates from the housing and population database, which is compiled by BridGIS on behalf of RIVM. The housing and population database is derived from the following underlying databases (PRTR Netherlands, 2010):

- The central geographic data source, the ACN (Address Coordinates in the Netherlands), which contains the coordinates of all private households in the Netherlands,
- LISA (National Job Information System and Location register). This is the only nationwide database with the following information per address.

Since there is no information available on the wood consumption by different types of buildings, an expert judgment is applied for this activity.

Table 17 shows in short form the main characteristics of the presented gridding methodologies.

Table 17: Available methodologies for the spatial distribution of diffuse non-industrial emissions

[19] Wood consumption is affected by very high uncertainties in many European countries due to illegal use of wood related fuels which are not covered by any officially statistical data

Methodology	Advantage	Disadvantage
NAEI Emission Mapping Methodology 2006 (UK) (Bush et al., 2008)	Information on gas distribution network, gas consumption, number of households, fuel split, High resolution 1 km x 1 km grid cell	This information is not available from a centralized data source for Europe.
Spatial allocation of diffuse industrial emissions - The Emission Register project (PRTR Netherlands, 2010)	Distribution using population data, the number of employees per business, and number of households	Number of households are not available for all EU 27 and EFTA4 countries
E-PRTR Methodology	Fuel Split for each pollutant population data and number of employees for EU 27 and EFTA4 countries available land cover data; High resolution (5 km x 5 km grid cell) emission distribution maps.	Missing number of households. No central database with activity data for all residential sectors, all pollutants and all countries.

4.6. Applied models

For spatial distribution of the residential combustion sector have been applied no models.

4.7. Conclusion and result

For spatial resolution of emission caused by residential stationary plants (NFR 1A4bi), the pollutant specific fuel splits have been compiled in a first step. The emissions from different fuel types are estimated by multiplying fuel use statistics from UNFCCC with country specific emission factors from the GAINS model. The allocation into administrative unit and grid cells has been conducted on base of population data and further on fuel specific assumptions by different population categories. Natural gas is rapidly expanding in urban areas and accounts for at least three times of household energy consumption in relation to rural regions, where wood is the preferred fuel type. Coal and oil consumption are assumed as equal in relation to rural and urban population areas.

For commercial and institutional stationary plants institutions (1A4ai), the emissions are allocated directly into administrative units and grids using the number of employees from EUROSTAT and the (Gallego, 2010) population data, which conduce as land use data. The allocation is carried out without considering a pollutant specific fuel split.

Four maps are compiled, one for the commercial sector unit and three fuel-specific maps for private households. To build the fuel-specific maps, weighting factors for densely/ intermediate/ thinly populated areas are assumed. These individual grid maps were finally aggregated to one resulting map for each pollutant showing the emission distribution on the resolution of 5 km by 5 km. Results are spatially highly resolved emission data for the residential combustion sector and for the considered pollutants NO_x, PM10, SO_2, CO and CO_2.

Figure 9 shows exemplarily the general distribution of the pollutant CO_2 for the residential combustion sector for the European domain in a spatial resolution of 5 km x 5 km.

Information about the number of households as proxy data would be more correlated to the number of combustion installations, than the population density. But such data sets are not available for all European countries on national and regional level and therefore not usable.

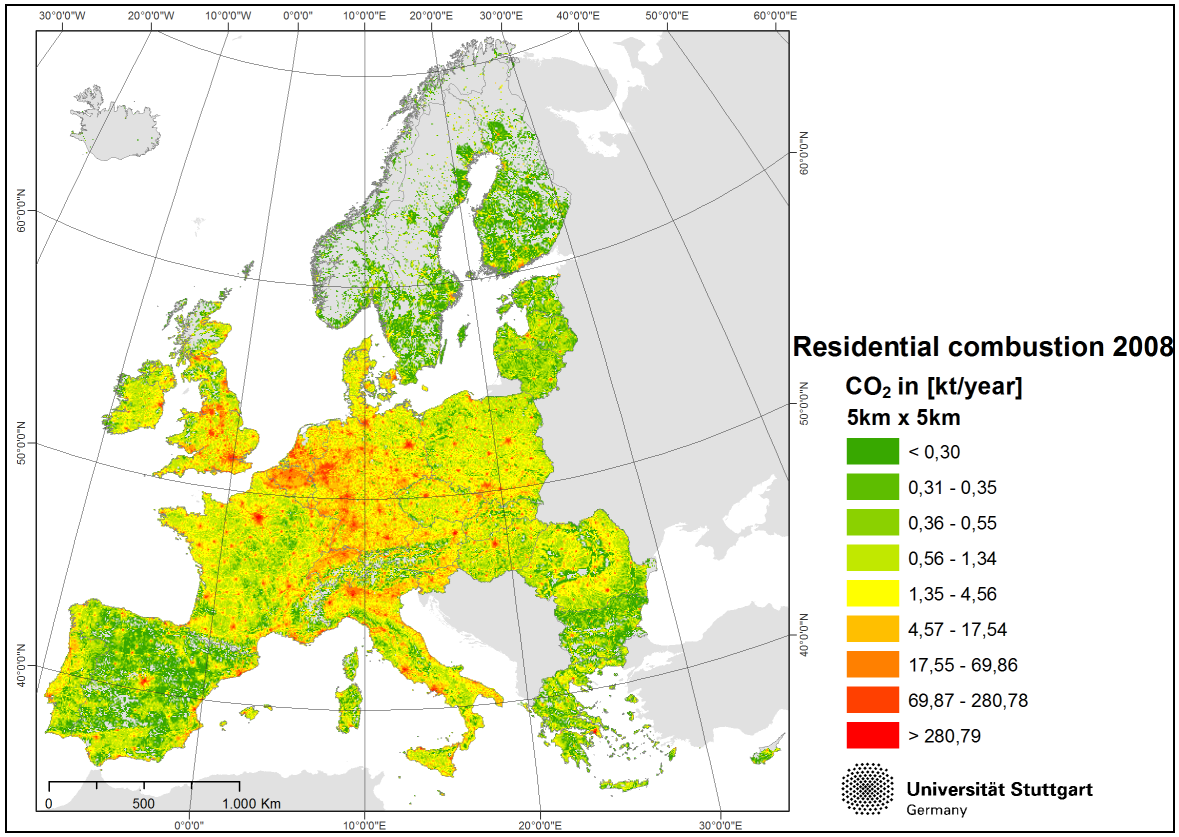

Figure 9: The CO_2 emission distribution from residential combustion for the year 2008

4.8. Detailed allocation to specific fuel splits

The specific **energy consumption** distinguished by residential combustion 1A4bi into Liquid-; Solid-; Gaseous Fuels and Biomass is derived from the National Inventory Submission reports for 2010 (UNFCCC, 2010). Table 18 shows the data of German submission for this sector for the year 2007 (submission 2010) as an example.

Table 18: Example of fuel splits based on the German submission report to UNFCCC 2007 (2010)

TABLE 1.A(a) SECTORAL BACKGROUND DATA FOR ENERGY Fuel Combustion Activities - Sectoral Approach (Sheet 4 of 4)					
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		IMPLIED EMISSION FACTORS (2)		
	Consumption		CO_2	CH_4	N_2O
	(TJ)	NCV/GCV(1)	(t/TJ)	(kg/TJ)	
1.A.4 Other Sectors	2.235.892,69	NCV			
Liquid Fuels	705.142,72	NCV	73,37	0,80	0,59
Solid Fuels	54.713,57	NCV	98,85	108,54	8,47
Gaseous Fuels	1.260.785,40	NCV	56,00	1,69	0,28
Biomass	215.251,00	NCV	102,01	93,32	1,39 (3)
Other Fuels	NO	NCV	NO	NO	NO
a. Commercial/Institutional	561.763,55	NCV			
Liquid Fuels	171.260,71	NCV	72,94	0,04	0,53
Solid Fuels	13.423,95	NCV	99,55	108,34	7,62
Gaseous Fuels	355.855,89	NCV	56,00	0,14	0,33
Biomass	21.223,00	NCV	101,08	49,56	0,14 (3)
[illegible]	NO	NCV	NO	NO	NO
b. Residential	1.584.793,00	NCV			
Liquid Fuels	467.033,00	NCV	73,49	0,34	0,54
Solid Fuels	39.418,00	NCV	98,66	109,44	8,74
Gaseous Fuels	893.848,00	NCV	56,00	2,32	0,25
Biomass	184.494,00	NCV	102,11	99,68	1,54 (3)
Other Fuels	NO	NCV	NO	NO	NO
c. Agriculture/Forestry/Fisheries	80.336,14	NCV			
Liquid Fuels	66.849,01	NCV	73,68	5,93	1,07
Solid Fuels	1.871,62	NCV	98,00	91,13	9,08
Gaseous Fuels	11.081,51	NCV	56,00	0,14	0,33
Biomass	9.534,00	NCV	102,11	67,48	1,46 (3)
Other Fuels	NO	NCV	NO	NO	NO
1.A.5 Other *(Not specified elsewhere)* (6)	19.244,55	NCV			
a. Stationary *(please specify)* (7)	9.904,62	NCV			
[illegible]					

Table 19 shows the assumed emission factors for Germany for the reference year 2005. These emission factors assume a country specific combustion and abatement technology split (cooking stoves, fire places, small boilers, etc.)

Table 19: Pollutant and fuel specific emission factors for Germany 2005 from the GAINS database (GAINS, 2010)

Country Code	NFR	Emission factor (kt/PJ)	Fuel	Pollutant
DE	1A4b	0.11	Biomass fuels	NO_x
DE	1A4b	0.15	Biomass fuels	PM10
DE	1A4b	0.03	Biomass fuels	SO_2
DE	1A4b	0.04	Gas	NO_x
DE	1A4b	0.00	Gas	PM10
DE	1A4b	0.00	Gas	SO_2
DE	1A4b	0.09	Oil	NO_x
DE	1A4b	0.01	Oil	PM10
DE	1A4b	0.13	Oil	SO_2
DE	1A4b	0.08	Solid fuels	NO_x
DE	1A4b	0.33	Solid fuels	PM10
DE	1A4b	0.40	Solid fuels	SO_2

The applied country specific and fuel related emission shares were derived on the basis of fuel consumptions listed in Table 18 and country and fuel specific emission factors listed in Table 19. These shares have been applied to the data officially reported to CLRTAP by the Member States for the year 2008. The result for Germany as an example for 2007 is shown in Table 20. This calculation procedure was carried out for all 31 countries.

Table 20: Allocation of the national totals of NO_x to different fuels for Germany, 2007 (example)

		Germany		
Fuel Type	**Consumption (UNFCCC[20]) [TJ]**	**NOx Emission-Factor (GAINS[21]) [kt/PJ]**	**Fuel related emis-sion share [%]**	**Fuel related NO_x emissions (reported to CLRTAP) [kt]**
Reported emissions (total)				54.93
Liquid Fuels	467,033	0.09	39.7	21.79
Solid Fuels	39,418	0.08	2.9	1.57
Gaseous Fuels	893,848	0.05	3.5	21.16
Biomass	184,494	0.11	18.9	10.41

Country specific CO emission factors were not available from the GAINS data base. Here have been applied default European CO emissions factors from the Emission Inventory Guidebook (2009). The used default emissions factors are shown in Table 21.

Table 21: CO Emission factor used by Emission Inventory Guidebook (2009)

Fuel type	Fuel_UNFCCC	Pollutant	EM_Factor [g/GJ]	EM_Factor [kt/PJ]
biomass	Biomass	CO	5,300	5.30
natural gas	Gaseous Fuels	CO	31	0.03
liquid fuels	Liquid Fuels	CO	46	0.05
hard coal and lignite coal	Solid Fuels	CO	4,600	4.60

The following tables list the fuel specific emission factors for all countries except for Liechtenstein and Iceland. For Liechtenstein have been applied emission factors from Switzerland and for Iceland emission factors from Norway. Emission factors for solid fuels were calculated as the average of emission factors for lignite and hard coal available from GAINS[23].

Table 22 shows the country specific emission factors applied for solid fuels. Table 22 doesn't include emission factors for Cyprus, Luxembourg, Malta, Portugal, Sweden, and Slovenia. For these countries no activities and emission factors for the use of hard and lignite coal assumed in the GAINS[23] data base. Table 23 shows the country specific emission factors applied for liquid fuels. Table 24 shows the country specific emission factors applied for gaseous fuels. Table 25 shows the country specific emission factors applied for biomass fuels, mainly wood based. Since Malta is not forested, it is also reasonable that the Table 25 doesn´t include the emission factor for biomass as well. This emission factor is also not available from the GAINS[23] data base.

[20] UNFCCC - National Inventory Submission reports for 2010 (http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php)

[21] The Emission Factor from the GAINS (Greenhouse Gas - Air Pollution Interactions and Synergies) database from reference year 2005 (update every 5 years) depends on the pollutant under consideration, emissions in country, activity level in a given sector, abatement technology and more parameters described in documentation by Amann et al. (2004).

Table 22: Emission factors for Solid Fuels for the year 2005 (GAINS, 2010)

		Emission factors				
Country	**NFR**	**NO_X [kt/PJ] EM_factor**	**PM10 [kt/PJ] EM_factor**	**SO_2 [kt/PJ] EM_factor**	**NH_3 [kt/PJ] EM_factor**	**CO [kt/PJ] EM_factor**
Austria	1A4b	0.08	0.54	0.54	0.01	4.60
Belgium	1A4b	0.08	0.20	0.60	0.01	4.60
Bulgaria	1A4b	0.08	0.98	1.99	0.01	4.60
Switzerland	1A4b	0.08	0.44	0.64	0.01	4.60
Czech Republic	1A4b	0.08	0.47	0.74	0.01	4.60
Germany	1A4b	0.08	0.33	0.40	0.01	4.60
Denmark	1A4b	0.08	0.52	0.28	0.01	4.60
Estonia	1A4b	0.12	0.83	0.64	0.01	4.60
Spain	1A4b	0.08	0.75	0.72	0.01	4.60
Finland	1A4b	0.08	0.37	0.36	0.01	4.60
France	1A4b	0.09	0.48	0.42	0.01	4.60
Greece	1A4b	0.08	1.06	1.14	0.01	4.60
Hungary	1A4b	0.08	0.66	2.50	0.01	4.60
Ireland	1A4b	0.07	0.18	0.44	0.01	4.60
Italy	1A4b	0.08	0.34	0.72	0.01	4.60
Lithuania	1A4b	0.08	0.84	1.03	0.01	4.60
Latvia	1A4b	0.08	0.56	0.66	0.01	4.60
Netherlands	1A4b	0.08	0.72	0.46	0.01	4.60
Norway	1A4b	0.08	0.26	0.38	0.01	4.60
Poland	1A4b	0.09	0.58	0.98	0.01	4.60
Romania	1A4b	0.08	0.74	2.01	0.01	4.60
Slovakia	1A4b	0.08	0.53	1.28	0.01	4.60
United Kingdom	1A4b	0.12	0.33	0.62	0.01	4.60

Table 23: Emission factors for liquid fuels for the year 2005 (GAINS, 2010)

Country	NFR	NO_X [kt/PJ] EM_factor	PM10 [kt/PJ] EM_factor	SO_2 [kt/PJ] EM_factor	NH_3 [kt/PJ] EM_factor	CO [kt/PJ] EM_factor
Austria	1A4b	0.09	0.01	0.10	0.00	0.05
Belgium	1A4b	0.09	0.01	0.19	0.00	0.05
Bulgaria	1A4b	0.11	0.01	0.67	0.00	0.05
Switzerland	1A4b	0.04	0.00	0.03	0.00	0.05
Cyprus	1A4b	0.06	0.00	0.00	0.00	0.05
Czech Republic	1A4b	0.11	0.01	0.24	0.00	0.05
Germany	1A4b	0.09	0.01	0.13	0.00	0.05
Denmark	1A4b	0.09	0.01	0.13	0.00	0.05
Estonia	1A4b	0.11	0.01	0.22	0.00	0.05
Spain	1A4b	0.11	0.01	0.29	0.00	0.05
Finland	1A4b	0.09	0.01	0.10	0.00	0.05
France	1A4b	0.09	0.01	0.19	0.00	0.05
Greece	1A4b	0.09	0.01	0.20	0.00	0.05
Hungary	1A4b	0.16	0.02	0.42	0.00	0.05
Ireland	1A4b	0.08	0.01	0.16	0.00	0.05
Italy	1A4b	0.09	0.01	0.13	0.00	0.05
Lithuania	1A4b	0.09	0.01	0.27	0.00	0.05
Luxembourg	1A4b	0.06	0.00	0.03	0.00	0.05
Latvia	1A4b	0.09	0.01	0.43	0.00	0.05
Malta	1A4b	0.11	0.01	0.24	0.00	0.05
Netherlands	1A4b	0.08	0.01	0.19	0.00	0.05
Norway	1A4b	0.09	0.01	0.11	0.00	0.05
Poland	1A4b	0.09	0.01	0.21	0.00	0.05
Portugal	1A4b	0.11	0.01	0.19	0.00	0.05
Romania	1A4b	0.09	0.01	0.27	0.00	0.05
Sweden	1A4b	0.09	0.01	0.11	0.00	0.05
Slovenia	1A4b	0.09	0.01	0.18	0.00	0.05
Slovakia	1A4b	0.11	0.01	0.29	0.00	0.05
United Kingdom	1A4b	0.09	0.01	0.14	0.00	0.05

Table 24: Emission factors for gaseous fuels for the year 2005 (GAINS, 2010)

Country	NFR	NO_x [kt/PJ] EM_factor	PM10 [kt/PJ] EM_factor	SO_2 [kt/PJ] EM_factor	NH_3 [kt/PJ] EM_factor	CO [kt/PJ] EM_factor
Austria	1A4b	0.06	0.00	0.00	0.00	0.03
Belgium	1A4b	0.06	0.00	0.00	0.00	0.03
Bulgaria	1A4b	0.06	0.00	0.00	0.00	0.03
Switzerland	1A4b	0.04	0.00	x	0.00	0.03
Cyprus	1A4b	0.06	0.00	0.00	0.00	0.03
Czech Republic	1A4b	0.06	0.00	0.00	0.00	0.03
Germany	1A4b	0.04	0.00	0.00	0.00	0.03
Denmark	1A4b	0.06	0.00	0.00	0.00	0.03
Estonia	1A4b	0.06	0.00	0.00	0.00	0.03
Spain	1A4b	0.06	0.00	0.00	0.00	0.03
Finland	1A4b	0.06	0.00	0.00	0.00	0.03
France	1A4b	0.06	0.00	0.00	0.00	0.03
Greece	1A4b	0.06	0.00	0.00	0.00	0.03
Hungary	1A4b	0.06	0.00	0.00	0.00	0.03
Ireland	1A4b	0.06	0.00	0.00	0.00	0.03
Italy	1A4b	0.06	0.00	0.00	0.00	0.03
Lithuania	1A4b	0.06	0.00	0.00	0.00	0.03
Luxembourg	1A4b	0.06	0.00	0.00	0.00	0.03
Latvia	1A4b	0.06	0.00	0.00	0.00	0.03
Malta	1A4b	0.06	0.00	0.00	0.00	0.03
Netherlands	1A4b	0.06	0.00	0.00	0.00	0.03
Norway	1A4b	0.06	0.00	0.00	0.00	0.03
Poland	1A4b	0.06	0.00	0.00	0.00	0.03
Portugal	1A4b	0.08	0.00	0.00	0.00	0.03
Romania	1A4b	0.06	0.00	0.00	0.00	0.03
Sweden	1A4b	0.06	0.00	0.00	0.00	0.03
Slovenia	1A4b	0.06	0.00	0.00	0.00	0.03
Slovakia	1A4b	0.06	0.00	0.00	0.00	0.03
United Kingdom	1A4b	0.07	0.00	0.00	0.00	0.03

Table 25: Emission factors for biomass fuels for the year 2005 (GAINS, 2010)

Country	NFR	NO_X [kt/PJ] EM_factor	PM10 [kt/PJ] EM_factor	SO_2 [kt/PJ] EM_factor	NH_3 [kt/PJ] EM_factor	CO [kt/PJ] EM_factor
Austria	1A4b	0.06	0.15	0.02	0.01	5.30
Belgium	1A4b	0.05	0.25	0.04	0.01	5.30
Bulgaria	1A4b	0.05	0.34	0.04	0.01	5.30
Switzerland	1A4b	0.05	0.23	0.04	0.01	5.30
Cyprus	1A4b	0.06	0.36	0.03	0.01	5.30
Czech Republic	1A4b	0.11	0.40	0.04	0.01	5.30
Germany	1A4b	0.11	0.15	0.03	0.01	5.30
Denmark	1A4b	0.11	0.53	0.04	0.01	5.30
Estonia	1A4b	0.08	0.49	0.01	0.01	5.30
Spain	1A4b	0.11	0.28	0.04	0.01	5.30
Finland	1A4b	0.11	0.33	0.00	0.01	5.30
France	1A4b	0.05	0.43	0.03	0.01	5.30
Greece	1A4b	0.05	0.38	0.04	0.01	5.30
Hungary	1A4b	0.11	0.40	0.04	0.01	5.30
Ireland	1A4b	0.11	0.34	0.04	0.01	5.30
Italy	1A4b	0.11	0.29	0.04	0.01	5.30
Lithuania	1A4b	0.05	0.28	0.04	0.01	5.30
Luxembourg	1A4b	0.05	0.33	0.04	0.01	5.30
Latvia	1A4b	0.05	0.30	0.06	0.01	5.30
Netherlands	1A4b	0.10	0.23	0.03	0.01	5.30
Norway	1A4b	0.05	0.98	0.03	0.01	5.30
Poland	1A4b	0.11	0.34	0.04	0.01	5.30
Portugal	1A4b	0.10	0.37	0.04	0.01	5.30
Romania	1A4b	0.05	0.34	0.04	0.01	5.30
Sweden	1A4b	0.06	0.12	0.02	0.01	5.30
Slovenia	1A4b	0.05	0.18	0.05	0.01	5.30
Slovakia	1A4b	0.05	0.31	0.04	0.01	5.30
United Kingdom	1A4b	0.07	0.32	0.13	0.01	5.30

5. Gridding methodology of the emissions from road transport

5.1. Sector description

The emissions from road transport arise from the combustion of fuels such as gasoline, diesel, liquefied petroleum gas (LPG), and natural gas in internal combustion engines (EMEP/EEA Emission Inventory Guidebook, 2009). The sector road transport considers all on road transportations of passengers as well as good from all vehicle classes driven by fuel combustion. This sector is considered as diffuse. Exhaust emissions from road transport are reported according to the following sector codes:

- CLRTAP in the New Format for Reporting (NFR) source categories:
    - 1A3bi Road Transport: Passenger cars
    - 1A3bii Road Transport: Light duty vehicles
    - 1A3biii Road Transport: Heavy duty vehicles
    - 1A3biv Road Transport: Mopeds & Motorcycles
- UNFCCC in the IPCC Common Reporting Format (CRF) source categories :
    - 1A3b Road Transport

The allocation of emissions distinguishes on-road activities on the following street types:

- Highways
- Rural roads
- Urban roads

Furthermore, the vehicle types are distinguished corresponding to the CLRTAP NFR codes:

- Passengers cars (LPG, diesel and gasoline)
- Light duty vehicles (diesel and gasoline)
- Heavy duty vehicles (diesel)
- Motor cycles (two and four-strokes, gasoline)

Pollutants covered:

The following pollutants are taken into account for the road transport: NO_x, PM10, SO_2, CO and CO_2.

5.2. Emission data input

The emission data used for the spatial distribution of emissions from road transport are provided by the following datasets:

- National emissions of CO_2 available from the EEA-website for 2008, (EEA/UNFCCC v.11, 2010)[22]
- National emissions reported to "Convention on Long-Range Transboundary Air Pollution (EEA/CLRTAP v10, 2010)"[23]

In particular, Emission data used for the gridding procedure are national totals from the CLRTAP NFR sectors 1A3bi Passenger cars 1A3bii, Light duty vehicles, 1A3biii Heavy duty vehicles, 1A3biv Mopeds & Motorcycles for CO, NO_X, PM10, and SO_2 emissions, and from UNFCCC CRF sector 1A3b Road Transport for CO_2 emissions.

PM10 emissions reported by the Member States for the activity sectors "Automobile tyre and brake wear (NFR 1 A 3 b vi)" and "Automobile road abrasion (NFR 1 A 3 b vii)" for paved and unpaved roads are not considered here for the spatial distribution of emissions from road transport. The emissions for 2008 from these source groups reported by the Member States to CLRTAP are listed in Table 45 in chapter 16.

- PM10 emissions from automobile tyre and brake wear (1 A 3 b vi) activities not reported in 2008 by the following countries: AT, BG, CH, GR, HU, IS, LU, MT, PT, RO and SK
- PM10 emissions from automobile road abrasion (1 A 3 b vii) activities not reported in 2008 by the following countries: BG, CH, CY, GR, HU, IE, IS, IT, LU, MT, PL, PT, RO, UK

Additional preparation of the emission data sets is necessary to distinguish between different road and vehicle types. These preparations are described in detail in the following paragraphs.

Intermediate calculations: distinction between road, vehicle types, line and area sources

The first intermediate calculation is related to CO_2 emissions from the UNFCCC. The source category 1A3b Road Transport indicates is not differentiated by vehicle types (while for CLRTAP reporting practice vehicle types are allocated to different NFR sectors). Therefore, CO_2 emissions have to be disaggregated in equivalent subcategories. For this disaggregation of the CRF sector 1A3b to the sub-sectors, the information on the shares between the vehicles types from TREMOVE model (TREMOVE, 2010) are used (see chapter 5.5 for more detailed description of TREMOVE).

The second intermediate calculation is the allocation of the emissions reported to CLRTAP and UN-FCCC into different road classes (highway, rural and urban on base of the TREMOVE model

[22] The emission data originate from http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-4 (downloaded at 12th July 2010, Version 11)

[23] The emission data originate from: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4 (downloaded at 12th July 2010, Version 2010 for 2007)

(TREMOVE, 2010). The results are road and vehicle class specific shares for each pollutant and country.

The next step is to harmonize the road and vehicle classes with the road network from the TRANS-TOOLS model (TRANS-TOOLS, 2010). The road classes (highway, rural and urban) are allocated to roads which are covered by the TRANS-TOOLS model and roads that are not covered by TRANS-TOOLS. TRANS-TOOLS cover highways and also major rural roads. Therefore, the emissions from rural roads based on TREMOVE calculation have to be partly allocated to the roads covered by Trans-Tools. The assumption is that 50% of the rural roads are allocated to the TRANS-TOOLS roads and the remaining 50% are categorized as rural road emissions (see also Figure 10).

The third intermediate calculation is for the distinction of the rural and urban road traffic into line and area sources. The assumption for the rural roads not covered by TRANS-TOOLS is that 80% of the emissions are categorized as line sources and the remaining 20% of the rural roads not covered by TRANS-TOOLS are categorized as area sources. The urban roads are categorized 50% as line and 50% as area sources.

5.3. Applied methodology

The methodology approach used for high spatial resolution gridding of emissions from road transport activities generally based on existing methods previously developed and applied for Europe. The spatial distribution of emission data into the 5km x 5km target grid cells is carried out using the approach given in the formula:

$$emission_{i,x} = emission_t \times \frac{value_{i,x}}{\sum_i value_{i,x}}$$

where:

- ***i:*** is a specific geographic feature;
  here: road segments within the grid layer
- ***x***: is a sector that is characterized by the surrogate dataset (x).
- ***emission*** $_{i,x}$***:*** is the emissions attributed to a specific geographical feature i (e.g. a grid, line, point or administrative boundary) within the spatial surrogate dataset x;
  here: emission of road transport (for each vehicle and road type) $_x$ at the specific road segment$_i$ within each EU27 and EFTA4 Member state
- ***emission*** $_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset;
  here: national total emission of road transport (distinguished by vehicle and road category)$_x$

- ***value*** $_{i,x}$ - are the surrogate data value (e.g. traffic volume) for each geographical feature within the spatial surrogate dataset x.
  here: the fraction of traffic volume for each individual road segment within each 5km x5km target grid cell of the sum of the overall traffic volume within the respective EU27 and EFTA4 member state

The specific geographic feature is here the line (road segment) and grid level. The use of surrogate data (proxy variables) allows determining the share of annual emissions which are attributed to each grid cell. The proxy data are correlated with the emission source sectors and defined by means of:

- geographical resolved statistical information or
- land cover/land use data

Spatial distribution and gridding

The methodology of the spatial distribution of the road transport can be summarized into the following main steps:

1. **Regionalization of national emission releases**: allocation of the emission values based on traffic volume data for each road segment and also population density related to roads not covered by TRANS-TOOLS. This allocate the share of the national totals of each specific pollutant to each road segment in the TRANS-TOOLS model (see chapter 5.5 for more detailed description of the model) and to NUTS level 3 regions for the urban and rural traffic not covered by TRANS-TOOLS.
2. **Gridding**: spatial distribution of the regionalized remission values on grid cell level is based on TRANS-TOOLS, GISCO (ROAD) (GISCO, 2010) road network and gridded population density from JRC (Gallego, 2010) (see also chapter 4.4). The result are gridded emissions for each road segment and regional unit to each grid cell according to the defined 5 km x 5 km grid, using the following underlying parameters:
   i. Traffic volume and road network from TRANS-TOOLS for highways and partly for rural roads;
   ii. Road network divided by road type from GISCO (ROAD) for the roads not covered in TRANS-TOOLS (secondary and local roads);
   iii. Gridded population density as weighting factor for line sources in relation to rural and urban roads not covered by TRANS-TOOLS. Additionally as distribution parameter for rural and urban area sources.
   iv. Degree of urbanisation (GISCO, 2010) (see also chapter 4.4a) for the categorization of the roads from GISCO and the gridded population from JRC (Gallego, 2010) (see also chapter 4.4) into urban and rural.

The methodology for the spatial distribution of national total emissions from road transport activities to a grid for each vehicle and road type is shown in Figure 10.

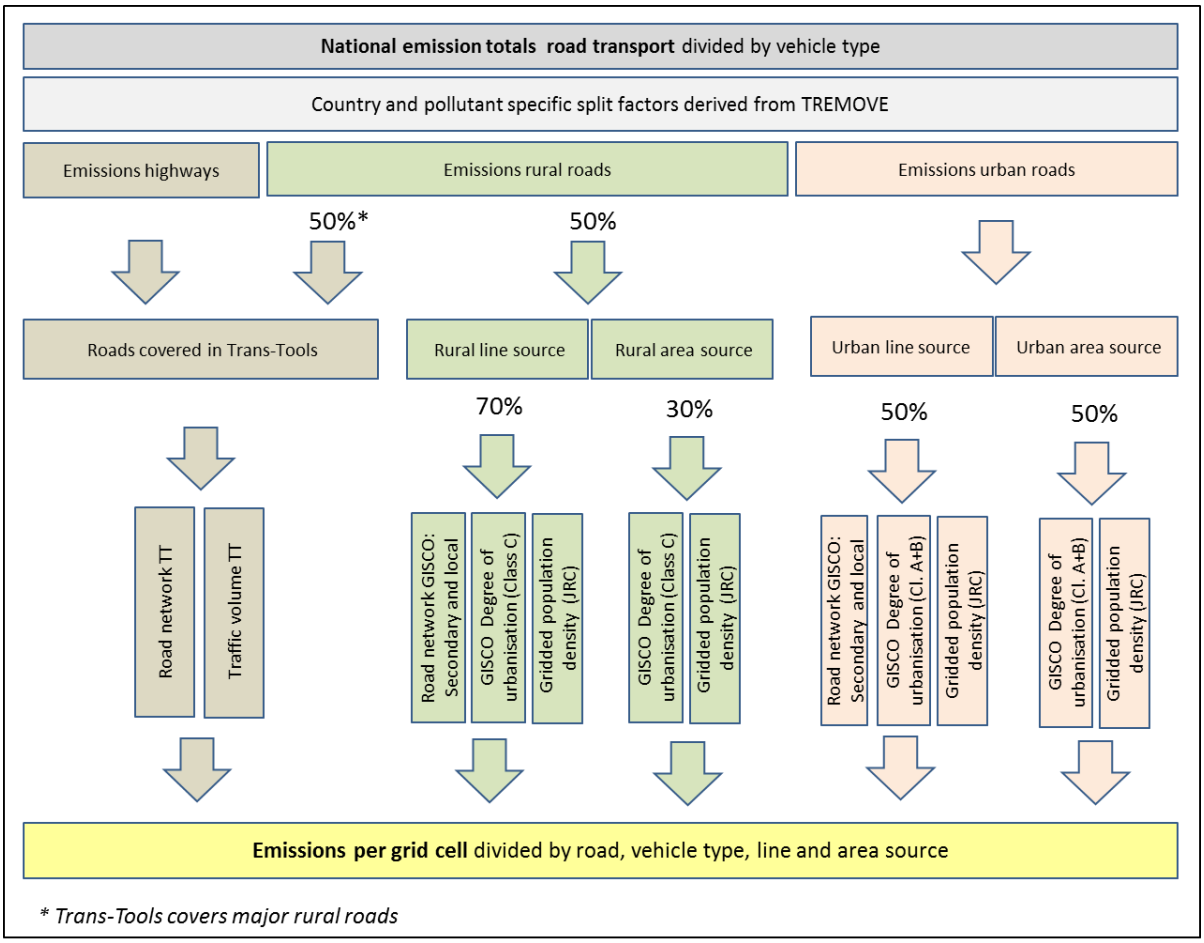

Figure 10: Overview of the applied methodology for the spatial distribution of the road transport

5.4. Emissions and proxy data sets

Emission data sources

The emissions for the road transport divided by considered pollutants are listed inTable 26. The national total emissions are aggregated for the EU27 and EFTA4 countries using 2008 UNFCCC data sets for CO_2 and 2008 CLRTAP data sets for NO_X, SO_2, PM10 and CO.

Table 26: Pollutant specific emissions from road transport in the EU27 and EFTA4 countries

Sector	Sector Code	Sector_Name	Emissions in 2008				
	[NFR]	[NFR]	CO_2[kt]	NO_x [t]	SO_2 [t]	PM10 [t]	CO [t]
			UNFCCC	CLRTAP			
Road transport	1A3bi	Road Transport: Passenger cars	519,869	1,991,915	12,786	81,149	7,805,255
	1A3bii	Road Transport: Light duty vehicles	75,638	370,183	2,652	39,114	518,750
	1A3biii	Road Transport: Heavy duty vehicles	316,741	1,905,042	6,341	69,651	605,974
	1A3biv	Road Transport: Mopeds & Motorcycles	10,374	14,960	103	4,239	617,858
	Sum		922,623	4,282,100	21,883	194,152	9,547,837
All reported emissions from EU27 + EFTA4 countries			**4,743,992**	**13,844,818**	**7,638,468**	**2,426,902**	**29,399,783**

Proxy data sources

The following proxy data sets are applied for spatial resolving the emissions from the road transport sector to a 5x5 km^2 grid (Table 27).

Table 27: Proxy data sets applied for spatial distribution of road transport emissions

Sector	Proxy Dataset	Data Source	Year	Extend
Road transport	Population density disaggregated with CORINE Land Cover 2000 and 2006	JRC	2000 and 2006	EU 27 + EFTA
	Split factors for vehicle and road class	TREMOVE	1995-2030	EU 27 + EFTA
	Emission factors for vehicle and road class	TREMOVE	1995-2030	EU 27 + EFTA
	Traffic volume for all road types on national level	TREMOVE	1995-2030	EU 27 + EFTA
	Traffic volume for road segments of highways and rurals roads	TRANS-TOOLS	Scenario for 2008	EU 27 + EFTA
	Road network for highways and rural roads	TRANS-TOOLS	Updated 2010	EU 27 + EFTA
	Road network for all street categories	Gisco (ROAD)	2010	EU 27 + EFTA

5.5.Existing gridding methods and applied proxy data sets

APMoSPHERE Approach

A European approach for spatial allocation of emission from road transport activities to a 1x1 km^2 grid has been developed in the APMoSPHERE project (Briggs, 2005). The developed methodology distinguishes the national total emissions by vehicle categories (cars, light goods, heavy goods and motorcycles) and also road types (highways, urban roads and rural roads). The allocation of different vehicle types to road type was carried out using the MEET profile (see Table 28). The classification of the road types was accomplished applying an intersection of the urban land cover classes from the CORINE Land Cover data set. This approach allocates each road type into one of three road types: highways, urban roads, and rural roads (ETC/ACC, 2007). Furthermore the traffic flows of the highways are subdivided into a base flow and a locally variable flow, which depends on surrounding population density. The sum of the different flows is used as a proxy to distribute the emissions from road transport activities.

In ETC/ACC (2007) is analyzed that the APMoSPHERE approach is comparable with the national approaches applied for the UK (Bush et al., 2008) and the Netherlands (PRTR Netherlands, 2010).

Table 28: MEET profile for road transport in the Netherlands (Briggs, 2005)

	Cars	LGV	HGV	Motor-cycles
Highways	28.1	25.6	33.6	8.0
Urban	35.4	41.1	32.4	72.0
Rural	36.5	33.3	34.0	20.0

Proxy datasets for allocation of emissions from road transport

TRANS-TOOLS

TRANS-TOOLS is a European transport network model **covering both passengers and freight related activities**, as well as intermodal transport (TRANS-TOOLS, 2010). The TRANS-TOOLS data set contains a traffic flow map that is based on modeled transport demand and network loads. The traffic flow map comprises a network of major rural roads and highways that covers whole of Europe, except for Turkey, for which only the European part is included, and Ukraine as well as Russia that also only partial covered. Based on among other data sets the ETIS database and the VACLAV model are taken into account in the TRANS-TOOLS model. For every considered road section TRANS-TOOLS contains traffic intensity for light and heavy duty vehicles. The TRANS-TOOLS model covers inter-urban transport, motorways and other main roads. Urban roads are associated with shorter ranges and are not covered. According to the TRANS-TOOLS documentation the following road classes are included in the road network attribute table:

- ME - European motorway
- M - Motorway
- DE - European dual carriageway
- D - Dual carriageway
- OE - Other European road
- F – Ferry

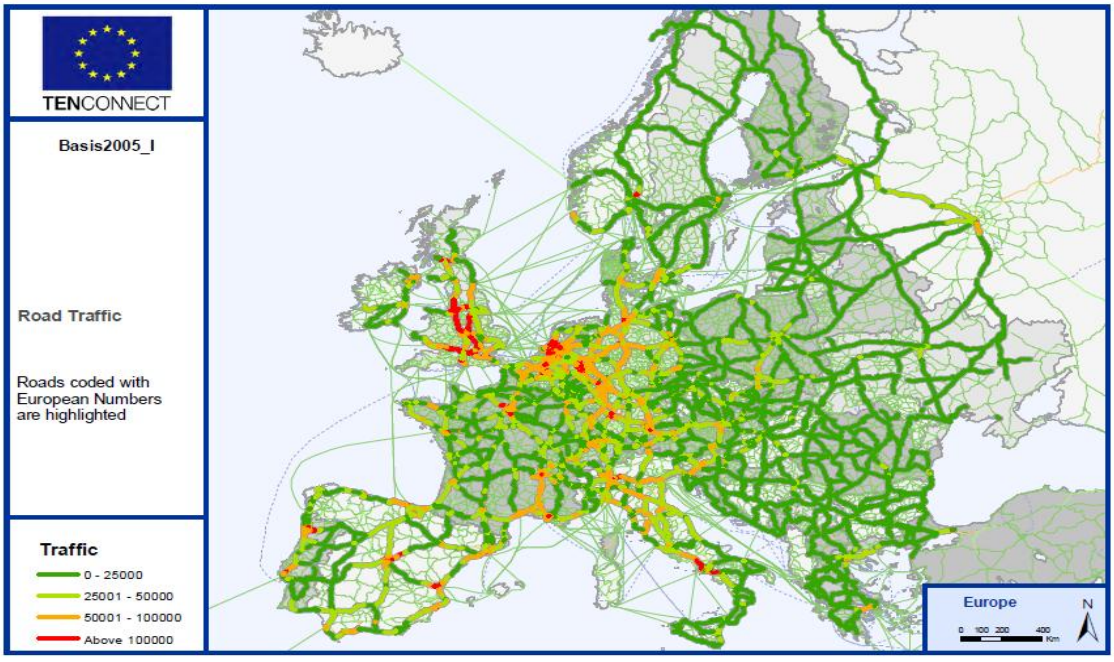

Figure 11: Traffic flow for the year 2005 in TRANS-TOOLS (Rich et al., 2009)

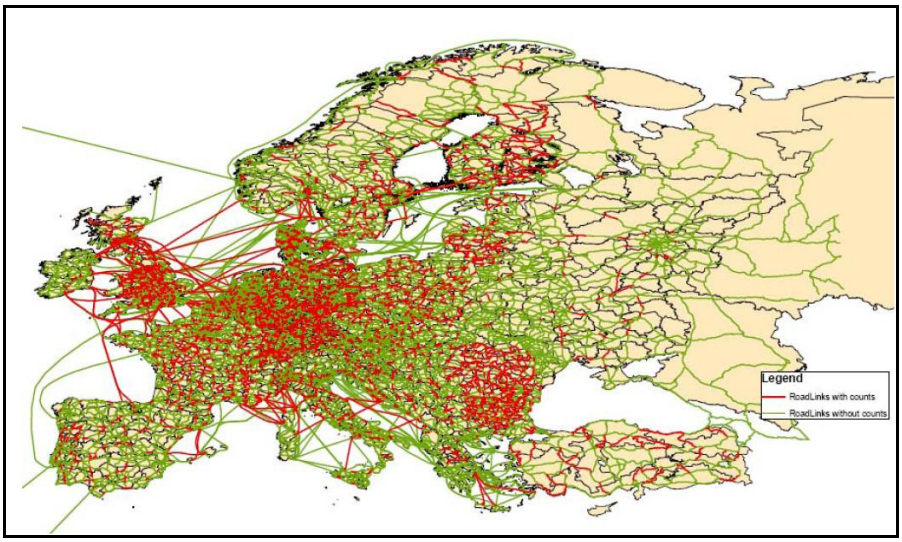

Figure 12: Road network with counts from TRANS-TOOLS (Rich et al., 2009)

Figure 12 illustrates the road network covered by the TRANS-TOOLS model. The red color indicates the part of the network with existing traffic count data and the green color indicates roads, which are modelled by TRANS-TOOLS.

TREMOVE

TREMOVE (TREMOVE, 2010) is a policy assessment model to assess the effects of environment policies on the emissions of the transport sector. The model estimates the transport demand, the modal shifts, the vehicle stock renewal, the emissions of air pollutants and the welfare level. The model are applied for environmental and economic analysis of different environmental policies as road pricing, public transport pricing, emission standards, subsidies for cleaner cars etc. (De Ceuster et al., 2007).

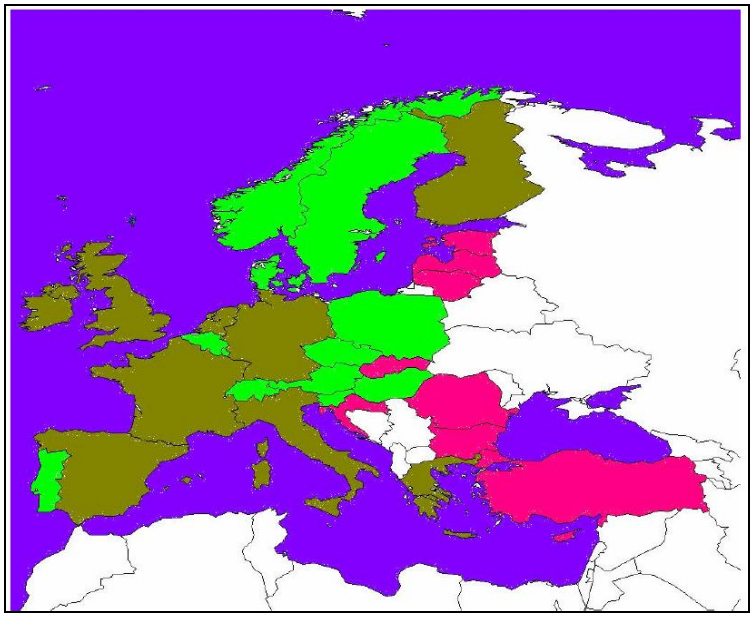

Figure 13: Countries covered by TREMOVE (De Ceuster et al., 2007)[24] [25]

[24] The colours in figure 4 indicate the different versions of TREMOVE and therefore all relevant countries are available.

GISCO road network

As Additionally information the GISCO (ROAD) data set have been used for spatial distribution of the on-road activities.

JRC Population density disaggregated with CORINE Land Cover 2000 and 2006

The gridded population density from JRC was distributed with CORINE Land cover (CLC) data. The gridded population data delivers population data on a 100m resolution for the model domain besides Switzerland. There are two versions available at the moment, combined with CLC 2000 or 2006. The basis for this map is the population number resolved to local administrative units' level (LAU2[26] level). The population census in order to calculate the gridded population density maps is provided by EUROSTAT (see Gallego (2010) for more details).

5.6. Applied models

The applied models are TREMOVE and TRANS-TOOLS. Both models described in detail in chapter 5.5.

5.7. Conclusion and results

The spatial distribution of emissions caused by the road transport sector is based on vehicle and road class specific emission data sets. Intermediate calculations need to be applied. The first intermediate calculation step is applied to allocate the country specific CO_2 emissions reported to UNFCCC, on base of the TREMOVE model (TREMOVE, 2010) to different vehicle types. The second intermediate calculation is the allocation of the emissions from CLRTAP and UNFCCC per vehicle class into different road classes to compile country specific shares for each pollutant. The next step is to harmonize the road and vehicle classes with the road network from the TRANS-TOOLS model (TRANS-TOOLS, 2010). The road classes are allocated to roads which are covered by the TRANS-TOOLS model and not covered by TRANS-TOOLS. For the harmonization it is necessary to divide the rural share in an additional step. The third intermediate calculation is for the distinction of the rural and urban road traffic into line and area sources.

Based on the national total emissions divided by road and vehicle classes, the emissions are allocated to roads covered by TRANSTOOLS and not covered by TRANSTOOLS. The regionalization of the emissions from road transport activities considers the traffic volume data for each road segment from TRANS-TOOLS and the population density as weighting factor for roads not covered by TRANS-TOOLS. The area sources not covered by TRANS-TOOLS are distributed to the grid using the gridded population density from Gallego (2010). The results of the regionalization are emission per road segment and emissions on NUTS3 level. These regionalized emissions are distributed to the 5x5 km^2 grid

[25] (The different colours indicate country groups, which are additional taken into account in different versions of the TREMOVE model. In the applied version are implemented all countries, which are coloured)

[26] LAU2: Local administrative unit. There are two levels of Local Administrative Units (LAU) defined. This category refers to units belonging to the second level (LAU 2, formerly known as NUTS 5), which is largely used by EUROSTAT and other European Union bodies.

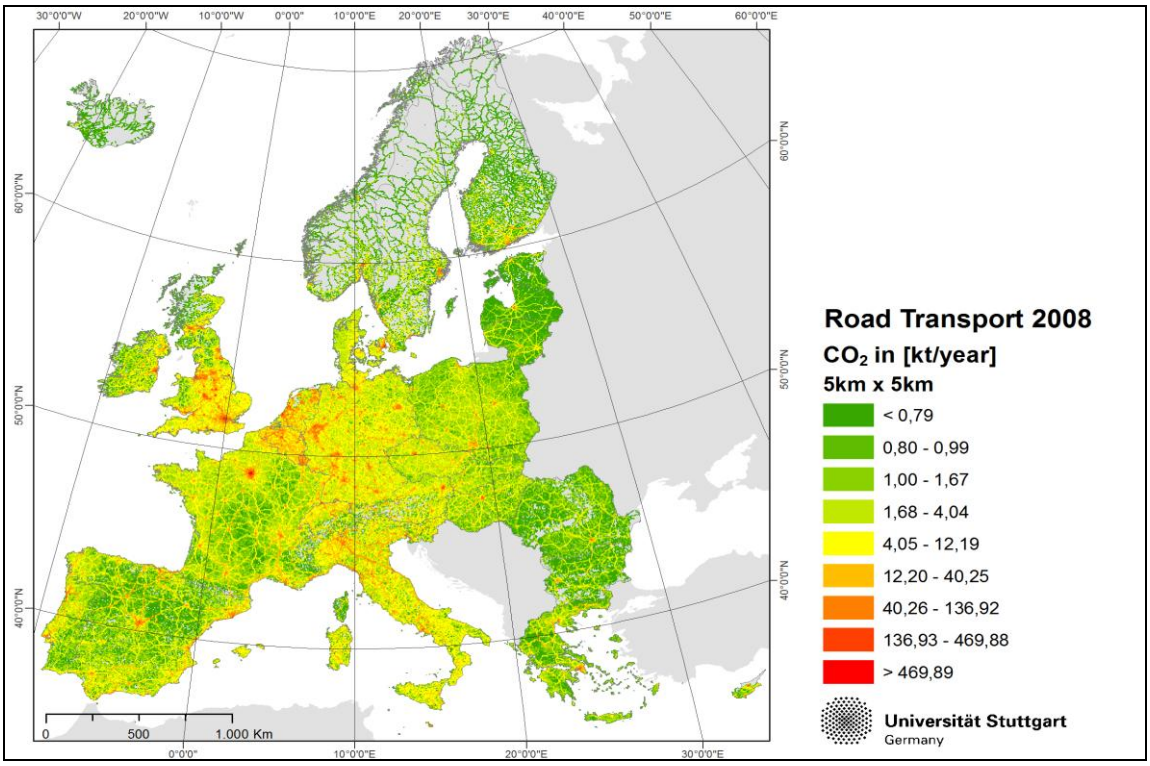

Figure 14: Results for spatial distribution of CO2 for the road transport in the year 2008

The roads not covered by TRANS-TOOLS are identified using a GIS-software which intersects the road network from TRANS-TOOLS, covering only highways and some rural roads, with the GISCO (ROAD) road network, covering all types of roads including urban roads. The developed methodology compiles maps for each pollutant divided by vehicle and road type in a 5x5 km^2 resolution for the EU27+EFTA4 countries. Figure 14 shows an example for the spatial distribution of CO_2 for all road and vehicles classes for the year 2008.

6. Gridding methodology for the domestic shipping sector

6.1. Sector description

This sector comprises all domestic shipping activities. The following subsectors are taken into account:

- Domestic shipping:
    - Coastal shipping
    - Harbour maneuvering
    - Inland waterway shipping
- National fishing

This sector is a diffuse emission source not included in the E-PRTR reporting obligations. The domestic shipping sector is covered by following source categories:

- 1A3dii National Navigation (Shipping)
- 1A4ciii Agriculture/Forestry/Fishing: National Fishing

- UNFCCC in the IPCC Common Reporting Format (CRF[27]) source categories:
    - 1A3d Navigation
    - 1A4c Agriculture/Forestry/Fisheries

The sector classification from UNFCCC for the CRF code 1A3d Navigation is not taking into account the distinction between international and national activities. Therefore the emissions need to be allocated to the according NFR subsectors.

Table 29 shows the source category structure referring to the NFR nomenclature from the EMEP/EEA Emission Inventory Guidebook 2009. All emissions reported to the NFR sectors National Navigation (Shipping) (1A3dii) and National Fishing (1A4ciii) are considered as caused by national shipping activities inside the national territory (including the 12 nautical miles territorial waters zone).

Table 29: Source category structure referring to NFR nomenclature (EMEP/EEA Emission Inventory Guidebook, 2009)

Source category	Coverage
1.A.3.d.ii Domestic water-borne navigation	Emissions from fuels used by vessels of all flags that depart and arrive in the same country (excludes fishing, which should be reported under 1.A.4.c.iii, and military, which should be reported under 1.A.5.b). Includes small leisure boats. Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu).
1.A.4.c.iii Fishing (mobile combustion)	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refueled in the country (include international fishing).

[27] The CRF code (Common Reporting Format) is based on the sector systematic which is applied by the countries for the UNFCCC reporting submissions

Pollutants covered

The following pollutants are considered: NO_x, PM10, SO_2, CO and CO_2.

6.2. Emission data input

The input emission data used for the spatial distribution of the domestic shipping are provided by the following datasets:

- National emissions of CO_2 available from the EEA-website for 2008 (EEA/UNFCCC v.11, 2010)[28]
- National emissions reported to "Convention on Long-Range Transboundary Air Pollution (CLRTAP)" (EEA/CLRTAP v.10, 2010)[29]

Distinction between international and national shipping activities

The CRF source category 1A3d "Navigation" indicates that there is no distinction between activities on international and national shipping while the CLRTAP reporting distinguish more to national and international activities. Based on the assumption that the NO_x emissions correlate with CO_2 emissions, CO_2 emissions (taken from the UNFCCC submissions) have been disaggregated in equivalent subcategories using information from the corresponding CLRTAP NFR sectors for NO_x. This split factors are derived for each country individually and differ from country to country in relation to the number and accessibility of the national inland waterways.

Distinction between agricultural, Forestry and Fishing activities

The intermediate calculation of the emissions from the UNFCCC CRF sector 1A4c "Agriculture/Forestry/Fisheries" based on the assumption that the NO_x emissions correlate with the CO_2 emissions. Following shares for CO_2 emissions from this category are applied:

- 1A4ci Agriculture/Forestry/Fishing: Stationary sources with 13%,
- 1A4cii Agriculture/Forestry/Fishing: Mobile sources (Off-road vehicles & other machinery) with 76%,
- 1A4ciii Agriculture/Forestry/Fishing: National fishing with 11%.

This split factors are derived for each country individually from the CLRTAP submissions for the respective NFR sectors.

Distinction between inland waterways, national coastal shipping and harbour related activities

The domestic shipping activities are distinguished into the three subsectors:

- Inland waterway shipping,
- National coastal shipping and
- Harbour maneuvering.

[28] The emission data originate from http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-4 (downloaded at 12th July 2010, Version 11)

[29] The emission data originate from: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4 (downloaded at 12th July 2010)

Italy or United Kingdom have a small amount of inland waterway shipping instead they have a high costal shipping fraction while Germany or the Netherlands have a higher share of inland waterway shipping in relation to costal shipping activities. The most appropriate indicator for allocating the emissions to inland waterway shipping and national coastal shipping activities is applied the ratio of the length of the inland waterways in relation to the length of the coastline (weighted with number of harbours) for each country. Four different categories of countries have been identified:

1. Countries with a small ratio between the inland waterways and the coastline like Italy, United Kingdom, and Spain etc.
2. Countries with a high ratio between inland waterway coastline like Germany, Netherlands, and Belgium etc.
3. Countries without a coast line and any sea-harbours like Austria, Bulgaria, Slovenia, Czech Republic
4. Countries without inland waterways like Norway, Denmark, and Sweden etc.

The following shares of different shipping activities for the different groups of countries have been defined:

Table 30: Share of different shipping activities shipping for groups of countries

Subsector domestic shipping	Group 1	Group 2	Group 3	Group 4
Inland waterway shipping	20%	75%	100%	0%
Coastal shipping	70%	20%	0%	90%
Harbour maneuvering	10%	5%	0%	10%

6.3. Applied methodology

The approach used for high spatial resolution gridding of domestic shipping activities is generally based on existing methods previously developed and applied in Europe. Spatial distribution of emission data into the 5km x5km target grid cells generally is carried out using the approach given in the formula:

$$emission_{i,x} = emission_t \times \frac{value_{i,x}}{\sum_i value_{i,x}}$$

where:

- ***i:*** is a specific geographic feature;
  here: inland waterway segments, harbours or grid cell within the grid layer
- ***x***: is a sector that is characterized by the surrogate dataset (x).
- ***emission*** $_{i,x}$***:*** is the emissions attributed to a specific geographical feature i (e.g. a grid, line, point or administrative boundary) within the spatial surrogate dataset x;

here: domestic or national shipping emission $_x$ at e.g. the specific inland waterway segment$_i$ within each EU27 and EFTA4 Member state

- ***emission*** $_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset;
  here: national total emissions for domestic or international shipping
- ***value*** $_{i,x}$ - are the surrogate data value (e.g. traffic volume) for each geographical feature within the spatial surrogate dataset x.
  here: for each e.g. individual inland waterway segment within each 5km x5km target grid cell the fraction of traffic volume of the sum of the overall traffic volume within the respective EU27 and EFTA4 member state

The specific geographic objects are line (inland waterway segment), point (harbours) and grid features (e.g. coastal zones). Surrogate data (proxy variables) are used for quantifying the share of annual emissions attributed to each grid cell. The proxy data are correlated with the emission source sectors and defined by means of:

- georeferenced statistical information
- land cover/land use data

Spatial distribution and gridding

The main step of the methodology of the spatial distribution of the shipping releases is:

- **Gridding**: spatial distribution of the emission values on grid cell level based on proxy data

The methodology for the spatial distribution of the shipping emissions is distinguished into:

a) domestic shipping;
b) national fishing.

➢ **Gridding emissions from domestic shipping**

The emissions from the domestic shipping (NFR 1A3dii) are distinguished into:

- emissions from the navigable rivers,
- emissions from national coastal shipping,
- emissions from harbours.

The approach for the domestic shipping is shown in Figure 15.

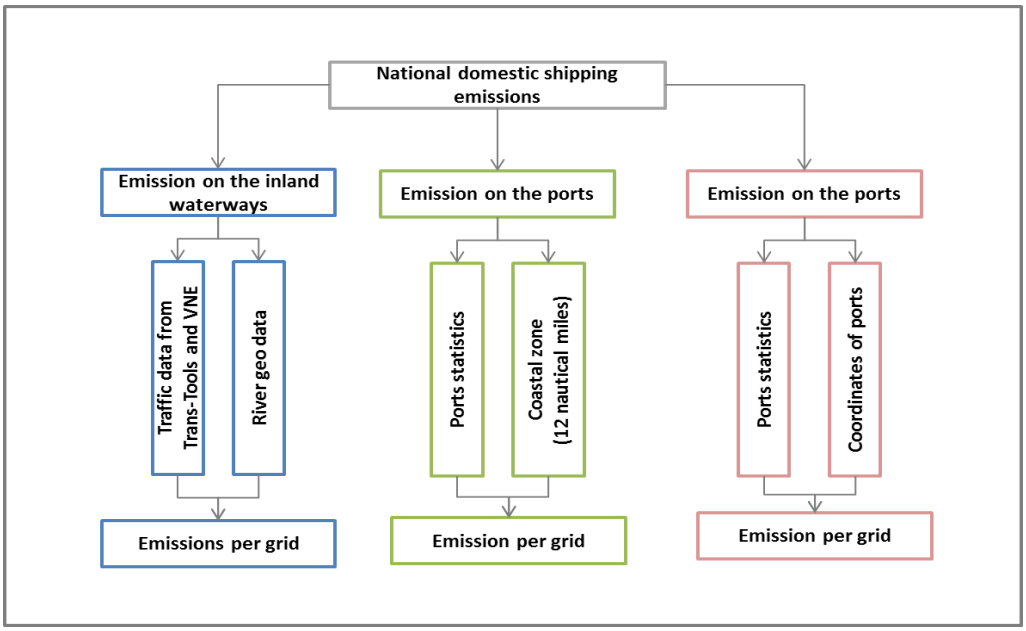

Figure 15: **Methodology for the gridding of the domestic shipping emissions**

➢ **Gridding emissions on the navigable inland waterways :**

- First the traffic volume on the sections of the waterways in combination with the accessibility of the inland waterways is quantified. This information is available for traffic volume from TRANS-TOOLS and for accessibility of ship types to European inland waterways from the inland waterways institution of France (Voies Navigables de France (VNF, 2010))
- Figure 17 shows information on the location and accessibility of the inland waterways from VNF and Figure 16 the corresponding network where the traffic volume is covered by TRANS-TOOLS
- The traffic volume on specific waterway sections is used as an indicator for the emission quantity
- The geo referencing of accessibility from VNF (2010) is realized by using river network from TRANS-TOOLS in combination with the river geo data from e.g. EUROSTAT, GISCO: Watercourses from EuroRegional Map v30: Hydrography (HYDR) (GISCO, 2010)
- The combination of traffic volume data from TRANS-TOOLS with the accessibility of the inland waterways from VNF (2010) and the geospatial inland waterways from river geo data are applied for the spatial distribution of emissions from shipping activities on navigable rivers in Europe

Figure 16: River network from TRANS-TOOLS (TRANS-TOOLS, 2010)

Figure 17: Accessibility of the inland waterways from Voies Navigables de France (VNF, 2010)

➢ **Gridding emissions from domestic coastal shipping**

- Allocation along the territorial waters along the respective national coast lines in a zone of approximately 12 nautical miles (12 nm = 21.9 km) according to the EAA maritime boundaries GIS data (http://www.eea.europa.eu/data-and-maps/data/maritime-boundaries, Figure 18); it is assumed that this is the area, where coastal shipping takes place (ENTEC, 2005);
- Coastal zones for Norway and Iceland are generated using GIS by taking the NUTS0 country borders at the sea side as base line for the 12 nm territorial waters zone areas.
- Assessment of activities: statistics are available from EUROSTAT on domestic sea shipping at harbours in terms of freight and passenger transport;
- Proxy data grids for coastal shipping: Distribution of the national coastal emission amounts over the whole national costal zones using the gridded weighting factors derived from the global shipping proxies (Wang et al., 2008).

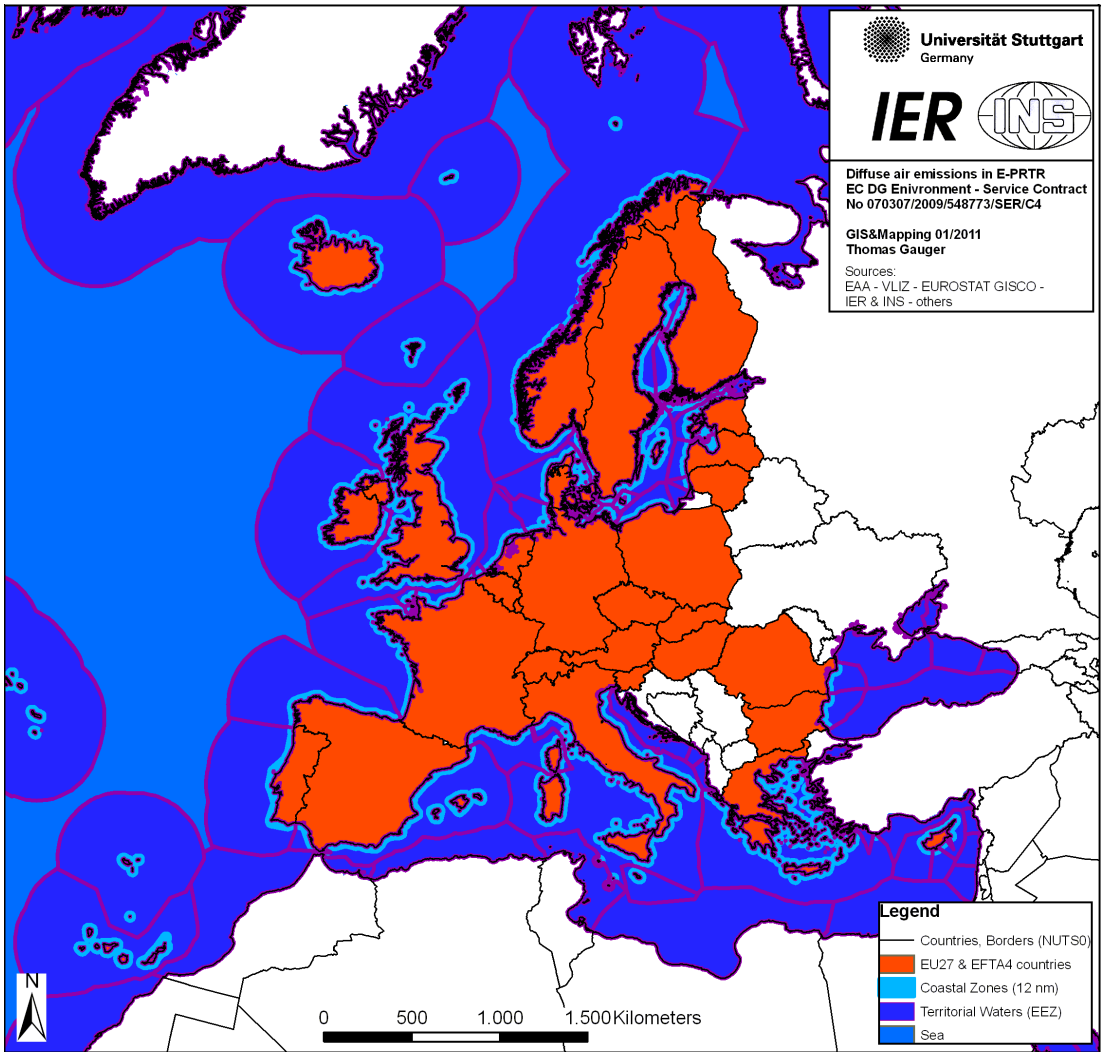

Figure 18: Maritime Boundaries used for deriving the 12nm coastal zones (VLIZ, 2009)

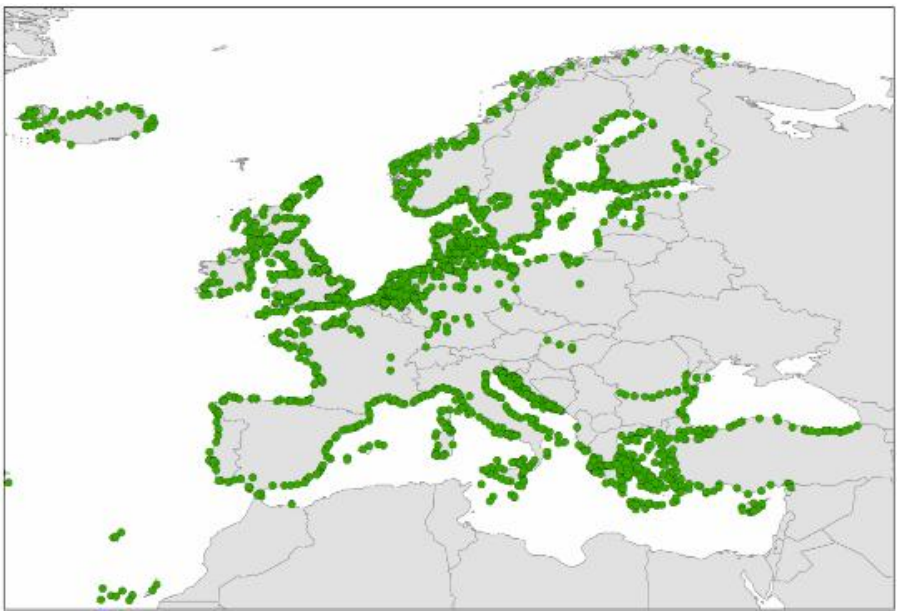

Figure 19: Ports in Europe from GISCO EUROSTAT (GISCO, 2008)

➢ **Gridding of harbour related emissions:**

- Gridding based on statistics considering goods and passenger movements:
  - Statistical data on harbour movements are available from EUROSTAT for the ports in Europe (on NUTS level 2);
  - Coordinates of the ports are available from GISCO (2008) (PORTS) from EUROSTAT which is already geo referenced.
- The combination of the harbour statistics enable distributing harbour related emissions.
- Spatial distribution of emissions to a semi-circle 20km around the harbours into the sea area.

➢ **Gridding of national fishing activities**

- The spatial distribution of the emissions from the sector National fishing activities (NFR 1A4ciii) is equally distributed to all grid cells of the land use class 5.1.2 (inland water bodies) of the CLC data set.

6.4. Emissions and proxy data sets

Table 31 shows the emissions of the different pollutants from domestic shipping activities.

Table 31: Domestic shipping releases to air distinguished by source category and pollutants

Sector	Sector Code	Sector_Name	Emissions in 2008				
	[NFR]	[NFR]	CO_2 [kt]	NO_x [t]	SO_2 [t]	PM10 [t]	CO [t]
			UNFCCC	CLRTAP			
Shipping	1A3dii	National Navigation (Shipping)	682	453,151	202,379	30,688	419,084
	1A4ciii	Agriculture/Forestry/Fishing: National Fishing	23,738	91,937	10,282	3,853	10,209
	Sum		24,420	545,088	212,661	34,541	429,293
All reported emissions from EU27 + EFTA4 countries			**4,743,992**	**13,844,818**	**7,638,468**	**2,426,902**	**29,399,783**

The main proxy data sets are:

- traffic volume and accessibility of inland waterways (VNF, 2010) ;
- VLIZ Maritime Boundaries Geodatabase data (VLIZ, 2009), Maritime Boundaries Geodatabase (version 5) used for deriving territorial waters data (12nm coastal zones)
- ports activity data (GISCO, 2010);
- georeferenced data for rivers and ports data (GISCO, 2010).

Table 32 shows the applied proxy data sets used for the spatial distribution of the emissions form domestic shipping activities.

Table 32: Proxy data sets used for the spatial distribution of domestic shipping activities

Sector	Sector_Code [NFR]	Subsector (NFR)	Proxy Dataset	Data Source	Year	Extend
Shipping	1A3dii	**Navigable inland waterways and coastal shipping**	Traffic data on the sections of the waterways	Voies Navigables de France (VNF)	2010	Selected countries
			Traffic volume	TRANS-TOOLS	2010	Selected countries
			River geo data/geospatial inland waterways	GISCO (HYDR)	2010	EU 27 + EFTA
			Statistical data on harbour movements	EUROSTAT	2009	Ports in Europe
			Georeferenced ports	GISCO	2010	World
			World EEZ, VLIZ Maritime Boundaries Geodatabase v5	Flanders Marine Institute (VLIZ)	2009	World
			EEA Maritime Boundaries Datasets	EEA	2009	EU 27
			Georeferenced global data set (activities & emissions)	Wang et al. (2008)	Updated 2010	Worldwide
	1A4ciii	**National fishing**	Water bodies	CORINE Land Cover data set 2000 (CLC, 2000); 2006 (CLC, 2006)	Updated 2010	EU 27 + EFTA

6.5. Existing gridding methods and applied proxy data sets

UK approach – NAEI study

UK shipping totals are calculated at a national level. These estimates include:

- Coastal shipping (fuel sales for ships confined to UK waters);
- Other UK shipping (UK bunker fuel sales corrected for estimation of emissions in port and -cruise in UK waters only).

The shipping emissions are distributed over the UK as follows. Emissions are assigned to port areas and coastal zones according to ship arrival data provided by Department for Transport UK (DfT UK,

2004). The port area emissions are mapped on the approximate port locations. The cruise emissions are assigned to the area of the coastline nearest to the relevant port and within 12 miles of the shore, based on an inverse distance weighting. This gives a rough approximation of where shipping is likely to be.

APMoSPHERE approach

The methodology applied in the APMoSPHERE project (Briggs, 2005) is based on information on port location and activity data from REGIO source and ENTEC study. A proposed approach was a weighted radius away from the port, to the extent of 12 miles territorial waters. This methodology shows a higher emission in the port (due to ship movements and emission from stationary ships) and decreasing emissions away from the port to the extent of 12 miles territorial waters. This source includes however only emissions from national shipping and not from international shipping. The discussion within APMoSPHERE project resulting in allocation of emissions to internal waterways in some countries and between neighboring countries.

ENTEC approach

The ENTEC approach can be described as a bottom up approach considering sea shipping, port and inland waterway activities.

"In bottom-up approaches emissions are directly estimated within a spatial context resulting in spatially resolved emission inventories. Ship- and route specific emissions are calculated based on ship movements, ship attributes (e.g., ship type, size, speed, and engine power), and ship emission factors. The locations of emissions are determined by the most probable navigation routes. A bottom-up inventory for Europe has been developed by ENTEC UK Limited." (Paxian et al., 2010)

The aim of the ENTEC study is the assignments of ship emissions to European countries. "Emissions to be assigned are sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), particulate matter (PM) and carbon dioxide (CO_2), for the years 2000, 2010, 2015, and 2020. Seven different methods were applied to assign emissions to each EU25 Member State plus Bulgaria, Romania, Turkey and Croatia." (ENTEC, 2005)

Voies Navigables de France (VNF, 2010)

The VNF (2010) is the national inland waterway department of France. VNF provides basic information on the European waterways on a map (see European waterways map for more details). The map delivers information on the accessibility of inland waterways for the major inland waterways in Europe considering the "Classes of navigable waterways". The VNF (2010) map delivers additional information to the traffic volume calculated in TRANS-TOOLS (2010). The VNF waterway map considers following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, France, United Kingdom, Hungary, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia, and Spain.

6.6. Applied models

For the spatial distribution of the shipping releases only one model was used:

TRANS-TOOLS

The Project TRANS-TOOLS - Tools for transport forecasting and scenario testing - aims to produce a European transport network model covering passenger and freight, as well as intermodal transport, which overcomes the shortcomings of current European transport network models. (For more information see: http://energy.jrc.ec.europa.eu/transtools/ or http://www.transport-research.info/web/projects/project_details.cfm?id=11088.)

The TRANS-TOOL model is mainly used to spatially distribute the domestic and international emissions on the inland waterways. The information used to accomplish the spatial allocation is the traffic volume with the associated river network. The TRANS-TOOLS (2010) model covers the major waterways in the following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, France, United Kingdom, Hungary, Lithuania, Luxembourg, Netherlands, Poland, Romania, and Slovakia.

6.7.Conclusion and result

The spatial distribution of the domestic shipping needs pre-processing of the input emission data. The pre-processing steps have to be performed for the following issues:

- Identification of national fishing fraction from the CRF sector 1A4c Agriculture/Forestry/Fisheries
- Distinction of the sectors 1A3dii National Navigation (Shipping) and 1A3d Navigation into inland waterway shipping, coastal shipping and harbour manoeuvring.

The gridding of the inland waterway shipping is performed using traffic volume data from TRANS-TOOLS (2010) and traffic data from VNF (2010) in combination with river geo data from GISCO (HYDR) (2010). The emissions to the coastline are distributed using harbour statistics from EUROSTAT and territorial waters (12 nautical miles coastal zones),(GISCO, 2010). The emissions for the harbours are distributed to the harbours using coordinates and harbour statistics from EUROSTAT (GISCO, 2010). The national fishing is distributed equally to all grid cells of the land use class water bodies from CORINE Land Cover (CLC2000/2006, 2010). An example of the results of spatial distributed SO_2 emissions for Europe for the year 2008 is shown in Figure 20.

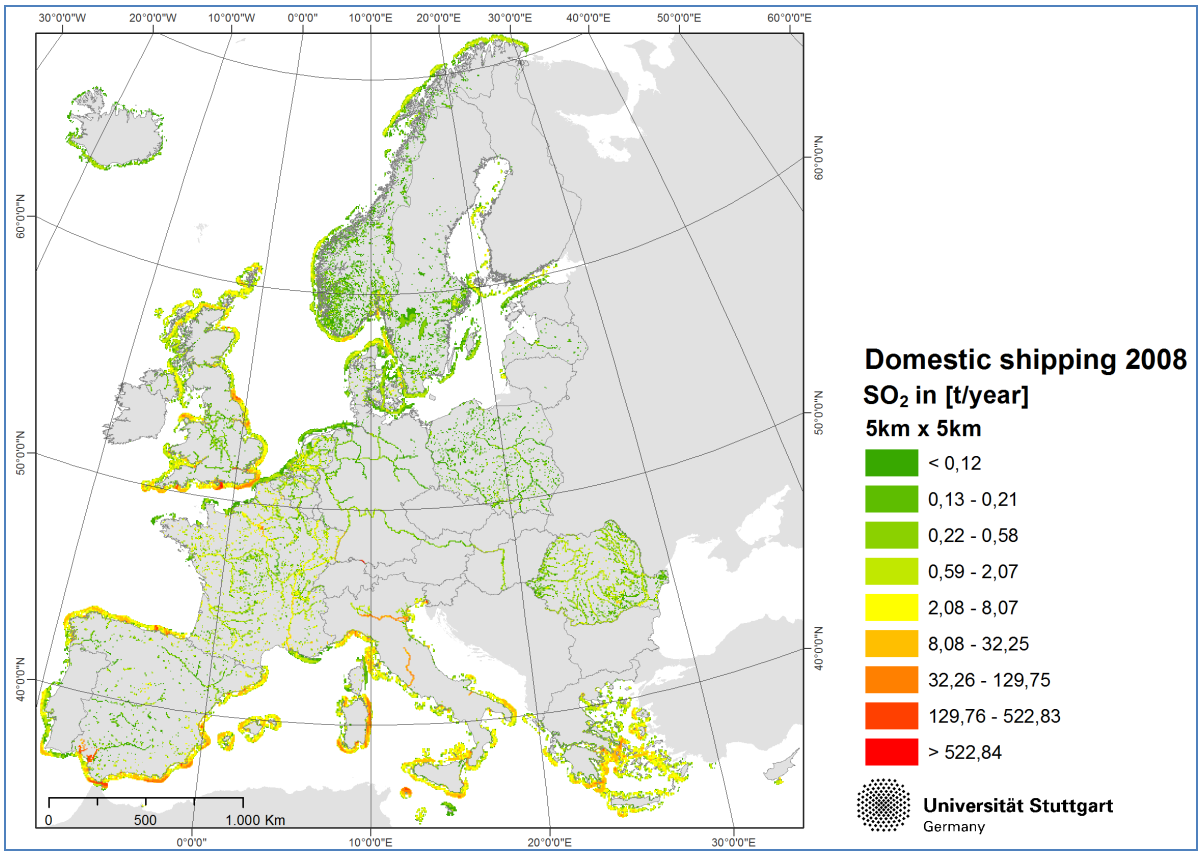

Figure 20: Gridded SO_2 emissions from domestic shipping activities in Europe for the year 2008

7. Gridding methodology for the international shipping sector

7.1. Sector description

This sector comprises all international shipping activities. The sector includes the following subsectors:

- International maritime shipping
- International shipping on inland waterways

This sector is a diffuse emission source not included in the E-PRTR reporting obligations. The emission releases of the international shipping sector are derived from the following source categories:

- CLRTAP in the New Format for Reporting (NFR[30]):
    - 1A3di(i) International maritime navigation
    - 1A3di(ii) International inland waterways
- UNFCCC in the IPCC Common Reporting Format (CRF[31]):
    - 1C1b International maritime transport

Table 33 shows the source category structure referring to NFR nomenclature from the Emission Inventory Guidebook (2009) for the international shipping. All emissions reported to the NFR sectors **International maritime navigation** (1A3di(i)) and International inland waterways (1A3di(ii)) are considered as caused by international shipping activities. International shipping activities are also occurring inside national territories, especially the emissions reported to the sector **International inland waterways** (1A3di(ii)). This sector taken into account international shipping activities on inland waterways (only reported for NL and BE but also occurred in other countries, e.g. Germany). The emissions from International maritime shipping activities are defined as outside country territories, still international shipping activities are also taking place within the 12 nm territorial waters zone.

[30] The NRF code (New Reporting Format) is based on the sector systematic which is applied by the countries for the CLRTAP reporting submissions

[31] The CRF code (Common Reporting Format) is based on the sector systematic which is applied by the countries for the UNFCCC reporting submissions

Table 33: Source category structure referring to NFR nomenclature (EMEP/EEA Emission Inventory Guidebook, 2009)

Source category	Coverage
1.A.3.d.i International water-borne navigation (International bunkers)	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. Excludes consumption by fishing vessels (see 1.A.4.c.iii - Fishing). Emissions from international military water-borne navigation can be included as a separate sub-category of international water-borne navigation provided that the same definitional distinction is applied and data are available to support the definition.

Pollutants covered

The following pollutants are considered: NO_x, PM10, SO_2, CO and CO_2.

7.2. Emission data input

The emission data used for the spatial distribution is provided by the following datasets:

- National emissions of CO_2 available from the EEA-website for 2008 (EEA/UNFCCC v.11, 2010)[32]
- National emissions of NO_x, PM10, SO_2 and CO reported to "Convention on Long-Range Transboundary Air Pollution (EEA/CLRTAP v.10, 2010)" for 2008[33]

Distinction between international shipping activities inside and outside the covered domain

The international shipping sector considers international destinations from Europe to other areas of the world as well as from countries outside of Europe to Europe. The fuel used is accounted in the reporting as international bunkers. The spatial allocation of all international shipping emissions to the European domain would lead to an overestimation of the emissions within the considered domain.

In order to distribute international shipping emissions between Europe and the rest of the world, within the map extent of the E-PRTR diffuse emission project, the proxy data on worldwide international shipping from Wang et al. (2008) have been used. These proxies allocate a certain share of emissions to each region of the world on the basis of a model developed to derive global shares of emissions.

Since these data are representative for global shipping emission inventory, proxy data adaptation is necessary in order to adjust them to the smaller mapping extent used for Europe. This was carried out by comparing map statistics of the Wang et al. 2008 proxy data between the global extent and the European extent of the E-PRTR diffuse emission project as shown in the Figure 21: Calculation of the emissions within the model domain for international shipping. The proxy data within the European

[32] The emission data originate from http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-4 (downloaded at 12th July 2010, Version 11)

[33] The emission data originate from: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4 (downloaded at 12th July 2010)

map extent accounts for about 40% of the total global ship emission proxy data. It was assumed the relative fuel consumption for international shipping to be the same at EU level as on the global scale. Hence a factor of 0.4 was applied to the proxy data derived by Wang et al. (2008) for distributing the emission data on the shipping routes allocated on sea area of the project's map extent accordingly.

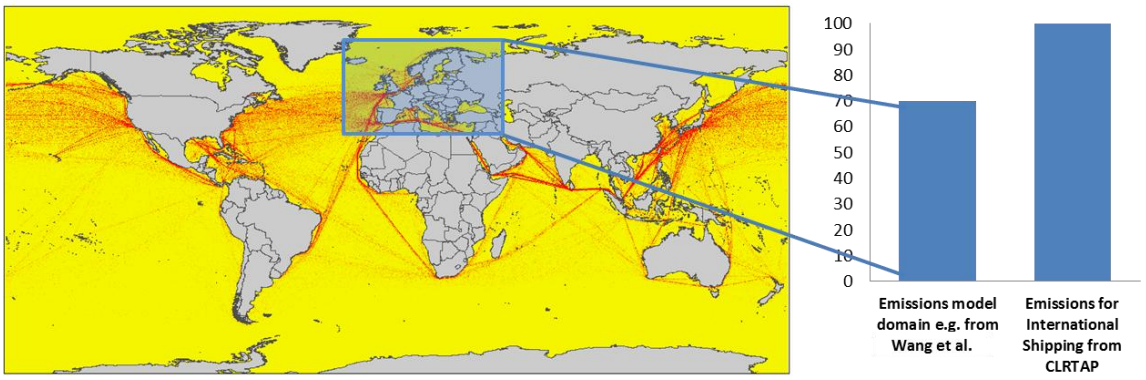

Figure 21: Calculation of the emissions within the model domain for international shipping

7.3.Applied methodology

The methodology developed for this sector is based on existing methods previously tested and applied in Europe. Spatial distribution of emission data into the 5km x5km target grid cells generally is carried out using the approach given in the formula:

$$emission_{i,x} = emission_t \times \frac{value_{i,x}}{\sum_i value_{i,x}}$$

where:

- ***i:*** is a specific geographic feature;
  here: grid cell within the grid layer
- ***x***: is a sector that is characterized by the surrogate dataset (x).
- ***emission*** $_{i,x}$: is the emissions attributed to a specific geographical feature i (e.g. a grid) within the spatial surrogate dataset x;
  here: international shipping emission $_x$ at e.g. the specific inland waterway segments and marine shipping routes within each EU27 and EFTA4 Member state
- ***emission*** $_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset;
  here: reported emissions for international shipping activities
- ***value*** $_{i,x}$ - are the surrogate data value (e.g. traffic volume) for each geographical feature within the spatial surrogate dataset x.
  here: the fraction of international shipping traffic volume related to Europe is allocated to

each individual grid cell of inland waterway and marine shipping routes segment within the 5km x5km grid .

The specific geographic objects are grid features (e.g. Wang et al., 2008) and line (international inland waterway segment and marine shipping routes). Surrogate data (proxy variables) are used for quantifying the share of annual emissions attributed to each grid cell. The proxy data are correlated with the emission source sectors and defined by means of:

- geo-referenced statistical information
- land cover/land use data (water ways and harbours)

Spatial distribution and gridding

The methodology for spatial allocation of the diffuse emissions of international shipping (NFR 1A3di and CRF 1C1b) contains two main steps:

- **Gridding emissions on the navigable inland waterways:**
  - First the traffic volume in combination with the accessibility of the inland waterways is quantified. The information on traffic volume is available from TRANS-TOOLS and on accessibility of ship types to European inland waterways from a French Institution (Voies Navigables de France (VNF, 2010))
  - Figure 23 shows information on the location and accessibility of the inland waterways from VNF (2010). Figure 22 shows the corresponding network where the traffic volume is covered by TRANS-TOOLS (2010)
  - The traffic volume on specific waterway sections is used as an indicator for the allocation of emissions
  - The classification of the accessibility of the geo referenced water ways was performed using the VNF (2010) data set, TRANS-TOOLS and GISCO river geo data. The accessibility of ship types for major inland waterways provided by VNF (2010). GISCO (HYDR) river geo data (GISCO, 2010) is realized by using the river network information from TRANS-TOOLS in combination with the river geo data information from GISCO (HYDR) river geo data (GISCO, 2010)
  - The combination of traffic volume data from TRANS-TOOLS (2010) with the accessibility of the inland waterways from VNF (2010) and the geospatial inland waterways from GISCO (2010) river geo data are applied for the spatial distribution of emissions from shipping activities on navigable rivers in Europe

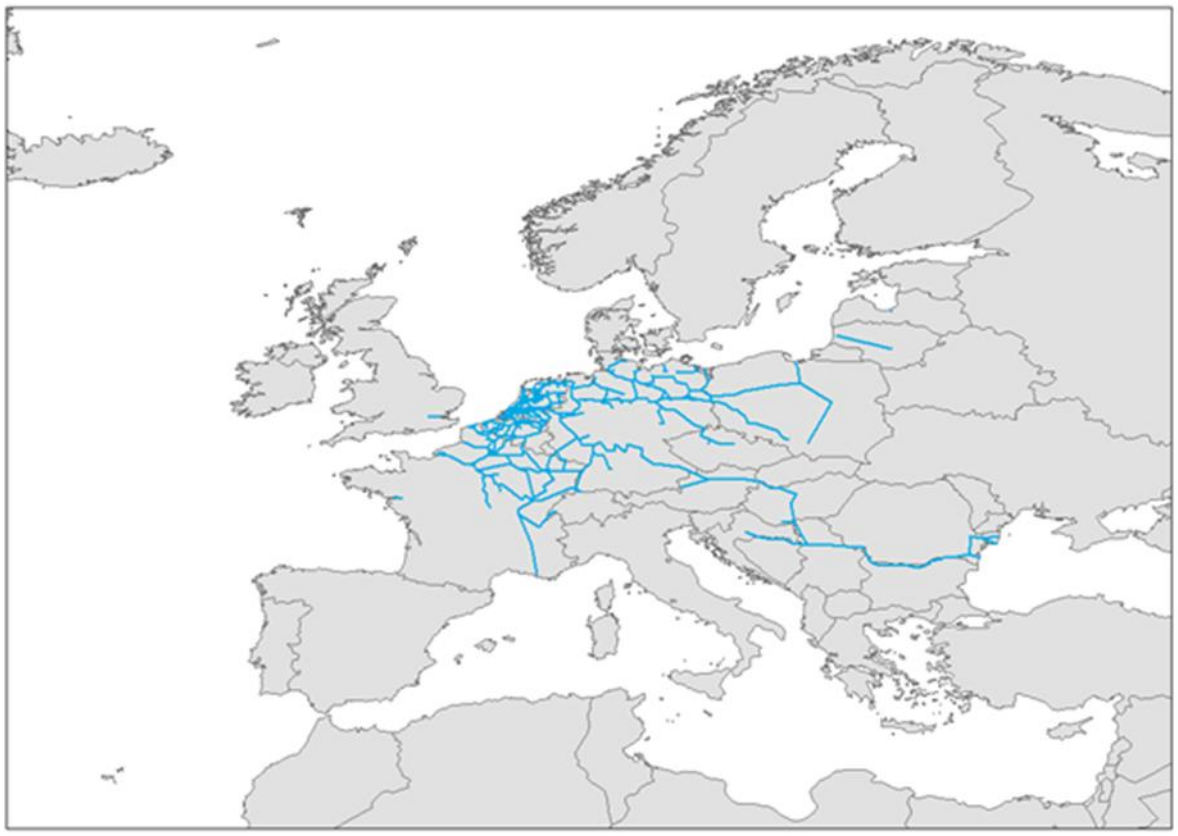

Figure 22: River network from TRANS-TOOLS (TRANS-TOOLS, 2010)

Figure 23: Accessibility of the inland waterways from Voies Navigables de France (VNF, 2010)

➢ **Gridding of international shipping activities**

The international shipping is distinguished into:

- International maritime shipping
- International inland waterways

  - **International maritime shipping**

- The prepared totals amounts for the European countries (see also chapter 6.2) are directly distributed to the international shipping proxies from Wang et al. (2008).
- Some minor modification of the global shipping proxies (Wang et al., 2008) has been performed to erase dislocated grid cells e.g. dislocated cells on the land (see Figure 24).
- According to the methodology developed by Wang et al. (2008) international coastal shipping is covered by their proxy data.

  - **International inland waterway shipping**

- After allocating a share of inland waterways which are used for international shipping activities; international emissions on inland waterways (NFR 1A3di(ii)) are gridded using traffic volume data for selected waterway sectors from the VNF (2010) data sets.

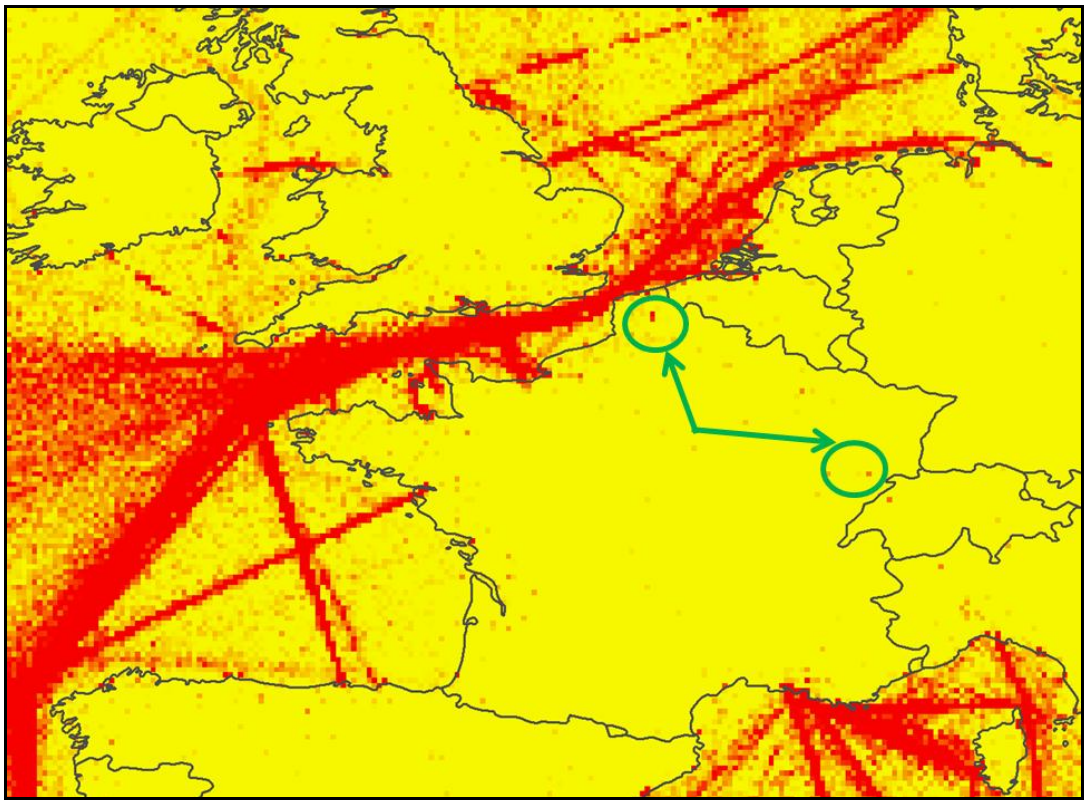

Figure 24: Modified global shipping proxies on base of Wang et al. (2008)

7.4. Emissions and proxy data sets

Table 34 shows emission values of the different pollutants for the international shipping activities.

Table 34: International shipping releases to air distinguished by source category and pollutants

Sector	Sector Code	Sector_Name	Emissions in 2008				
	[NFR]	[NFR]	CO_2 [kt]	NO_x [t]	SO_2 [t]	PM10 [t]	CO [t]
			UNFCCC	CLRTAP			
International Shipping	1 A 3 d i (i)	International maritime navigation	53,215	843,553	649,581	66,409	73,225
	1 A 3 d i (ii)	International inland waterways	530	20,906	2,515	820	4,683
	Sum		53,745	864,459	652,096	67,229	77,908
All reported emissions from EU27 + EFTA4 countries			**4,743,992**	**13,844,818**	**7,638,468**	**2,426,902**	**29,399,783**

The spatial distribution and the attribution of grid cells for each pollutant are based on the emissions presented summarized in table 26. The main proxy data sets are:

- traffic volume and accessibility of inland waterways ;
- geo- referenced data for rivers .

The corresponding main sources are:

- International shipping proxies (Wang et al., 2008)
- TRANS-TOOLS (2010)
- Voies Navigables de France (VNF, 2010)
- GISCO Watercourses from EuroRegional Map v30 (HYDR) (GISCO, 2010)
- EUROSTAT GISCO location and area of harbours(GISCO, 2010)

The main selection criteria for the chosen proxy data for the spatial distribution of emissions from the international shipping activities are availability and consistency of data. In Table 35 the main proxy variables are shown used for spatial distribution of the diffuse part of international shipping.

Table 35: Proxy data sets used for the spatial distribution of the international shipping

Sector	Sector_Code [NFR]	Subsector (NFR)	Proxy Dataset	Data Source	Year	Extend
International shipping	1A3di(ii)	International emissions on inland waterways	Traffic volume	TRANS-TOOLS	2010	Selected countries
			River geo data	GISCO (HYDR)	2010	EU 27 + EFTA
			Selected traffic data for selected waterway sectors	Voies Navigables de France (VNF)	2010	Selected countries
	1A3di(i)	International maritime navigation	Georeferenced global data set (activities & emissions)	Wang et al. (2008)	Updated 2010	Worldwide

7.5. Existing gridding methods and applied proxy data sets

EDGAR approach

The EDGAR approach can be described as a combination of a bottom-up and a top-down approach. The calculation of the emissions is the bottom-up part and the spatial distribution using the global shipping proxies Wang et al. (2008) and population maps is the top-down part.

The calculation of the emissions is realized using emission factors and fuel statistics from International Energy Agency Statistics (IEA, 2007), considering information on fuel usage of the different vessel types. The EDGAR approach also calculates emissions on the ports considering port activities and ship types.

The spatial distribution of the international maritime shipping based on the calculated emissions is also realized using the 6min x 6min resolved global shipping proxies from Wang et al. (2008). The domestic shipping is spatially resolved using population density maps. For more detailed information see http://edgar.jrc.ec.europa.eu/factsheet_1a3d-1c2.php.

ENTEC approach

The ENTEC approach can be described as a bottom up approach considering sea shipping, port and inland waterway activities.

"In bottom-up approaches emissions are directly estimated within a spatial context resulting in spatially resolved emission inventories. Ship- and route specific emissions are calculated based on ship movements, ship attributes (e.g., ship type, size, speed, and engine power), and ship emission factors. The locations of emissions are determined by the most probable shipping routes. A bottom-up inventory for Europe has been developed by ENTEC UK Limited." (Paxian et al., 2010)

The aim of the ENTEC study is the assignments of ship emissions to European countries. "Emissions to be assigned are sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), particulate matter (PM) and carbon dioxide (CO_2), for the years 2000, 2010, 2015, and 2020. Seven different methods were applied to assign emissions to each EU25 Member State plus Bulgaria, Romania, Turkey and Croatia." (ENTEC, 2005)

Global shipping proxies

The global shipping proxies and emissions from Wang et al. (2008) are calculated using ship activity patterns depicted by the International Comprehensive Ocean–Atmosphere Data Set (ICOADS), the Automated Mutual-Assistance Vessel Rescue System (AMVER) data set, and their combination (see for detailed description Wang et al. (2008)). According to the homepage of University of Delaware College of Marine and Earth Studies the improved ICOADS data set, which is available at the homepage is the most appropriate global ship traffic proxy identified to date for using a top down approach (Global shipping proxies, 2010).

The Wang et al. (2008) data set analyses a waterway network composed of the routes actually used by ships (Miola & Ciuffo, 2011). "They evaluate the traffic (for different ships' categories) on each link of the network by using information on the trade activities to calculate the traffic demand between different pairs of ports. They evaluate fuel consumption, emissions and their spatial distribution based on assumptions on the average travel time for each link of the network" (Miola & Ciuffo, 2011). The global shipping proxies are available at a resolution of 6min by 6min (approximately 12 km x 12km). As a consequence, the results of the spatial distribution of the international maritime shipping are basically also in the same resolution, but divided into 5km grid cells.

Voies Navigables de France (VNF, 2010)

The VNF (2010) is the national inland waterway department of France. VNF provides basic information on the European waterways on a map (see European waterways map for more details). The map delivers information on the accessibility of inland waterways for the major inland waterways in Europe considering the "Classes of navigable waterways". The VNF map delivers additional information to the traffic volume calculated in Trans-Tools. The VNF waterway map considers following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, France, United Kingdom, Hungary, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia, and Spain.

7.6. Applied models

For the spatial distribution of the international shipping releases basically only the Trans-Tools model is used. The Trans-Tool model is especially necessary to distribute the international shipping on the inland waterways see also chapter 7.3 as well as chapter 6.6 for more information.

TRANS-TOOLS (2010)

The Project TRANS-TOOLS (2010) - Tools for transport forecasting and scenario testing - aims to produce a European transport network model covering passenger and freight, as well as intermodal transport, which overcomes the shortcomings of current European transport network models. (For more information see: http://energy.jrc.ec.europa.eu/transtools/ or http://www.transport-research.info/web/projects/project_details.cfm?id=11088.)

The TRANS-TOOLS model (2010) is mainly used to spatially distribute the domestic and international emissions on the inland waterways. The information used to accomplish the spatial allocation is the traffic volume with the associated river network. The TRANS-TOOLS model (2010) covers the major waterways in the following countries: Austria, Belgium, Bulgaria, Czech Republic, Germany, France, United Kingdom, Hungary, Lithuania, Luxembourg, Netherlands, Poland, Romania, and Slovakia.

For the international inland waterway shipping at the moment only Netherlands and Belgium are reporting additional emissions to the maritime shipping.

7.7.Conclusion and result

The spatial distribution of international shipping activities needs as described in chapter 7.2. a pre-processing of the emission data for allocation of emissions from the international maritime shipping emitted in Europe. This step is basically performed to identify the part of the reported emissions which are emitted within the model domain.

The gridding of the emissions from international inland waterway shipping is performed using traffic volume data from TRANS-TOOLS (2010) and traffic data from VNF (2010) in combination with river geo data from GISCO (HYDR) (2010). The emission of international maritime shipping is allocated to the grid cells using global shipping proxies from Wang et al. (2008). The remaining part of the international inland waterway shipping is distributed using TRANS-TOOLS (2010) and VNF (2010) data in combination with the river geo data from GISCO (HYDR) (2010). The results for the spatial distribution of SO_2 emissions are shown in Figure 25.

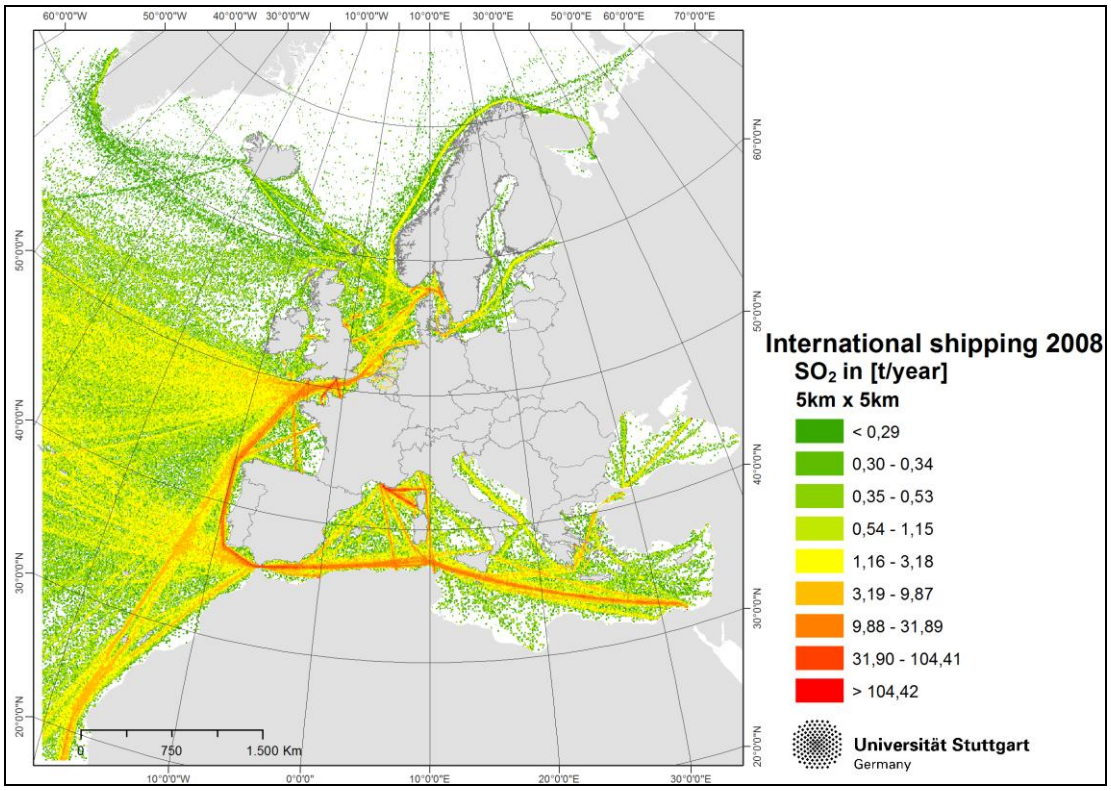

Figure 25: Gridded SO_2 emissions from international shipping in Europe for the year 2008

8. Gridding methodology for domestic aviation activities

8.1. Sector description

This sector covers emission released by domestic aviation activities including:

- Civil aviation within a country (domestic **L**anding and **T**ake-**O**ff cycles, LTO)
- Combustion emissions from mobile sources including movement of people and/or freight by air (EMEP/EEA Emission Inventory Guidebook, 2009).

The landing and take-off cycle covers all air traffic activities below a height of 1000m at and close to the airport. This includes taxi-out, take-off, climb-out, approach landing, and taxi-in (EMEP/EEA Emission Inventory Guidebook, 2009). Since transport sector emissions are not included in the E-PRTR regulation reporting requirements, all emissions released from these activities are considered as releases from diffuse sources. The relevant sector codes for Civil Aviation (Domestic, LTO) are NFR 1A3aii(i) related to the CLRTAP reporting system and CRF 1A3a related to the UNFCCC reporting system

Pollutants covered: NO_X, PM10, SO_2, CO and CO_2.

8.2. Emission data input

The emission data used for the spatial distribution of the domestic aviation sector are:

- National emissions of CO_2 available from the EEA-website for 2008 (EEA/UNFCCC v.11, 2010)[34]
- National emissions reported to "Convention on Long-Range Transboundary Air Pollution[35] (EEA/CLRTAP v.10, 2010)

Emission data used are national totals reported to CLRTAP as NFR 1A3aii(i), Civil Aviation (Domestic, LTO) for CO, NO_X, PM10, and SO_2, and to UNFCCC as CRF 1A3a, Domestic Aviation data for CO_2 emissions.

The CO_2 emission data for the civil domestic aviation (CRF 1A3a) for the year 2008 is reported to UNFCCC without a distinction between releases emitted during LTO cycles and cruise. Therefore in order to distinguish the CO_2 emissions between LTO and cruise, the NO_x emissions, reported to CLRTAP, are used as a proxy. The countries without corresponding information for the civil domestic aviation for NO_x (e.g. only LTO emissions are reported) were distinguished using a European average NO_x share between LTO and cruise related emissions. The relevant countries without the corresponding infor-

[34] The emission data originate from http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-4 (downloaded at 12th July 2010, Version 11)

[35] The emission data originate from: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4 (downloaded at 12th July 2010, Version 2010 for 2007)

mation are: Greece, Iceland, Italy, Netherlands, Slovenia and Slovakia. The choice to use the NO_x emission as a proxy for CO_2 relies on the fact that the emission share correlate quite good as both pollutants are related to combustion processes.

Cruise related emissions are by definition above 1000m. They have no direct impact to the regional air quality. Therefore they have not been taken into account here. Emissions related to international flight activities have not been taken into account because these emissions are outside of the direct reporting obligations of the countries.

8.3.Applied methodology

The methodology developed for this sector is based on the assumption that domestic aviation emission data below 1000m is based on existing methods applied in Europe. Spatial distribution of emission data into the 5km x 5km target grid cells generally is carried out using the approach given in the formula:

$$emission_{i,x} = emission_t \times \frac{value_{i,x}}{\sum_i value_{i,x}}$$

where:

- ***i:*** is a specific geographic feature;
  here: airport allocation within the grid layer
- ***x***: is a sector that is characterized by the surrogate dataset (x).
- ***emission*** $_{i,x}$*:* is the emissions attributed to a specific geographical feature i (e.g. a grid, line, point or administrative boundary) within the spatial surrogate dataset x;
  here: emission of domestic aviation (only LTO cycles for domestic flights)$_x$ at the specific airports within each EU27 and EFTA4 Member state
- ***emission*** $_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset;
  here: national total emission of domestic aviation (only LTO cycles for domestic flights)$_x$
- ***value*** $_{i,x}$ - are the surrogate data value (e.g. population density) for each geographical feature within the spatial surrogate dataset x.
  here: the fraction of domestic LTO cycles as part of the sum of all domestic LTO cycles is allocated to the area fraction of each i airport within the 5km x5km target grid cell within the respective EU27 and EFTA4 member state

Spatial distribution and gridding

The methodology for spatial allocation of the diffuse emissions of domestic aviation (CRF 1A3a) from LTO cycles contains two main steps:

1. **Regionalization of national emission releases**: The share of the national total emission of each pollutant is allocated on the basis of statistical proxy data for each airport using LTO cycle data from EUROSTAT.

2. **Gridding: The emission releases are allocated (**spatial distribution) to the 5 km x 5 km target grid using:

    1. CORINE Land Cover data (CLC2000/2006, 2010)
    2. EUROSTAT GISCO (GISCO, 2010) airport area data set
    3. EUROSTAT GISCO (GISCO, 2010) point data set on airport locations
    4. the allocation of airport areas within each 5 km x 5 km grid cell, derived using CORINE Land Cover data (CLC2000, CLC2006 class "1.2.4: Airports") and EUROSTAT GISCO airport area data set (GISCO, 2010)
    5. Calculation of gridded emission values by combining regionalized emissions and proxy data indices

8.4.Emissions and proxy data sets

Emission data sources

In Table 36 the emissions of domestic aviation (only LTO cycles) for each pollutant considered are shown. The national total emission is aggregated for the EU27 and EFTA4 countries, using 2008 CO_2 emission data reported to UNFCCC, and 2008 data of NO_X, SO_X, PM10 and CO reported to CLRTAP.

Table 36: Emissions from domestic aviation activities in EU27 and EFTA4 countries

Sector	Sector Code	Sector_Name	Emissions in 2008				
	[NFR]	[NFR/CRF]	CO_2 [kt]	NO_x [t]	SO_2 [t]	PM10 [t]	CO [t]
			UNFCCC	CLRTAP			
Domestic aviation	1A3aii(i) /1A3a	Civil Aviation (Domestic. LTO) /a. Civil Aviation	7,771	35,533	2,560	655	73,687
	Sum		7,771	35,533	2,560	655	73,687
All reported emissions from EU27 + EFTA4 countries			**4,743,992**	**13,844,818**	**7,638,468**	**2,426,902**	**29,399,783**
Countries for which no data are available from official reporting			*2 countries: CY, HU*	*5 countries: CY, HU, LI, LT, RO*	*7 countries: CY, EE, HU, LI, LT, PL, RO*	*13 countries: BE, BG, CY, CZ, EE, GR, HU, LI, LT, LU, MT,RO, SI*	*7 countries: CY, HU, LI, LT, LU, MT, RO*

However, data on domestic aviation are not available for all EU27 and EFTA4 member states for the year 2008. A lack of data for all five pollutant releases considered is observed for Cyprus (CY) and Hungary (HU). In Table 36 the total annual emissions of the EU27 and EFTA4 member states are given, where at present no emission data for the respective pollutants are available.

The data gaps on domestic LTO emissions could be closed by using EUROSTAT data on LTO cycles combined with pollutant specific average LTO emissions factors from the Emission Inventory Guidebook (2009). Since no gap filling is carried out in this project only available national total emission data officially reported by the countries are used.

According to the described method only the available domestic LTO emissions are spatially resolved. This leads in some cases to unexpected results e.g. the Brussels airport is not shown in the domestic aviation map, because smaller airports more frequented by domestic flights, especially in relation to larger airports. For the larger airports the corresponding emissions are distributed to more grid cells due their spatial extension. This causes a reduction of the absolute value for the airport specific grid cells. In addition, during the rationalization process, which was performed to improve the map display performance, the grid cells with small values were deleted.

Proxy data sources

Detailed information on spatial allocation of the emission sources is needed in order to re-distribute and disaggregate national total emissions of the domestic aviation sector.

- NUTS (level 1 to level 3) data, intersected with the 5km x5km target grid, is used in order to allocate the shape, extent, and borders of the EU27 and EFTA4 countries within the whole mapping extent.
- EUROSTAT GISCO (GISCO, 2010) point data set on airport locations (using airport coordinates) is providing information on the location of the airports within EU27 and EFTA4 countries. This information is used to identify each airport as geographical object.
- CORINE Land Cover (CLC) (CLC1990/2000/2006, 2010) data on airport areas (polygon data; CORINE Land Cover level 3 code 1.2.4: airports) and the 2009 EUROSTAT GISCO (GISCO, 2010) airport area data set is providing information on the area extent of each airport. This information is used in combination with the EUROSTAT GISCO (GISCO, 2010) point data set airport identification. The quality of these data sets was checked randomly with satellite data and a strong relation could be identified.
- Activity data on emission at each airport is given by EUROSTAT LTO cycles (EUROSTAT LTO data 2008) at airports for domestic operations at each airport. These data are attributed to each airport location.
- Fractions of each airport area within each target 5km x5km grid cell (gridded polygon data) are attributed to airport locations (point coordinates, IDs), by overlaying and intersecting the respective airport areas from CLC airport area sub-grid information. The fraction of LTO cycles at each airport within the individual countries is calculated and attributed to each grid cell, where an airport is allocated.
- The final indicator for the distribution of the national totals of domestic aviation LTO emissions for each pollutant species considered is derived combining both, the fractions of LTO cycles at each airport within each nation, and the fractions of each airport area within each 5 km x 5 km grid cell.

Table 37 shows the used proxy data sets for the spatial distribution of the domestic aviation.

Table 37: Proxy data sets used for the spatial distribution of domestic aviation

Sector	Proxy Dataset	Data Source	Year	Extend
Domestic aviation	CORINE Land Cover 2000 and 2006 (air ports)	EEA	2000 and 2006	EU 27 + EFTA
	LTO cycles (Aircraft traffic data by main airport)	EUROSTAT	2010	EU 27 + EFTA
	Airport coordinates	GISCO	2006	EU 27 + EFTA

8.5.Existing gridding methods and applied proxy data sets

Gridding methodologies

Existing methods used for the spatial distribution of LTO emissions of the aviation sector, as summarized and outlined in the EEA Emission Inventory Guidebook (2009), , where allocated national emission estimates to airport locations, either as point source (using airport coordinates) or attributed to the area extent of the airport (using e.g. small scale land use data or similar proxy data as classified airport area size (Briggs, 2005) or a certain radius (e.g. 5 km) centered on the airport).

Recent methodology descriptions can be found in the literature for the MEET project (Methodologies for estimating air pollutant emissions from transport) (MEET, 1999), for the SAGE project (System for assessing Aviation's Global Emissions) in Kim et al. (2005), for the APMoSPHERE project in Briggs (2005) (Air Pollution Modeling for Support to Policy on Health and Environmental Risk in Europe, http://www.apmosphere.org/), and for the EDGAR project (Emissions Database for Global Atmospheric Research, http://edgar.jrc.ec.europa.eu/methodology.php, http://ccuprod2.jrc.it/wiki/index.php/Aviation_maps).

Basically, the existing methods are very similar to each other. All methods use airport coordinates and also LTO cycles to distribute the emissions from the domestic aviation. The main difference is in the attribution of the emissions to the airport area. The allocation of the emissions to the airport can be realized for instance using certain defined areas, circles around the airport coordinates or use the land use information to resolve the emissions to the grid. The distribution using the land use data is recently the best applicable method.

Proxy datasets for allocation of emissions

The base grid coverage used in this project is covering the EU27 and EFTA countries in 5km x5km grid resolution. In order to assign administrative borders and the area extent of land, sea, and of each country, NUTS level 1 to 3 regions are intersected with the base grid coverage and attributed in sub-grid resolution to the gridded polygon layer.

The geo-referencing for airports is performed using EUROSTAT GISCO (GISCO, 2010) data sets for airports, providing reference point locality information on about 1943 airports, and CORINE Land

Cover data (CLC2006, for GR and UK CLC2000, and CLC1990 for Switzerland) (CLC1990/2000/2006, 2010), providing information on the area coverage of these airports using CLC dataset level 3 class code 1.2.4: airports.

These locations of airports, being the source of the respective emissions of air traffic activities below 1000m during LTO (landing, taxi, take off) cycles, which includes passenger and freight transport during domestic operations, are linked and attributed to the base grid coverage polygon layer, using identifies (ID) for each airport. The ICAO (International Civil Aviation Organization) definition of LTO cycle is shown in Figure 26.

The definition of the LTO cycle is given in the Emission Inventory Guidebook (2009) (EEA, 2009) as follows: "LTO is an abbreviation for the Landing and Take-Off cycle. International Civil Aviation Organisation (ICAO) defines the LTO cycle as those activities occurring below a height of 3000 feet (914 m)", and, "The landing and take-off cycle includes all activities near the airport that take place below a height of 3 000 ft (914 m). This therefore includes taxi-in and -out, take-off, climb-out and approach-landing" (see Figure 26).

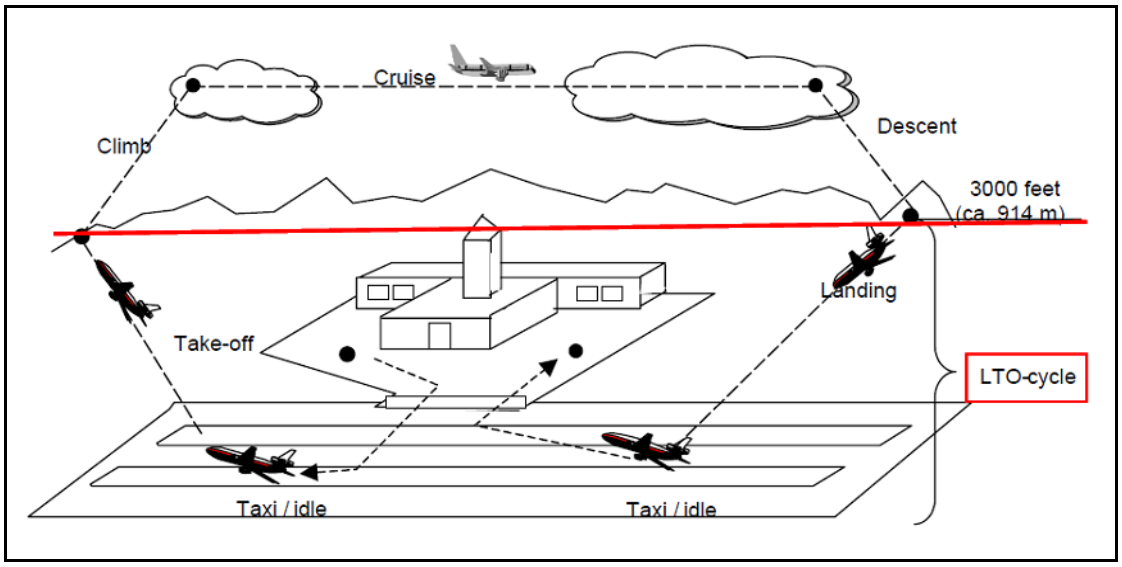

Figure 26: ICAO LTO cycle definition (EEA, 2009)

Information on the areas of each airport, taken from CORINE Land cover data set classes, is calculated as sub-grid fraction of each of the grid cells, and linked to the airport IDs using overlay and intersection procedures, and added in terms of attributes to the gridded airport location layers.

Quantitative information on all LTO cycles at each airport is derived from EUROSTAT data on LTO cycles for domestic and international operations, and also attributed to the respective ID of the gridded airport location layers.

Finally national total emissions of each of the species considered are distributed to the airport areas within the gridded airport location layers using the quantitative LTO cycle information for each airport.

8.6. Applied models

No third party models are applied.

8.7. Conclusion and result

Spatial disaggregation of officially reported national total emission estimates of the aviation sector to high resolution gridded GIS data layers over EU27 and EFTA4 countries is carried out. Information on land, sea and country extent within the mapping domain is attributed to the target grid cells on a sub-grid scale. Information on source distribution is approximated by airport location coordinates from GISCO (GISCO, 2010), and spatial extent of airports is defined using high resolution CORINE Land Cover class 1.2.4 data and the 2009 EUROSTAT GISCO (GISCO, 2010) airport area data set available with a resolution below 1km x 1km. Source intensity is derived using available EUROSTAT LTO cycle information of each airport within the mapping extent as activity data substitution. Emission data used for the gridding procedure are national totals of CLRTAP NFR 1A3aii(i), Civil Aviation (Domestic, LTO) data for CO, NO_X, PM10 and SO_2 emissions and UNFCCC CRF 1A3a, Domestic Aviation data for CO_2 emissions.

Generating proxy data sets, calculation, and/or linkage of all data sets is realized using GIS technique, preserving proper allocation of sources, proxy data and emissions within one gridding system. An outline with graphical illustration of the gridding procedures is summarised in Figure 27.

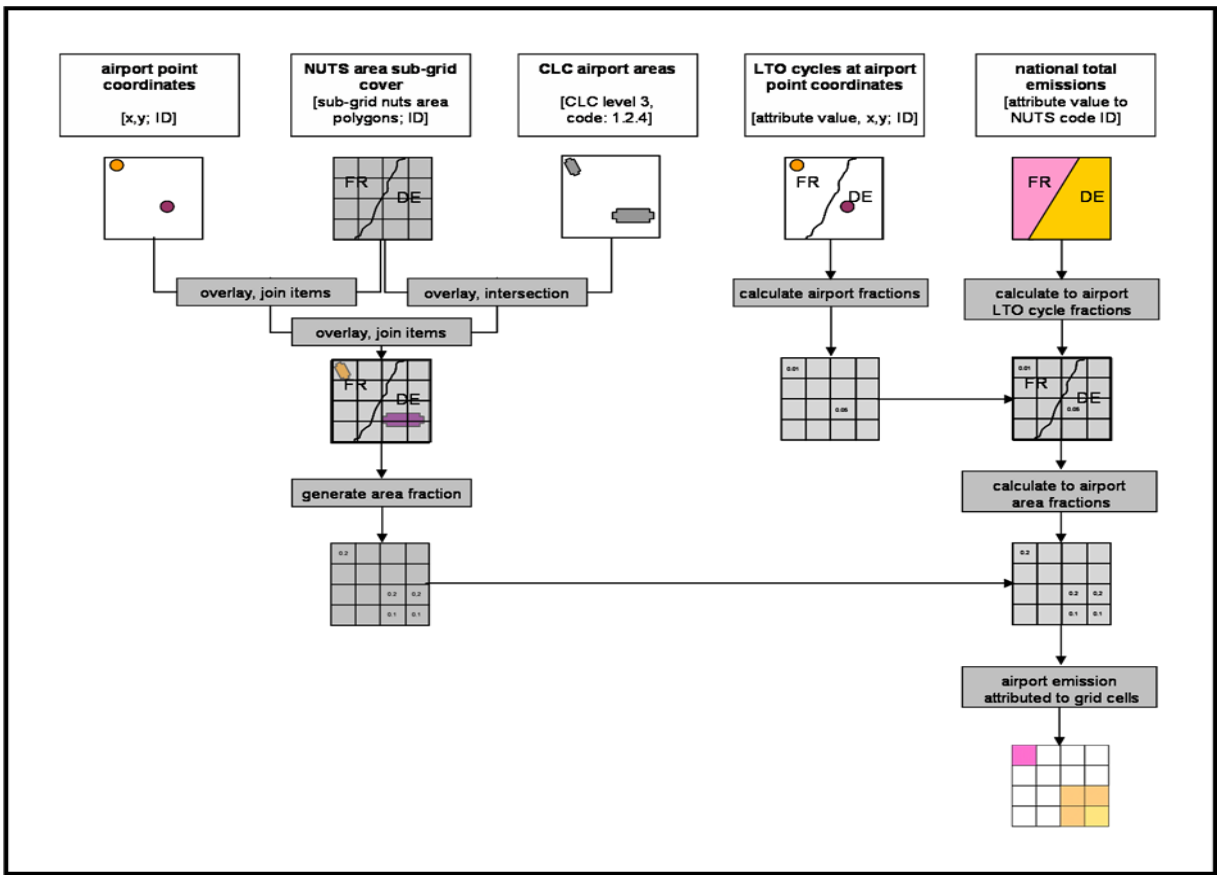

Figure 27: Outline of the aviation sector emissions gridding procedure

Basic input data are either GIS data sets (EUROSTAT GISCO (GISCO, 2010) airport location point and polygon maps providing coordinates, NUTS regions level 1 to 3 polygon layers, CLC data), or statistical and inventory data sets (EUROSTAT LTO cycles, UNFCCC and CLRTAP national total emissions). These data sets are successively combined, joined and linked, respectively, using mainly overlay and intersection technique within the GIS system, in order to derive gridded indicator values used for the spatial disaggregation of national total emissions.

In order to meet the needs of the E-PRTR web site, the emission data metric square gridded map layers are transformed from European Terrestrial Reference System (1989) - Lambert Azimuthal Equal Area Coordinate Reference System projection (ETRS_1989_LAEA_52N_10E), also used as EEA standard projection, into the geographic World Geodetic System 1984 (WGS84:4326) E-PRTR target projection. The transformation preserves area of data and allocation, but not shape of the gridded maps, and hence only affects visual effect of emission grid maps during transformation.

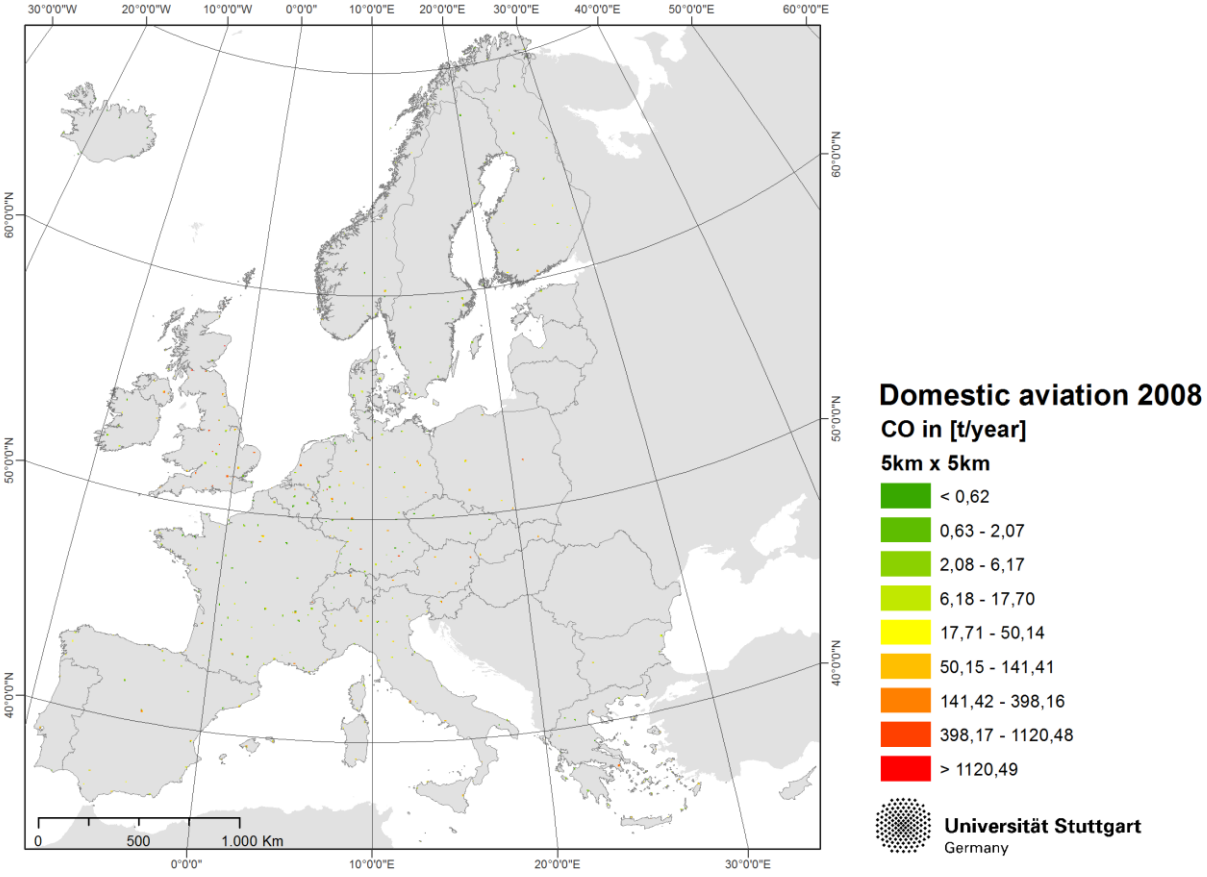

Figure 28: Gridding result for CO emissions using coordinates and LTO cycles from EUROSTAT

9. Gridding methodology for the agricultural releases

9.1. Sector description

This sector covers emission released by agricultural activities as animal husbandry and manure management (NFR 4B), crop production and agricultural soils (NFR 4D). The main pollution sources are animal waste digestion (grazing animals), fertilization, livestock farms and field operation.

The considered pollutants for this sector are:

- NH_3 released by:
  - animal waste digestion (grazing animals)
  - N-fertilizer application in crop production.
- PM10 released by:
  - livestock facilities and animal husbandry
  - soil cultivation and crop harvesting.

Pollutants covered: PM10, NH_3

9.2. Emission data input

The emission data used for spatial distribution of the agriculture sector are retrieved from the data reported by the countries to the "Convention on Long-Range Transboundary Air Pollution (CLRTAP)"[36] (EEA/CLRTAP v.10, 2010).

Before gridding, no additional preparation of the releases from agriculture sources is necessary, except of the subtraction process for point sources for swine (NFR-4B8) and for poultry (NFR-4B9) activities since they are also reported as point sources to E-PRTR (Activity 7.a Intensive rearing of poultry or pigs with a capacity threshold of 40.000 places of poultry, 2000 places pigs (over 30 kg) and 750 places for sows). Details on the subtraction method are given in chapter 2.

[36] CLRTAP_NFR09_GF_v10 (Convention on Long-range Transboundary Air Pollution) [URL: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-4, 05.08.2010]

9.3. Applied methodology

The methodology developed for this sector is based on the assumption that the agricultural emissions are correlated with the spatial distribution of the different type of agricultural land (land cover classes). In particular the emissions of NH_3 and PM10 caused by crop production and from agricultural soils are affected by two determines:

- Amount of fertilizer used

- Logistic of distribution of agricultural products

The emissions are therefore allocated as a function of fertilizer–N use and of handling and transport of agriculture products and they are spatially disaggregated using the distribution of agricultural land cover classes (CLC2000/2006, 2010).

The method for emissions allocation for the sector is based on the following formula (EEA, 2009):

$$emission_{i,x} = emission_t \times \frac{value_{i,x}}{\sum_i value_{i,x}}$$

where:

- ***i:*** is a specific geographic feature;

  here: e.g. an administrative unit at NUTS 3 level for the regionalization and 5km x 5km grid for gridding

- ***x***: is a sector that is characterized by the surrogate dataset (x).

- ***emission $_{i,x}$:*** is the emission attributed to a specific geographical feature i (e.g. an administrative unit or grid cell) within the spatial surrogate dataset x;

  here: emissions released by agricultural activities in a specific administrative unit or grid cell (5km x 5km) using the amount of animal or land cover classes as surrogate dataset x;

- ***emission $_t$*:** is the total amount of national emissions for a sector t to be distributed across the national area using the (x) surrogate spatial dataset;

  here: the amount of national total emissions from agricultural activities (see Table 32) for each pollutant reported to CLRTAP (NH_3 and PM_{10})

- ***value $_{i,x}$***: are the surrogate data value of each of the specific geographical features within the spatial surrogate dataset x;

  here: the number of animals in each NUTS3 region related to the animals number at national level and area of determined CORINE Land Cover classes (CLC) in each 5km x 5km grid cell related to area of determined CLC on NUTS3 level

The methodology for spatial allocation of the diffuse share of emissions from agriculture activities caused by animal husbandry and manure management (NFR 4B) contains two main steps:

1) Regionalization of national emission releases:

- The share of the national total emission of each pollutant to NUTS 3 level is allocated using the numbers animal at regional level provided by EUROSTAT combined with FAO data (2010).

2) Gridding:

- The allocation of the emission releases on NUTS 3 level to each grid cell of the defined 5km x 5km grid is achieved using the following data :
  v. Land cover type (CLC2000/2006 (2010), CLC1990 Switzerland (2010));
  vi. Area calculations of determined land cover types for each NUTS3 unit and grid cell (e.g. Land use class "pastures" – CLC2000/2006(2010), CLC1990 Switzerland(2010));
  vii. Calculation of the share of determined land cover types in each grid cell in relation to the determined land cover types at NUTS3 level (e.g. Land use class "pastures" – CLC2000/2006 (2010), CLC1990 Switzerland (2010));
  viii. Calculation of emission values for each grid cell/polygon based on combination of the applied proxy data.

The emission caused by crop production and agricultural soils (NFR 4D sector) is allocated directly into a 5km x 5km grid using the following land use category “class 2: **Agricultural areas**, except the sub-classes 2.1.3. (rice fields)”.

In order to distribute the emissions between cattle and sheep livestock, the information about the distribution of grazing land is used. For distributing emission releases between pigs and poultries, the distribution of all non-urban land is used following the approach developed by (Dragosits, 1998). The amount of agricultural land, including pastures, natural grassland, non-irrigated arable land etc. spread over the administrative units, are grouped on NUTS 3-Level.

9.4. Emissions and proxy data sets

Table 38 shows the European emissions from agricultural activities (NFR 4B and NFR 4BD) in relation to the officially reported emission totals to CLRTAP (all EU27 + EFTA4 countries).

Table 38: Diffuse emissions of PM10 and NH_3 from agricultural activities in EU27 + EFTA4 countries

Sector	Sector_Code	Sector_Name	Emissions (2008)	
	[NFR[1]]	[NFR]	NH_3 [t]	PM10 [t]
Manure Management and animal husbandry	4B1a	Cattle Dairy	780,849	7,737
	4B1b	Cattle Non-Dairy	746,776	9,644
	4B2	Buffalo	71,227	116
	4B3	Sheep	9,687	592
	4B4	Goats	62,675	85
	4B6	Horses	10,983	667
	4B7	Mules and Asses	52,809	36
	4B8	Swine	462,578	46,290
	4B9a	Laying Hens	104,708	13,367
	4B9b	Broilers	77,071	22,855
	4B9c	Turkeys	11,650	371
	4B9d	Other Poultry	102,553	19,032
	4B13	Other	71,227	2
Crop production and agricultural soils	4D1a	Synthetic N-fertilizers	844,740	102,445
	4D2a	Farm-level agricultural operations incl. storage, handling and transport of agricultural products	4,240	29,042
	4D2b	Off-farm storage. handling and transport of bulk and agricultural products	0	86
	4D2c	N-excretion on pasture range and paddock Unspecified	28,503	0
	Sum		**3,442,278**	**252,367**
All reported emissions from EU27 + EFTA4 countries			**3,898,001**	**2,426,902**

The spatial distribution to grid cells for each pollutant is based on emissions presented in Table 38 in combination with the following proxy data sets:

- animal numbers
- land use data.

Table 39 lists the main proxy variables used for spatial distribution of diffuse emissions from the agricultural sector.

Table 39: Main proxy variables used for spatial distribution of the agricultural sector

NFR_Code	Sector_Name	Proxy Data for Regionalisation	Proxy Data for Gridding
4B1a	Cattle Dairy	Animal data (EUROSTAT, 2008) & Animal density (FAO, 2005 (2010))	*CORINE Land Cover (2010)* (CLC90) Switzerland (CLC 2000) Europe (CLC 2006) Europe class 2: Agricultural areas 2.1. Arable land 2.2. Permanent crops 2.3. Pastures 2.4. Heterogeneous agricultural areas
4B1b	Cattle Non-Dairy		
4B2	Buffalo		
4B3	Sheep		
4B4	Goats		
4B8	Swine		
4B6	Horses	---	
4B7	Mules and Asses		
4B9a	Laying Hens	Animal density (FAO, 2005 (2010))	
4B9b	Broilers		
4B9c	Turkeys		
4B9d	Other Poultry		
4B13	Other	---	
4D1a	Synthetic N-fertilizers	---	*CORINE Land Cover (2010)* (CLC90) Switzerland (CLC 2000) Europe (CLC 2006) Europe class 2: **Agricultural areas** except the sub-classes 2.1.3. (rice fields)
4D2a	Farm-level agricultural operations incl. storage, handling and transport of agricultural products		
4D2b	Off-farm storage, handling and transport of bulk agricultural products		
4D2c	N-excretion on pasture range and paddock Unspecified		

EUROSTAT statistical data contains the annual total population of buffalos, cattle, sheep, pigs, goats and dairy cows on NUTS 2 level, however with some gaps. These gaps are in EUROSTAT with "**:**" (colon) marked and in the legend of EUROSTAT as Data "*Not available*" explained. Table 34 shows the missing animal data on NUTS2 level (in total exists 282 NUTS2 units in the considered EU27 + EFTA4 countries related area).

Table 40: Missing animal data on NUTS2 level from EUROSTAT (2008)

NFR_Code	Sector_Name	NUTS2 level
4B1a	Cattle Dairy	73 NUTS2 unit are missing
4B1b	Cattle Non-Dairy	73 NUTS2 unit are missing
4B2	Buffalo	165 NUTS2 unit are missing
4B3	Sheep	127 NUTS2 unit are missing
4B4	Goats	132 NUTS2 unit are missing
4B8	Swine	103 NUTS2 unit are missing
4B6	Horses	not available
4B7	Mules and Asses	not available
4B9a	Laying Hens	not available
4B9b	Broilers	not available
4B9c	Turkeys	not available
4B9d	Other Poultry	not available
4B13	Other	not available

Therefore the FAO (2010) animal density data for 2005 with a resolution of 3 arc minutes (approximately 3.5 km at 50° N latitude) are used for gap filling of the missing animal numbers and for allocation the EUROSTAT animal data to NUTS3 level. FAO data concern gridded livestock distributions for the entire globe for the following animal species: cattle, buffalos, goats, sheep, pigs and poultry; these data are derived from "The Food and Agriculture Organisation ´s Gridded Livestock of the World". While the emissions released by horses (NFR 4B6), mules and asses (NFR 4B7) and other (NFR 4B13) are distributed directly to the 5km x 5km grid cell using the CORINE Land Cover classes since they are not available in the EUROSTAT dataset on NUTS2 level nor in the gridded FAO data. For the agriculture sector (NFR4B and NFR4D) the following CORINE land classes are taken into account:

Agricultural areas (CLC Class 2):
- 2.1. Arable land
- 2.2. Permanent crops
- 2.3. Pastures
- 2.4. Heterogeneous agricultural areas

The geographical coverage of CLC2006 (2010) includes all countries within Europe except UK, Greece and Switzerland. In order to close the gap, CLC2000 (2010) and CLC1990 (2010) for Switzerland are used.

Different gridding methodologies are used on country level. This paragraph present some interesting approaches used for gridding emissions releases from agriculture that where found innovative but could not be used at European level for lack of adequate spatial allocation data only available at country level.

UK approach:

Emissions of PM10 from agricultural livestock and poultry sources are distributed to a 1 km x 1 km grid resolution using a combination of animal census and land use data. For England data from Department for Environment Food and Rural Affairs (Defra) on farm level was collected. For Scotland,

Wales and Northern Ireland agricultural census data were only available for larger spatial units - Parishes in Scotland, Districts in Northern Ireland Small Areas in Wales and therefore the land use data were used to generate an emission distribution within these spatial units. The resulting distributions for England, Scotland Wales and Northern Ireland were combined and weighted according to the relevant regional statistics on the number of livestock or poultry in these regions (Bush et al., 2008).

The distribution of NH_3, releases from agricultural sources is mapped on a 5km x 5km grid resolution. Data from agricultural census for whole UK were combined with emission factors for livestock and fertilizer use and the Land Cover Map 2000 data from the Centre for Ecology and Hydrology (CEH) within the Atmospheric Emissions for National Environmental Impacts Determination model (AENEID) to calculate emission maps (Bush et al., 2008). In comparison to the E_PRTR approach, where emission factors for calculating the emission maps weren´t used, the UK approach is more detailed.

UK distributed emissions releases by other agricultural activities as well as off-road machinery, agriculture machinery, field burning of agricultural waste (PM10 emissions, PM2.5 emissions). For mapping emissions from agricultural off-road machineries and vehicles, the Centre for Ecology and Hydrology (CEH) Land Cover Map 2000 data (combination of arable, pasture and forestry land use) were applied. Each of these land cover classes was weighted according to the off-road machinery activity on each land use.

EDGAR Modell used by JRC:

The spatial allocation of emissions released by animal husbandry applied by the EDGAR Model is based on animal density maps based on FAO (2010) data sets about cattle, buffalo, goats, pigs, sheep and poultry numbers. *Other animals are allocated via the grassland map* generated by the EDGAR project (2010) [http://edgar.jrc.ec.europa.eu/factsheet_4a-b-d2.php].

NL approach:

The allocation of PM10 and NH_3 emission to a grid is based on numbers of livestock and land use data using the GIAB database (**G**eographical **I**nformation System for **A**gricultural Farms), which records the location of every farm. Various farm data are linked to farm locations, originating from the agricultural survey carried out by the Ministry of Agriculture, Nature and Food Quality Livestock data derived on data from the Animal Health Service. In this way the spatial allocation of emissions is rather precise when combined with Country specific emission factors for PM10 per animal category. The applied emission factors are in accordance with the factors used by the Netherlands Environmental Assessment Agency (PBL) to report data to the Netherland Pollutant Release & Transfer Register and E-PRTR. Additionally other determines as the mineral excretion per category of livestock, the ammonia volatilization percentages of various barn types, manure application techniques and statutory fertilization norms are used for calculation and allocation of the ammonia emission (PRTR Netherlands, 2010).

The protection of privacy of individual farms is ensured by presenting the emissions in cells only if there are more than five farms, but by distributing the emissions equally across these cells. Table 41 shows the main characteristics of the gridding methodologies for UK and NL.

Table 41: Available methodologies for the spatial distribution of the agricultural sector

Methodology	Characteristics
NAEI Emission Mapping Methodology (2006) (UK)	PM10 emission distribution at high resolution (1km x 1km grid cell) based on detailed agriculture census and land use data. NH_3 emission distribution at resolution (5km x 5km) using emission factors for livestock and fertilizer use and Land Cover Map 2000 data within the AENEID Model Bottom - Up Method
Spatial allocation of diffuse agricultural emissions - The Emission Register project (PRTR Netherlands, 2010)	PM10 and NH_3 distribution at high resolution (1km x 1km and 5km x 5 km) based on farm data linked to specific locations, emission factors for PM10 per animal category and land use data Bottom - Up Method
E-PRTR Methodology	Available land cover data; Available animal data High resolution (5 km x 5 km grid cell) emission distribution maps. Top down method

9.5. Applied models

No third party models are applied.

9.6. Conclusion and result

The allocation of emissions released by the agricultural activities of animal husbandry and manure management (NFR 4B) activities is based on animal census from EUROSTAT, gridded animal data from FAO (2010) and CORINE Land Cover data (2010). On the basis of this information it was possible to allocate the diffuse emissions of PM_{10} and NH_3 released by each animal in a high spatial resolution of 5km x 5km across Europe. A different approach has been used for the allocation of the emissions of NH_3 and of PM_{10} from crop production and agricultural soils (NFR 4D) are generally proportional to the amount of applied N-fertilizers and agricultural activities. The emissions are allocated directly into 5km x 5km grids using the area calculation of CORINE Land Cover classes 2 that provide information on agricultural areas in each grid cell.

Figure 29 shows the NH_3 emissions from agricultural activities for Europe distributed on a 5km x 5km grid. The main source for NH_3 emissions is the agricultural sector, contributing about 95% of the whole amount of NH_3 emissions in Europe.

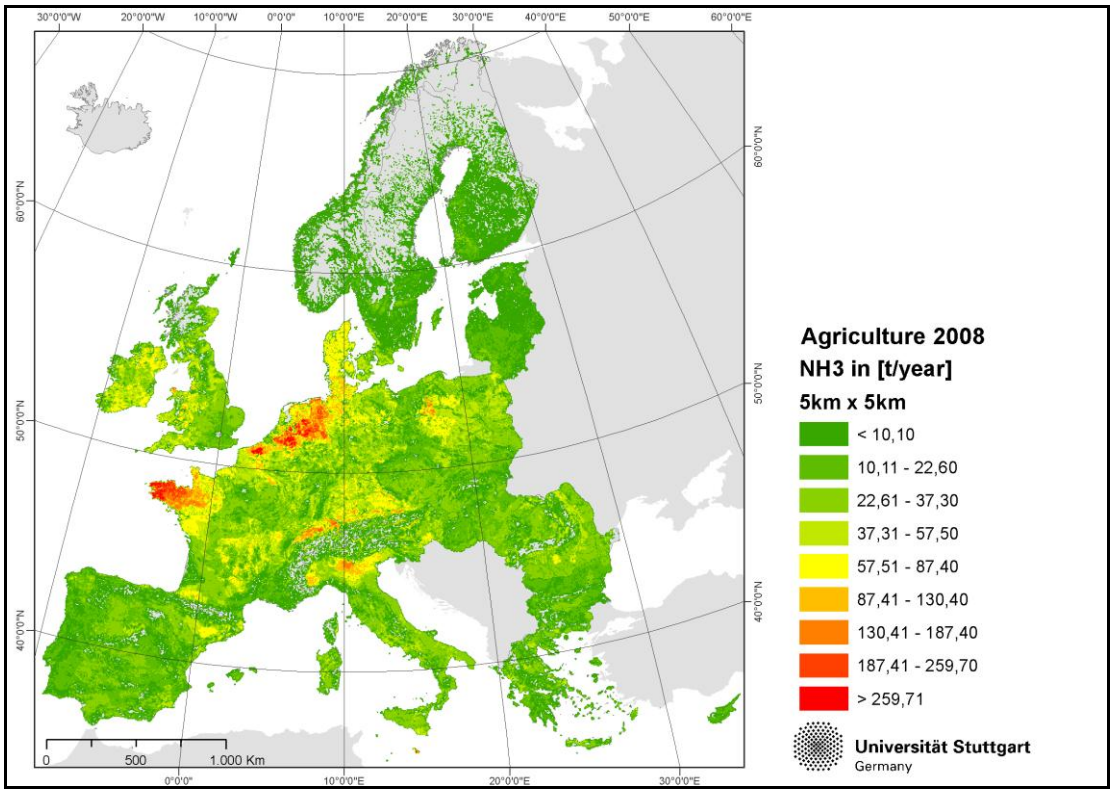

Figure 29: Gridded NH_3 emissions from agricultural activities in Europe for the year 2008

10. Rationalization Procedure

The created 32 European Emission maps are public available and allow citizens to localize the focal points of air pollution from diffuse sources. Due to the large number of 5km x 5km cells over Europe would be the visualization on the E-PRTR website very slow and so not really user-friendly. The fast improvement in performance over the raw data was therefore carried out by dissolving process using ArcGIS 10[37].

The following steps are necessary regarding the improving the performance of the maps:

1. Minimizing decimal digits by rounding the pollutant values to one decimals number
2. ”No data” and “0” emission is deleted from the data sets
3. Indexing of the tables
4. Dissolving neighbouring grids with identical values

With the applying the minimizing the data volume of the maps shrunk for example the 5km² grid file/map from residential sector from 315Mb to 3.5Mb and the display boots from > 1minute to < 1 second (respectively 0.4 sec of delay), which was the criterion for the visualization maps. All maps are therefore carried out by this method and visualized using a file with one decimal place. The drawback with this method is that the dissolving process (aggregation of cell information with identical values) corresponds with loss of individual cell information. The exact pollutant information is not retained on the cellular level, but aggregated to better performing datasets. This disadvantage is still “tolerable” in comparison to the slow visualization performance of the original compiled data sets.

[37] ArcGIS 10: ESRI product, for more information see: http://www.esri.com/software/arcgis/arcgis10/

11. Conclusion and recommendation for future work

This document describes the methodologies developed for the spatial distribution of diffuse emissions for EU27 and EFTA (Switzerland, Iceland, Lichtenstein and Norway) countries. The dissemination of this work on diffuse emission source is of relevance for the scientific community of modelers working at regional and global scale given the consistent methodology applied at European level. Furthermore environmental authorities and civil society have been provided with exemplary default grid maps covering key air pollutants and greenhouse gases that can be used as model for setting up local emission inventories.

The distribution was realized with a spatial resolution of 5 km x 5 km considering the pollutants NO_x, SO_2, PM10, CO, NH_3 and CO_2 from the following sources:

- On-road transport activities
- National and international shipping activities
- Domestic aviation activities
- Stationary commercial and residential combustion activities
- Industrial releases from Annex I of the E-PRTR Regulation below the capacity thresholds (Annex I) and release thresholds (Annex II) of the Regulation
- and emissions of NH_3 and PM10 from agricultural activities.

Diffuse sources are defined as sources which are not monitored as point sources by the E-PRTR Regulation.

For the industrial and agricultural sectors, which contain both diffuse sources and E-PRTR point sources, a consistent subtraction methodology for quantifying the country specific diffuse share of emissions was developed and applied.

The description of the approaches includes the explanation of the selection of distribution parameters, which are necessary for the gridding of diffuse emissions for each pollutant and each sector.

Based on the developed methodologies, spatial emission maps covering all EU27 Member states and the EFTA countries (Switzerland, Liechtenstein, Norway and Iceland) for the selected sectors and pollutants have been produced.

The accepted differences between input and output data (input-output-check) of the spatially resolved emissions are for the NUTS3 level 5 $*10^{-8}$ % and for the grid level 0.1%. On the grid level for countries with reported emissions considering oversea territories outside the model domain like Spain, Portugal, France, and United Kingdom the threshold is defined at <5%.

The results presented in this document have the highest resolution for the model domain of EU27 and EFTA, considering the most up to date data sets and methodologies for the relevant sectors on the European scale. Still, there are limitations of the results as well as of the used data sets and of the methodologies. The aim of the following section is to summarize the limitations and to give recommendations for future improvements.

Beginning with limitations, one of the main limitations is that the emission reporting situation is heterogeneous among the European countries. For instance, PM10 emissions were not reported from agricultural sources from many countries like Portugal, Greece, Norway, Hungary, etc. Table 42 gives an overview of the reporting situation of the relevant European countries. The recommendation for future improvement is that datasets of sector-specific emission totals that are not consistent or not complete gap filled added by the EMEP- EEA's emissions inventory guidebook as main approach and/or involving member states if resources allow. The produced maps also indicate where improvement by a complete emission inventory can be made, resolving inconsistencies.

Table 42 gives an overview of the missing emissions from CLRTAP and UNFCCC in the E-PRTR aggregated sector structure.

Table 42: Missing emissions from CLRTAP (EEA/CLRTAP v.10, 2010) and UNFCCC (EEA/UNFCCC v.11, 2010) by aggregated sectors [Yellow cross= not reported][38]

Aggregated E-PRTR sectors	Code	Country	CO	NH3	NOx	PM10	SOx	CO2
Industry	GR	Greece				x		
Industry	IS	Iceland				x		
Industry	LU	Luxembourg				x		
Residential and Commercial	GR	Greece				x		
Residential and Commercial	IS	Iceland				x		
Residential and Commercial	LU	Luxembourg	x			x		
Residential and Commercial	MT	Malta				x		
Road transport	GR	Greece				x		
Road transport	IS	Iceland				x		
Road transport	LU	Luxembourg	x			x		
Road transport	MT	Malta	x					
National shipping	BG	Bulgaria	x		x	x	x	x
National shipping	CY	Cyprus	x		x	x	x	x
National shipping	GR	Greece				x		
National shipping	IS	Iceland				x		
National shipping	LI	Liechtenstein	x		x	x	x	x
National shipping	LU	Luxembourg	x			x		
National shipping	MT	Malta				x		
National shipping	SK	Slovakia						x
National shipping	SI	Slovenia	x		x	x	x	x
International shipping	AT	Austria	x		x	x	x	
International shipping	BG	Bulgaria	x		x	x	x	
International shipping	CH	Switzerland	x		x	x	x	x
International shipping	CY	Cyprus	x			x		
International shipping	CZ	Czech Republic	x		x	x	x	x
International shipping	FI	Finland				x		
International shipping	GR	Greece				x		
International shipping	HU	Hungary	x		x	x	x	x
International shipping	IS	Iceland				x		

[38]. Here are not indicated gaps if countries have reported only partly to the concerning sectors.

Aggregated E-PRTR sectors	Code	Country	CO	NH3	NOx	PM10	SOx	CO2
International shipping	LI	Liechtenstein	x		x	x	x	x
International shipping	LU	Luxembourg	x			x		
International shipping	LV	Latvia				x		
International shipping	MT	Malta				x		
International shipping	PL	Poland	x		x	x	x	
International shipping	RO	Romania	x		x	x	x	
International shipping	SI	Slovenia	x		x	x	x	
International shipping	SK	Slovakia	x		x	x	x	
Domestic aviation (Domestic, LTO)	BE	Belgium				x		
Domestic aviation (Domestic, LTO)	BG	Bulgaria				x		
Domestic aviation (Domestic, LTO)	CY	Cyprus	x		x	x	x	x
Domestic aviation (Domestic, LTO)	CZ	Czech Republic				x		
Domestic aviation (Domestic, LTO)	EE	Estonia				x	x	
Domestic aviation (Domestic, LTO)	GR	Greece				x		
Domestic aviation (Domestic, LTO)	HU	Hungary	x		x	x	x	x
Domestic aviation (Domestic, LTO)	IS	Iceland				x		
Domestic aviation (Domestic, LTO)	LI	Liechtenstein	x		x	x	x	
Domestic aviation (Domestic, LTO)	LT	Lithuania	x		x	x	x	
Domestic aviation (Domestic, LTO)	LU	Luxembourg	x			x		
Domestic aviation (Domestic, LTO)	MT	Malta	x			x		
Domestic aviation (Domestic, LTO)	PL	Poland					x	
Domestic aviation (Domestic, LTO)	RO	Romania	x		x	x	x	
Domestic aviation (Domestic, LTO)	SI	Slovenia				x		
Agriculture	BG	Bulgaria				x		
Agriculture	GR	Greece				x		
Agriculture	HU	Hungary				x		
Agriculture	IS	Iceland		x		x		
Agriculture	LI	Liechtenstein				x		
Agriculture	LT	Lithuania				x		
Agriculture	LU	Luxembourg				x		
Agriculture	NO	Norway				x		
Agriculture	PT	Portugal				x		
Agriculture	SK	Slovakia				x		

The second issue concerns also the inconsistency of the reporting situation on industrial releases. As described in the chapter with the subtraction method, the industrial emissions from E-PRTR, CLRTAP and UNFCCC differ from each other for the same sector. The emissions from CLRTAP and UNFCCC were defined as the reference for national totals, but as the subtraction process revealed, E-PRTR emissions are higher for some sectors than the national total of the reference system. In this document a solution was presented to solve this issue, but the solution can be seen as an auxiliary calculation. For a real solution the reasons for the inconsistencies have to be identified and corrected, but this was not possible within the framework of this project. This has to be considered especially by the reporting countries as well as from the institutions responsible for the reporting guidelines. The out-

come of the subtraction process can be used as a starting point to identify and pinpoint the inconsistencies in the reporting procedure.

As already mentioned in the methodology description of the domestic aviation, the applied method delivers unexpected results like missing of Brussels airport in the emission maps. The cause of this situation is that only domestic Landing and Take-off (LTO) emissions were distributed. The explanation for this artifact is that the smaller airports are more frequented by domestic flights, especially in relation to the big international airports. For the larger international airports the corresponding emissions are distributed to more grid cells due the size of the large international airport and this causes a reduction of the absolute value for the grid cells. In addition, during the rationalization process, which was performed to improve the map display performance, the grid cells with small values were deleted. In summary, to get more realistic results, it is necessary to consider also the international LTO cycles. Another limitation for the domestic aviation sector is that the CO_2 emission data for the civil domestic aviation (CRF 1A3a) for the year 2008 is reported to UNFCCC without a distinction between releases emitted during LTO cycles and cruise. The reason is that the sector structure does not allow such a distinction. Therefore in order to distinguish the CO_2 emissions between LTO and cruise, the NOx emissions from civil aviation, reported to CLRTAP, have been used as a proxy. The countries without corresponding information for the civil domestic aviation for NOx (e.g. only LTO emissions are reported) were distinguished using an European average NOx share between LTO and cruise. The relevant countries without the corresponding information are: Greece, Iceland, Italy, Netherlands, Slovenia and Slovakia. The choice to use the NOx emission as a proxy for CO_2 relies on the fact that the emission share correlate quite good as both are emitted during the combustion process. The future improvement of the aviation sector would firstly consider the international LTO emissions and on a second step gap fill the CO_2 LTO emissions as well as the data gaps for countries with no reported emissions for the remaining pollutants using EUROSTAT LTO cycles and emission factors from EMEP-EEA's emission inventory guidebook. However consideration shall be given to the fact that international aviation is best gridded on a global scale even if emission below 1000 meters are relevant sources for E-PRTR. Inconsistency in definition also increases uncertainty in the allocation of emission to domestic and international aviation.

The limitations for the residential and commercial combustion sector are gaps in emission reporting (see also Table 42), missing country specific emission factor for CO releases, urbanization degree by EUROSTAT is from 2001, and estimated wood and gas use factors in rural and urban areas is not country specific. The future recommendation concerning the handling of emission data gaps is the use of the EMEP-EEA's Emission Inventory Guidebook for gap filling and/or involving member states if resources allow. The aim for the residential sector is to have fuel specific emissions in order to apply fuel specific proxy data sets. For that reason country specific emission factors from GAINS were applied, except for CO. For CO the average European tier 1 emission factor was used, because the GAINS CO emission factor was not verified in the data collection phase of this project. A major improvement would be an update of the CO emission factor for each country. To be able to distinguish between rural and urban emissions the urbanization degree from GISCO (EUROSTAT) from the year 2001 was applied. After the data collection and preparation phase a newer data set from EUROSTAT on NUTS level was identified. The future recommendation on the urbanization degrees is to update the information, whereas relevant. The inclusion on information on district heating is also to be considered to reduce uncertainties. Finally, the wood usage factor in rural areas was estimated as a consequence of the lack of appropriate information. For a future project the wood usage factor should be updated on the base of proper data sets, if available to improve PM emission allocation.

The spatial distribution of the road transport has basically two weaknesses. One is that the PM10 relevant sectors “NFR 1 A 3 b vi Road transport: Automobile tyre and brake wear” and “NFR 1 A 3 b vii Road transport: Automobile road abrasion” were not considered among the considered road transport sectors. The second limitation is that national gridded data sets (e.g. UKNAEI and E-PRTR NL) on road traffic were not applied to calibrate the emissions from the road traffic. The future improvement should therefore be the consideration of the omitted sectors and the usage of the results from national high resolution models to verify and calibrate the European road transport emissions. It would also be an additional improvement to check the reported e.g. PM10 or SO_x emissions for potential errors due to wrong emission factors or fuel consumption that do not match traffic volume, but this is not a major issue. For few countries unpaved and off-road emission are available thus EU level reporting is not yet complete.

The national shipping limitations concern the distinction between the sub sectors of national navigation, national fishing, coastal shipping and harbour related emissions. The allocation of the national navigation was achieved using an expert judgment while national fishing emissions were allocated using land use data as a consequence of missing better data sets. Thus, one of the recommendations for future projects is to update the split factors using data on emissions or national shipping activities. The next recommendation affects the distribution parameter of the national navigation. The national navigation was distributed only using land use information without data on activities. The improvement should take activity data into account, if available. The coastal shipping was distributed using a combination of global shipping proxies from Wang et al. (2008) and the economic zones. The result of the coastal shipping shows gaps in the grid cells. The reason for that is because the shipping proxies from Wang. et al. (2008) do not represent the coastal shipping optimally. To solve this issue an updated method using harbour information with more detailed calculation is necessary. The final optimization potential is for the harbour related emissions. The harbour emissions were distributed using harbour statistics available only on NUTS2 level from EUROSTAT. The optimization would be to use more detailed harbour statistics for each harbour including harbour surface and activity levels.

The international maritime shipping was spatial resolved using the global shipping proxies from Wang et al. (2008). A recent publication from Miola & Ciuffo (2011) analyzed that the usability of global shipping proxies for Europe and argued about weaknesses of the Wang et al. (2008) data set concerning the European domain. The future recommendation would be to consider the outcome of the mentioned analysis and comparison of international shipping proxy data. Satellite data could also be used for gridding costal, river and fishing activities in the future.

The applied spatial distribution method of the agricultural sector does not differ very much from other existing methods especially on the European scale. The limitations for this sector are that due to confidentiality measures it is difficult to get farm level information besides the facilities reporting to E-PRTR. As the emissions from animal husbandry are distributed to all agricultural land use classes the result is affected by larger uncertainties related to their spatial allocation. An improvement could be reached by either getting farm level information or identifying the areas where only crops are grown and distinct them from the areas with animal husbandry activities.

The recommendation would be to improve the allocation of the different agricultural activities to subsector specific agricultural land use classes. Another issue concerning animal husbandry activities is that not all animal species numbers are available on NUTS2 level, but on NUTS0 level. Thus national emissions from buffalos or horses are allocated directly to the specific agricultural land use classes.

But these missing animal numbers make only a small contribution to the total agricultural emissions and therefore almost negligible. Nevertheless, a complete datasets of EUROSTAT animal data on NUTS 2 level would be helpful.

In summary, all mentioned sectors can be improved by harmonizing and updating the emission inventories. On the other hand verification and calibration using gridded national data sets would lead to more consistent European data set.

The final recommendation is the consideration of other sectors like railways or waste related emissions to E-PRTR for completeness of the spatial distribution of all sectors.

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14. Annex 1 - E-PRTR Main Activities

Table 43: E-PRTR Main Activities

Code	MainIAActivityName
1.(a)	Mineral oil and gas refineries
1.(b)	Installations for gasification and liquefaction
1.(c)	Thermal power stations and other combustion installations
1.(d)	Coke ovens
1.(e)	Coal rolling mills
1.(f)	Installations for the manufacture of coal products and solid smokeless fuel
2.(a)	Metal ore (including sulphide ore) roasting or sintering installations
2.(b)	Installations for the production of pig iron or steel (primary or secondary melting) including continuous casting
2.(c)	Installations for the processing of ferrous metals
2.(d)	Ferrous metal foundries
2.(e)	Installations:
2.(f)	Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process
3.(a)	Underground mining and related operations
3.(b)	Opencast mining and quarrying
3.(c)	Installations for the production of:
3.(e)	Installations for the manufacture of glass, including glass fibre
3.(f)	Installations for melting mineral substances, including the production of mineral fibres
3.(g)	Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain
4.(a)	Chemical installations for the production on an industrial scale of basic organic chemicals
4.(b)	Chemical installations for the production on an industrial scale of basic inorganic chemicals
4.(c)	Chemical installations for the production on an industrial scale of phosphorous-, nitrogen- or potassium-based fertilisers (simple or compound fertilisers)

Code	MainIAActivityName
4.(d)	Chemical installations for production on industrial scale of basic plant health products & biocides
4.(e)	Installations using a chemical or biological process for the production on an industrial scale of basic pharmaceutical products
4.(f)	Installations for the production on an industrial scale of explosives and pyrotechnic products
5.(a)	Installations for the recovery or disposal of hazardous waste
5.(b)	Installations for the incineration of non-hazardous waste in the scope of Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste
5.(c)	Installations for the disposal of non-hazardous waste
5.(d)	Landfills (see note in Guidance Document)
5.(e)	Installations for the disposal or recycling of animal carcasses and animal waste
5.(f)	Urban waste-water treatment plants
5.(g)	Independently operated industrial waste-water treatment plants which serve one or more activities of this annex
6.(a)	Industrial plants for the production of pulp from timber or similar fibrous materials
6.(b)	Industrial plants for the production of paper and board and other primary wood products
6.(c)	Industrial plants for the preservation of wood and wood products with chemicals
7.(a)	Installations for the intensive rearing of poultry or pigs
7.(b)	Intensive aquaculture
8.(a)	Slaughterhouses
8.(b)	Treatment and processing intended for the production of food and beverage products from:
8.(c)	Treatment and processing of milk
9.(a)	Plants for the pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of fibres or textiles
9.(b)	Plants for the tanning of hides and skins
9.(c)	Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating
9.(d)	Installations for the production of carbon (hard-burnt coal) or electro-graphite by means of incineration or graphitization
9.(e)	Installations for the building of, and painting or removal of paint from ships

15. Annex 2 - Member States' CO_2 reporting practice

15.1 Reported Data for 2007 to the E-PRTR system

Figure 30 summarizes the reporting practice concerning biomass related CO_2 emissions.

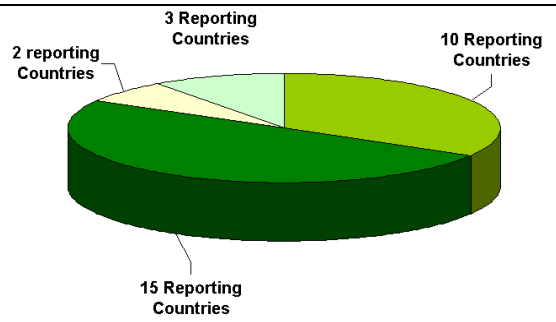
SITUATION OF THE DATA REPORTED FOR THE YEAR 2007		Reporting countries	Potential number of facilities
	**Reporting totals**	15	979
	Reporting excluding biomass	10	748
	Some facilities exclude biomass	2	252
	Unknown	3	8

Figure 30: CO_2 reporting practice by the countries in 2007

- **15** Reporting Countries are fully reporting total quantities of CO_2 for all E-PRTR facilities above the thresholds for CO_2.
- These countries are: BG, DK, FR, IE, LT, LV, MT, NL, PL, RO, SE, SI, SK, UK and NO.
- **2** Reporting Countries are reporting mostly totals except in some Regions were the ETS rule has been followed. These countries are:
  - Belgium: all regions are delivering totals except Wallonia which is following the ETS rule. Belgium confirmed its contacts with the Wallonian compe tent authority to obtain totals.
  - Spain: all regions are delivering totals except Catalonia which is following the ETS rule. Spain confirmed its contacts with the Catalonian compe tent authority to obtain totals.

- **10** Countries indicated that their reports for 2007 do not contain the fraction corresponding biomass: AT, CY, CZ, DE, EE, EL, FI, HU, IT and PT

- **3** Countries did not provide the information, LU, LI and IS. However, LI did not have any facility reporting CO_2 in the year 2007.

15.2 Reporting practice concerning the biomass related on CLRTAP and UNFCCC level

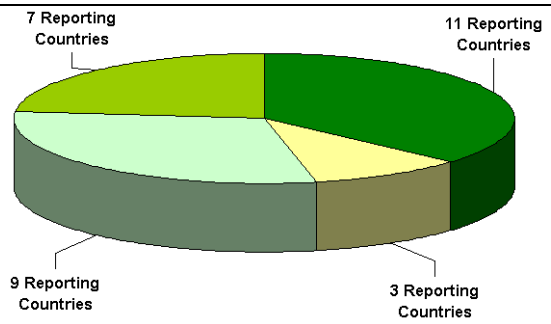
AVAILABILITY OF DATA ON BIOMASS EMISSIONS		Reporting countries	Potential number of facilities
	**Full availability**	11	796
	Partial availability	3	506
	Non available	9	321
	Unknown	7	364

Figure 31: Reporting practice of the countries concerning the biomass related emissions

- **11** Reporting Countries expressed their full availability of a subset containing information on biomass emissions. This availability could enable these countries to easily report CO2 emissions excluding biomass. These countries are: CY, FI, FR, HU, IE, LT (no biomass releases in 2007), MT (no biomass releases in 2007), NL, SE, UK and NO.

- **3** Reporting Countries expressed their limited availability of data on biomass emissions, meaning that only data for ETS facilities is gathered. These countries are: DE, EL and IT.

- **9** Countries expressed their current unavailability of a subset containing information on biomass releases. These countries are: AT, BG, DK, EE, LV, PL, RO, SI and SK

- **7** Countries did not provide the information: BE, CZ, ES, LU, PT, LI and IS.

16. Annex 3 - Additional information on sectoral emissions

Table 44: Reported diffuse dust emissions from construction, handling and transport

Code	Country	Pollutant	Year	Unit	Construction and demolition (NFR 2 A 7 b)	Storage, handling and transport of mineral products (NFR 2 A 7 c)	Storage, handling and transport of chemical products (NFR 2 B 5 b)	Storage, handling and transport of metal products (NFR 2 C 5 f)
AT	Austria	PM10	2008	Gg	1.46	Not reported	Not reported	Not reported
BE	Belgium	PM10	2008	Gg	Not reported	Not reported	Not reported	0.04
BG	Bulgaria	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
CH	Switzerland	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
CY	Cyprus	PM10	2008	Gg	0.29	0.07	Not reported	Not reported
CZ	Czech Republic	PM10	2008	Gg	0.58	0.00	Not reported	Not reported
DE	Germany	PM10	2008	Gg	3.04	Not reported	Not reported	Not reported
DK	Denmark	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
EE	Estonia	PM10	2008	Gg	Not reported	Not reported	0.00	Not reported
ES	Spain	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
FI	Finland	PM10	2008	Gg	0.65	0.46	0.01	0.29
FR	France	PM10	2008	Gg	26.34	Not reported	Not reported	Not reported
GR	Greece	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
HU	Hungary	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
IE	Ireland	PM10	2008	Gg	Not reported	Not reported	0.04	Not reported
IS	Iceland	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
IT	Italy	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
LI	Liechtenstein	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
LT	Lithuania	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
LU	Luxembourg	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
LV	Latvia	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
MT	Malta	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
NL	Netherlands	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
NO	Norway	PM10	2008	Gg	1.24	Not reported	Not reported	Not reported
PL	Poland	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
PT	Portugal	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
RO	Romania	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
SE	Sweden	PM10	2008	Gg	0.57	Not reported	Not reported	Not reported
SI	Slovenia	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
SK	Slovakia	PM10	2008	Gg	Not reported	Not reported	Not reported	Not reported
UK	United Kingdom	PM10	2008	Gg	0.95	0.15	Not reported	Not reported

Table 45: Reporting data on automobile tyre and brake wear and road abrasion

Code	Country	Pollutant	Year	Unit	Automobile tyre and brake wear (NFR 1 A 3 b vi)	Automobile road abrasion (NFR 1 A 3 b vii)
AT	Austria	PM10	2008	Gg	Not reported	3.55
BE	Belgium	PM10	2008	Gg	1.34	0.68
BG	Bulgaria	PM10	2008	Gg	Not reported	Not reported
CH	Switzerland	PM10	2008	Gg	Not reported	Not reported
CY	Cyprus	PM10	2008	Gg	0.19	Not reported
CZ	Czech Republic	PM10	2008	Gg	0.89	0.58
DE	Germany	PM10	2008	Gg	12.51	7.01
DK	Denmark	PM10	2008	Gg	1.20	0.57
EE	Estonia	PM10	2008	Gg	0.17	0.09
ES	Spain	PM10	2008	Gg	6.46	3.87
FI	Finland	PM10	2008	Gg	1.12	7.13
FR	France	PM10	2008	Gg	10.69	5.09
GR	Greece	PM10	2008	Gg	Not reported	Not reported
HU	Hungary	PM10	2008	Gg	Not reported	Not reported
IE	Ireland	PM10	2008	Gg	1.30	Not reported
IS	Iceland	PM10	2008	Gg	Not reported	Not reported
IT	Italy	PM10	2008	Gg	9.82	Not reported
LI	Liechtenstein	PM10	2008	Gg	0.00	0.00
LT	Lithuania	PM10	2008	Gg	0.30	0.24
LU	Luxembourg	PM10	2008	Gg	Not reported	Not reported
LV	Latvia	PM10	2008	Gg	0.29	0.15
MT	Malta	PM10	2008	Gg	Not reported	Not reported
NL	Netherlands	PM10	2008	Gg	1.50	1.15
NO	Norway	PM10	2008	Gg	0.54	1.39
PL	Poland	PM10	2008	Gg	3.99	Not reported
PT	Portugal	PM10	2008	Gg	Not reported	Not reported
RO	Romania	PM10	2008	Gg	Not reported	Not reported
SE	Sweden	PM10	2008	Gg	1.60	7.13
SI	Slovenia	PM10	2008	Gg	0.52	0.30
SK	Slovakia	PM10	2008	Gg	Not reported	0.98
UK	United Kingdom	PM10	2008	Gg	9.53	Not reported