MapEIre – Technical documentation report

Documentation of the spatial and temporal emission model for Ireland

Academic report from the Department of Environmental Science

2019

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Summary	This reports documents the spatio-temporal emission model (MapEIre) created for Ireland under the project 'National mapping of GHG and non-GHG emissions sources' funded by the Irish EPA. The report describes the technical specifications of the model as well as the spatial distribution keys (GeoKeys) and the temporal distribution profiles (TKeys) developed and used in the model. The technical documentation is intended to serve as guidance for experts installing and implementing the model as well as a thorough documentation of the GeoKeys and the TKeys used in the model.
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Contents

Introduction

This report serves as technical documentation for the MapEIre model, which is prepared by the Department of Environmental Science (ENVS) at Aarhus University (AU), Denmark. The work is part of the project 'National mapping of GHG and non-GHG emissions sources' (MapEIre), which is funded by the Irish Environmental Protection Agency (EPA) and is part of the EPA's Research Call 2015 on Climate - Air Science under the EPA Research Programme 2014-2020. The report documents the technical prerequisites and the specifications for the model, and serves as documentation for technicians installing and implementing the model as well as for future development of the spatial distribution keys (GeoKeys) and the temporal distribution keys (TKeys) used in the model as well as the model itself.

The MapEIre model provides a high spatial resolution of Irish emissions, including all sectors and pollutants in the national inventories of GHG and non-GHG emissions. The MapEIre model enables spatial emission mapping on two sectoral levels; nomenclature for reporting (NRF) and gridded nomenclature for reporting (GNFR), and on two spatial resolution levels; 1 km x 1 km and 0.1 degree x 0.1 degree.

Further, the MapEIre model includes a module that adds a temporal component and calculates spatio-temporal emissions on a spatial resolution of 1 km x 1 km and a temporal resolution of 1 hour. The temporal distribution is based on three levels of temporal profiles; hourly (24 hours), daily (7 days), and monthly (12 months).

The MapEIre model is an integrated database system, and the modules and their specifications are described in this report together with the requirement for installing the model system. Further, the data tables in the model, including GeoKeys and TKeys, are presented. The report is organised in five chapters:

- CHAPTER ONE gives an overview of the hardware and software requirements
- CHAPTER TWO describes the model development, here among information on the data concept, input data and the content of the model
- CHAPTER THREE describes the individual parts of the MapEIre model system
- CHAPTER FOUR describes spatial definitions and methodology for development of GeoKeys
- CHAPTER FIVE describes temporal definitions and methodology for development of TKeys

The technical documentation report is accompanied by a user manual providing more detailed instructions for users of the MapEIre model system.

1 Software and hardware requirements

A number of requirements regarding hardware and software needs to be fulfilled in order to be able to install and run the model. The aim is to prepare a model system that is rather easy to operate for the end users, but that still manage to handle the large data amounts and run complex calculations at high speed. The main requirements to hardware and software are:

- The client PC needs:
  - MS Excel 2013 or newer
  - MS Access 2013 or newer
  - MS Windows 2010 or newer
- The server needs:
  - MS SQL Server 2016

It is possible to install the MS SQL Server 2016 on the client PC. This is the recommended setup because of the need for fast performance when running the model. It is possible to back up the database file using a MS SQL Server Management task.

The database requires a minimum of 10 GB hard disk space plus hard disk space for MS SQL Server. The model has been developed using a PC with i7 processor, 16 GB Ram, and a dedicated hard disk for the database files and log files. The model has a number of different setup opportunities, which are described in detail in the user manual.

2 Model description

An integrated database system as the MapEIre model require a well organised setup. The data concept has to be clear and the interrelationships between the incorporated parameters has to be precise and to the extent possible prevent the user to introduce errors to the calculations. One example is to build in simple user interfaces to minimise the risk of the user to introduce typing errors, another to define primary keys in the database tables to avoid doublets in the data sets. This part of the report describes the definitions and tables comprising the base for the MapEIre model system.

2.1 The data concept

The core data can be categories as Facts (e.g. emission) or Dimensions (e.g. pollutant and sector) and a hierarchy.

The following dimensions are included in the MapEIre model:

- Spatial dimension
- Temporal dimension
- Sectoral dimension
- Pollutant dimension

The hierarchies included in the model are:

- Spatial hierarchy; **National**, 0.1 degree x 0.1 degree grid, **1 km x 1 km grid**.
- Temporal hierarchy; **Year**, Month, Day, Hour.
- Sectoral hierarchy; AllSectors (national total), GSector (GNFR sector), **Sector (NFR/CRF sector)**
- Pollutant has no hierarchy; **Pollutant**

The **bold** names show the hierarchy level stored in the database. The other levels has to be calculated.

Dimensions are stored at the most detailed level, except for the temporal dimension, which is stored at the most aggregated level and has to be disaggregated via temporal distribution tables (month, weekday and hour). Disaggregation of temporal dimensions are normally only for visualization purposes. The spatial dimension stores the emissions at national level and at 1 km x 1 km grid level. The national level is the level of the input data to the system (emissions from NFR and CRF reports).

The Facts included in the MapEIre model are:

- Emission (the national level)
- GEmission (the 1 km x 1 km grid cell level)

The MapEIre model system is very comprehensive and operate at a highly disaggregated level regarding both spatial and sectoral resolution. Further, the model covers all pollutants included in the NFR and CRF reports, see Table 1.

Table 1 Pollutants included in the MapEIre model

Pollutant group	**Pollutant**
Main pollutants	NO_x
	NMVOC
	SO_x
	NH_3
Particulate matter	$PM_{2.5}$
	PM_{10}
	TSP
	BC
Other	CO
Priority heavy metals	Pb
	Cd
	Hg
Additional heavy metals	As
	Cr
	Cu
	Ni
	Se
	Zn
Persistent organic pollutants, POPs	PCDD/PCDF (dioxins/furans)
	Bbenzo(a)pyrene
	Benzo(b)fluoranthene
	Benzo(k)fluoranthene
	Indeno(1,2,3-cd)pyrene
	PAH
	HCB
	PCBs
Greenhouse gases, GHG	CH_4
	CO_2
	N_2O
	HFCs
	PFCs
	SF_6
	NF_3

The resulting size for the dimensions and potential and actual resolution of the model is listed in Table 2.

Table 2 Size for the dimensions, and potential and actual resolution of the model

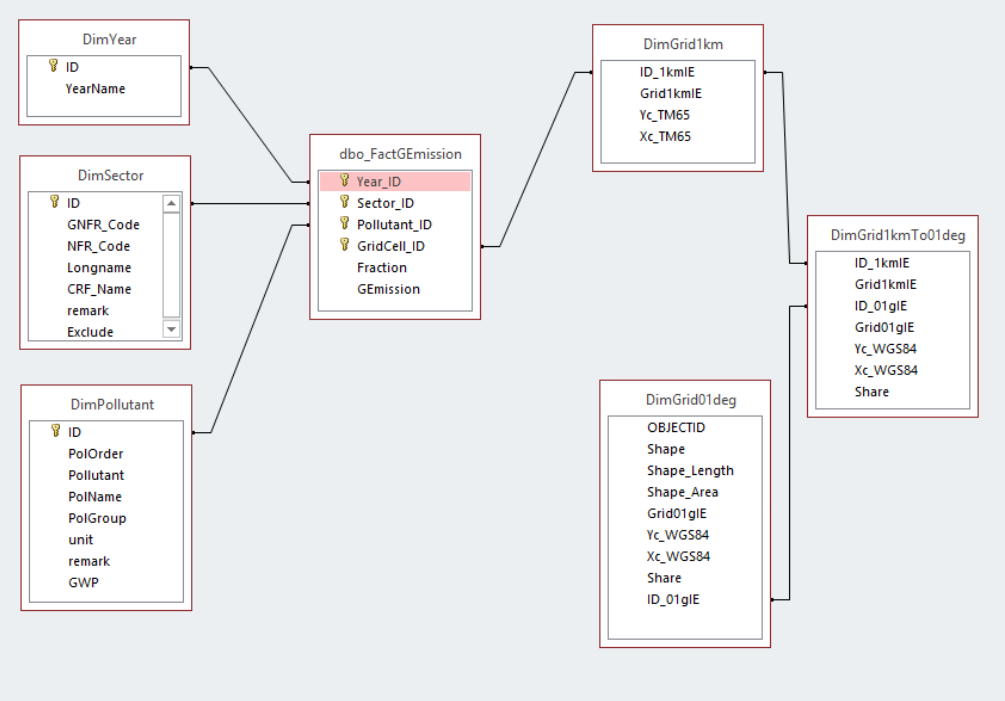
Dimension	**Size**
Spatial	741,275 (1 km x1 km squares inside the Irish Exclusive Economic Zone (EEZ))
Temporal	2+ (2015, 2016, ..)
Sectoral	138 (From NFR and CRF)
Pollutant	32 (From NFR and CRF)
Potential resolution	3.273.470.400 for each year
Actual resolution in database	~49 millions

2.2 Implementation

The data concept is implemented in a database system with numerous tables. Figure 1 shows the dimensions and the Fact GEmission implemented as tables in a database. Each table has columns describing the dimension or fact. The fact table **dbo_FactGEmission** has the data columns **GEmission** and **Fraction** and the rest of the columns in the table are the relations to the dimensions tables. The lines between tables also shows the relationships. The dimensions tables are descried in details in chapter 3.2.

When at table is prefixed "dbo_" it is stored in the MS SQL Server MapEIre. Else the table is stored in an MS Access file.

Figure 1 Dimensions and Fact GEmission implemented as tables in a database



2.3 Input data for the spatial model system

There are three external data sources for the spatial model system. The NFR Report, the CRF Report and the GeoKeys. The NFR and CRF tables holds emissions data at the national level. The national total emissions from the NFR and CRF are spatially disaggregated to the 1 km x 1 km grid for Ireland using GeoKeys, which are tables holding the fraction of the national total emission to be allocated to the individual grid cell. The GeoKeys are described in chapter 4, including descriptions of the methods and spatial data used.

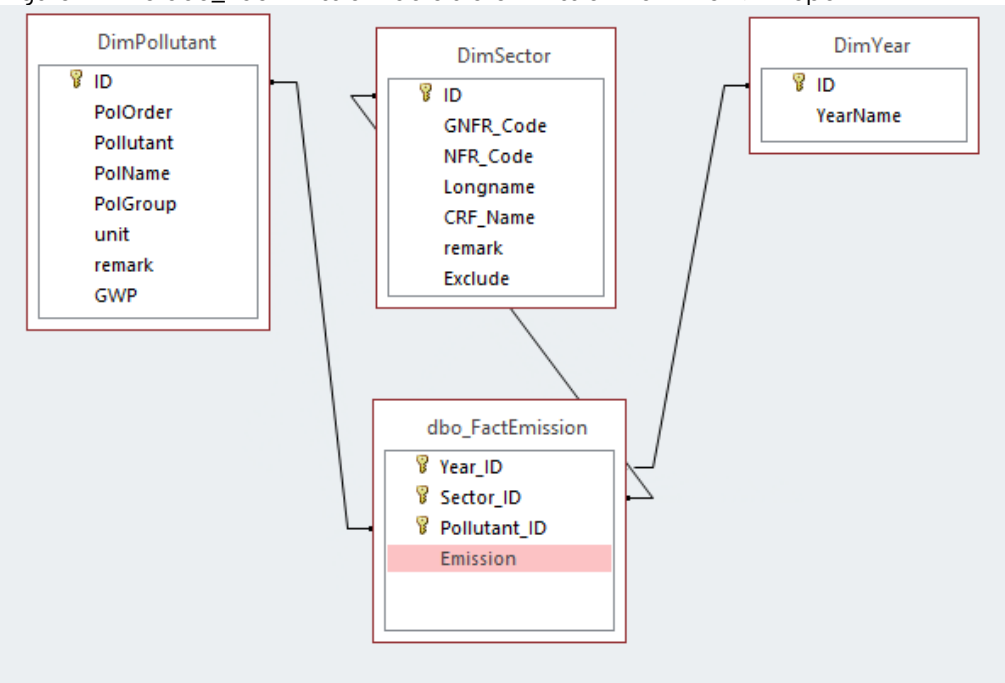
2.3.1 NFR Report

The NFR holds national total emissions for air pollution for the sectors, pollutants and years defined in the UNECE reporting guidelines.

Input data from the NFR are stored in the model for all reporting years. NULL and 0 (zero) values are not imported from the NFR report to the model nor are notation keys (NA, NE, NO, IE, NR, C).

The national total emissions from the NFR report are stored in the table **FactEmission.**

Figure 2 The dbo_FactEmission table store Emission from the NFR report.



2.3.2 CRF Report

The CRF holds national emissions for greenhouse gases for the sectors, pollutants and years defined in the UNFCCC reporting guidelines. Data for the reporting years are stored in separate CRF tables.

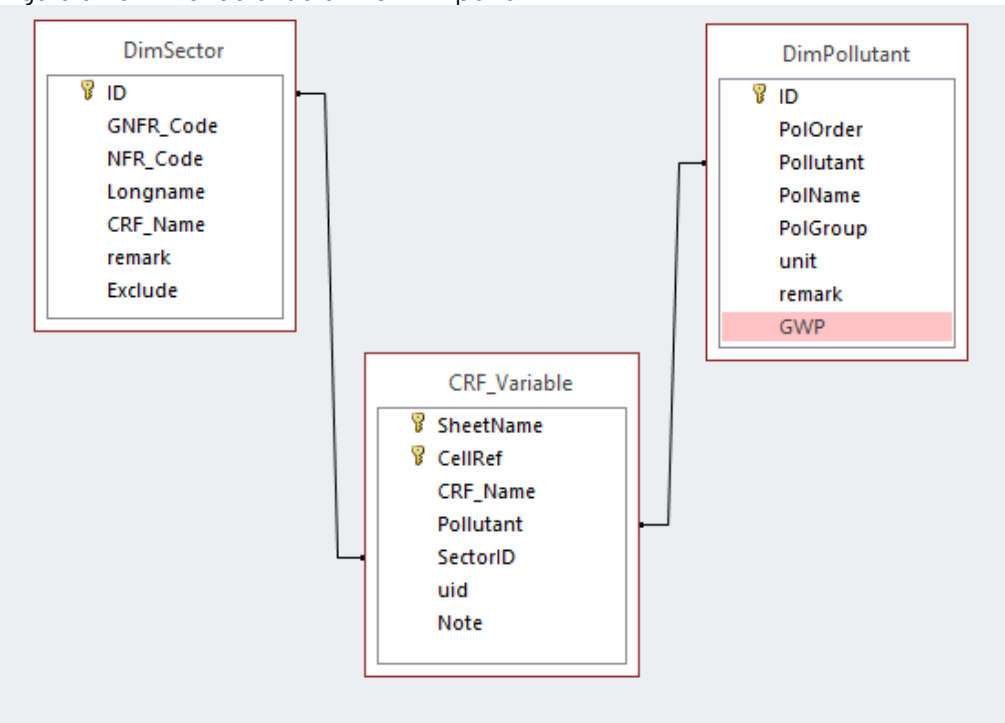
Input data from the CRF report is stored in the model for selected years. NULL and 0 (zero) values are not imported from the CRF to the model, and neither are the notation keys NA, NE, NO, IE and C.

It is possible to configure, which CRF variables to import to the table **CRF_Variable** in the **CRF_Import** database.

The CRF holds both aggregated f-gas emissions in CO_2 equivalents (Table2(I)) and specific f-gas emissions in tonnes (Table2(II)B-Hs1 and Table2(II)B-Hs2). Recalculation of f-gas emissions from mass unit to CO_2 equivalents are made using the GWP factors included in the dimension table **DimPollutant**.

All emissions from the table Table2(II)B-Hs2 ("From manufacturing", "From stocks", and "From disposal") in the CRF_Variable table have to be selected. The import function automatically sum up the three sources to one emission value.

Figure 3 CRF Variable table in CRF importer



2.3.3 GeoKeys

Spatial distribution keys (GeoKeys) holds information on how emissions are distributed spatially in the MapEIre model. The tables including shares of emissions to be allocated to the individual cells in the 1 km x 1 km grid. GeoKeys are prepared from various data sources including a spatial component in a GIS or in Excel, and the requisite information is exported and stored in GeoKey tables in the **GeoKeys_Final_to_model.mdb** database. The GeoKey tables include reference to the grid cells and the year, and the share of emission.

A comprehensive description of the GeoKeys included in the MapEIre model, including the methodology and basis data, is given in Chapter 4.

2.4 Spatial distribution

The spatial emission for a given year, sector, pollutant and grid cell is calculated as:

$$GEmission = Emission * Share$$

Where Emission is the national total emission for a pollutant from a given sector in a given year, and where Share is a value between 0 and 1, specifying the share of the national emission to be allocated to the individual grid cell in the 1 km x 1 km grid. The sum of all grid cells' shares for a given sector is 1.

Share is stored in the GeoKey tables, and the relationship between emission sectors and GeoKeys is managed in the spatial model.

2.5 Temporal distribution

The temporal emission for a given year, sector, pollutant and grid cell is calculated as:

$$TEmission = Emission * TShare$$

where TShare is a value between 0 and 1.

TShare is calculated for each sector as:

$$TShare = Share(month) * Share(weekday) * Share(hour)$$

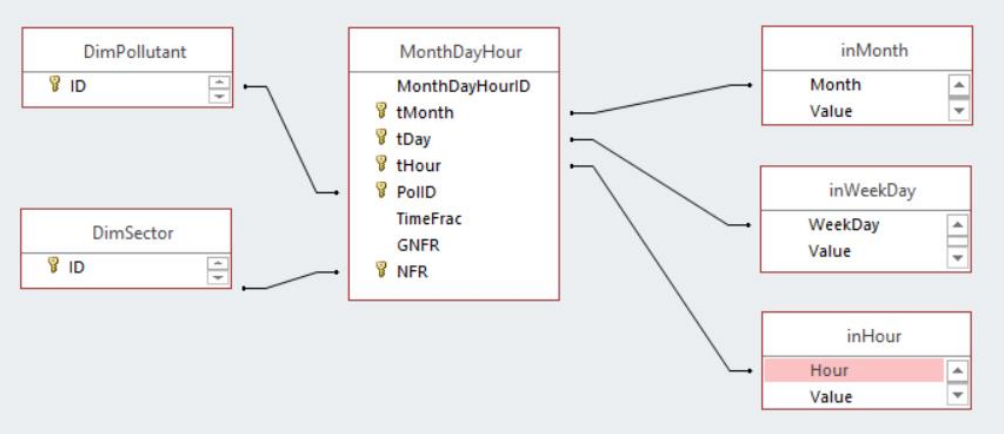
where Share(month), Share (weekday) and Share(hour) are values between 0 and 1, and individually sum up to 1 for each sector.

The number of possible temporal combinations for each sector is 12 months * 7 week days * 24 hours = 2016.

2.5.1 The implementation

The temporal data is imported from an Excel sheet prepared by the sector experts. The imported sector specific temporal profile data are stored in the tables **inMonth**, **inWeekDay** and **inHour**. From the three levels of temporal profiles, the combined temporal shares can be calculated. The combined shares is stored in the table **MonthWeekDayHourKey**.

Figure 4 The tables in the temporal database



3 The MapEIre system and its parts

The MapEIre model system is divided in functional parts for importing, calculation and reporting. The parts are made in MS Excel, MS Access and MS SQL server.

The top level parts are:

- **MapEIre**; the MS SQL Database that stores all the Fact tables and is used by most parts of the system
- **Ireland_Dimensions_dw**; a MS Access database that stores all the Dimension tables and is used by most parts of the system
- **NFR_Importer**; a MS Access database used for import of data from the NFR Report
- **CRF_Importer**; a MS Access database used for import of data from the CRF Report
- **GeoKeys_Final_to_model**; a MS database that stores all GeoKeys used for calculation of spatial emissions
- **GKey_Manage**; a MS Access database used to manage GeoKeys and for calculation of spatial emissions
- **QC**; a MS Access database for data quality control.
- **MapEIre_Reporting**; a MS Access database used for calculation of emissions for reporting to the UNECE LRTAP convention
- **MapDatebasesMake**; a MS Access database for making map data to be used in GIS like ESRI ArcMap
- **TempMapEire**; a MS Access database for calculation temporal emission for a subset of the spatial emissions.

3.1 MapEIre database

The MS SQL Server database stores all the fact tables. The database has the following tables:

- **dbo.FactEmission**; stores all the imported emissions at national level
- **dbo.FactGEmission**; stores all the spatial emissions at 1 km x 1 km grid level. This table has a Non Clustered Column Store Index for optimizing calculation of aggregations (MS SQL server technology, from version 2016)

3.2 Dimensions database

The MS Access database **Ireland_Dimensions_dw** stores all the dimensions tables:

- **DimYear;** 1987 to 2030.
- **DimSector;** all sectors from NFR and CRF, including sectors that are not currently used in the Irish emission reporting, to enable incorporation in the MapEIre model if emissions are being reported in the future
- **DimPollutant**; Pollutants from the NFR (air pollutants) and CRF (greenhouse gases)
- **DimGrid1km**; all cells in the 1 km x 1 km grid prepared for use in the MapEIre model including both land and sea area

- **DimGrid01deg**; all cells in the 0.1 degree x 0.1 degree grid prepared for use in the MapEIre model including both land and sea area
- **DimGrid1kmTo01deg**; relationship between grid cells and shares for recalculation of emissions between the 1 km x 1 km grid and the 0.1 degree x 0.1 degree grid

3.3 NFR_Importer database

This MS Access database is used for import of data from the NFR Report to the MapEIre database. The database links to the following tables in Ireland_Dimensions_dw database and MapEIre:

- DimPolluntant
- DimYear
- DimSector
- dbo.FactEmission

Further, an Excel macro sheet is used to generate an xml file for import of data.

3.4 CRF_Importer database

This MS Access database is used for import of data from the CRF to the MapEIre database. The database links to the following tables in Ireland_Dimensions_dw database and MapEIre:

- DimPolluntant
- DimYear
- DimSector
- dbo.FactEmission.

The table CRF_Variables is used to specify which CFR variables that is to be imported.

3.5 GeoKeys_Final_to_model

This MS Access database is storing all GeoKeys used in the spatial model. The spatial distribution keys are prepared in GIS or in spread sheets depending on the type of background data. The spatial distribution keys often include more information than needed in the spatial model, e.g. keys prepared in GIS might be saved as shape files. The relevant information from the spatial distribution keys are extracted in database tables (GeoKeys) and stored in the **GeoKeys_Final_to_model** database.

The GeoKeys include the parameters:

- **ID_1kmIE**; Grid cell ID
- **Grid1kmIE**; Grid cell name
- **Year**; Year (Year="9999" if the GeoKey is used for all years)
- **Share**; Share of sectoral emission

3.6 GKey_Manage

This MS Access database is used for managing the GeoKeys and for spatial distribution of emissions.

The spatial emissions are calculated from the national total emissions and the shares in the GeoKeys. The relationship between emission sectors (NFR/CRF) and GeoKeys are managed in the GKey_Manage database. The database includes links to all GeoKeys that is used for calculation of spatial emissions.

The GeoKeys have to be defined in the GKey table. Relationships between emission sectors and GeoKeys are created using the form frmGKey_Sector_AllPol_Add for GeoKeys that apply for all pollutants in the sector and the form frmGKey_Sector_Pol_Add for pollutant specific GeoKeys that apply for one or part of the pollutants in the sector.

The national emissions are available in the linked table dbo_FactEmis and the calculated spatial emission are stored in the linked table dbo_FactGEmis, both handled in the MS SQL Server.

The GKey_Manage database include the tables, forms and queries listed below.

Tables:

- Links to dimensions tables, see Chapter 3.2
- Links to GeoKey tables, see Chapter 3.5
- **GKey**; name and ID for all GeoKeys
- **GKey_Sector_Pollutant**; relationship between emission GeoKey, sector and pollutant
- **dbo_FactEmis**; national total emissions on NFR/CRF sector level
- **dbo_FactGEmis**; spatial emissions with a resolution of 1 km x 1 km on NFR/CRF sector level

Forms:

- **frmGKey_Sector_AllPol_Add**; to assign the relationship between GeoKey and sector
- **frmGKey_Sector_Pol_Add**; to assign the relationship between GeoKey, sector and pollutants
- f**rmLoadMAPEire**; used for calculation of spatial emissions (GEmissions), see Chapter 3.6.1

Queries:

- **qGKey_Sector**; returning a list of all relationships between GeoKeys and sectors.
- **qGKey_Sector_Pollutant**; returning a list of all relationships between GeoKeys, sectors and pollutants.
- **qSector_PolWithNoGKey**; returning a list of all combinations of sectors and pollutants that are not assigned a GeoKey.
- **qSectorWithNoGKey**; returning a list of sectors that are not assigned a GeoKey for any pollutant.
- **qdbo_FactGEmission_AddPAH**; used for calculation of spatial emissions og PAHs (GEmissions), see Chapter 3.6.1

3.6.1 GEmission calculation

This part of the system performers the calculation of the spatial distribution of the national emissions and is built into the GKey_Manage database using the following procedure:

Forms:
frmLoadMAPEire: From this form the user select a year for calculation and the form execute a series of append queries made by code in the form. The internal append query calculates the distribution for all combinations of GeoKey and sector, and append the result to **dbo_FactGEmission**. The progress of the calculations are logged in the log file **MapEireCalcLog.txt**. The calculation for one year can take more than 24 hours.

Queries:
qGKey_Sector: The query is used by the code in the form **frmLoadMAPEire**, which execute an append query for every record in the table **qGKey_Sector**
qdbo_FactGEmission_AddPAH: Distribution of PAHs emissions are handled separately due to the data format in the CRF reporting tables. After the distribution of emissions other than PAHs, the distribution of PAHs can be calculated by this query. PAHs emissions as the sum of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene are stored in the database. Note: This function has to be automated in the form **frmLoadMapEIre** in next version. At the moment the user has to this himself.

3.6.2 Quality control

The MS Access database QC.accdb is used for quality control of data import and distribution. The query qQC sums the GEmissions against the NRF and CRF totals (runtime: some minutes).

3.7 MapEIre_Reporting

This MS Access database is used for generating spatial emission in an output format useful for reporting of gridded emissions to the UNECE LRTAP convention. The sectoral aggregation level is GNFR and the spatial resolution corresponds the 0.1 degree x 0.1 degree EMEP grid.

Tables:
Link to dboFactGEmission, see Chapter 3.1
Links to DimGrid1km, DimGrid01deg, DimGrid1kmTo01deg, see Chapter 3.2

Queries:
qGNFR_Report_Crostab: Makes the dataset for the UNECE LRTAP convention in the reporting format. It is possibly to copy and paste the result to the Excel reporting table. The database has a set of queries which can be used as template for user-specified queries.

3.8 MapDatabasesMake

This MS Access database can generate datasets to be used in a geographical information system, GIS. It generates a data set for each GNFR category, for NFR total, and for CRF total. It generate the data set in the form of database tables in separate MS Access databases, which can be access from a GIS.

3.9 TempMapEIre

The MS Access database TempMapEIre is used for calculation of temporal emissions. The temporal model potentially generates very large data amounts. To reduce the data amounts and thereby increase the model performance, the user must define start data, end date, sector and pollutant for the temporal calculation, e.g. NO_x emissions (pollutant: nox) from passenger cars (sector: 1a3bi) for February 2016 (start date: 2016-02-01, end date: 2016-03-01).

The database generates a table with spatio-temporal emissions including time data in a format, which can be used in ArcGIS to make hourly maps, which again can be used to prepare animations of spatio-temporal emissions.

The database include the following tables:

- **inHour**, **inWeekDay** and **inMonth**: imported temporal profiles from spreadsheet.
- **MonthDayHour**: combined temporal profile calculated from inHour, inWeekDay and inMonth in model time.
- **DayHourlookup**: supporting table for day intervals to day numbers
- **tblCalenderHour**: supporting table with real world dates on hourly basis. Used when model time is mapped to real world time.
- **TimeEmission**: The result table for temporal emissions for a user selected subset of data to be used in GIS.
- Link to **dboFactGEmission**
- Links to the dimensions tables **DimGrid1km**, **DimPollutant**, **DimSector** and **DimYear**

The main queries in the database are:

- **qMonthWeekDay_Add**: Calculates the combined temporal profiles from in-data
- **qTimeEmission_Add**: Calculates the time based emissions based on temporal profiles and spatial emissions from the FactGEmission table.

How to use the TempEmission table in ArcGIS is described in the User manual.

4 GeoKey development

A GeoKey is a normalized table holding shares of a national total emission, e.g. NO_x from road transport in 2015, which should be allocated to the individual cells in a predefined grid.

All NFR/CRF sectors in the Irish emission inventory are assigned a GeoKey in the MapEIre model. The GeoKeys are prepared from the most detailed, complete and accurate data available, the best being data on source level.

A GeoKey is stored as a database table including the parameters as shown in Table 3.

Table 3 Parameters used in the definition tables of GeoKeys.

Field name	Description	Data type
ID_1kmIE	Grid cell	Long integer
Grid1kmIE	Grid cell name	Text (Length=20)
Year	Year (Year="9999" if the GeoKey is used for all years)	Text (Length=4)
Share	Share of sectoral emission	Decimal (settings: Precision=19, Scale=18)

The methodology for preparing GeoKeys depends on the characteristics of the emission source; if it is a point source with a known geographical location, or if is an area source where emissions occur from an area or from small point sources that cannot be treated individually.

For emission sources that are included in the emission inventory as point sources, the GeoKeys are based on the point source data available in the inventory. This can be emissions, fuel consumption, or activity level (e.g. production). In some cases, the addresses for point sources are available without further details, and GeoKeys are created to distribute the emissions evenly between the address points

Many sources in the emission inventory are area sources, which refer to emissions that come from small point sources that are too large in number to be treated individually, from line sources like roads and railways, or from area sources like fields or other areas with common land use. GeoKeys for area sources either distributes the emissions to the relevant areas evenly according to the share of area, or weighted by other proxy data like statistics. Statistics are often available on an aggregated level e.g. by small area, electoral districts or county. In this case land use data can be used to improve the spatial emission distribution, e.g. by excluding areas where a specific source does not occur.

4.1 General methodology

GeoKeys for point sources are prepared in spreadsheets, as the inventory data it is based on. The point sources are geocoded based on address or facility name. When none of these is included in the inventory data, the locations of facilities are found via internet searching. All point source locations are geocoded using the common projection of the MapEIre model; the Irish projection TM65.

GeoKeys for area sources are prepared using the Geographical Information System ArcGIS. Spatial data are collected from different sources and data providers, and

might have different projections, which has to be aligned before further data processing. The overall methodology for the GIS processing of digital spatial data is to intersect a feature data set (e.g. grassland area or road network) with the grid (e.g. the 1 km x 1 km grid used in MapEIre, WL_1kmIE), and following calculate the share of the total feature layer located in each grid cell (e.g. share of total grassland area or share or total road length).

4.2 Sector specific GeoKeys

GeoKeys are prepared from the most detailed, complete and accurate data available, the best being data on source level. Pollutant and/or year specific GeoKeys are prepared for sectors if detailed emissions or activity data is available, e.g. data from PRTR reporting or information provided by individual plants, facilities or companies. If less detailed data are available, the sectoral GeoKeys are used for all pollutants and/or for all years, causing similar spatial emission patterns for the sector for all pollutants and/or all years included in the model. This is most likely not the case, but a necessary assumption in the spatial emission model due to data limitations.

A number of GeoKeys are a combination of two or more sub-sector keys. When a NFR sector covers both point sources and area sources, e.g. Non-ferrous metals (NFR category 1A2b) where 85 % of the emissions are covered by point sources, a spatial distribution key is prepared from the point source data. The remaining emissions from the sector will be allocated using a spatially distribution based on more general data, e.g. heat demand for industrial buildings. The sectoral GeoKey will be calculated as an average of the two spatial distributions, weighted by the share of emissions from point sources and area sources, respectively.

Table 4.a-d give examples on GeoKeys for Industrial waste incineration (5C1bi), Lime production (2A2), Other metal production (2C7c), and Public electricity and heat production (1A1a). These GeoKeys are all based on point source data with different level of details, and the resulting GeoKeys exemplifies the different types of GeoKeys;

The GeoKey for 5C1bi is based on activity data for the latest reporting year to PRTR, and the same GeoKey is used for all years and all pollutants.
The GeoKey for 2A2 is based on annual plant specific activity data, and enabling the creation of year specific GeoKeys.
The GeoKey for 2C7c is based on PRTR data from the latest reporting year, which are available for selected pollutants. For this sector, pollutant specific GeoKeys are prepared for Cd, Pb and Zn, plus a GeoKey for all remaining pollutants.
The GeoKey for 1A1a is based on emissions and fuel consumption data from ETS reporting. Year and pollutant specific GeoKeys are prepared for SO_2 and NO_x, plus a year dependent GeoKey for all remaining pollutants.

Table 4 Example of GeoKeys for a) industrial waste incineration, b) Lime production, c) Other metal production, and d) Public electricity and heat production

a) GeoKey for Industrial waste incineration (NFR sector 5C1bi)

5C1bi			
ID_1kmIE	Grid1kmIE	Year	Share
312044	*	9999	0.4133
319400	*	9999	0.2686
320143	*	9999	0.0220
444769	*	9999	0.0388
444772	*	9999	0.2571
449545	*	9999	0.0002
SUM			*1*

b) Year specific GeoKey for Lime production (NFR sector 2A2)

2A2			
ID_1kmIE	Grid1kmIE	Year	Share
479066	*	*2014*	*0.5177*
405895	*	*2014*	*0.2582*
401438	*	*2014*	*0.2242*
479066	*	**2015**	**0.4375**
405895	*	**2015**	**0.3020**
401438	*	**2015**	**0.2605**
SUM			*2*

c) Pollutant specific GeoKey for lead (Pb) for Other metal production (NFR sector 2C7c)

2C7c_Pb			
ID_1kmIE	Grid1kmIE	Year	Share
324905	*	9999	0.2439
324906	*	9999	0.2683
353337	*	9999	0.2439
430786	*	9999	0.2439
SUM			*1*

d) Year and pollutant specific GeoKey for pollutants other than SO_2 and NO_x for Public electricity and heat production (NFR sector 1A1a)

1A1a_rest			
ID_1kmIE	Grid1kmIE	Year	Share
441859	*	*2014*	*0.1115*
320849	*	*2014*	*0.0531*
327315	*	*2014*	*0.0001*
357859	*	*2014*	*0.0051*
383901	*	*2014*	*0.0011*
385914	*	*2014*	*0.3582*
430786	*	*2014*	*0.0423*
320150	*	*2014*	*0.0618*
433804	*	*2014*	*0.0663*
444775	*	*2014*	*0.0457*
446896	*	*2014*	*0.1037*
447964	*	*2014*	*0.0008*
446897	*	*2014*	*0.0752*
516580	*	*2014*	*0.0001*
447897	*	*2014*	*0.0001*
473103	*	*2014*	*0.0747*
320150	*	**2015**	**0.0677**
320849	*	**2015**	**0.0324**
473103	*	**2015**	**0.0767**
327315	*	**2015**	**0.00001**
357859	*	**2015**	**0.0492**
447964	*	**2015**	**0.0003**
433804	*	**2015**	**0.0615**
385914	*	**2015**	**0.4075**
446896	*	**2015**	**0.1023**
447897	*	**2015**	**0.0003**
430786	*	**2015**	**0.0196**
446897	*	**2015**	**0.0094**
516580	*	**2015**	**0.0002**
441859	*	**2015**	**0.0995**
444775	*	**2015**	**0.0716**
383901	*	**2015**	**0.0016**
SUM			*2*

4.2.1 General GeoKeys

If source specific data are not available, spatial proxy data are used to prepare the GeoKeys, preferably on sector level, but in cases where no spatial sector specific data exists or are available the GeoKeys are based on general spatial data, e.g. buildings, heat demand or population. Even if general GeoKeys are prepared from detailed, complete and accurate spatial data, the appropriateness as proxy for a given emission sector might be poor, which is often the case when population density is used as proxy.

In other cases the GeoKey is based on spatial data that serves as a good proxy, but that is poor regarding accuracy, spatial resolution or that is out-of-data, an example being the use of catching statistics by ICES areas as a proxy for emissions from fishing, due to the low spatial resolution of the spatial data. Another example is the use of CORINE land cover (CLC) maps to prepare GeoKeys for the LULUCF sector. This satellite based pan-European map has considerable uncertainties when applied on a national scale regarding geographical demarcation of features and assigned land use category.

4.3 Spatial definitions

The MapEIre model is prepared in consideration of a number of spatial definitions agreed on in the steering committee, regarding projection, geographic scope and grids. The spatial definitions are described in details in the following chapters.

4.3.1 Projection

The Irish grid TM65 (EPSG 29902) is used in the emission mapping model. Geodata provided in other projections, e.g. TM75 (EPSG 29903) and IRENET95 (EPSG 2157) are reprojected using the built-in projection transformations in ArcMAP, e.g. “TM65_To_WGS_1984_2” and “TM75_To_WGS_1984_2”. Details for the TM65 projection are included in Table 5. Reprojection of coordinates for point sources is made in the program Franson CoordTrans (http://coordtrans.com/coordtrans/).

Table 5 Details for the Irish grid TM65

TM65_Irish_Grid **WKID: 29902 Authority: EPSG**
Projection: Transverse_Mercator False_Easting: 200000,0 False_Northing: 250000,0 Central_Meridian: -8,0 Scale_Factor: 1,000035 Latitude_Of_Origin: 53,5 Linear Unit: Meter (1,0)
Geographic Coordinate System: GCS_TM65 Angular Unit: Degree (0,0174532925199433) Prime Meridian: Greenwich (0,0) Datum: D_TM65 Spheroid: Airy_Modified Semimajor Axis: 6377340,189 Semiminor Axis: 6356034,447938534 Inverse Flattening: 299,3249646

4.3.2 Borders

The geographical scope of the spatial emission model is the Irish territory, and the exclusive economic zone (EEZ) is used as line of demarcation of the sea area. The coastline provided by EPA is used as line of demarcation of the land area.

4.3.2.1 EEZ

The shape of the Irish EEZ is based on data from MarineRegions.org. The data has been manually edited to complete the geometry and extent the EEZ line to the meet the coastline. The resulting layer is a polygon covering the Irish land and sea area.

4.3.2.2 Coastline

The coastline shapefile provided by the Irish EPA ("ADMIN_Coast.shp ") is used as line of demarcation of the land area towards the sea.

4.3.2.3 National border

Different spatial data are available that include the national border between the Republic of Ireland and Northern Ireland ("Census2011_Small_Areas_generalised20m" (data source: CSO), "Census2011_Garda_Districts_Nov2013" (data source: CSO), "Census2011_Constituencies_2013" (CSO), "Agri" (data source: latest gridded emission inventory), and "northern_ireland_counties" (data source: ShareGeo Open, http://www.sharegeo.ac.uk/).

Analysis of the spatial data shows only smaller differences between the country border between the Republic of Ireland and Northern Ireland. In most cases the difference is below 25 meters, and of minor importance for gridding of emissions on a grid with a resolution of 1 km x 1 km.

Based on the analysis, the data set "Census2011_Garda_Districts_Nov2013" provided by CSO is used as line of demarcation for the Republic of Ireland, as this layer corresponds well with maps including regions in Northern Ireland, and as this layer follows the coastline rather than the administrative boundaries along water bodies. The file is stored as:

\\MapEire\DataLibrary\Borders\Borders.mdb\NationalBorder

4.3.2.4 Border files

File	File location
EEZ	\\MapEire\DataLibrary\Borders\Borders.mdb\EEZ
Coastline	\\MapEire\DataLibrary\Borders\Borders.mdb\Coastline
National border	\\MapEire\DataLibrary\Borders\Borders.mdb\NationalBorder

4.4 Grids

4.4.1 Grid 1km x 1km

A grid with a resolution of 1 km x 1 km is developed for the spatial emission model, using the standard tool "Create Fishnet" in ArcMap. The fishnet is created so that the corners of the grid cells follow the 1 000 meter x-axis and y-axis in the TM65 projection (EPSG 29902). The grid covers a square around the Exclusive Economic Zone (EEZ). The extent and resolution are defined by the following parameters:

Extent	Bottom: -365 000 Top: 630 000 Left: -360 000 Right: 385 000
Resolution	Width: 1 000 m Height: 1 000 m
Size	Number of rows: 995 Number of columns: 745

Using the calculate geometry tool in ArcMAP, each grid cell is applied X and Y coordinates for the centroid (Xc and Yc).

The grid cells are named according to the location of the lower left corner and the grid resolution;

IE_1km_±Y_±X

where ±Y and ±X are the Y and X coordinates for the lower left corner rounded down to nearest full kilometre (e.g. the point *(-296 713.384 , 158 922.683)* will be given the grid ID 1km_158_-297).

By using a name convention based on the X and Y coordinates, it is easy to apply grid cell name to point sources, which are defined by their exact location (X,Y), and following to summarise emissions from point sources and area sources per grid cell, without using GIS. Grid cell names are applied using the standard tool "Calculate Field" in ArcMAP with the script;

```
Grid1kmIE: CStr("1km_" & (IIf([Yc_TM65]<0 And [Yc_TM65]>-1000;-
1;(IIf([Yc_TM65]<1000 And
[Yc_TM65]>=0;0;Left((IIf([Yc_TM65]<0;([Yc_TM65]-1000);[Yc_TM65]));(
IIf((Len((CStr((Round((IIf([Yc_TM65]<0;([Yc_TM65]-
1000);[Yc_TM65]));0))))))>2;(
Len((CStr((Round((IIf([Yc_TM65]<0;([Yc_TM65]-1000);[Yc_TM65]));0))))))-
3;0))))))) & "_" & (IIf([Xc_TM65]<0 And [Xc_TM65]>-1000;-
1;(IIf([Xc_TM65]<1000 And
[Xc_TM65]>=0;0;Left((IIf([Xc_TM65]<0;([Xc_TM65]-1000);[Xc_TM65]));(
IIf((Len((CStr((Round((IIf([Xc_TM65]<0;([Xc_TM65]-
1000);[Xc_TM65]));0))))))>2;(
Len((CStr((Round((IIf([Xc_TM65]<0;([Xc_TM65]-1000);[Xc_TM65]));0))))))-
3;0))))))))
```

Correspondingly Grid ID can be applied in Access using the query:

```
Grid1kmIE: CStr("1km_" & (IIf([Northing]<0 And [Northing]>-1000;-
1;(IIf([Northing]<1000 And [Northing]>=0;0;Left((IIf([Northing]<0;([North-
ing]-1000);[Northing]));(IIf((Len((CStr((Round((IIf([Northing]<0;([Northing]-
1000);[Northing]));0))))))>2;(Len((CStr((Round((IIf([Northing]<0;([Northing]-
1000);[Northing]));0))))))-3;0))))))) & "_" & (IIf([Easting]<0 And [Easting]>-
```

1000;-1;(IIf([Easting]<1000 And [Easting]>=0;0;Left((IIf([Easting]<0;([Easting]-1000);[Easting]));(IIf((Len((CStr((Round((IIf([Easting]<0;([Easting]-1000);[Easting]));0))))))>2;(Len((CStr((Round((IIf([Easting]<0;([Easting]-1000);[Easting]));0))))))-3;0))))))))

Four separate grids are prepared for;

- G_1kmIE, for the area (square) defined by the parameters above
- WL_1kmIE, for the area defined by the Irish EEZ including both land and sea area
- W_1kmIE, for the sea area defined by the EEZ and the coastline
- L_1kmIE, for the land area defined by the coastline

4.4.2 Grid 0.1° x 0.1°

A grid with a spatial resolution of 0.1° x 0.1° in the projection WGS84 (EPSG 4326), following the definitions for the EMEP grid, is developed for reporting of spatial emission to LRTAP, using the standard tool "Create Fishnet" in ArcMap. The fishnet is created so that the corners of the grid cells follow the 0.1° x-axis and y-axis. The grid covers a square around the Exclusive Economic Zone (EEZ). The extent and resolution are defined by the following parameters:

Extent	Bottom: 47.0 Top: 57.0 Left: -17.0 Right: -4.0
Resolution	Width: 0.1° Height: 0.1°
Size	Number of rows: 100 Number of columns: 130

Using the calculate geometry tool in ArcMAP, each grid cell is applied X and Y coordinates for the centroid (Xc and Yc). The grid cells are named according to the location of the centroid and the grid resolution;

01g_±Yc_±Xc

where ±Y and ±X are Yc and Xc coordinates rounded to two decimals.

By using a name convention based on the X and Y coordinates, it is easy to apply grid cell name to point sources, which are defined by their exact location (X,Y), and following to summarise emissions from point sources and area sources per grid cell, without using GIS. Grid cell names are applied using the standard tool "Calculate Field" in ArcMAP with the script:

Grid01gIE: CStr("01g_" & Round([Yc_WGS84],2) & "_" & Round([Xc_WGS84],2))

Two separate grids are prepared for;

- G_01gIE, for the area corresponding to G_1kmIE
- WL_01gIE, for the area corresponding to WL_1kmIE

4.4.3 Conversion from the 1x1 km grid to the 0.1x0.1 ° grid

A conversion table is created for reallocation of emissions from the 1 km x 1 km grid to the 0.1 ° x 0.1 ° grid, including the share of each 1 km x 1 km grid cell to be allocated to the intersecting 0.1 ° x 0.1 ° grid cells. The conversion shares in the list are based on an intersection of the 1 km x 1 km grid and the 0.1 ° x 0.1 ° grids covering the Irish territory (land and sea area).

4.4.4 Grid files

A number of grid files are included in the MapEIre model with different spatial resolution and of different extend. The grid files are listed in Table 6.

Table 6 Grid files in the MapEIre model

File	**File location**
G_1kmIE	\\MapEIre\DataLibrary\Grids.mdb\G_1kmIE
WL_1kmIE	\\MapEIre\DataLibrary\Grids.mdb\WL_1kmIE
W_1kmIE	\\MapEIre\DataLibrary\Grids.mdb\W_1kmIE
L_1kmIE	\\MapEIre\DataLibrary\Grids.mdb\L_1kmIE
G_01gIE	\\MapEIre\DataLibrary\Grids.mdb\G_01gIE
WL_01gIE	\\MapEIre\DataLibrary\Grids.mdb\WL_01gIE
Conversion from 1x1km grid to 0.1x0.1° grid	\\MapEIre\DataLibrary\Grids.mdb\Share_of_1km_to_01g

4.5 GeoKeys

An overview of development of the GeoKeys used in the Irish emission mapping model is included in the following chapters.

The GeoKeys are prepared in GIS (ArcMAP) and databases (MS Access) and the final GeoKeys for use in the emission mapping model are collected in the database GeoKeys_to_model.mdb. Where data is available for more years, time-series have been prepared for the GeoKeys. Table 7 lists the GeoKeys, for which time-series are included in the spatial model, including information on background data and the years for which GeoKeys are available.

Table 7 GeoKeys with time-series

Gkey	NFR/CRF	Years	Data source
1A1a_rest	Public electricity and heat production	1990-2015	Point source data
1A1c	Manufacture of solid fuels and other energy industries	1990-2015	Point source data
1A3ai(i)	International aviation LTO (civil)	1990-2015	Inventory data
1A3aii(i)	Domestic aviation LTO (civil)	1990-2015	Inventory data
1A3aii(ii)	Domestic aviation cruise (civil)	1990-2015	Inventory data
1A3c	Railways	2011, 2016	Irish rail
1B1a_Handling	Fugitive emission from solid fuels: Coal mining and handling	1990-2015	Inventory data
2A1	Cement production	1990-2015	Inventory data
2A2	Lime production	1990-2015	Inventory data
2A4d	Mineral industry - Other process uses of carbonates - Other	1990-2015	Inventory data
2C2_Cd	Ferroalloys production	1990-2015	Inventory data
2C2_Pb	Ferroalloys production	1990-2015	Inventory data
2C2_PM	Ferroalloys production	1990-2015	Inventory data

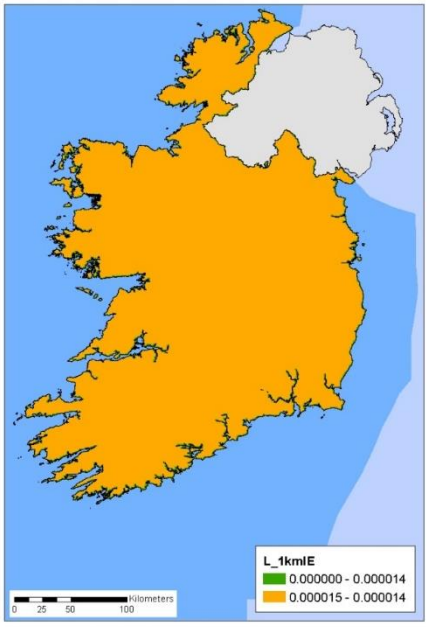
3B1a	Manure management - Dairy cattle	2000, 2010	CSO, Census of Agriculture 2010
3B1b	Manure management - Non-dairy cattle	2000, 2010	CSO, Census of Agriculture 2010
3B2	Manure management - Sheep	2000, 2010	CSO, Census of Agriculture 2010
3B4e	Manure management - Horses	2000, 2010	CSO, Census of Agriculture 2010
3B4f	Manure management - Mules and asses	2000, 2010	CSO, Census of Agriculture 2010
3B4h	Manure management - Other animals (please specify in IIR)	2000, 2010	CSO, Census of Agriculture 2010
3Da2a	Animal manure applied to soils	2000, 2010	CSO, Census of Agriculture 2010
3Da3	Urine and dung deposited by grazing animals	2000, 2010	CSO, Census of Agriculture 2010
5B1	Biological treatment of waste - Composting	1990-2015	Inventory data
5C1bv	Cremation	1990-2015	Inventory data
Population	2D2 - Paraffin wax use 2D3a - Domestic solvent use in-cluding fungicides 2D3d - Coating applications 2D3i - Other solvent use 2F1a - Commercial refrigeration 2F4 – Aerosols 2F6 - Other applications 2G – Other product use (NMVOC) 4G - LULUCF Harvested wood product 5E - Other waste	2011, 2016	CSO, Census 2016

The GeoKeys are described separately in the following sections, including information on source data, methodology for preparing the GeoKeys, and the NFR/CRF sectors for which the GeoKeys are applied in the MapEIre model. A list of all GeoKeys in the model is included in Annex 1 and a correspondence list between NFR sectors and GeoKeys are included in Annex 2.

4.5.1 AreaLand

Source data	L_1kmIE
Data provider	Aarhus University
File location*	\\MapEIre\DataLibrary\Grids.mdb\L_1kmIE
Projection	TM65
Data description	1 km x 1 km grid covering land area
Workflow	GeoKey calculated as share of land area by grid cell
GeoKey	AreaLand
NFR/CRF sector	2L - Other production, consumption, storage, transportation or handling of bulk products 3B5 - Indirect N_2O emission 3Db1 - Atmospheric deposition

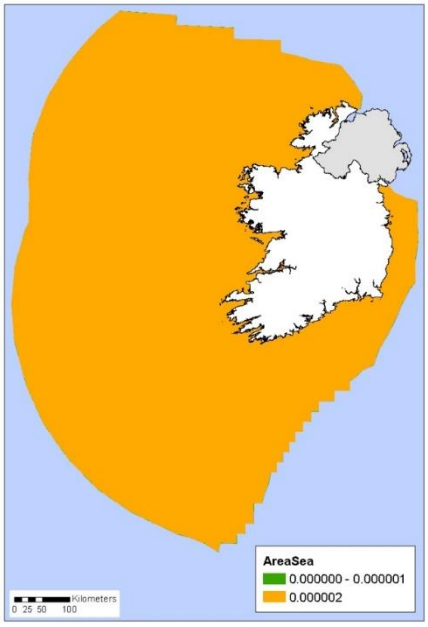
AreaLand



4.5.2 AreaSea

Source data	W_1kmIE
Data provider	Aarhus University
File location*	\\MapEIre\DataLibrary\Grids.mdb\W_1kmIE
Projection	TM65
Data description	1 km x 1 km grid covering sea area
Workflow	GeoKey calculated as share of sea area by grid cell
GeoKey	AreaSea
NFR/CRF sector	1A3di(i) - International maritime navigation 1A3di(ii) - International inland waterways

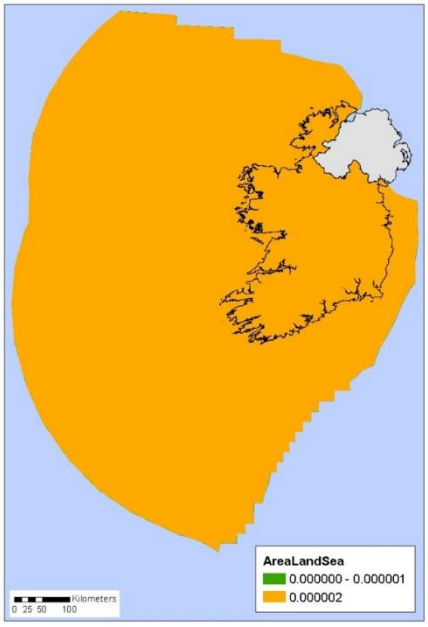
AreaSea



4.5.3 AreaLandSea

Source data	WL_1kmIE
Data provider	Aarhus University
File location*	\\MapEire\DataLibrary\Grids.mdb\WL_1kmIE
Projection	TM65
Data description	1 km x 1 km grid covering land and sea area
Workflow	GeoKey calculated as share of total area (land and sea) by grid cell
GeoKey	AreaLandSea
NFR/CRF sector	1A3ai(ii) - International aviation cruise (civil)

AreaLandSea

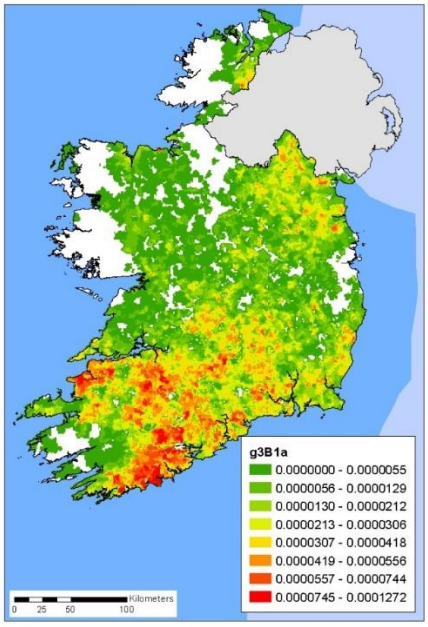


4.5.4 Animals on ED level, cattle, sheep, and horses

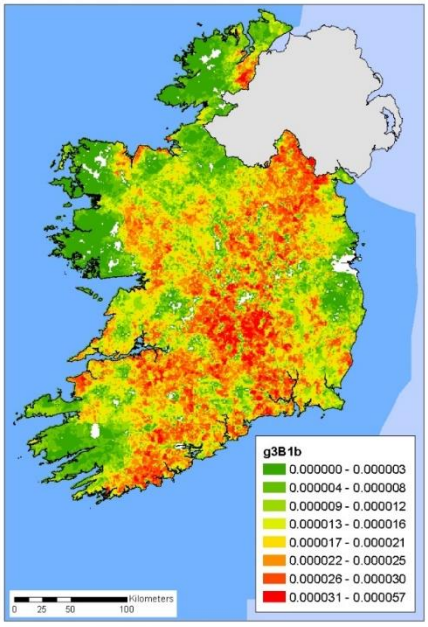
Source data	agricedfigs20002010.shp
Data provider	CSO
File location*	\\MapEIre\DataLibrary\Agriculture\agricedfigs20002010.shp \\MapEIre\DataLibrary\ Agriculture\Farmyard1kmED.mdb
Projection	TM65
Data description	"agricedfigs20002010.shp": Animal numbers for 2000 and 2010 by electoral districts (ED) for dairy cows, other cows, sheep, and horses. 2010 data is used "Farmyard1kmED.mdb":
Workflow	Animal numbers from "agricedfigs20002010.shp" is spatially distributed by ED according to the occurrence of "Farmyards" and "Buildings" in LPIS.
GeoKey	3B1a 3B1b 3B2 3B4e
NFR/CRF sector	3A1a - Dairy cattle 3A1b - Non-dairy cattle 3A2 - Sheep 3A4e - Horses 3B1a - Manure management - Dairy cattle 3B1b - Manure management - Non-dairy cattle 3B2 - Manure management - Sheep 3B4e - Manure management - Horses

* See description regarding `Farmyard1kmED` in the LPIS chapter below

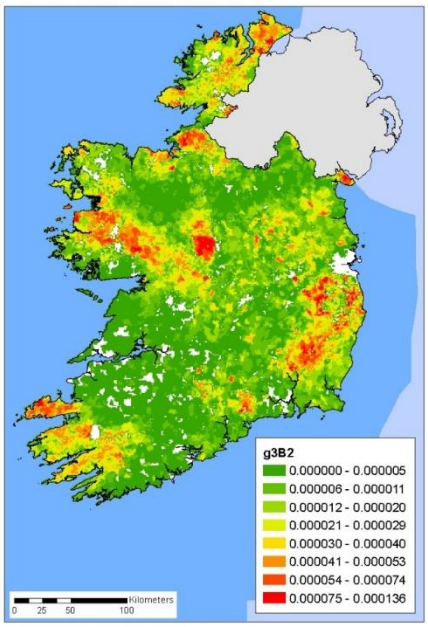
3B1a



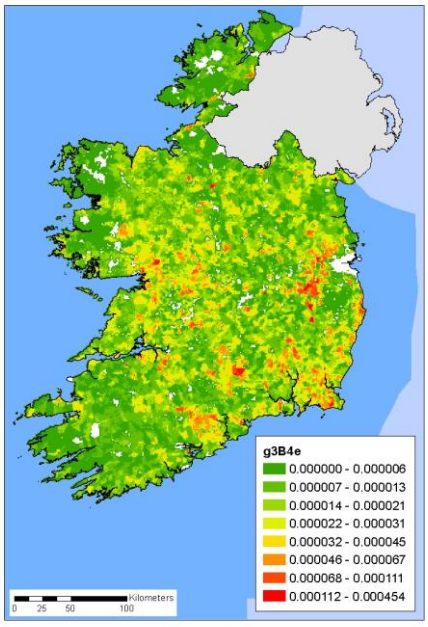
3B1b



3B2



3B4e

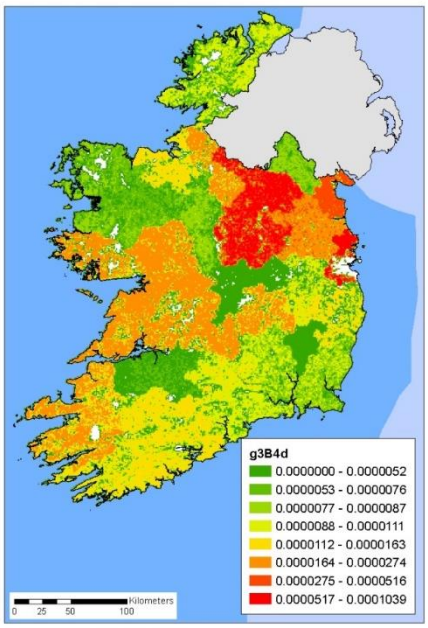


4.5.5 Animals on county level, goats, and mules & asses

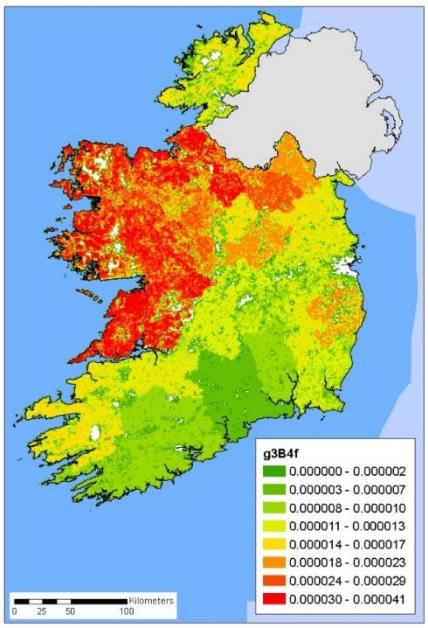
Source data	Census of Agriculture 2010 Table 8.xlsx
Data provider	CSO
File location	\\MapEIre\DataLibrary\Agriculture\Census of Agriculture 2010 Table 8.xlsx \\MapEIre\DataLibrary\ Agriculture\Farmyard1kmED.mdb
Projection	
Data description	Animal numbers by county (goats, deer, mules/jennets/asses)

Workflow	Animal numbers for 2010 from "Census of Agriculture 2010 Table 8.xlsx" are spatially distributed by ED according to the occurrence of "Farmyards" and "Buildings" in LPIS.
GeoKey	3B4d 3B4f
NFR/CRF sector	3A4d - Goats 3A4f - Mules and asses 3B4d - Manure management - Goats 3B4f - Manure management - Mules and asses

3B4d



3B4f



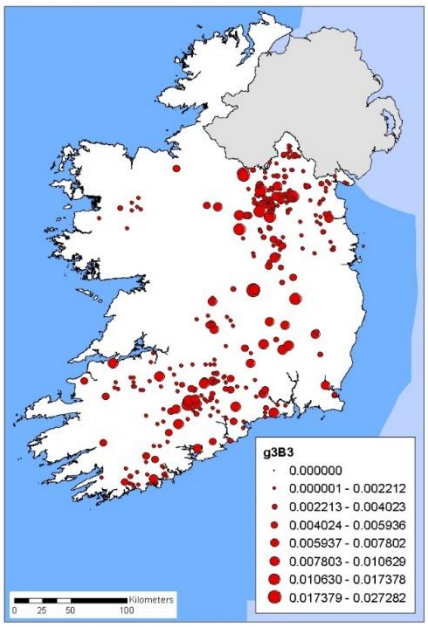
4.5.6 Animals on farm level, pigs, poultry

Source data	Pig_Licensed_TM65 Pig_Unlicensed_TM65 Poultry_Broiler_Licensed_TM65 Poultry_Layer_Licensed_TM65 Poultry_Unlicensed_TM65
Data provider	UCD (December 2016)
File location	\\MapEIre\DataLibrary\Agriculture\UCDdata.mdb \\MapEIre\DataLibrary\Agriculture\UCD_IEN.mdb
Projection	TM65
Data description	Location of pig and poultry houses based on CSO and IPPC licensing figures, and animal numbers for licensed pigs and poultry. The data set is assumed to account for 94 % of the pig production and 99 % of the poultry production. The data set is a draft version, and is being improved by UCD.

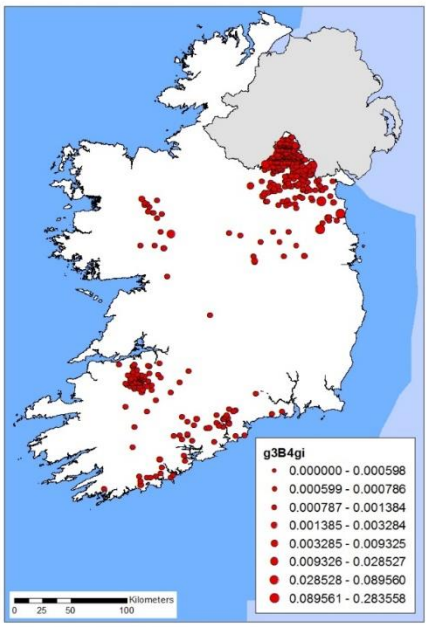
Workflow	Share of licensed pigs is calculated by 1 km grid cell ([ShrLicPig]) Share of unlicensed pig houses is calculated by 1 km grid cell ([ShrunLicPig]) The share licensed pigs make of total number of pigs in the census is calculated ([LicOfCensus])* The GeoKey shares are calculated by weighting the shares for licensed and unlicensed pigs according to the shares of the total number of pigs in the census; (Share=Sum(([ShrLicPig]*[LicOfCensus])+([ShrunLicPig]*(1-[LicOfCensus])))) Similar workflow is used to prepare GeoKeys for broilers and Laying hens.
GeoKey	3B3 3B4gi 3B4gii 3B4giv
NFR/CRF sector	3A3 - Swine 3A4g – Poultry** 3B3 - Manure management - Swine 3B4gi - Manure management - Laying hens 3B4gii - Manure management - Broilers 3B4giii - Manure management - Turkeys*** 3B4giv - Manure management - Other poultry

* Shares that UCD licensed animal numbers make of the animals in the census: Broilers = 0.78, Laying hens = 0.66, Pigs = 0.71
** GeoKey 3B4gii applied for Poultry
***GeoKey 3B4giv applied for Turkeys

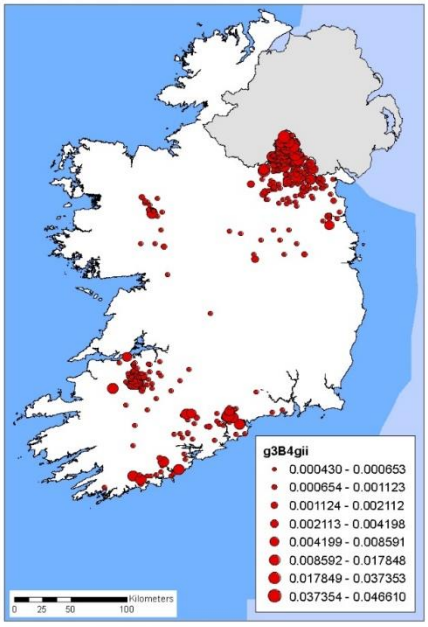
3B3



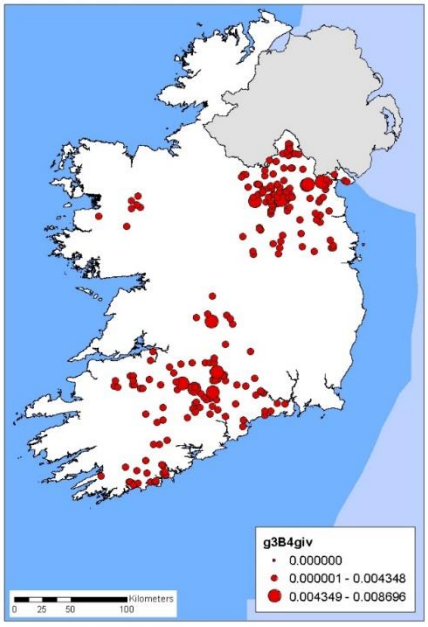
3B4gi



3B4gii



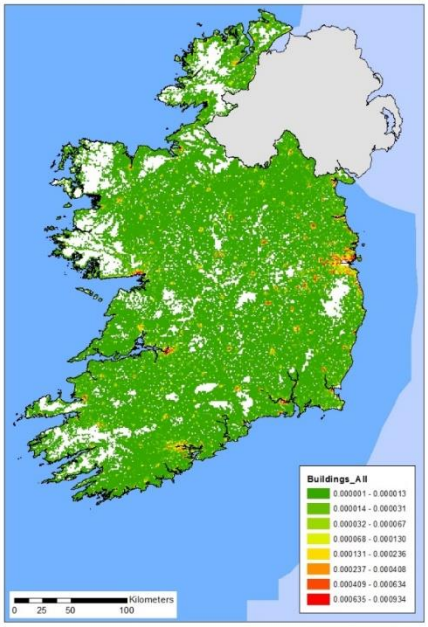
3B4giv



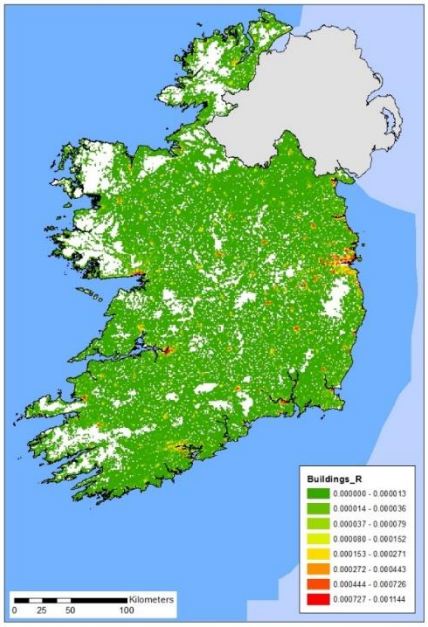
4.5.7 Buildings

Source data	GEODIR_Buildings
Data provider	EPA
File location	\\MapEire\DataLibrary\Buildings\ BuildUse.mdb
Projection	TM65
Data description	GEODIR_Buildings holds points for buildings and including four categories of building use (commercial, residential, both, and unknown)
Workflow	GeoKeys are prepared by selecting the relevant building type (R) or all buildings (All), and then calculate the share of the number of selected buildings by grid cell
GeoKey	Buildings_All Buildings_R
NFR/CRF sector	2A5b - Construction and demolition 2D3c - Asphalt roofing 2F1f - Stationary air-conditioning 1A4bii - Residential: Household and gardening (mobile)

Buildings_All



Buildings_R

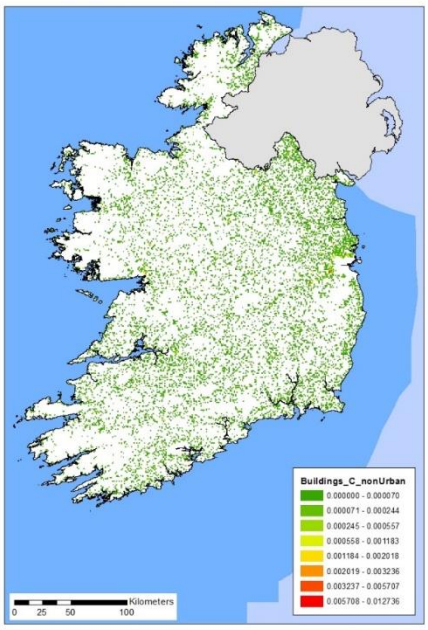


4.5.8 Buildings excluding specific areas

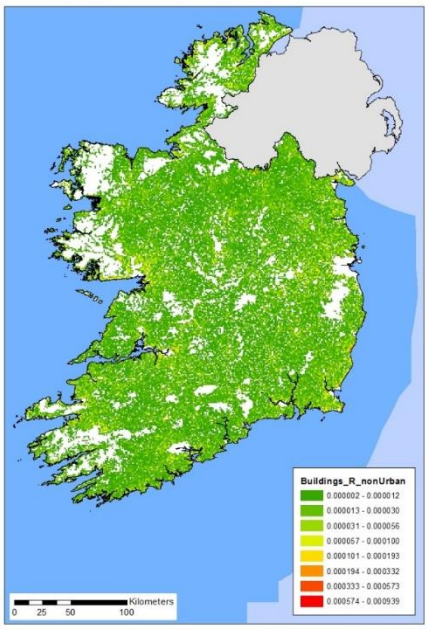
Source data	GEODIR_Buildings UWWT_SeweredAreas Census2011_Settlements
Data provider	EPA (GEODIR_Buildings and UWWT_SeweredAreas) CSO (Census2011_Settlements)
File location	\\MapEIre\DataLibrary\Buildings\ BuildUse.mdb
Projection	
Data description	GEODIR_Buildings holds points for buildings and including four categories of building use (commercial, residential, both, and unknown) UWWT_SeweredAreas is a polygon theme of sewered areas based on data from Irish Water at the end of 2015 Census2011_Settlements is a polygon theme of areas defined as settlements. A town is by CSO defined as "a cluster with a minimum of 50 occupied dwellings, with a maximum distance between any dwelling and the building closest to it of 100 metres, and where there was evidence of an urban centre (shop, school etc.)."

Workflow	Preparing the GeoKey "Building_C_non-urban"; Buildings in areas defined as "Settlements" are excluded from the data, and then the shares of Commercial buildings are calculated by grid cell. Preparing the GeoKey "Building_R_non-urban"; Buildings in areas defined as "Settlements" are excluded from the data, and then the shares of Residential buildings are calculated by grid cell. Preparing the GeoKey "Building_R_non- Sewered"; Buildings in areas defined as "Sewered areas" are excluded from the data, and then the shares of Commercial buildings are calculated by grid cell.
GeoKey	Building_C_nonurban Building_R_nonurban Buildings_R_non-Sewered
NFR/CRF sector	2I - Wood processing 5C2 - Open burning of waste 5D1 - Domestic wastewater handling 5D2 - Industrial wastewater handling 5D3 - Other wastewater handling

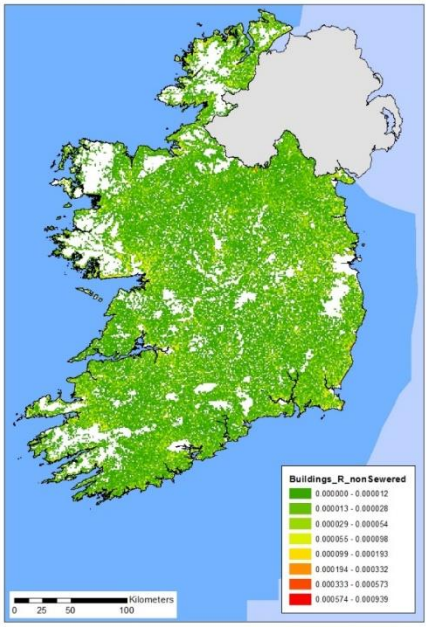
Building_C_nonurban



Building_R_nonurban



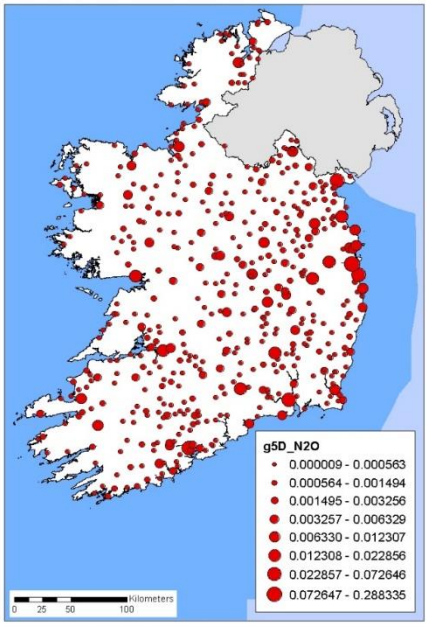
Buildings_R_non-Sewered



4.5.9 Domestic wastewater handling

Source data	Inventory data LEMA_EMISSIONPTS_TYPES.shp
Data provider	EPA
File location	
Projection	TM65
Data description	Person equivalent (PE) by wastewater treatment plant Licence Enforcement and Monitoring Application (LAME) Emission Points
Workflow	The LEMA emission points are geocoded and the GeoKey is calculated as share of PE by grid cell
GeoKey	5D_N2O
NFR/CRF sector	5D1 - Domestic wastewater handling 5D2 - Industrial wastewater handling 5D3 - Other wastewater handling

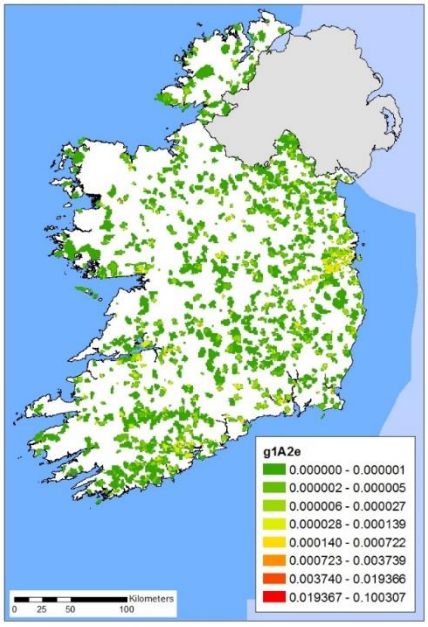
5D_N2O



4.5.10 Food and beverages industry

Source data	Inventory data GeoKey "HeatDemand_Industrial" (see Section 4.5.13)
Data provider	EPA
File location	
Projection	
Data description	Fuel consumption at plant level for large point sources (LPS, 28 plants in 2015)
Workflow	Emissions from LPS are allocated to the location of the plants The remaining sectoral emission is allocated according to "HeatDemand_Industrial" A weighting factor for LPS is calculated as the share LPS fuel consumption make of the total sectoral fuel consumption. The GeoKey is calculated as a weighted average of the shares for LPS and for area sources by grid cell.
GeoKey	1A2e
NFR/CRF sector	1A2e - Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco 2H2 - Food and beverages industry

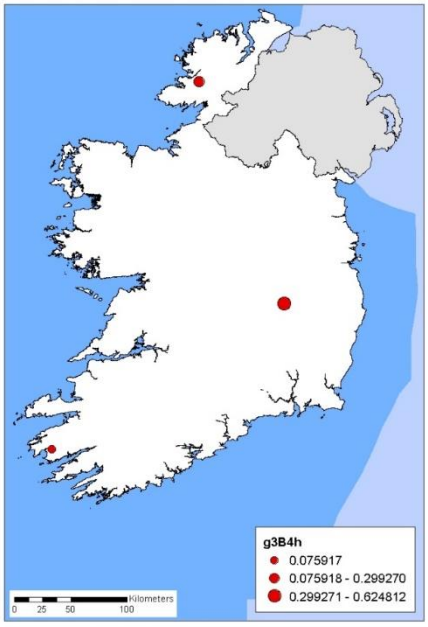
1A2e



4.5.11 Fur animals

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Mink population by farm (3 farms in 2015)
Workflow	The farms are geocoded and the GeoKey is calculated as the share of total mink population by grid cell
GeoKey	3B4h
NFR/CRF sector	3A4h - Other animals 3B4h - Manure management - Other animals

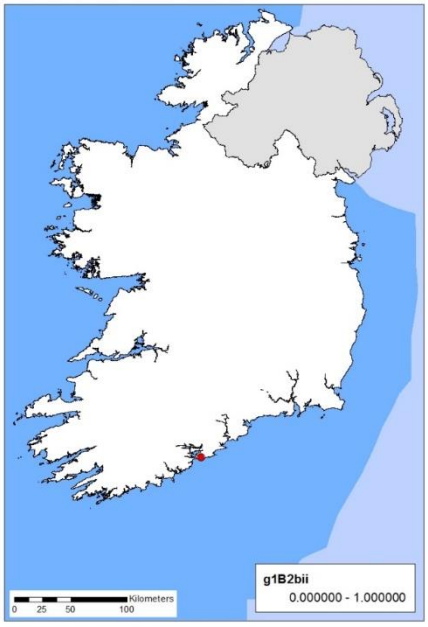
3B4h



4.5.12 Gas terminal

Source data	
Data provider	
File location	
Projection	
Data description	
Workflow	Emissions are allocate to the gas metering terminal (Kinsale Energy Inch Terminal, Co. Cork)
GeoKey	1B2bii
NFR/CRF sector	1A3ei - Pipeline transport 1B2b - Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)

1B2bii

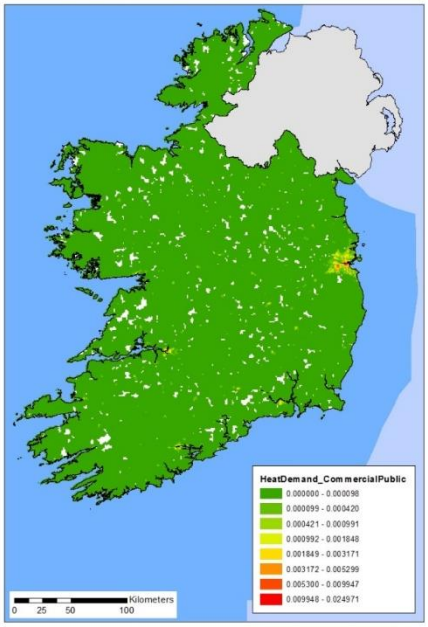


4.5.13 Heat demand

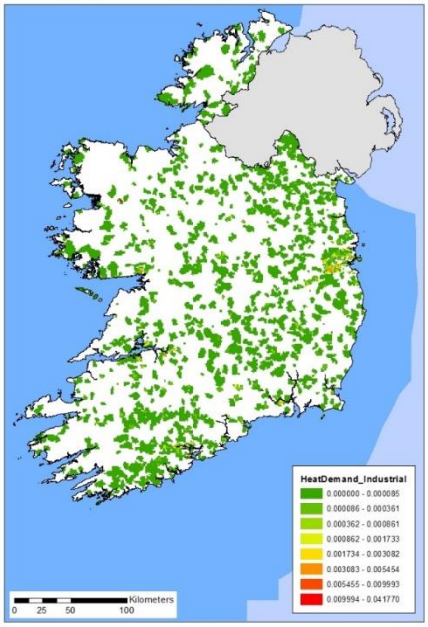
Source data	HeatDemand.xlsx Small areas (SA)
Data provider	SEAI CSO
File location	\ \MapEIre\DataLibrary\HeatMap\HeatDemand.xlsx \\MapEIre\DataLibrary\HeatMap\SAI_HeatDemand.mdb \\MapEIre\DataLibrary\HeatMap\Key_Heat.mdb
Projection	TM65
Data description	Heat demand data per small area are downloaded from http://maps.seai.ie/heatdemand/ for the individual counties and combined in one spreadsheet. The data set includes heat demand for the commercial, public, industrial and domestic sectors per small areas, and total heat demand per road, gas and water network. Further, the data set include population by small area.

Workflow	As the SA polygon layer from CSO differ from the coastline used in the spatial model, the SA layer is clipped by the coastline to exclude water areas and areas in North Ireland. The clipped layer is intersected with the 1 km grid and stored as SAI_HeatDemand.mdb\SAI_1km. The share of SA area is calculated by grid cell ([ShareOfSAI]) Heat demand is joined to SAI_1km on SA and the layer is saved as SAI_HeatDemand.mdb\SAI_heat Calculate share of heat demand for Industry (ind15) by grid cell ([ShrInd15]) Calculate the GeoKey shares as [ShareOfSAI]*[ShrInd15] Similar workflow is used to prepare GeoKeys for the sum of heat demand for commercial and public (comm15+pub15)
GeoKey	HeatDemand_CommercialPublic HeatDemand_Industrial
NFR/CRF sector	1A4ai - Commercial/institutional: Stationary 1A4aii - Commercial/institutional: Mobile 1A2a - Stationary combustion in manufacturing industries and construction: Iron and steel 1A2d - Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print 2A4a - Ceramics 2A6 - Other mineral products (please specify in the IIR) 2D3g - Chemical products 2D3h – Printing 2F3 - Fire protection 2G – Other product use (other pollutants than NMVOC) 3Dd - Off-farm storage, handling and transport of bulk agricultural products

HeatDemand_CommercialPublic



HeatDemand_Industrial

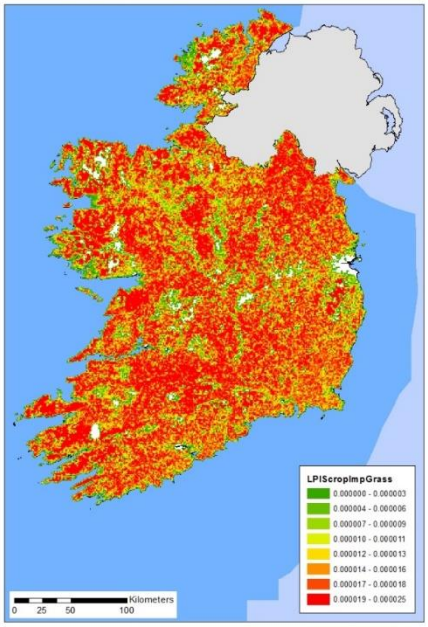


4.5.14 Land parcel identification system, LPIS

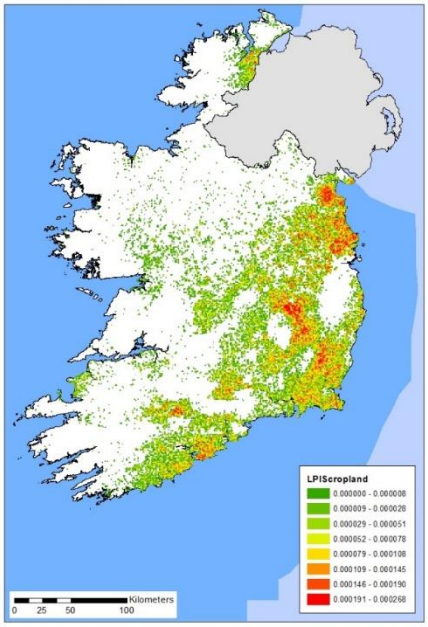
Source data	Lpis_cpy.shp Census2011_Electoral_Divisions_generalised20m
Data provider	EPA CSO
File location	\MapEIre\DataLibrary\LPIS\LPIS_1km.gdb \\MapEIre\DataLibrary\LPIS\LPIS_Key.mdb
Projection	TM75_Irish_Grid (EPSG: 29903)
Data description	Land parcels map with information on crop description, IPCC category and LU category

Workflow	LPIS data is provided by the Irish EPA. The data set include a land use classification (LU), based mainly on the included IPCC category, but few observations occur where the same IPCC category is assigned different LU categories. LU is missing for all land parcels in County Mayo in the data set. Based on the relation between IPCC category and LU category for all other land parcels, LU categories are assigned to the land parcels in County Mayo. A correspondence list is included in Annex 3. The edited LPIS data set is stored as \\MapEIre\DataLibrary\LPIS\LPIS_1km.gdb\LPIS1km Areas are calculated by land parcel, and the layer is intersected with the 1 km grid. The areas of the intersection polygons ([AreaInt]) are calculated by polygon. Land parcels with land use categorized as cropland ([LU] LIKE 'Cropland*') are selected and the GeoKey is calculated as share of cropland area by grid cell Similar workflow is used to prepare the GeoKeys "LPIS-cropImpGrass" (including areas with land use classified as cropland and improved grassland), "LPISgrassland" (including areas with land use classified as improved grassland, unimproved grassland, and natural grassland), and "LPISfarmyard" (including areas with crop description classified as farmyard and building).
GeoKey	LPIScropImpGrass LPIScropland LPISfarmyard LPISgrassland
NFR/CRF sector	3Da2a - Animal manure applied to soils 3Dc - Farm-level agricultural operations including storage, handling and transport of agricultural products 3G – Liming 3Da2b - Sewage sludge applied to soils 3Da2c - Other organic fertilisers applied to soils (including compost) 3Da4 - Crop residues applied to soils 3Da5 - Mineralization 3Db - Indirect emissions from managed soils 3De - Cultivated crops 3Df - Use of pesticides 3F - Field burning of agricultural residues 1A4ci - Agriculture/Forestry/Fishing: Stationary 2B10b - Storage, handling and transport of chemical products 3Da3 - Urine and dung deposited by grazing animals

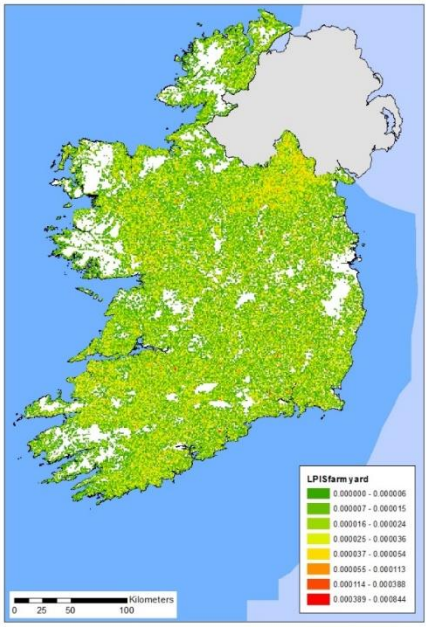
LPIScropImpGrass



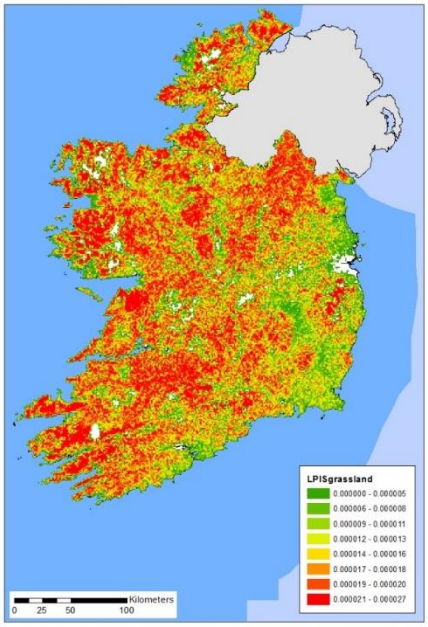
LPIScropland



LPISfarmyard



LPISgrassland

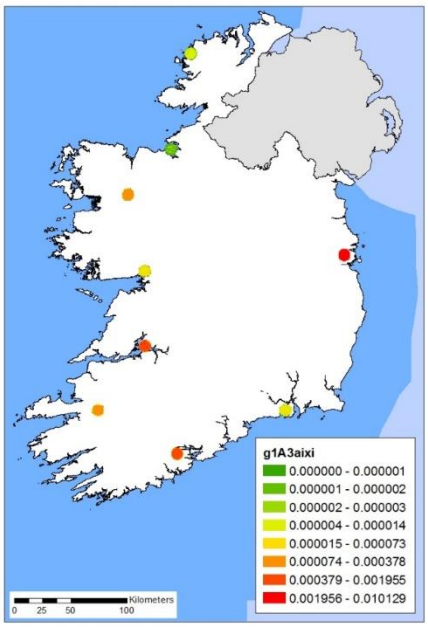


4.5.15 LTO

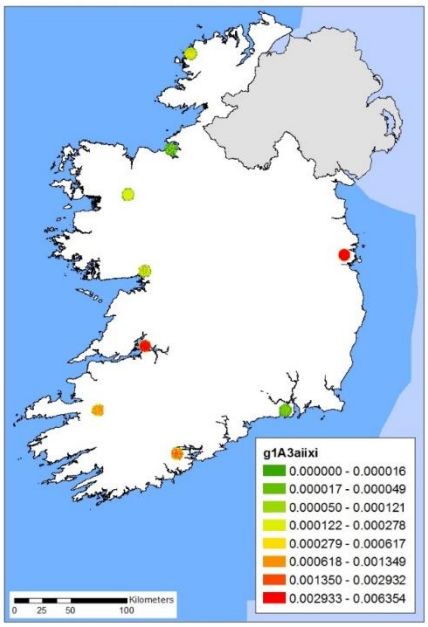
Source data	Inventory data for LTO
Data provider	EPA
File location	\\MapEIre\DataLibrary\Aviation\Aviation.mdb
Projection	
Data description	

Workflow	Emissions from LTO are allocated to a 5 km buffer zone around the airports. The GeoKey shares are calculated from the share of the fuel consumption by airport and the share of the buffer zone area by the 1 km grid cells for each airport.
GeoKey	1A3ai(i) 1A3aii(i)
NFR/CRF sector	1A3ai(i) – International LTO 1A3aii(i) – Domestic LTO

1A3ai(i)



1A3aii(i)

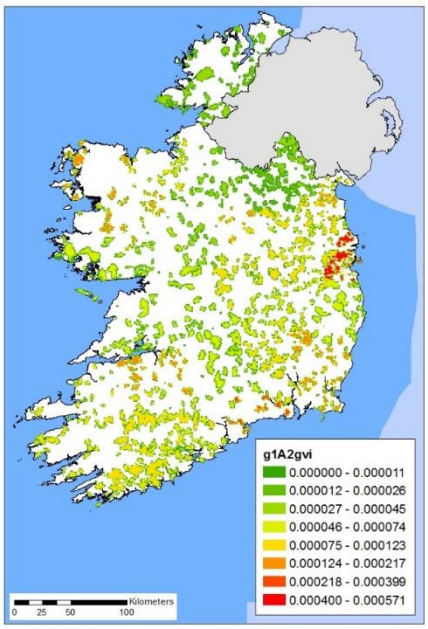


4.5.16 Machinery in agriculture and industry

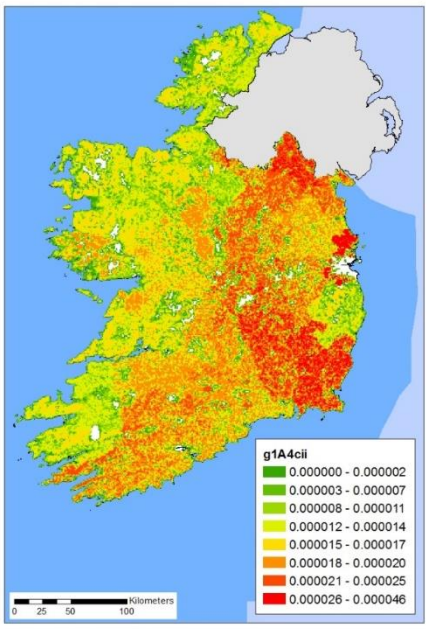
Source data	epa_20161208.xlsx
Data provider	CSO
File location	\\MapEIre\DataLibrary\Machinery\epa_20161208.xlsx \\MapEIre\DataLibrary\Machinery\Machinery.mdb
Projection	
Data description	Mileage for non-road machinery

Workflow	In the Machinery data set, Tipperary county is split into TIPPERARY NR and TIPPERARY SR. These two sub-counties are summarised in accordance with the CSO county data. The shares of mileage for agricultural machinery (agricultural tractor, haulage tractor, and combined harvester, [ShrAgri]) and for non-agricultural machinery (dumper, excavator, forklift, haulage tractor, mobile machinery, and off-road dumper, [ShrNonAgri]) are calculated by county from the machinery data The county layer is prepared for joining the machinery data by adding corresponding county names, and merging counties that are split into sub-counties in the county layer. The output is saved as Machinery.mdb\CountyMerge The GeoKey for agricultural machinery is based on mileage for agricultural machinery by county (share of mileage by county, [SumOfShrAgri]) and cropland and improved grassland (AgriArea) from LPIS (share of AgriArea by grid cell, [ShrAgriArea]). GeoKey shares are calculated as [ShrAgriArea]*[SumOfShrAgri]
GeoKey	1A2gvi 1A4cii
NFR/CRF sector	1A2gvii - Mobile Combustion in manufacturing industries and construction 1A4cii - Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

1A2gvi



1A4cii

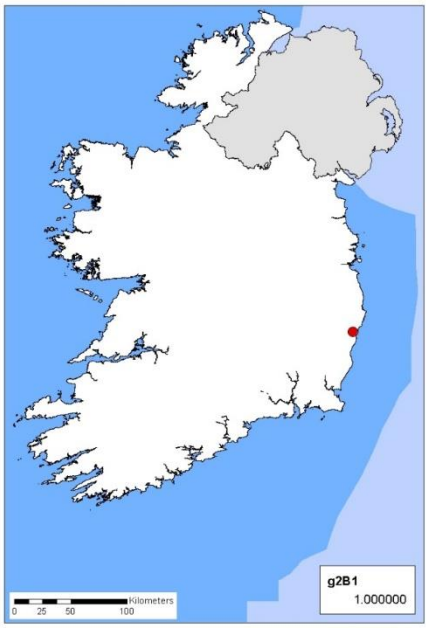


4.5.17 Other metal production

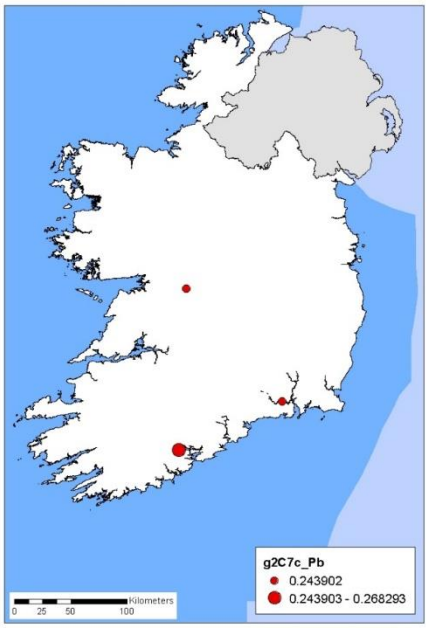
Source data	Inventory data

Data provider	EPA
File location	
Projection	
Data description	Emissions of heavy metals at plant level
Workflow	Separate GeoKeys area prepared for Cd, Pb and Zn based on share of emission by plant. The GeoKey for the remaining pollutants (rest) are allocating emissions equally between the 4 plants.
GeoKey	2C7c_Cd 2C7c_Pb 2C7c_rest 2C7c_Zn
NFR/CRF sector	2C7c - Other metal production 2D3e - Degreasing

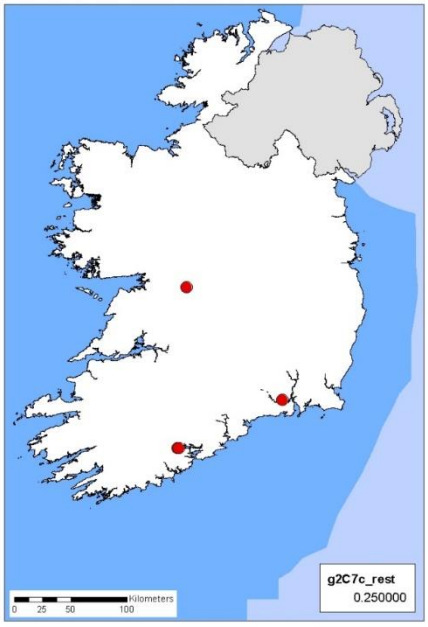
2C7c_Cd



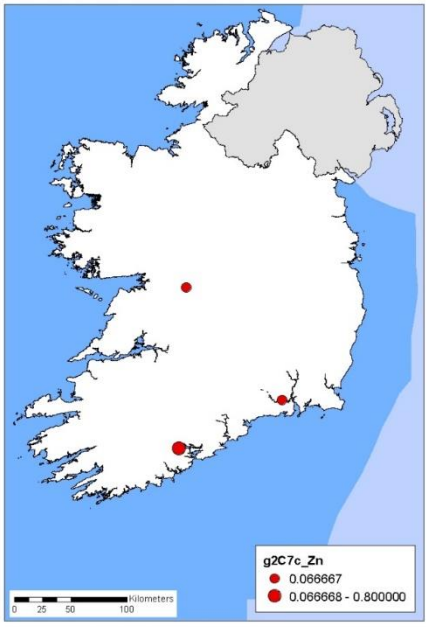
2C7c_Pb



2C7c_rest



2C7c_Zn

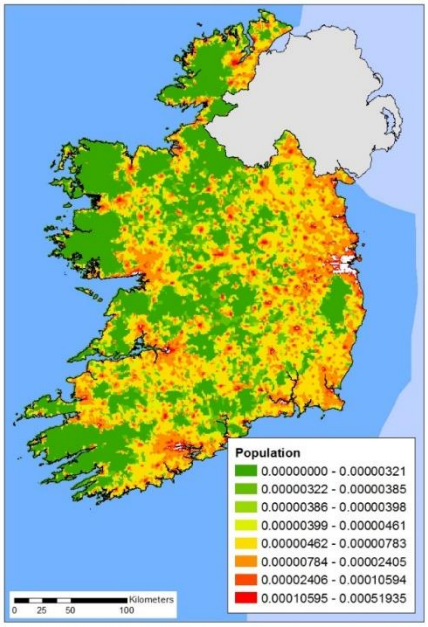


4.5.18 Population

Source data	HeatDemand.xlsx Small areas (SA)
Data provider	SEAI CSO
File location	\ \MapEIre\DataLibrary\HeatMap\HeatDemand.xlsx \\MapEIre\DataLibrary\HeatMap\SAI_HeatDemand.mdb \\MapEIre\DataLibrary\HeatMap\Key_Heat.mdb
Projection	TM65
Data description	Heat demand data per small area are downloaded from http://maps.seai.ie/heatdemand/ for the individual counties and combined in one spreadsheet. The data set includes heat demand for the commercial, public, industrial and domestic sectors per small areas, and total heat demand per road, gas and water network. Further, the data set include population by small area.

Workflow	As the SA polygon layer from CSO differ from the coastline used in the spatial model, the SA layer is clipped by the coastline to exclude water areas and areas in North Ireland. The clipped layer is intersected with the 1 km grid and stored as SAI_HeatDemand.mdb\SAI_1km. The share of SA area is calculated by grid cell ([ShareOfSAI]) Heat demand is joined to SAI_1km on SA and the layer is saved as SAI_HeatDemand.mdb\SAI_heat Calculate share of population (Pop) by grid cell ([ShrPop]) Calculate the GeoKey shares as [ShareOfSAI]*[ShrPop]
GeoKey	Population
NFR/CRF sector	2D2 - Paraffin wax use 2D3a - Domestic solvent use including fungicides 2D3d - Coating applications 2D3i - Other solvent use 2F1a - Commercial refrigeration 2F4 - Aerosols 2F6 - Other applications 2G – Other product use (NMVOC) 4G - LULUCF Harvested wood product 5E - Other waste

Population

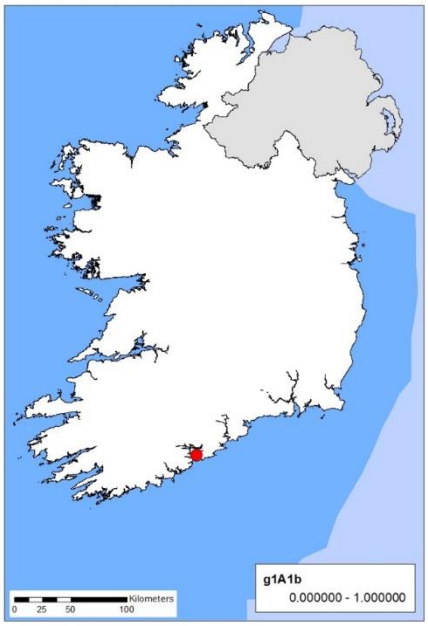


4.5.19 Refinery

Source data	Geographical coordinates for the refinery
Data provider	
File location	
Projection	TM65

Data description	
Workflow	Emissions are allocate to the refinery (Whitegate Refinery, Co. Cork)
GeoKey	1A1b
NFR/CRF sector	1A1b - Petroleum refining 1B2aiv - Fugitive emissions oil: Refining / storage

1A1b



4.5.20 Road transport

Mileage data (total and heavy vehicles) is available only for the national road network (NRN) for 2015. Total mileage is available in the national emission inventory. Mileage for other roads than national roads is calculated as the residual of total mileage when NRN mileage is subtracted.

Mileage driven on national roads is allocated according to the spatial key prepared from the mileage data from TII. The remaining mileage is allocated to roads other than national roads (other roads). As a digital map for other roads or for the entire road network including road categories is not available, a map is created from the road network map including all roads and the national road map using the following procedure:

Mileage data for the national road network is available from TII as line feature data set, while the national road network is available both as line and polygon feature. As no attributes are available for the road network that could be used as a proxy for mileage, the polygon data will be used and in this way the width of the roads will be used as a proxy for mileage. The national road map and the road network map are displaced probably according to projection issues. It has not been possible to correct for this displacement, but it has been taken into account in the data processing.

A map of the major roads is included in the spatial analysis as this fits to the road network, but only includes the major roads, among which the national roads should be

found. To be able to exclude the national roads from the road network, buffer zones are created from the line theme. Different buffer sizes are tested and, after visual evaluation, a buffer zone of 150 m (75m on each side of the lines) is chosen to make the best overlay with the major road map. A line theme holding the parts of major roads that are located within the 150m buffer zone for the national roads is created in GIS using the clip tool.

A buffer zone of 50 meter (25 m on each side of the lines) is found to be most for appropriate for overlay with the road network and for excluding the relevant road segments from the road network. This leaves back a theme including all roads except the national roads but with some minor errors due to the selected size of the buffer zones. I some areas the selected buffer zones does not include all relevant road segments due to large displacement or large width of the road polygons. In other areas the buffer zones cover nearby roads or road segments with a different road category.

TII traffic count data for the TII traffic counters located on the national roads include the vehicle categories MBIKE, CAR, LGV, BUS, HGV_RIG, HGV_ART, CARAVAN. The gridded mileage data provided by TII include AADT and percHV. In the spatial analysis for preparing the GeoKey for road transport, HV is assumed to cover BUS, HGV_RIG and HGV_ART. The national emission inventory includes the vehicle categories mopeds, motorcycles, passenger cars, light commercial vehicles, heavy duty trucks and buses. In the GeoKey calculation heavy duty trucks and buses are summarized to calculate HV, while AADT is assumed to be the sum of all vehicle types in the emission inventory including mopeds, which might not be included in TII traffic count data.

The GeoKeys for road transport is created by combining the spatial keys based on AADT for national roads, and the road network for all roads excluding national roads.

4.5.20.1 National roads

Source data	2015_NRN_link.shp	
Data provider	TII	
File location	\\MapEIre\DataLibrary\Road\2015_NRN_link.mdb \\MapEIre\DataLibrary\Road\RoadAnalysis.mdb	
Projection	IRENET95_Irish_Transverse_Mercator	
Data description	Road network for national roads including annual mileage (average daily traffic, AADT) and percent heavy vehicles (HV) Line theme	
Workflow	The road network is reprojected to TM6 and intersected with the 1 km x 1 km grid. Spatial keys are calculated as share of AADT [Share_AADT] and share of HV [Share_HV] by grid cell. A buffer zone of 150 m (75m on each side of the lines) is created for the national roads ("2015_NRN_link") and stored as "NRN_buffer_W150m"	
GeoKey	*Spatial key for national roads for input to Road_HV, Road_PC, Road_PCHV*	
NFR/CRF sector		

4.5.20.2 Major roads

Source data	INFRA_MajorRoads	
Data provider	EPA	
File location	\\MapEIre\DataLibrary\Road\RoadAnalysis.mdb	
Projection	TM65	
Data description	Road network for major roads Line theme	
Workflow	A line theme holding the parts of major roads ("INFRA_MajorRoads") that are located within the 150m buffer zone ("NRN_buffer_W150m") for the national roads is created ("MajorClipNRN150m") A buffer zone of 50 meter (25 m on each side of the lines) is created for "MajorClipNRN150m" and stored as "MajorClipNRN150mBufferW50m"	
GeoKey	*Input to spatial key for other roads*	
NFR/CRF sector		

4.5.20.3 All roads

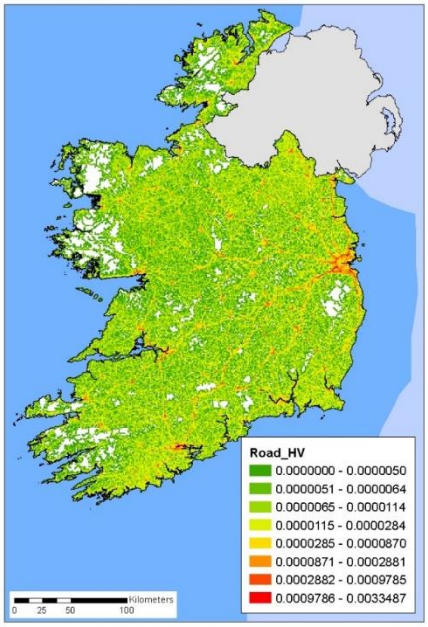
Source data	ROADS_POLY_area	
Data provider	EPA	
File location	\\MapEIre\DataLibrary\Road\RoadAnalysis.mdb	
Projection	TM75_Irish_Grid	
Data description	Road network for all roads including major roads and national road Polygon theme	
Workflow	The polygon road network is dissolved to simplify the data set and saved as "RoadP_dissolve_" A polygon theme is created by excluding "MajorClipNRN150mBufferW50m" from "RoadP_dissolve_", leaving roads other than national roads. The layer is intersected with the 1 km x 1 km grid and saved as "RoadPexNRN_1km" Some minor errors occur in the final layer due to the selected size of the buffer zones. In some areas the selected buffer zones does not include all relevant road segments due to large displacement or large width of the road polygons. In other areas the buffer zones cover nearby roads or road segments with a different road category. A spatial key is created by calculating the share of area by grid cell.	

GeoKey	*Spatial key for other roads for input to Road_HV, Road_PC, Road_PCHV*	
NFR/CRF sector		

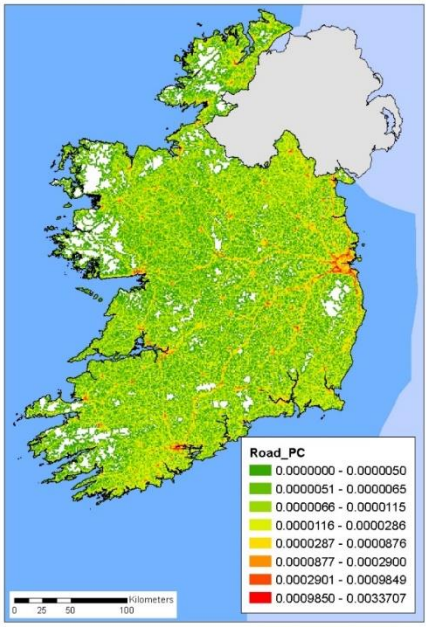
4.5.20.4 Preparing GeoKeys by combining data from different road themes

Source data	*See above*	
Data provider	*See above*	
File location	\\MapEIre\DataLibrary\Road\Road_Key.mdb	
Workflow	The GeoKey for passenger cars (PC), heavy vehicles (HV) and all vehicles (PCHV) is created by combining the spatial key for the national roads, based on mileage data (AADT), and the spatial key for other roads, based on area. The weighting of the spatial keys are calculated from the share that the mileage on national roads (NRN AADT) make of the national total mileage from the emission inventory data.	
GeoKey	Road_HV Road_PC Road_PCHV	
NFR/CRF sector	1A3biii - Road transport: Heavy duty vehicles and buses 1A3bi - Road transport: Passenger cars 1A3bii - Road transport: Light duty vehicles 1A3biv - Road transport: Mopeds & motorcycles 1A3bv - Road transport: Gasoline evaporation 1A3bvi - Road transport: Automobile tyre and brake wear 1A3bvii - Road transport: Automobile road abrasion 2D1 - Lubricant use 2D3b - Road paving with asphalt 2F1e - Mobile air-conditioning	

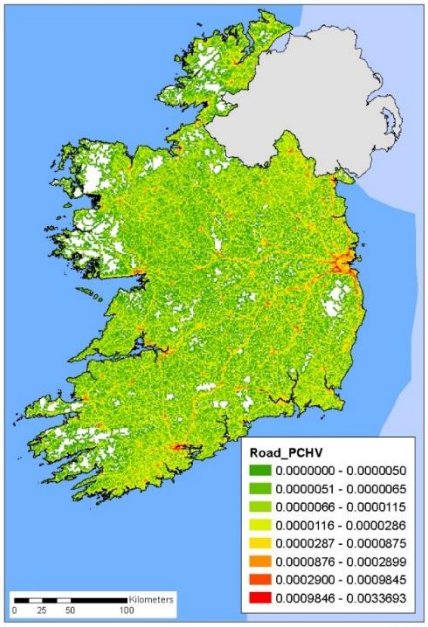
Road_HV



Road_PC



Road_PCHV

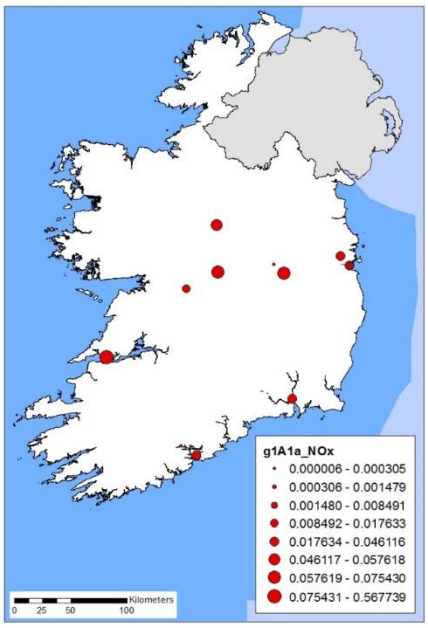


4.5.21 1A1a - Public electricity and heat production

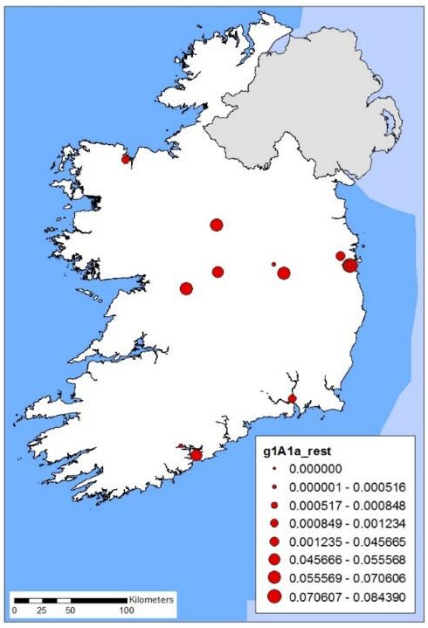
Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Emissions by plant
Workflow	The plants are geocoded and the GeoKeys are calculated as shares of sectoral emission by grid cell for NO_x, SO_x and CO_2
GeoKey	1A1a_NOx

	1A1a_rest 1A1a_SO2
NFR/CRF sector	1A1a - Public electricity and heat production

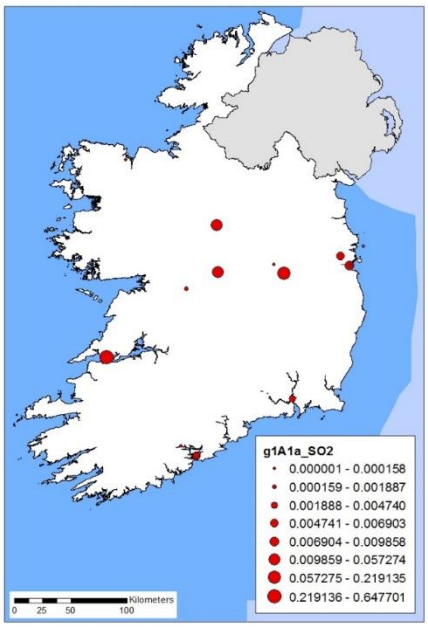
1A1a_NOx



1A1a_rest



1A1a_SO2

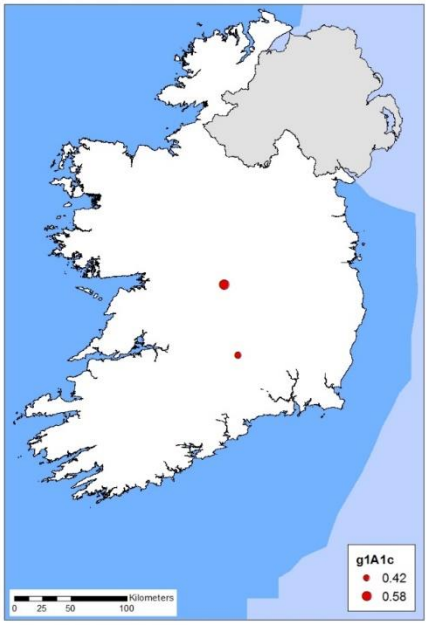


4.5.22 1A1c - Manufacture of solid fuels and other energy industries

Source data	Inventory data
Data provider	EPA
File location	

Projection	
Data description	Peat consumption and CO2 emissions by briquette factories (2 plants in 2015)
Workflow	The plants are geocoded and the GeoKey is calculated as shares of the total peat consumption by grid cell
GeoKey	1A1c
NFR/CRF sector	1A1c - Manufacture of solid fuels and other energy industries

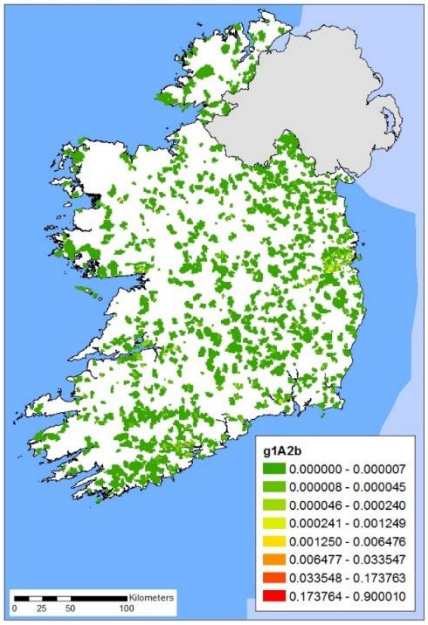
1A1c



4.5.23 1A2b - Stationary combustion in manufacturing industries and construction: Non-ferrous metals

Source data	Inventory data GeoKey "HeatDemand_Industrial" (see Section 4.5.13)
Data provider	EPA
File location	
Projection	
Data description	Fuel consumption at plant level for large point sources (LPS, 1 plant in 2015)
Workflow	Emissions from LPS are allocated to the location of the plant The remaining sectoral emission is allocated according to "HeatDemand_Industrial" A weighting factor for LPS is calculated as the share LPS fuel consumption make of the total sectoral fuel consumption. The GeoKey is calculated as a weighted average of the shares for LPS and for area sources by grid cell.
GeoKey	1A2b
NFR/CRF sector	1A2b - Stationary combustion in manufacturing industries and construction: Non-ferrous metals

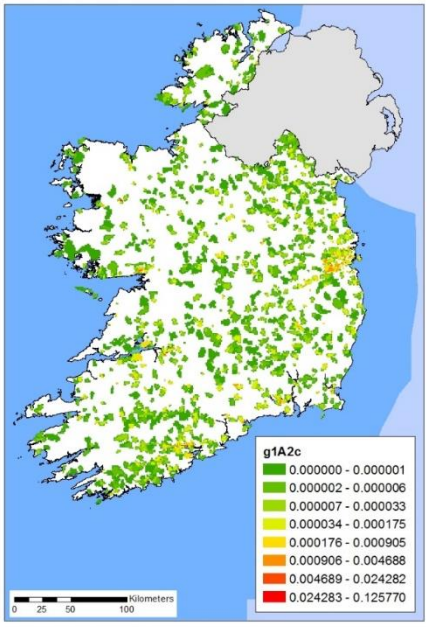
1A2b



4.5.24 1A2c - Stationary combustion in manufacturing industries and construction: Chemicals

Source data	Inventory data GeoKey "HeatDemand_Industrial" (see Section 4.5.13)
Data provider	EPA
File location	
Projection	
Data description	Fuel consumption at plant level for large point sources (LPS, 3 plants in 2015)
Workflow	Emissions from LPS are allocated to the location of the plants The remaining sectoral emission is allocated according to "HeatDemand_Industrial" A weighting factor for LPS is calculated as the share LPS fuel consumption make of the total sectoral fuel consumption. The GeoKey is calculated as a weighted average of the shares for LPS and for area sources by grid cell.
GeoKey	1A2c
NFR/CRF sector	1A2c - Stationary combustion in manufacturing industries and construction: Chemicals

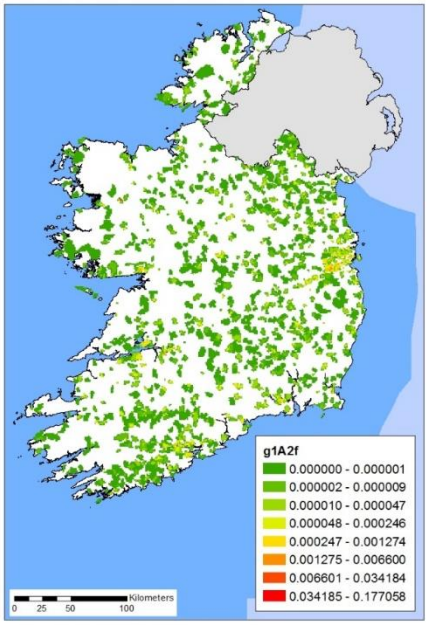
1A2c



4.5.25 1A2f - Stationary combustion in manufacturing industries and construction: Non-metallic minerals

Source data	Inventory data GeoKey "HeatDemand_Industrial" (see Section 4.5.13)
Data provider	EPA
File location	
Projection	
Data description	Fuel consumption at plant level for large point sources (LPS, 9 plants in 2015)
Workflow	Emissions from LPS are allocated to the location of the plants The remaining sectoral emission is allocated according to "HeatDemand_Industrial" A weighting factor for LPS is calculated as the share LPS fuel consumption make of the total sectoral fuel consumption. The GeoKey is calculated as a weighted average of the shares for LPS and for area sources by grid cell.
GeoKey	1A2f
NFR/CRF sector	1A2f - Stationary combustion in manufacturing industries and construction: Non-metallic minerals

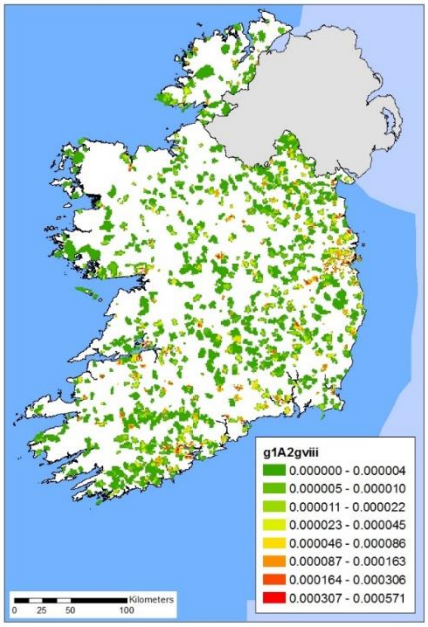
1A2f



4.5.26 1A2gviii - Stationary combustion in manufacturing industries and construction: Other

Source data	Inventory data GeoKey "HeatDemand_Industrial" (see Section 4.5.13)
Data provider	EPA
File location	
Projection	
Data description	Fuel consumption at plant level for large point sources (LPS, 22 plants in 2015)
Workflow	Emissions from LPS are allocated to the location of the plants The remaining sectoral emission is allocated according to "HeatDemand_Industrial" A weighting factor for LPS is calculated as the share LPS fuel consumption make of the total sectoral fuel consumption. The GeoKey is calculated as a weighted average of the shares for LPS and for area sources by grid cell.
GeoKey	1A2gviii
NFR/CRF sector	1A2gviii - Stationary combustion in manufacturing industries and construction: Other

1A2gviii

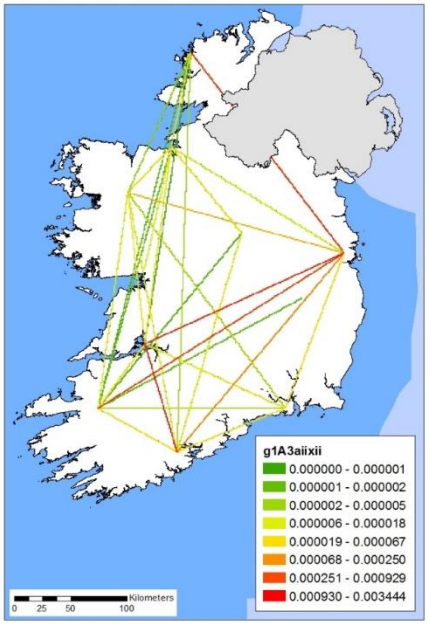


4.5.27 1A3aii(ii) – Domestic cruise

Source data	Inventory data for domestic cruise
Data provider	EPA
File location	\\MapEIre\DataLibrary\Aviation\Aviation.mdb
Projection	
Data description	
Workflow	Route lines are created between the airports in the inventory data from XY coordinates using GIS. The GeoKey shares are calculated from the share of total fuel consumption by airport and the share of flights by route for each airport.
GeoKey	1A3aii(ii)
NFR/CRF sector	1A3aii(ii) – Domestic cruise

*Emissions are allocated only to the segments of the routes that are within EEZ

1A3aii(ii)

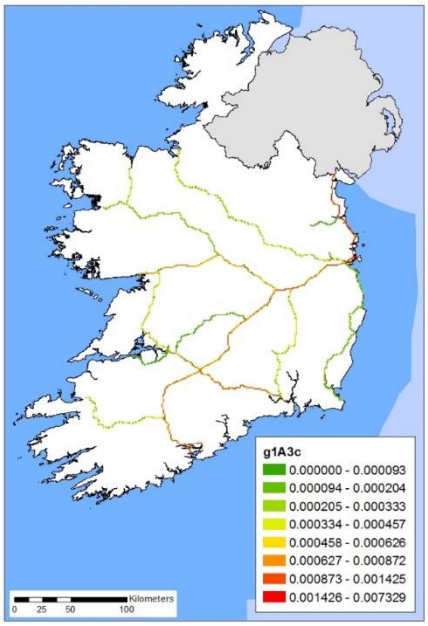


4.5.28 1A3c - Railways

Source data	IR Network and 2016 Traffic (2016 05 24)(RevA).pdf) IR_Rail_Network_LineNames_20161219
Data provider	Irish Rail
File location	\\MapEIre\DataLibrary\Rail\IR Network and 2016 Traffic (2016 05 24)(RevA).pdf \\MapEIre\DataLibrary\Rail\Rail.mdb
Projection	ING-75 (Authority: Custom) (corresponds to TM75_Irish_Grid, EPSG: 29903)
Data description	Annual train passes on different sections of the network for 2011 and 2016 Centre lines for the Irish Rail track network

Workflow	The rail network layer is modified by deleting the coastline segments, and adding length of rail network by route. Annual train passages in 2016 [ATP_2016] are added to the routes in the rail network layer. Only one ATP is applied for each route, and for routes where more ATP values are available, the selection of ATP will be based on expert judgement, but in general the highest ATP value will be applied. Annual train kilometres are calculated by route ([ATP_2016]*[Length]), and the share of total train kilometres are calculated by route ([ShrATP16xL]) Add field "ATPxLen16" and calculate value as [ATP_2016]*[Length] Add field "ShrATP16xL" and calculate values as [ATPxLen16]/SumOf[ATPxLen16], the latter from the statistics tool. The share of the total rail network length is calculated by grid cell ([LenPrRoute]) The GeoKey shares are calculated as [ShrATP16xL]*[LenPrRoute]
GeoKey	1A3c
NFR/CRF sector	1A3c - Railways

1A3c

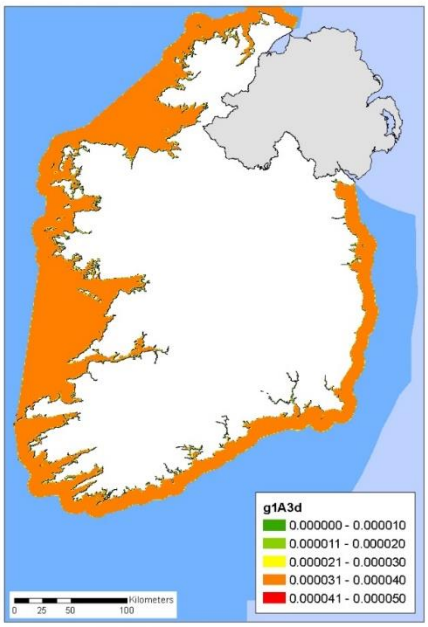


4.5.29 1A3dii - National navigation (shipping)

Source data	Census2011_Garda_Districts_Nov2013
Data provider	CSO
File location	\\MapEire\DataLibrary\Borders\Borders.mdb\Buffer

Projection	TM65
Data description	National border
Workflow	A coastal buffer zone for navigation is created by manually extending a 6 nautical mile buffer zone around the national border, to include sea areas defined by the shortest path between headlands, e.g. between the peninsulas of Dingle and Errismore.
GeoKey	1A3d
NFR/CRF sector	1A3dii - National navigation (shipping)

1A3d

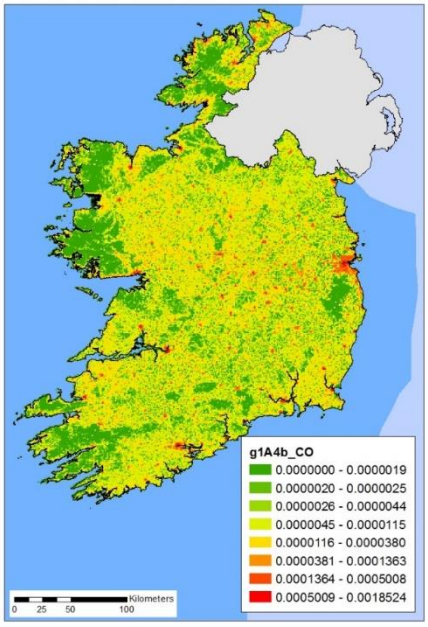


4.5.30 1A4bi - Residential: Stationary

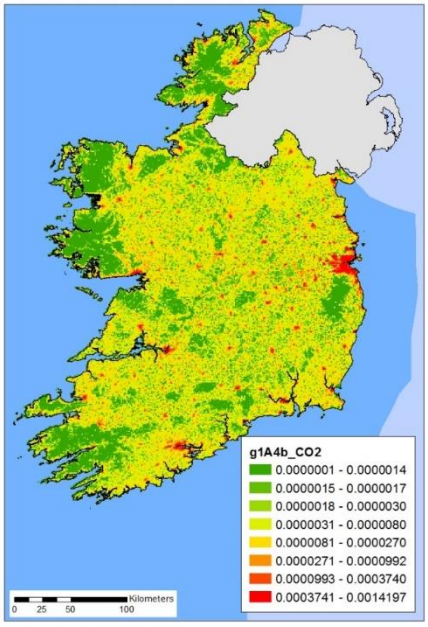
Source data	Messing with Residentials.xlsx GEODIR_Buildings Census2011_Small_Areas_generalised20m.shp
Data provider	EPA
File location	\\MapEIre\DataLibrary\ResidentialCombustion\ResidentialCombustion.xlsx \\MapEIre\DataLibrary\ResidentialCombustion\ResidentialCombustion.mdb
Projection	TM65
Data description	

Workflow	Calculation of emissions from residential combustion is based on number of appliances by small area from the EPA study on residential combustion combined with national fuel consumption in residential plants from the national energy statistics and emission factors from the national emission inventory. The following calculation sequence is made for the fuel types oil, natural gas, coal, peat, LPG, wood, and "no central heating", the latter being estimated as ½*coal+½*peat. Energy consumption per residential unit [GJ] = Total energy consumption [GJ] / Total number of residential units Emission per residential unit [kg] = Energy consumption per residential unit [GJ] * Pollutant specific emission factor [g/GJ] / 1000 Emission per small area [kg] = Emission per residential unit [kg] * Number of residential units by small area The spatial distribution of emission per small area by pollutant is calculated for the pollutants SO_2, NO_x, NMVOC, CO, CO_2 and $PM_{2.5}$ ([ShrSO_2], [ShrNO_x], etc.). One of the small areas (GEOGID: A087066033) included in the EPA study with a number of residential appliances does not have buildings with building use R, B or NoData in GEODIR. This small area has been excluded from the GeoKey. The allocation of emissions by small area based is based on the Geodirectory point theme of buildings. Buildings categories R, B and NoData is included in the calculation. The spatial distribution of buildings (R+B+NoData) is calculated as the share of number of buildings (R+B+NoData) by 1 km * 1 km grid cell [ShrRBNoData_bySA]. The GeoKey for SO_2 is calculated as ([ShrSO_2] * [ShrRBNoData_bySA]) and similar for NO_x, NMVOC, CO, CO_2 and $PM_{2.5}$.
GeoKey	1A4b_CO 1A4b_CO2 1A4b_NMVOC 1A4b_NOx 1A4b_PM25 1A4b_SO2
NFR/CRF sector	1A4bi - Residential: Stationary

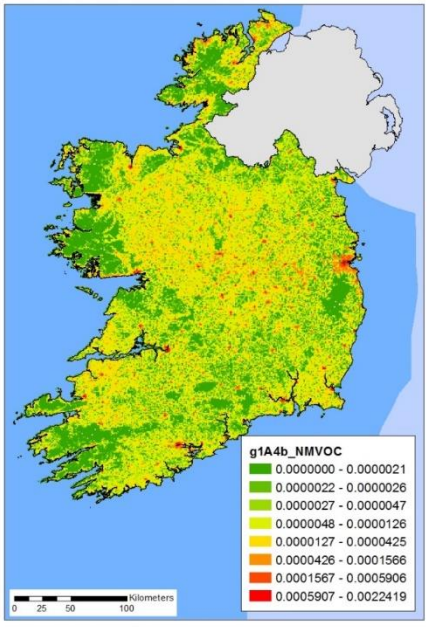
1A4b_CO



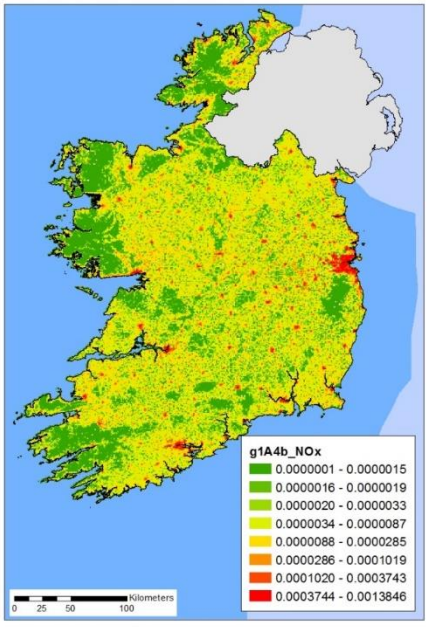
1A4b_CO2



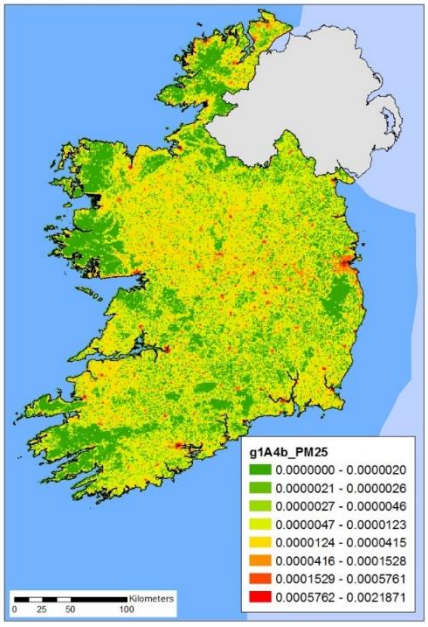
1A4b_NMVOC



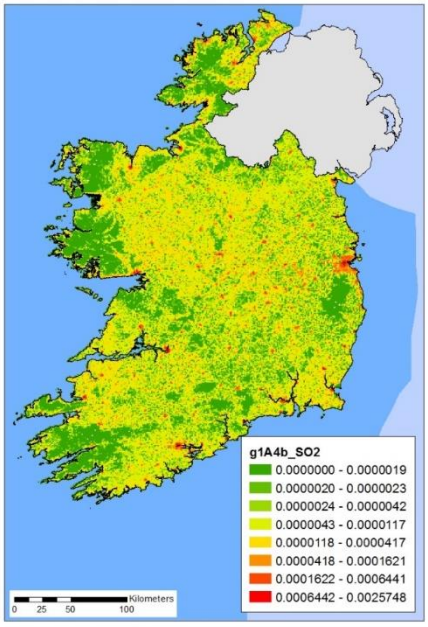
1A4b_NOx



1A4b_PM25



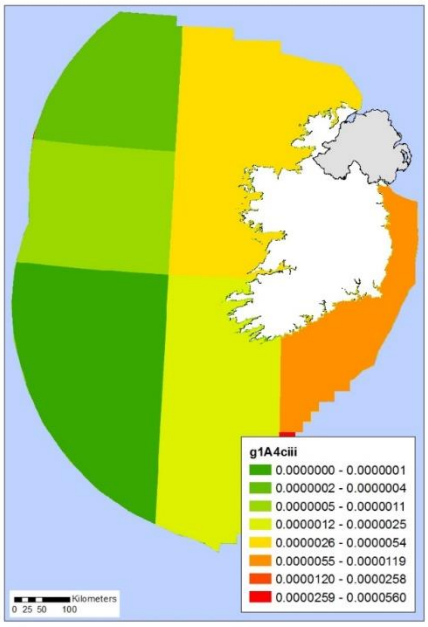
1A4b_SO2



4.5.31 1A4ciii - Agriculture/Forestry/Fishing: National fishing

Source data	Catches - North-east Atlantic (from 2000 onwards) ICES areas
Data provider	Eurostat [fish_ca_atl27] The International Council for the Exploration of the Sea (ICES)
File location	\ \MapEIre\DataLibrary\Fishing\fish_ca_atl27.zip \ \MapEIre\DataLibrary\Fishing\ICES_areas.zip \ \MapEIre\DataLibrary\Fishing\Fishing.mdb
Projection	GCS_WGS_1984
Data description	Eurostat Landings statistics (total fishery products) by ICES area for 2015 as per 12.09.2016 Shape file of ICES areas
Workflow	Landings data from Eurostat is appended to the ICES area data. The share of total landings is calculated by grid cell [ShrFish] The share of area per ICES area is calculated by grid cell [ShrICES] The GeoKey shares are calculated as [ShrFish]* [ShrICES]
GeoKey	1A4ciii
NFR/CRF sector	1A4ciii - Agriculture/Forestry/Fishing: National fishing

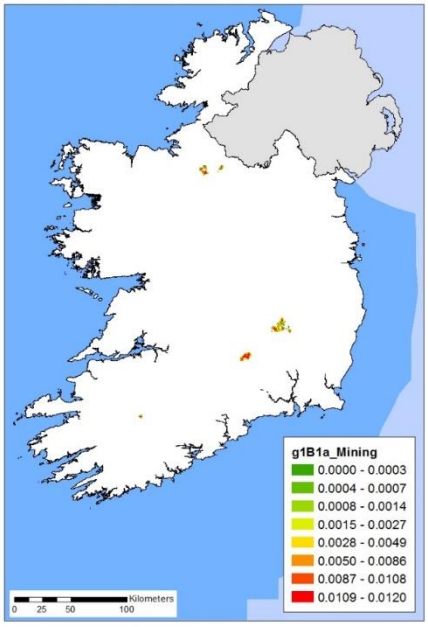
1A4ciii



4.5.32 1B1a - Coal mining

Source data	Mines - Site Locations Mines - Site Features
Data provider	EPA
File location	\\MapEIre\DataLibrary\Quarrying_Mining\Mining.mdb
Projection	
Data description	Mines - Site Locations: point data holding locations for mine sites including production type (Ba, Coal, CU, Fe, etc.) Mines - Site Features: polygon theme of mine sites
Workflow	Mine site locations with coal production are selected and 1 km buffer zones are created around the selected points. Production type is joined to the mine site features from mine site locations based on spatial location. Buffer zones and mine site features are combined in a polygon theme (Mining.mdb\Mines_COAL_merge) The GeoKey shares is calculated as the coal area by grid cell
GeoKey	1B1a_Mining
NFR/CRF sector	1B1a - Fugitive emission from solid fuels: Coal mining and handling (NMVOC and CH_4)

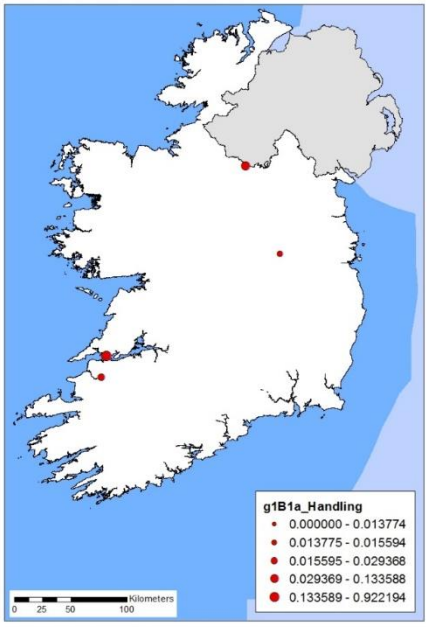
1B1a_Mining



4.5.33 1B1a - Coal handling

Source data	Inventory data
Data provider	EPA
File location	\\MapEire\DataLibrary\Quarrying_Mining\Coal use.xlsx
Projection	
Data description	Site specific coal consumption data
Workflow	
GeoKey	1B1a_Handling
NFR/CRF sector	1B1a - Fugitive emission from solid fuels: Coal mining and handling (TSP, PM_{10}, $PM_{2.5}$ and BC)

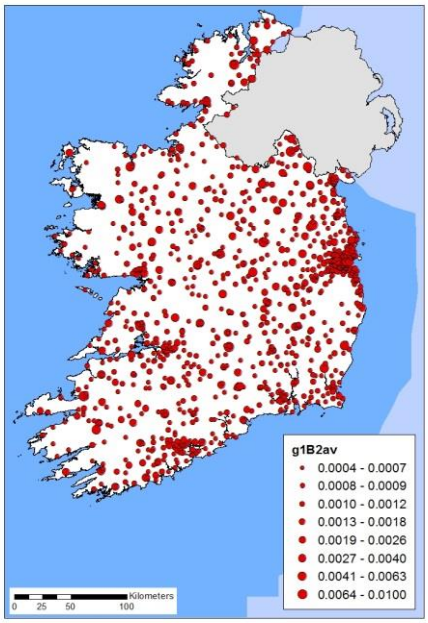
1B1a_Handling



4.5.34 1B2av - Distribution of oil products

Source data	licensed-auto-fuel-traders.xls
Data provider	CSO
File location	\\MapEIre\DataLibrary\ServiceStations\licensed-auto-fuel-traders.xls \\MapEIre\DataLibrary\ServiceStations\excel-geocoding-tool.xls \\MapEIre\DataLibrary\ServiceStations\Servicestations.xls \\MapEIre\DataLibrary\ServiceStations\ServiceStationsPoint.mdb
Last update	
Projection	
Data description	Address list for service stations
Workflow	The geocoding tool "excel-geocoding-tool.xls" is used to add longitude and latitude based on addresses of the service station. Addresses that the tool cannot geocode is edited manually and then geocoded. Two addresses located in Great Britain and one in North Ireland are deleted from the data set. Further 2 addresses are erroneously geocoded to USA. These are located in Google Maps and the coordinates are corrected manually in the geocoding tool. The projection of the output coordinated from the geocoding tool is unknown, but from the link to Google Maps that it generates as part of the output it appears that the output coordinates are not the same as in Google Maps, that use WGS84. To come around this error, the coordinates are extracted from the text string holding the Google Maps link using Access. Grid ID and grid name and from XY coordinates as described in chapter "Grids"
GeoKey	1B2av
NFR sector	1B2av - Distribution of oil products

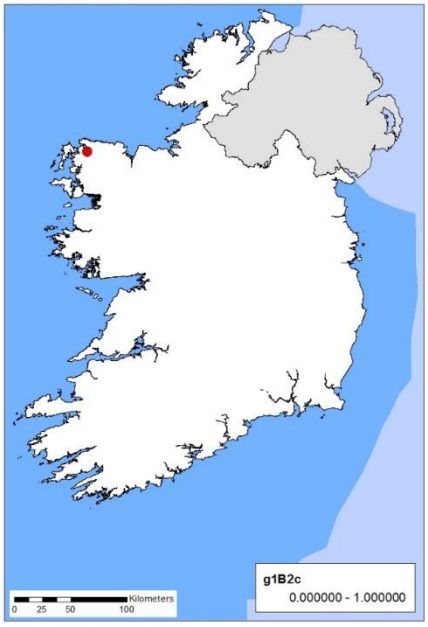
1B2av



4.5.35 1B2c - Venting and flaring (oil, gas, combined oil and gas)

Source data	
Data provider	
File location	
Projection	
Data description	
Workflow	Emissions are allocate to the gas processing terminal (Bellanaboy Bridge Gas Terminal, Co. Mayo)
GeoKey	1B2c
NFR/CRF sector	1B2c - Venting and flaring (oil, gas, combined oil and gas)

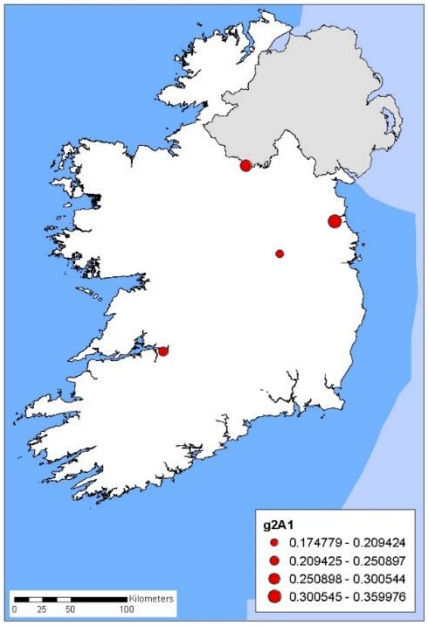
1B2c



4.5.36 2A1 - Cement production

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Clinker production by plant (4 plants in 2015)
Workflow	The plants are geocoded and the GeoKey is calculated as shares of the total clinker production by grid cell
GeoKey	2A1
NFR/CRF sector	2A1 - Cement production

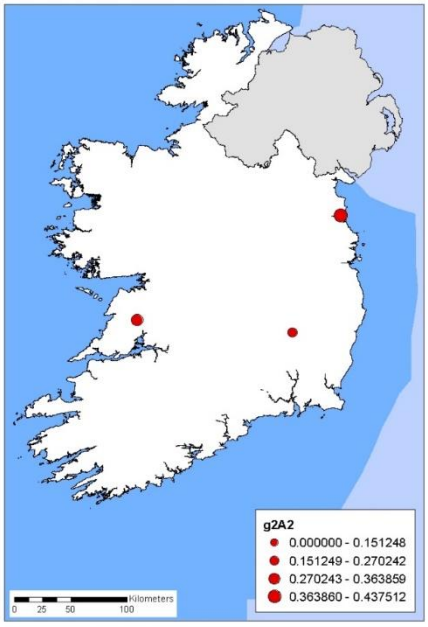
2A1



4.5.37 2A2 - Lime production

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Lime production by plant (3 plants in 2015)
Workflow	The plants are geocoded and the GeoKeys are calculated as shares of the total lime production by grid cell
GeoKey	2A2
NFR/CRF sector	2A2 - Lime production

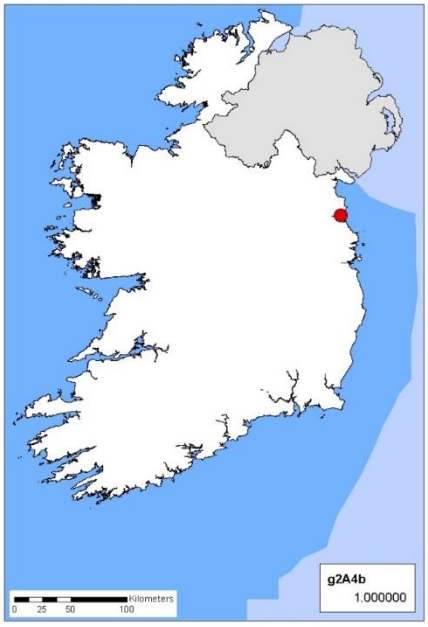
2A2



4.5.38 2A4b - Other uses of soda ash

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Soda ash use by plant (1 plants in 2015)
Workflow	Emissions are allocate to the plant (Premier Periclase, Co. Louth)
GeoKey	2A4b
NFR/CRF sector	2A4b - Other uses of soda ash

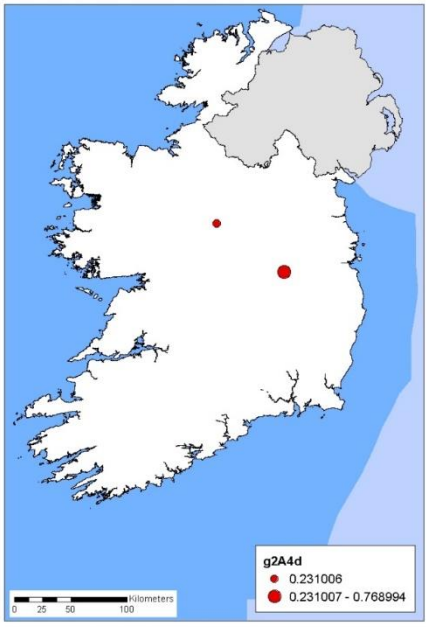
2A4b



4.5.39 2A4d - Other uses of carbonates

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Carbonate use by plant (2 plants in 2015)
Workflow	The plants are geocoded and the GeoKey is calculated as shares of the total carbonate use by grid cell
GeoKey	2A4d
NFR/CRF sector	2A4d - Other uses of carbonates

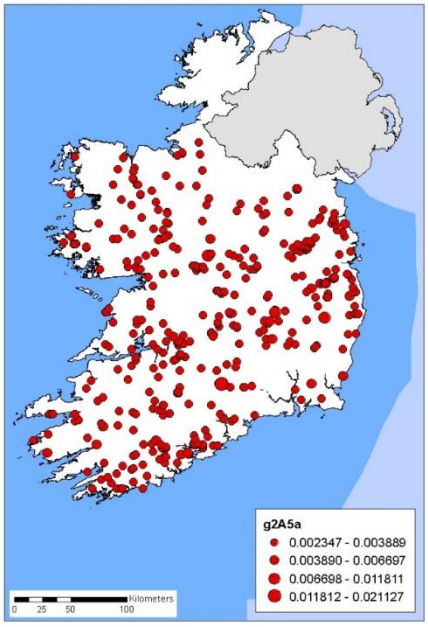
2A4d



4.5.40 2A5a - Quarrying and mining of minerals other than coal

Source data	MINES_Quarries_02
Data provider	EPA
File location	\\MapEire\DataLibrary\Quarrying_Mining\Quarrying.mdb
Projection	TM65
Data description	Point data set for quarries
Workflow	The GeoKey is calculated as the share of the total number of quarries by grid cell
GeoKey	2A5a
NFR/CRF sector	2A5a - Quarrying and mining of minerals other than coal

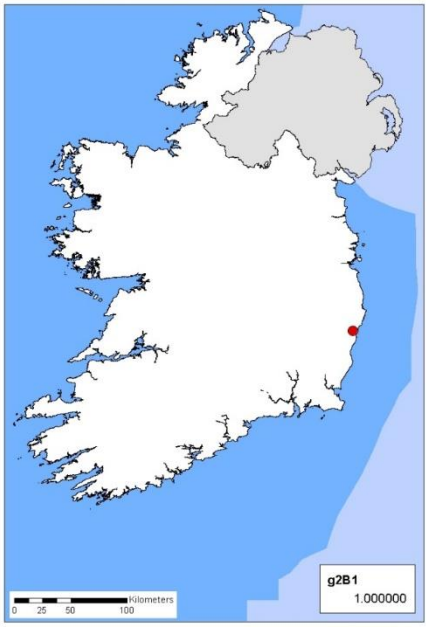
2A5a



4.5.41 2B1 - Ammonia production

Source data	
Data provider	
File location	
Projection	
Data description	
Workflow	Emissions are allocated to the ammonia production plant (Marino Point, Co. Cork)
GeoKey	2B1
NFR/CRF sector	2B1 - Ammonia production

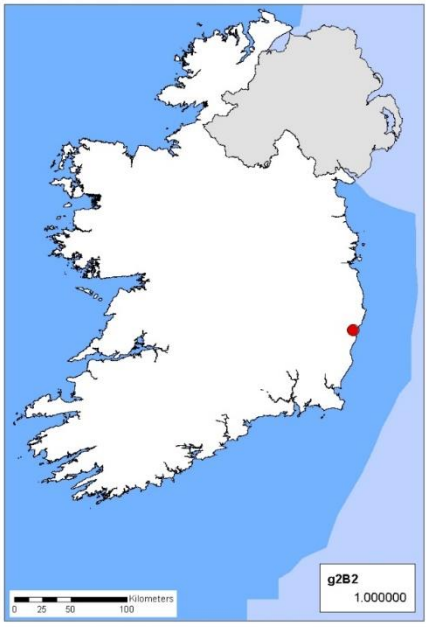
2B1



4.5.42 2B2 - Nitric acid production

Source data	
Data provider	
File location	
Projection	
Data description	
Workflow	Emissions are allocate to the fertilizer plant (Arklow, Co. Wicklow)
GeoKey	2B2
NFR/CRF sector	2B2 - Nitric acid production

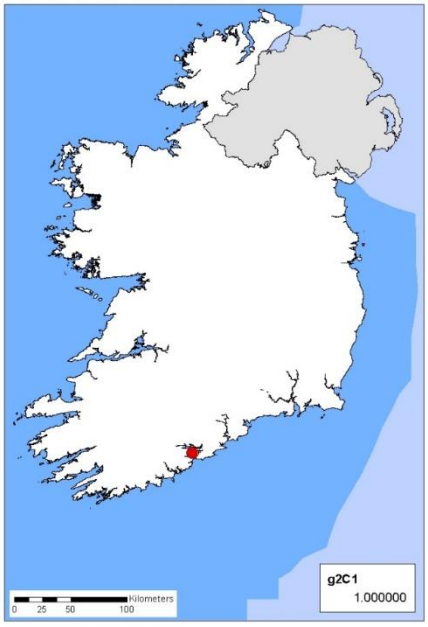
2B2



4.5.43 2C1 - Iron and steel production

Source data	
Data provider	
File location	
Projection	
Data description	
Workflow	Emissions are allocate to the steel plant (Irish Steel company, Co.Cork)
GeoKey	2C1
NFR/CRF sector	2C1 - Iron and steel production

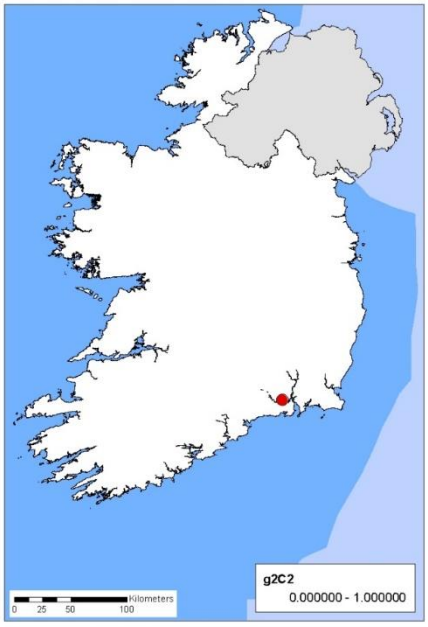
2C1



4.5.44 2C2 - Ferroalloys production

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Emissions by plant (1 plant in 2015)
Workflow	The plants are geocoded and the GeoKeys are calculated as shares of sectoral emission by grid cell for Cd, Pb and PM
GeoKey	2C2_Cd 2C2_Pb 2C2_PM
NFR/CRF sector	2C2 - Ferroalloys production

2C2*

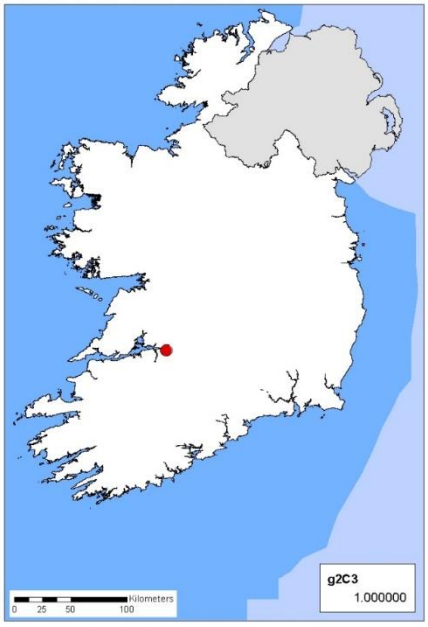


* Same GeoKey for all pollutants in 2015 as only 1 p is active.

4.5.45 2C3 - Aluminium production

Source data	
Data provider	
File location	
Projection	Atlas Aluminium Limited
Data description	
Workflow	Emissions are allocate to the aluminium plant (Atlas Aluminium Limited, Co. Limerick)
GeoKey	2C3
NFR/CRF sector	2C3 - Aluminium production

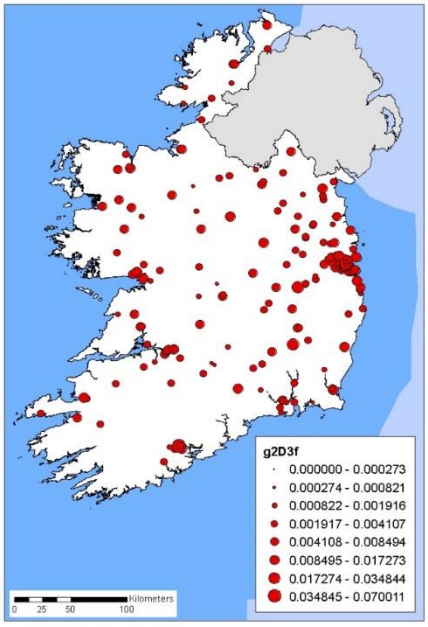
2C3



4.5.46 2D3f - Dry cleaning

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Solvent used in 2008, 2009 and 2010 by dry cleaner (287 facilities)
Workflow	The facilities are geocoded and the GeoKey is calculated as the share of average of solvents used in 2008-2010 by grid cell
GeoKey	2D3
NFR/CRF sector	2D3f - Dry cleaning

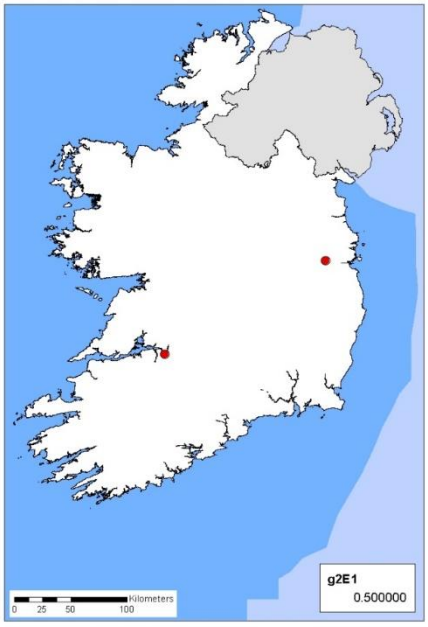
2D3



4.5.47 2E - Electronics industry

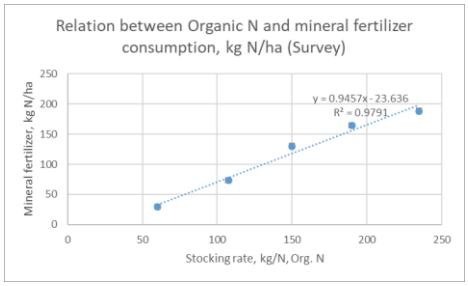
Source data	
Data provider	
File location	
Projection	
Data description	2 plants in 2015
Workflow	Emissions are distributed evenly to the plants
GeoKey	2E1
NFR/CRF sector	2E - Electronics industry

2E1

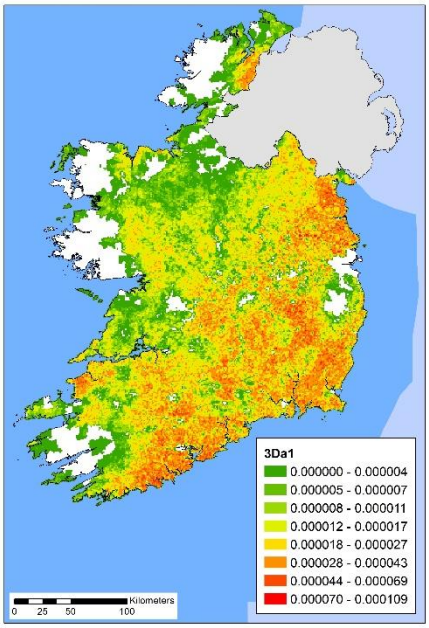


4.5.48 3Da1 - N input from application of inorganic fertilizers to cropland and grassland

Source data	Lpis_cpy.shp and Nex_Ireland.acddb
Data provider	
File location	Census2011_Electoral_Divisions_generalised20m
Projection	TM75_Irish_Grid (EPSG: 29903)
Data description*	Distribution of sold amount of mineral fertiliser

Workflow	Mineral fertilizer application rate depends crop need and animal density. The distribution is taken from "Nitrogen use in Ireland, 2005-2015 (https://www.teagasc.ie/media/website/crops/soil-and-soil-fertility/Wall-Dillon-et-al-Fert-Use-Survey_FAI-Kildalton-2017.pdf). According to "Nitrogen use in Ireland, 2005-2015" is there a relationship with stocking density and mineral fertilizer use as high stocking rates gives higher fertilization rate. The following equation is used in the distribution.  For each grid cell is estimated a theoretical N fertilization based on annual crops grown in that grid cell plus fertilization rate for grass according to the nitrogen excretion (Nex) from animals in that grid cell. The Nex calculation is based on Nex rates from Statuary Instruments S.I. No. 31 of 2014 (http://www.irishstatutebook.ie/eli/2014/si/31/made/en/pdf) The total theoretical mineral N use in each grid cell is corrected according to actual sales data. The difference between actual sales data and the calculated theoretical is <10% and therefore assumed to be a fair distribution key. Updating of the key can be made in the Access database "Nex_Ireland".
GeoKey	3Da1
NFR/CRF sector	3Da1 - Inorganic N-fertilizers (includes also urea application) 3H - Urea application

3Da1



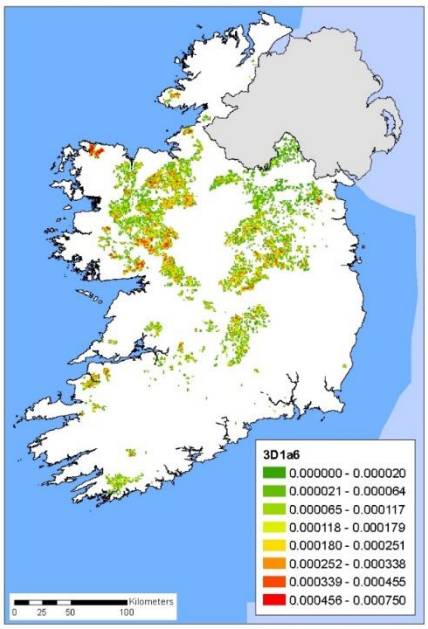
4.5.49 3D1a6 - Cultivation of organic soils (i.e. histosols)/ 3Da6 - Cultivation of organic soils

Source data	LPIS soils_ie_f1.shp
Data provider	EPA
File location	\\MapEIre\DataLibrary\LPIS\LPIS_soil_org.mdb\LPIS_soil_org_1km \\MapEIre\DataLibrary\LPIS\LPIS_soil_Key.mdb
Projection	TM65
Data description*	Land parcels including crop description and land use class Soil types for centroids of LPIS polygons

Workflow	The following soil types (IFS_SOIL) are included in the GeoKey: AminPDPT - Peaty Gleys Acidic AminSPPT - Peaty Gleys Shallow AminSRPT - Podzols Peaty BktPt - Blanket peat BminPDPT - Peaty Gleys Basic Parent Materials Basic BminSPPT - Peaty Gleys Shallow Cut - Raised Bog cutaway/cutover RsPt - Raised bog Soil type is spatially joined to LPIS layer, the output layer is intersected with the 1 km grid, and the area is calculated by the resulting polygons ([AreaInt]). The following land use classes (LU) are included in the GeoKey: Cropland* Grassland Improved* Grassland Unimproved* Select polygons where crop description is "Cropland*" and calculate share of area [ShrArea] by grid cell The GeoKey shares are calculated as [AreaInt]*[ShrArea]
GeoKey	3D1a6
NFR/CRF sector	3Da6 - Cultivation of organic soils

* See description regarding LPIS data in the LPIS chapter below

3D1a6

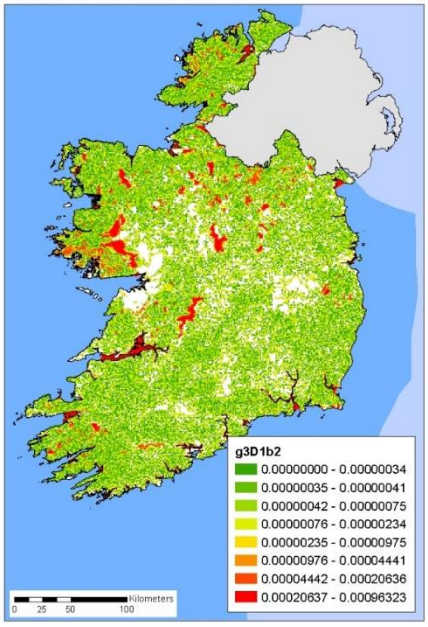


4.5.50 3Db2 - Nitrogen leaching and run-off

Source data	WFD_RiverWaterbodies.shp WFD_LakeWaterbodies.shp TransitionalWaterbodiesActive_08012014

Data provider	EPA
File location	EPA geoportal
Projection	TM65
Data description	River: line theme of rivers Lake: polygon layer of lakes waterbodies Transitional: polygon layer of transitional waterbodies Description of the different water areas (lakes, rivers, transitional waters and coastal waters) http://www.wiser.eu/background/water-framework-directive/
Workflow	River: The river area [RiverArea] is calculated by grid cell, using the attribute data on river area ([AreaKm2]) and river length ([LENGTHKM]) to calculate the width for the river lines, and, after intersection with the grid, the river length and area by grid cell. Lake: The lake area([LakeArea]) is calculated by grid cell using the geometry calculation tool in GIS Transitional: The transitional water body area [TransArea] is calculated by grid cell using the geometry calculation tool in GIS The GeoKey is calculated as the share of the total waterbody area ([RiverArea]+[LakeArea]+[TransArea]) by grid cell. Calculate "WaterbodyArea" as [RiverArea]+[LakeArea]+[TransArea] Calculate "Share" as [WaterbodyArea]/[SumOfWaterbodyArea]
GeoKey	3D1b2
NFR/CRF sector	3Db2 - Nitrogen leaching and run-off

3D1b2

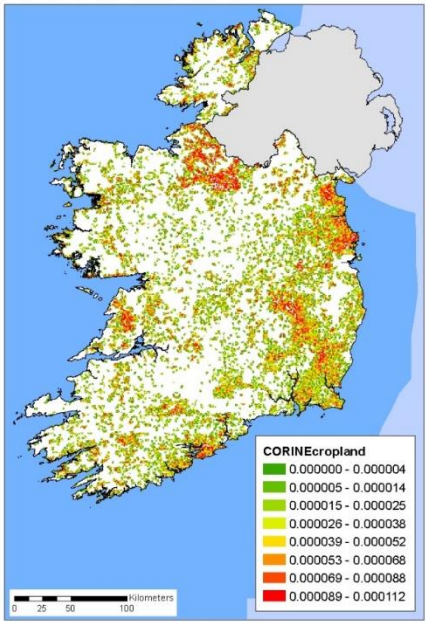


4.5.51 4 - Land use, land-use change and forestry

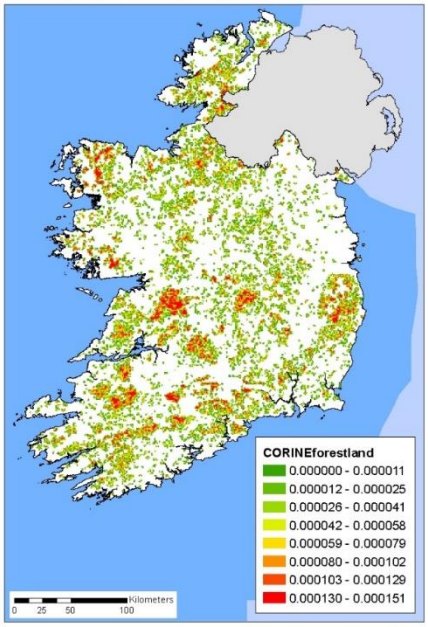
Source data	CORINE land cover maps (CLC2012)
Data provider	Copernicus
File location	\\MapEire\DataLibrary\CORINE\CLCkeys.mdb
Projection	ETRS_1989_LAEA
Data description	CORINE CLC12 is a vector data land cover map for Europe including 44 land cover classes, based on satellite images. The 2012 revision of the CORINE land cover map is used
Workflow	Areas of cropland are selected from CORINE CLC12 based on the land cover classes. Following the GeoKey is calculated as the shares of the cropland area by grid cell. Similar workflow is used to prepare GeoKeys for forestland, grassland, other land, settlements, and wetland. The following CORINE land cover classes are selected for the different GeoKeys: Cropland: 212, 222, 242, 243 Forestland: 311, 312, 313, 324 Grassland: 231, 321 Otherland: 322, 331, 332, 333 Wetland: 411, 412, 421, 423, 511, 512 Settlement: 111, 112, 121, 122, 123, 124, 131, 132, 133, 141, 142
GeoKey	CORINEcropland CORINEforestland CORINEgrassland CORINEotherland CORINEsettlement CORINEwetland
NFR/CRF sector	4A - Land use, land-use change and forestry, Forest land 4B - Land use, land-use change and forestry, Cropland 4C - Land use, land-use change and forestry, Grassland

	4D - Land use, land-use change and forestry, Wetland 4E - Land use, land-use change and forestry, Settlements 4F - Land use, land-use change and forestry, Other land

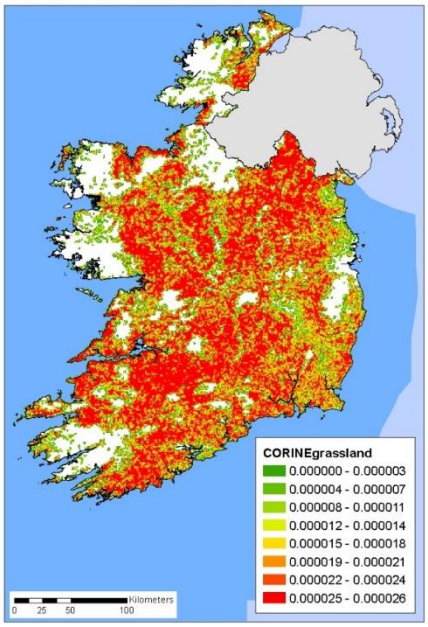
CORINEcropland



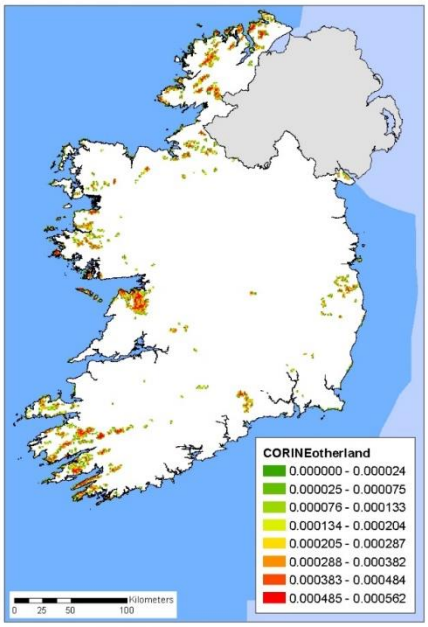
CORINEforestland



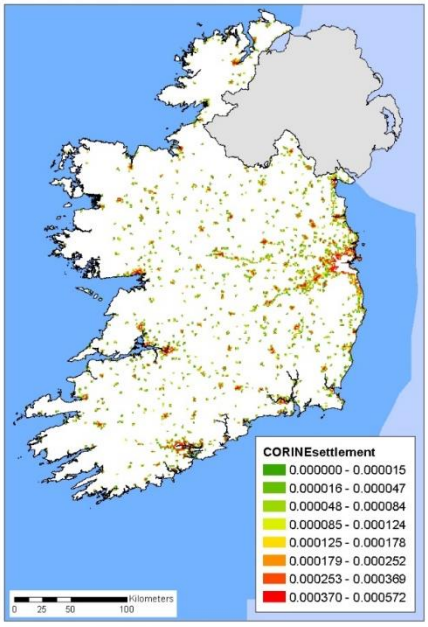
CORINEgrassland



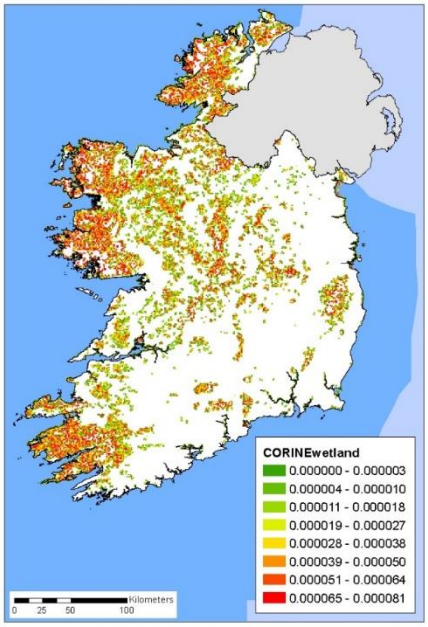
CORINEotherland



CORINEsettlement



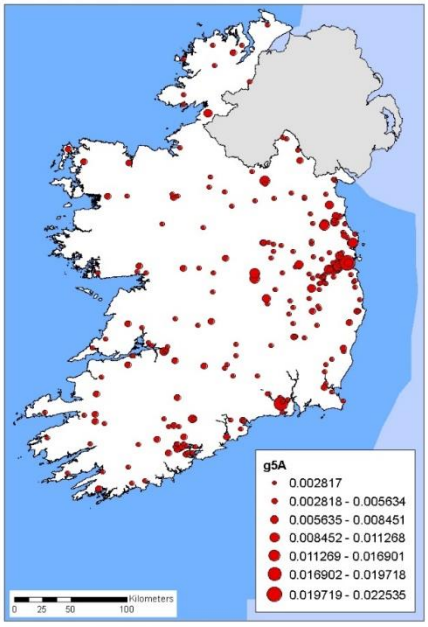
CORINEwetland



4.5.52 5A - Biological treatment of waste - Solid waste disposal on land

Source data	WST_Facilities
Data provider	EPA
File location	
Projection	TM65
Data description	Location of waste facilities
Workflow	The GeoKey is calculated of share of the total number of facilities by grid cell
GeoKey	5A
NFR/CRF sector	5A - Biological treatment of waste - Solid waste disposal on land

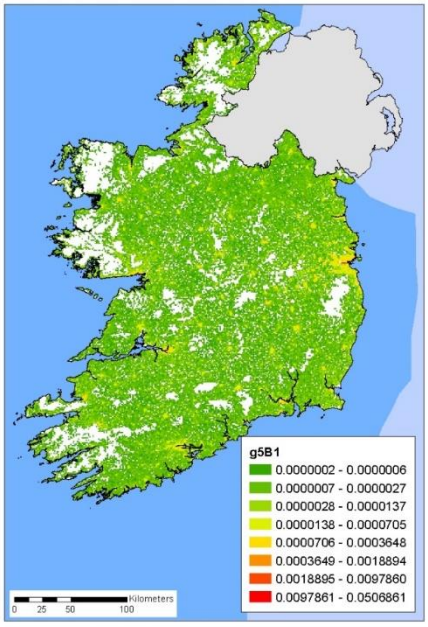
5A



4.5.53 5B1 - Biological treatment of waste - Composting

Source data	Inventory data LicencedWasteFacilities_17042015 GEODIR_Buildings
Data provider	EPA
File location	\\MapEIre\DataLibrary\Waste\Composting.mdb
Projection	TM65
Data description	Inventory data for annual composting amounts for composting sites and in household Location of licensed waste facilities including facility type. Buildings including building type
Workflow	The inventory data for composting is used to calculate the weighting between composting sites and residential buildings. Emissions from residential composting is spatially distributed following the GeoKey for residential buildings (Buildings_R) Emissions from composting sites is spatially distributed on the licensed waste facilities with the facility type "Composting/Anaerobic Digestion" The GeoKey is created as a weighted combination of shares for composting sites and households
GeoKey	5B1
NFR/CRF sector	5B1 - Biological treatment of waste - Composting

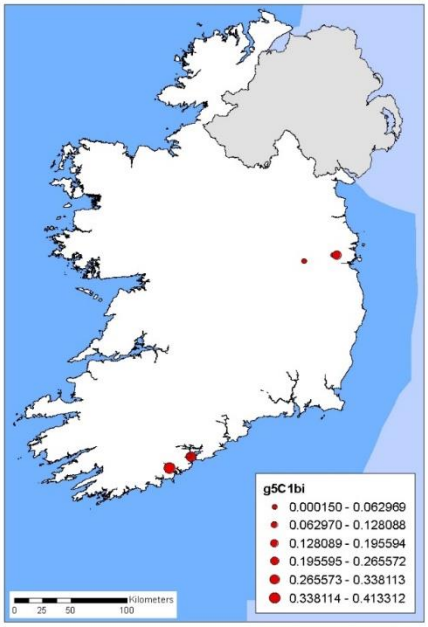
5B1



4.5.54 5C1bi - Industrial waste incineration

Source data	PRTR data
Data provider	EPA
File location	
Projection	
Data description	Activity data (D10, tonnage) by industrial waste incineration facility
Workflow	The GeoKey is calculated as shares of total industrial waste incineration by plant
GeoKey	5C1bi
NFR/CRF sector	5C1bi - Industrial waste incineration

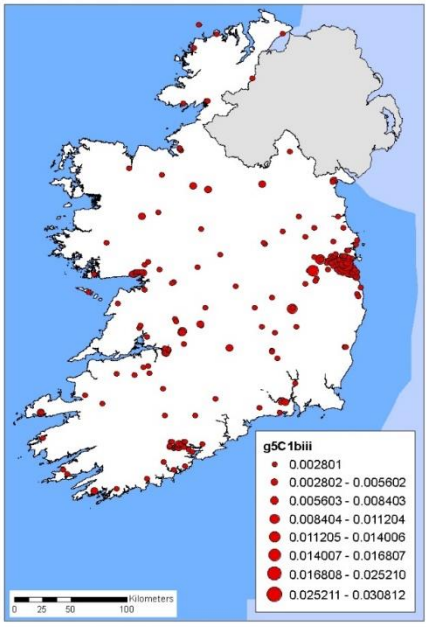
5C1bi



4.5.55 5C1biii - Clinical waste incineration

Source data	Points
Data provider	Geofabrik
File location	http://download.geofabrik.de/
Projection	WGS84
Data description	Point features from Open Street Map available from Geofabrik. Points are categorised into 600 categories
Workflow	Points categorised as “Hospitals” and “Clinics” and that are located inside the Irish EEZ are selected. The GeoKey is calculated as share of number of hospitals and clinics by grid cell
GeoKey	5C1biii
NFR/CRF sector	5C1biii - Clinical waste incineration

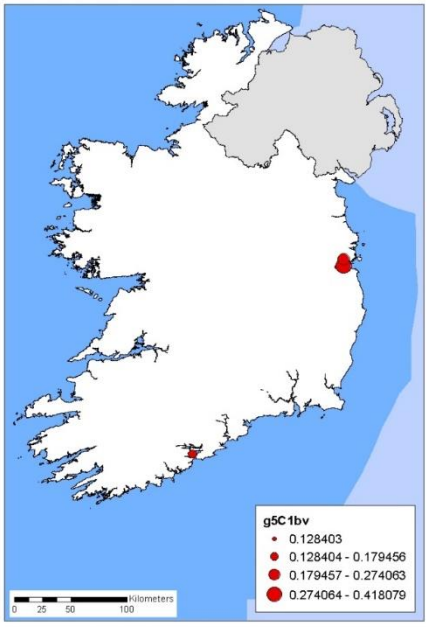
5C1biii



4.5.56 5C1bv - Cremation

Source data	Inventory data
Data provider	EPA
File location	
Projection	
Data description	Number of cremations by crematorium (4 facilities in 2015)
Workflow	The facilities are geocoded and the GeoKey is calculated as shares of total number of cremations by facility
GeoKey	5C1bv
NFR/CRF sector	5C1bv – Cremation

5C1bv


g5C1bv
0.128403
0.128404 - 0.179456
0.179457 - 0.274063
0.274064 - 0.418079
Kilometers
0 25 50 100

5 TKey development

5.1 Temporal keys (TKeys)

A temporal key (TKey) is a table holding shares of an emission to be allocated to given time intervals, e.g. shares of the NO_x from road transport with passenger cars to be allocated by month. The TKeys are normalised tables where the sum of shares for each table is one. Three temporal profiles are prepared for each emission source category in the spatial model describing the monthly, the daily and the hourly distributions. For selected emission sources, separate hourly TKeys are prepared for different days of the week, where weekday 1 refer to Monday. An example is road transport, where separate hourly TKeys are prepared for Monday (weekday 1), Tuesday-Thursday (weekday 2-4), Friday (weekday 5), Saturday (weekday 6) and Sunday (weekday 7), respectively. In other cases, separate TKeys are prepared for different pollutants for an emission source category, as the emissions are related to different activities or processes. This is e.g. the case for domestic wastewater handling, where two separate TKeys are prepared for N_2O and for remaining pollutants, respectively.

TKeys are stored as tables in MS Excel and imported to the temporal model in MS Access database. The TKeys include the parameters;

Monthly TKeys:

- GNFR: GNFR category name
- NFR: NFR category name
- PolID: pollutant. If a specific pollutant name is applied, the TKey will be used for that pollutant only, e.g. N_2O. If the value "All" is applied, the TKey will be used for all pollutants that does not have a specific TKey
- Month: share of emission sum up to 1

Daily TKeys:

- GNFR: GNFR category name
- NFR: NFR category name
- PolID: pollutant. If a specific pollutant name is applied, the TKey will be used for that pollutant only, e.g. N_2O. If the value "All" is applied, the TKey will be used for all pollutants that does not have a specific TKey
- Day: share of emission sum up to 1

Hourly TKeys:

- GNFR: GNFR category name
- NFR: NFR category name
- Weekday: share of emission sum up to 1

The tables below gives examples on monthly, daily and hourly TKeys for Waste (GNFR category J), Industry (GNFR category B) and road transport (NFR categories 1A3bi, 1A3bii, and 1A3biii).

Table 8 Monthly TKey for waste

GNFR	NFR	pol_id	1	2	3	4	5	6	7	8	9	10	11	12
J_Waste	5A	All	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
J_Waste	5B1	All	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
J_Waste	5C1bi	All	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
J_Waste	5C1bv	All	0.095	0.095	0.095	0.083	0.083	0.083	0.078	0.078	0.078	0.078	0.078	0.078
J_Waste	5C2	All	0.160	0.160	0.160	0.100	0.000	0.000	0.000	0.000	0.000	0.100	0.160	0.160
J_Waste	5D1	All	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
J_Waste	5D1	N2O	0.057	0.061	0.066	0.085	0.094	0.098	0.096	0.098	0.096	0.094	0.088	0.066
J_Waste	5E	All	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083

Table 9 Daily TKey for industry

GNFR	NFR	pol_id	1	2	3	4	5	6	7
B_Industry	1A1b	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	1A1c	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	1A2a	All	0.200	0.200	0.200	0.200	0.200	0.000	0.000
B_Industry	1A2b	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	1A2c	All	0.167	0.167	0.167	0.167	0.167	0.083	0.083
B_Industry	1A2d	All	0.200	0.200	0.200	0.200	0.200	0.000	0.000
B_Industry	1A2e	All	0.167	0.167	0.167	0.167	0.167	0.083	0.083
B_Industry	1A2f	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	1A2gviii	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143

B_Industry	2A1	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	2A2	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	2A4a	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	2A4b	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	2A4d	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	2A5a	All	0.200	0.200	0.200	0.200	0.200	0.000	0.000
B_Industry	2A5b	All	0.156	0.156	0.156	0.156	0.156	0.109	0.109
B_Industry	2A5c	All	0.200	0.200	0.200	0.200	0.200	0.000	0.000
B_Industry	2A6	All	0.200	0.200	0.200	0.200	0.200	0.000	0.000
B_Industry	2B10b	All	0.157	0.178	0.182	0.184	0.177	0.076	0.046
B_Industry	2C2	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	2D3b	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143
B_Industry	2D3c	All	0.200	0.200	0.200	0.200	0.200	0.000	0.000
B_Industry	2H2	All	0.167	0.167	0.167	0.167	0.167	0.083	0.083
B_Industry	2I	All	0.143	0.143	0.143	0.143	0.143	0.143	0.143

Table 10 Hourly TKey for road transport for passenger cars (1A3bi), light duty vehicles (1A3bii), and heavy duty vehicles (1A3biii).

GNFR	NFR	Weekday	0	1	2	3	4	5	6	7	8	9	10	11
F_RoadTransport	1A3bi	1	0.007	0.004	0.002	0.003	0.006	0.013	0.038	0.067	0.075	0.058	0.050	0.053
F_RoadTransport	1A3bi	2-4	0.006	0.003	0.002	0.002	0.005	0.011	0.037	0.068	0.078	0.061	0.050	0.050
F_RoadTransport	1A3bi	5	0.007	0.004	0.003	0.003	0.005	0.010	0.030	0.058	0.066	0.052	0.047	0.052
F_RoadTransport	1A3bi	6	0.011	0.007	0.005	0.004	0.006	0.008	0.014	0.024	0.037	0.052	0.063	0.076

F_RoadTransport	1A3bi	7	0.012	0.009	0.006	0.005	0.006	0.006	0.010	0.016	0.021	0.034	0.048	0.065
F_RoadTransport	1A3bii	1	0.005	0.004	0.003	0.004	0.008	0.018	0.052	0.077	0.070	0.069	0.063	0.063
F_RoadTransport	1A3bii	2-4	0.005	0.004	0.003	0.004	0.007	0.015	0.050	0.077	0.070	0.068	0.062	0.061
F_RoadTransport	1A3bii	5	0.006	0.005	0.004	0.004	0.007	0.015	0.046	0.073	0.066	0.064	0.061	0.063
F_RoadTransport	1A3bii	6	0.011	0.009	0.008	0.008	0.010	0.013	0.027	0.048	0.057	0.065	0.070	0.076
F_RoadTransport	1A3bii	7	0.014	0.013	0.011	0.010	0.010	0.011	0.017	0.026	0.034	0.045	0.054	0.066
F_RoadTransport	1A3biii	1	0.008	0.007	0.007	0.010	0.014	0.027	0.050	0.061	0.065	0.072	0.073	0.074
F_RoadTransport	1A3biii	2-4	0.011	0.010	0.010	0.011	0.016	0.028	0.051	0.062	0.065	0.071	0.071	0.072
F_RoadTransport	1A3biii	5	0.012	0.011	0.011	0.012	0.017	0.030	0.053	0.065	0.067	0.072	0.072	0.073
F_RoadTransport	1A3biii	6	0.026	0.022	0.020	0.022	0.025	0.033	0.051	0.062	0.069	0.073	0.073	0.069
F_RoadTransport	1A3biii	7	0.022	0.018	0.015	0.016	0.017	0.019	0.030	0.037	0.044	0.050	0.052	0.053

continued

GNFR	NFR	Weekday	12	13	14	15	16	17	18	19	20	21	22	23
F_RoadTransport	1A3bi	1	0.057	0.060	0.061	0.066	0.080	0.088	0.073	0.050	0.036	0.026	0.017	0.010
F_RoadTransport	1A3bi	2-4	0.053	0.057	0.058	0.065	0.080	0.088	0.075	0.053	0.037	0.028	0.020	0.012
F_RoadTransport	1A3bi	5	0.059	0.064	0.069	0.077	0.082	0.081	0.071	0.056	0.041	0.029	0.021	0.014
F_RoadTransport	1A3bi	6	0.084	0.086	0.083	0.078	0.076	0.072	0.063	0.050	0.038	0.027	0.020	0.016
F_RoadTransport	1A3bi	7	0.081	0.088	0.086	0.083	0.081	0.080	0.076	0.065	0.051	0.035	0.022	0.013
F_RoadTransport	1A3bii	1	0.064	0.062	0.065	0.072	0.080	0.073	0.053	0.036	0.024	0.017	0.011	0.007
F_RoadTransport	1A3bii	2-4	0.062	0.062	0.065	0.073	0.082	0.073	0.054	0.037	0.025	0.018	0.012	0.008
F_RoadTransport	1A3bii	5	0.066	0.069	0.074	0.080	0.075	0.065	0.050	0.037	0.026	0.019	0.013	0.009

F_RoadTransport	1A3bii	6	0.079	0.078	0.074	0.070	0.066	0.060	0.051	0.040	0.030	0.021	0.016	0.013
F_RoadTransport	1A3bii	7	0.075	0.079	0.077	0.075	0.074	0.073	0.069	0.058	0.044	0.031	0.021	0.014
F_RoadTransport	1A3biii	1	0.073	0.070	0.071	0.070	0.061	0.048	0.040	0.031	0.023	0.018	0.015	0.013
F_RoadTransport	1A3biii	2-4	0.072	0.070	0.071	0.069	0.060	0.046	0.038	0.030	0.022	0.018	0.015	0.013
F_RoadTransport	1A3biii	5	0.073	0.071	0.070	0.065	0.055	0.044	0.036	0.028	0.021	0.017	0.014	0.012
F_RoadTransport	1A3biii	6	0.066	0.060	0.053	0.048	0.044	0.041	0.038	0.032	0.024	0.019	0.015	0.014
F_RoadTransport	1A3biii	7	0.056	0.057	0.055	0.055	0.058	0.063	0.068	0.061	0.050	0.041	0.033	0.028

5.2 General methodology

The TKeys are prepared in MS Excel and the final TKeys are collected in common worksheets for monthly, daily and hourly profiles, respectively, for import to the temporal model in MS Access. The TKeys are described separately in the next sections.

TKeys are developed to reflect the distribution of emissions from a source on a given temporal level (months, days, or hours). The temporal distribution can be based on different kinds of temporal data and information, e.g. monthly electricity output, hourly traffic counts, and assumptions such as close down or reduced activity levels in weekends for specific industries. Some of the temporal input data are closely related to the emission, e.g. electricity output, as the fuel consumption and to a certain degree also emissions are well correlated with the electricity production. Others are poorer proxies, e.g. number of trains by route from time tables, as the trains might be of different characters. Further, neither activities at service and shunting areas nor freight trains are covered in the time tables, but contribute significantly to the emissions.

To improve the quality of the temporal distribution, TKeys should be prepared on a disaggregated sectoral level, as this leave the possibility to reflect the sectoral properties as detailed as possible. E.g. separate TKeys should be prepared for different animal types in the agricultural sectors and for different vehicle types for road transport. In some cases it can be of benefit to prepare separate TKeys for different pollutants for a sector, as pollutants might occur from different activities or processes. This is e.g. the case for domestic wastewater handling, where N_2O show a seasonal variation with the water temperature, while the same correlation is not found for CH_4.

The temporal model use the TKeys for the entire Irish domain, and following it is not possible to reflect regional differences using the temporal emission distribution. Including a spatial parameter in the temporal model would increase the data amounts significantly, and for many sectors it would be of no or little relevance, as the TKeys are based on proxies for national characteristics. Few sources could benefit from including a spatial parameter in the temporal model, e.g. agricultural soils, where different practices occur in different parts of the country, and road transport, where the temporal pattern is different in large cities, along commuting routes and in rural areas.

5.3 TKeys

All NFR/CRF sectors in the Irish emission inventory are assigned a TKey in the MapEIre model. This chapter describes the development of the TKeys used in the Irish temporal emission mapping model, including information on the data, information and assumptions used to derive the TKeys. A list of the monthly, daily and hourly TKeys are found in **Annex 4 - List of TKeys**. The data used to compile the temporal profiles vary among the sectors, depending on data availability. Hourly electricity generation and hourly vehicle numbers are used to make temporal profiles for public power and road transport, respectively. In both cases, the input data are of high detail and well correlated to the emissions. Information from time tables are used for railways and aviation, but even though information are available on hourly basis, the number of trains/planes are less well correlated to the emissions, due to the different emission properties for different train and plane types. Availability of temporal data are generally scarce, and for many sectors, the temporal profiles are based on assumptions.

5.3.1 Public power

GNFR	A		
NFR/CRF	1A1a		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Monday-Saturday Sunday
Input data	MSM01: Electricity Output by State, Month and Statistic Net Electricity Output (Gigawatt Hours)	Electricity generation excluding wind. Hourly actual electricity generation (MW)	Electricity generation excluding wind. Hourly actual electricity generation (MW)
Data provider	CSO	EirGrid	EirGrid
Data source	https://www.cso.ie/en/databases/https://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=MSM01&PLanguage=0	http://smartgriddashboard.eirgrid.com/#	http://smartgriddashboard.eirgrid.com/#
Description	Average monthly net electricity output for the years 2010-2017	Average electricity generation ex. wind by weekday	Average electricity generation ex. wind by hour for Monday-Saturday and for Sunday

5.3.2 Industry

GNFR	B_Industry
NFR/CRF	1A2b 1A2f 1A2gviii
Pollutant	All

Temporal resolution	Monthly	Daily	Hourly
Weekday			All
Input data	Industrial volume indices - MIM03		
Data provider	CSO		
Data source	https://www.cso.ie/en/databases/		
Description	Average for years 2010-2017 for the following categories: 1A2b: Basic metals and fabricated metal products 1A2f: Other non-metallic mineral products 1A2gviii: Rubber and plastic products, Machinery and equipment n.e.c, Tobacco: leather; petroleum; transport equipment; furniture; repair of machinery Textiles, wearing apparel and leather products Computer, electronic, optical and electrical equipment Transport equipment Other manufacturing, repair and installation of machinery and equipment	Assumption: Even distribution	Assumption: Even distribution

GNFR	B_Industry
NFR/CRF	1A2a 1A2d
Pollutant	All

Temporal resolution	Monthly	Daily	Hourly
Weekday			All
Input data	Industrial volume indices - MIM03		
Data provider	CSO		
Data source	https://www.cso.ie/en/databases/		
Description	Average for years 2010-2017 for the following categories: 1A2a: Basic metals and fabricated metal products 1A2d: Paper and paper products, printing and reproduction of recorded media	Assumption: Even distribution for working days	Assumption: Even distribution for working hours (7-16)

GNFR	B_Industry		
NFR/CRF	2A5a		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			All
Input data	Industrial volume indices - MIM03		
Data provider	CSO		
Data source	https://www.cso.ie/en/databases/		
Description	Average for years 2010-2017 for the following category: 2A5a: Mining and quarrying	Assumption: Even distribution for working days	Assumption: Even distribution for daytime hours (7-22) and less production at night

GNFR	B_Industry		
NFR/CRF	1A2c 1A2e 2H2		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Industrial volume indices - MIM03		
Data provider	CSO		
Data source	https://www.cso.ie/en/databases/		
Description	Average for years 2010-2017 for the following categories: 1A2c: Chemicals and pharmaceuticals 1A2e, 2H2: Food products and beverages	Assumption: Even distribution for working days and less production in weekends	Assumption: Even distribution for daytime hours (7-22) and less production at night

GNFR	B_Industry		
NFR/CRF	1A1b 1A1c		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			

Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

GNFR	B_Industry		
NFR/CRF	2A1 2A2 2A4a 2A4b 2A4d		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: same distribution as 1A2f	Assumption: Even distribution	Assumption: Even distribution

GNFR	B_Industry		
NFR/CRF	2A5b		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Index of Employment in Building and Construction Industry - BBM02	The Non-Domestic Energy Assessment Procedure (NEAP)	The Non-Domestic Energy Assessment Procedure (NEAP)

		NMC database	NMC database
Data provider	CSO	SEAI	SEAI
Data source	https://www.cso.ie/en/databases/	https://www.seai.ie/energy-in-business/ber-assessor-support/neap/	https://www.seai.ie/energy-in-business/ber-assessor-support/neap/
Description	Average for years 2000-2007	Hourly equipment fractions for weekdays and weekends for industrial process buildings	Hourly equipment fractions for industrial process areas in industrial process buildings

GNFR	B_Industry		
NFR/CRF	2A6 2D3c		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution for weekdays	Assumption: Even distribution for daytime hours (7-22) and less production at night

GNFR	B_Industry
NFR/CRF	2C2 2I
Pollutant	All

Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

GNFR	B_Industry		
NFR/CRF	2B10b		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Same as Road transport: Heavy duty vehicles and buses	Assumption: Same as Road transport: Heavy duty vehicles and buses	Assumption: Same as Road transport: Heavy duty vehicles and buses

GNFR	B_Industry		
NFR/CRF	2D3b		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			

Data provider			
Data source			
Description	Assumption: Even distribution May-October, less activity in March-April and November, and low activity in December-February	Assumption: Even distribution	Assumption: Even distribution

5.3.3 Other stationary combustion

GNFR	C_OtherStationaryComb		
NFR/CRF	1A4ai		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate profiles for working days and weekends
Input data	Monthly degree days	The Non-Domestic Energy Assessment Procedure (NEAP) NMC database	The Non-Domestic Energy Assessment Procedure (NEAP) NMC database
Data provider	Met Eirann	SEAI	SEAI
Data source	https://www.met.ie/climate/available-data/monthly-data	https://www.seai.ie/energy-in-business/ber-assessor-support/neap/	https://www.seai.ie/energy-in-business/ber-assessor-support/neap/
Description	Monthly degree days data sets for 25 synoptic weather stations	Hourly equipment fractions for weekdays and weekends for dwellings	Smoothed hourly equipment fractions for weekdays and weekends for dwellings.

GNFR	C_OtherStationaryComb
NFR/CRF	1A4bi
Pollutant	All

Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate profiles for working days and weekends
Input data	Monthly degree days	The Non-Domestic Energy Assessment Procedure (NEAP) NMC database	The Non-Domestic Energy Assessment Procedure (NEAP) NMC database
Data provider	Met Eirann	SEAI	SEAI
Data source	https://www.met.ie/climate/available-data/monthly-data	https://www.seai.ie/energy-in-business/ber-assessor-support/neap/	https://www.seai.ie/energy-in-business/ber-assessor-support/neap/
Description	Monthly degree days data sets for 25 synoptic weather stations	Hourly equipment fractions for weekdays and weekends for commercial and institutional buildings	Smoothed hourly equipment fractions for weekdays and weekends for commercial and institutional buildings

GNFR	C_OtherStationaryComb		
NFR/CRF	1A4ci		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Monthly degree days		Hourly temperature data for Dublin airport
Data provider	Met Eirann		data.gov.ie
Data source	https://www.met.ie/climate/available-data/monthly-data		https://data.gov.ie/dataset/dublin-airport-daily-weather-station-data
Description	Monthly degree days data sets for 25 synoptic weather stations	Assumption: Even distribution	Assumption: the activity is inversely proportional to the temperature when the

			annual average for a month-hour combination is below 14 degree

5.3.4 Fugitive emissions from fuels

GNFR	D_Fugitive		
NFR/CRF	1B1a 1B2aiv 1B2c		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

GNFR	D_Fugitive		
NFR/CRF	1B2av		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Traffic count data	Traffic count data	Traffic count data
Data provider	TII / NRA	TII / NRA	TII / NRA
Data source	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie

Description	Hourly passenger cars volumes in 2017 for all traffic counter sites aggregated by month	Hourly passenger cars volumes in 2017 for all traffic counter sites aggregated by weekday	Hourly passenger cars volumes in 2017 for all traffic counter sites

GNFR	D_Fugitive		
NFR/CRF	1B2b		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate distributions for Monday-Saturday and Sunday
Input data	Networked gas consumption		
Data provider	CSO		
Data source			
Description	Networked Gas Consumption by Quarter for the residential and the non-residential sector for 2011-2017. Monthly distribution estimated using interpolation.	Assumption: same distribution as 1A1a	Assumption: same distribution as 1A1a

5.3.5 Solvents

GNFR	E_Solvents		
NFR/CRF	2D3d 2D3e		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly

Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution for working hours (7-20)

GNFR	E_Solvents		
NFR/CRF	2D3f		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution for working days	Assumption: Even distribution for daytime hours (7-22) and less production at night

GNFR	E_Solvents		
NFR/CRF	2D3a		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate profiles for working days and weekends

Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: same as 1A4bi	Assumption: same as 1A4bi

GNFR	E_Solvents		
NFR/CRF	2D3g 2D3h 2G1 2G2		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

GNFR	E_Solvents		
NFR/CRF	2D3i		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			

Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution for day-time hours (7-22) and less production at night

5.3.6 Road transport

GNFR	F_RoadTransport		
NFR/CRF	1A3bi		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate temporal distribution for Monday, Tuesday-Thursday, Friday, Saturday and Sunday
Input data	Traffic count data	Traffic count data	Traffic count data
Data provider	TII / NRA	TII / NRA	TII / NRA
Data source	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie
Description	Hourly passenger cars volumes in 2017 for all traffic counter sites aggregated by month	Hourly passenger cars volumes in 2017 for all traffic counter sites aggregated by weekday	Hourly passenger cars volumes in 2017 for all traffic counter sites

GNFR	F_RoadTransport		
NFR/CRF	1A3bii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly

Weekday			Separate temporal distribution for Monday, Tuesday-Thursday, Friday, Saturday and Sunday
Input data	Traffic count data	Traffic count data	Traffic count data
Data provider	TII / NRA	TII / NRA	TII / NRA
Data source	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie
Description	Hourly light duty vehicles volumes in 2017 for all traffic counter sites aggregated by month	Hourly light duty vehicles volumes in 2017 for all traffic counter sites aggregated by weekday	Hourly light duty vehicles volumes in 2017 for all traffic counter sites

GNFR	F_RoadTransport		
NFR/CRF	1A3biii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate temporal distribution for Monday, Tuesday-Thursday, Friday, Saturday and Sunday
Input data	Traffic count data	Traffic count data	Traffic count data
Data provider	TII / NRA	TII / NRA	TII / NRA
Data source	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie
Description	Hourly heavy duty vehicles volumes in 2017 for all traffic counter sites aggregated by month	Hourly heavy duty vehicles volumes in 2017 for all traffic counter sites aggregated by weekday	Hourly heavy duty vehicles volumes in 2017 for all traffic counter sites

GNFR	F_RoadTransport
NFR/CRF	1A3biv

Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate temporal distribution for Monday, Tuesday-Thursday, Friday, Saturday and Sunday
Input data	Traffic count data	Traffic count data	Traffic count data
Data provider	TII / NRA	TII / NRA	TII / NRA
Data source	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie
Description	Hourly motorcycles volumes in 2017 for all traffic counter sites aggregated by month	Hourly motorcycles volumes in 2017 for all traffic counter sites aggregated by weekday	Hourly motorcycles volumes in 2017 for all traffic counter sites

GNFR	F_RoadTransport		
NFR/CRF	1A3bv		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Monthly temperature		Hourly temperature data for Dublin airport
Data provider	Met Eirann		data.gov.ie
Data source	https://www.met.ie/climate/available-data/monthly-data		https://data.gov.ie/dataset/dublin-airport-daily-weather-station-data
Description	Monthly temperature data sets for 25 synoptic weather stations	Assumption: Even distribution	Annual average diurnal temperature variation minus 6 degree

GNFR	F_RoadTransport		
NFR/CRF	1A3bvi		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate temporal distribution for Monday, Tuesday-Thursday, Friday, Saturday and Sunday
Input data	Traffic count data	Traffic count data	Traffic count data
Data provider	TII / NRA	TII / NRA	TII / NRA
Data source	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie	https://www.nratrafficdata.ie
Description	Hourly traffic volumes for all vehicle types in 2017 for all traffic counter sites aggregated by month	Hourly traffic volumes for all vehicle types in 2017 for all traffic counter sites aggregated by weekday	Hourly traffic volumes for all vehicle types in 2017 for all traffic counter sites

5.3.7 Shipping

GNFR	G_Shipping		
NFR/CRF	1A3dii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

GNFR	P_IntShipping		
NFR/CRF	1A3di(i)		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

5.3.8 Aviation

GNFR	H_Aviation		
NFR/CRF	1A3ai(i) 1A3aii(i)		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Passenger numbers classified by national and international traffic handled by main airports Passenger numbers classified by arrivals and departures by month handled by main airports	Summer and winter timetables for Dublin airport for 2017	Summer and winter timetables for Dublin airport for 2017
Data provider	CSO	Dublin Airport	Dublin Airport
Data source	https://cso.ie/en/releasesandpublications/er/as/aviationstatistics2014/	https://www.dublinairport.com/flight-information/online-timetables	https://www.dublinairport.com/flight-information/online-timetables

		https://www.dublinair-port.com/docs/default-source/Flight-In-formation-Documents/dublin-airport-summer-timetable-2017.pdf?sfvrsn=2	https://www.dublinair-port.com/docs/default-source/Flight-In-formation-Documents/dublin-airport-summer-timetable-2017.pdf?sfvrsn=2
Description	Monthly passenger numbers by main air-port for 2014 combined with ratio of na-tional and international traffic by main airport for 2014	Number of domestic and international departures and arrivals by airport and by weekday	Number of domestic and international departures and arrivals by airport and by hour

GNFR	O_AviCruise		
NFR/CRF	1A3ai(ii) 1A3aii(ii)		
Pollutant	All		
Temporal reso-lution	Monthly	Daily	Hourly
Weekday			
Input data	Monthly flight numbers for main airports	Summer and winter timetables for Dublin airport for 2017	Summer and winter timetables for Dublin airport for 2017
Data provider	Irish Aviation Authority	Dublin Airport	Dublin Airport
Data source	https://www.iaa.ie/who-we-are/flight-statistics/monthly-review	https://www.dublinairport.com/flight-in-formation/online-timetables https://www.dublinair-port.com/docs/default-source/Flight-In-formation-Documents/dublin-airport-summer-timetable-2017.pdf?sfvrsn=2	https://www.dublinairport.com/flight-in-formation/online-timetables https://www.dublinair-port.com/docs/default-source/Flight-In-formation-Documents/dublin-airport-summer-timetable-2017.pdf?sfvrsn=2

Description	Average monthly en route, terminal and North Atlantic communications flights for 2016-2017	Number of domestic and international departures and arrivals by airport and by weekday	Number of domestic and international departures and arrivals by airport and by hour

5.3.9 Offroad

GNFR	I_Offroad		
NFR/CRF	1A2gvii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Index of Employment in Building and Construction Industry - BBM02		
Data provider	CSO		
Data source	https://www.cso.ie/en/databases/		
Description	Average for years 2000-2007	Assumption: Even distribution	Assumption: Even distribution

GNFR	I_Offroad		
NFR/CRF	1A3c		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate temporal distribution for Monday-Friday, Saturday and Sunday
Input data		Timetables by route	Timetables by route

Data provider		Irish rail	Irish rail
Data source		http://www.irishrail.ie/train-timetables/timetables-by-route	http://www.irishrail.ie/train-timetables/timetables-by-route
Description	Assumption: Even distribution	Number of passenger train by route and weekday Assumption: 50 % of emissions from passenger trains and 50 % emissions from freight. Even distribution of emissions from freight	Number of passenger train by route, weekday and hour Assumption: 50 % of emissions from passenger trains and 50 % emissions from freight. Even distribution of emissions from freight

GNFR	I_Offroad		
NFR/CRF	1A3ei		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

GNFR	I_Offroad		
NFR/CRF	1A4aii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly

Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: same as 1A4ai	Assumption: same as 1A4ai	Assumption: same as 1A4ai

GNFR	I_Offroad		
NFR/CRF	1A4bii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: same as 1A4bi	Assumption: same as 1A4bi	Assumption: same as 1A4bi

GNFR	I_Offroad		
NFR/CRF	1A4cii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Number of and fuel consumption by field activities for annual crops and for grass and grazing, and monthly distribution of activities		

Data provider	The Danish Institute of Agricultural Sciences (now DCA – Danish Centre for Food and Agriculture) The Danish National Agricultural Advisory Centre (now SEGES)		
Data source	Markbrug (Tillage). DJF-report no. 105. June 2004. http://web.agrsci.dk/djfpublikation/index.asp?action=show&id=778 Håndbog for driftsplanlægning (Operations Planning Manual), Landbrugsforlaget, 2009		
Description		Assumption: Even distribution for Monday-Saturday and less activity on Sunday	Assumption: Even distribution for working hours (8-18)

GNFR	I_Offroad		
NFR/CRF	1A4ciii		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Fish landings by Irish Vessels		
Data provider	CSO		
Data source	https://www.cso.ie/en/releasesandpublications/er/fl/fishlandings2007-2016/		

Description	Average landings by Irish vessels by month for the years 2003-2016	Assumption: Even distribution	Assumption: Even distribution

5.3.10 Waste

GNFR	J_Waste		
NFR/CRF	5A 5B1 5D1		
Pollutant	All excl. N_2O		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

GNFR	J_Waste		
NFR/CRF	5D1		
Pollutant	N_2O		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Monthly average nitrous oxide emission and wastewater temperature		
Data provider			
Data source	Daelman et al. (2013)		

Description	Based on a delayed correlation between N_2O and wastewater temperature	Assumption: Even distribution	Assumption: Even distribution

GNFR	J_Waste		
NFR/CRF	5C1bi		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Assumption: Even distribution	Assumption: Even distribution for working days	Assumption: Even distribution for daytime hours (7-18)

GNFR	J_Waste		
NFR/CRF	5C1bv		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data	Deaths Registered Provisional by Sex, Quarter and Statistic (VSQ17)		
Data provider	CSO		
Data source	https://www.cso.ie/en/databases/		

Description	Average for the years 2010-2017	Assumption: Even distribution for working days	Assumption: Even distribution for working hours (9-17)

GNFR	J_Waste		
NFR/CRF	5C2		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			Assumption: Even distribution for working hours (10-17)
Description	Assumption: Even distribution for November-March, less activity for April and October, and no activity for May-September	Assumption: Even distribution	Assumption: Even distribution for working hours (10-17)

GNFR	J_Waste		
NFR/CRF	5E		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			

Description	Assumption: Even distribution	Assumption: Even distribution for working days and higher activity level in weekends, as fires occur evenly, but contribution from bonfires and other open burning is assumed to be skewed towards the weekends	Assumption: increasing activity in the afternoon and evening. Highest activity level for the hours 20-21 and lowest activity level for the hours 1-5

5.3.11 Agriculture

GNFR	K_AgriLivestock		
NFR/CRF	3B1a		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	K_AgriLivestock		
NFR/CRF	3B1b 3B4d		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	K_AgriLivestock		
NFR/CRF	3B2		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			

Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	K_AgriLivestock		
NFR/CRF	3B3 3B4giii 3B4giv 3B4h		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See	Assumption: Even distribution	Assumption: Even distribution

	spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf		

GNFR	K_AgriLivestock		
NFR/CRF	3B4e		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	K_AgriLivestock		
NFR/CRF	3B4f 3B4gi		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	K_AgriLivestock		
NFR/CRF	3B4gii		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly

Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	K_AgriLivestock		
NFR/CRF	3B5		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm	Assumption: Even distribution	Assumption: Even distribution

	Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf		

GNFR	L_AgriOther		
NFR/CRF	3Da1 3Da2b 3Da2c		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution with less activity (50%) on Sundays	Assumption: Even distribution

GNFR	L_AgriOther		
NFR/CRF	3Da2a		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution with less activity (50%) on Sundays	Assumption: Even distribution

GNFR	L_AgriOther		
NFR/CRF	3Da3		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			

Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	L_AgriOther		
NFR/CRF	3Da4		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm	Assumption: Even distribution	Assumption: Even distribution

	Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf		

GNFR	L_AgriOther		
NFR/CRF	3Db 3Dc		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

GNFR	L_AgriOther		
NFR/CRF	3Dd All 3Dd TSP 3De All 3De PM10		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Evenly on daytime hours (7-20) with less activity (50%) on the hours 7-8 and 19-20

GNFR	L_AgriOther		
NFR/CRF	3Dd PM10		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly

Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution with less activity (50%) on Sundays	Assumption: Even distribution for daytime hours (7-20) with less activity (50%) on the hours 7-8 and 19-20

GNFR	L_AgriOther		
NFR/CRF	3Dd PM2_5		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm	Assumption: Even distribution with less activity (50%) on Sundays	Assumption: Even distribution for daytime hours (7-20) with less activity (50%) on the hours 7-8 and 19-20

	Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf		

GNFR	L_AgriOther		
NFR/CRF	3De PM2_5		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution for daytime hours (7-20) with less activity (50%) on the hours 7-8 and 19-20

GNFR	L_AgriOther		
NFR/CRF	3Df		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			Separate profiles for Monday-Saturday and Sunday
Input data			
Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution with less activity (50%) on Sundays	Assumption: Even distribution for daytime hours (7-20) with less activity (50%) on the hours 7-8 and 19-20

GNFR	L_AgriOther		
NFR/CRF	3F		
Pollutant			
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			

Data provider			
Data source			
Description	Varies according to agreed distribution with Mr. Bernard Hyde, Irish EPA. See spreadsheet: Agriculture_temporal_resolution. Partly based on: National Farm Survey of Manure Application and Storage Practices on Irish Farms. https://www.teagasc.ie/media/website/publications/2011/TeagascNationalFarmSurveyOfManureApplication.pdf	Assumption: Even distribution	Assumption: Even distribution

5.3.12 LULUCF

GNFR	q_LULUCF		
NFR/CRF	4A 4B 4C 4D 4E 4F 4G		
Pollutant	All		
Temporal resolution	Monthly	Daily	Hourly
Weekday			
Input data			
Data provider			

Data source			
Description	Assumption: Even distribution	Assumption: Even distribution	Assumption: Even distribution

Annex 1 - List of GeoKeys

GeoKey
1A1a_NOx
1A1a_rest
1A1a_SO2
1A1b
1A1c
1A2b
1A2c
1A2e
1A2f
1A2gvi
1A2gviii
1A3ai(i)
1A3aii(i)
1A3aii(ii)
1A3c
1A3d
1A3e
1A4b_CO
1A4b_CO2
1A4b_NMVOC
1A4b_NOx
1A4b_PM25
1A4b_SO2
1A4cii
1A4ciii
1B1a_Handling
1B1a_Mining
1B2av
1B2bii
1B2c
2A1

GeoKey (continued)
2A2
2A4b
2A4d
2A5a
2B1
2B2
2C1
2C2_Cd
2C2_Pb
2C2_PM
2C3
2C7c_Cd
2C7c_Pb
2C7c_rest
2C7c_Zn
2D3f
2E1
3B1a
3B1b
3B2
3B3
3B4d
3B4e
3B4f
3B4gi
3B4gii
3B4giv
3B4h
3D1a6
3D1b2
3Da2a

GeoKey (continued)
5A
5B1
5C1bi
5C1biii
5C1bv
5D_N2O
AreaLand
AreaLandSea
AreaSea
Buildings_All
Buildings_C_nonUrban
Buildings_R
Buildings_R_nonSewered
Buildings_R_nonUrban
CORINEcropland
CORINEforestland
CORINEgrassland
CORINEotherland
CORINEsettlement
CORINEwetland
HeatDemand_CommercialPublic
HeatDemand_Industrial
LPIScropImpGrass
LPIScropland
LPISfarmyard
LPISgrassland
Population
Road_HV
Road_PC
Road_PCHV

Annex 2 - Correspondence between GNFR, NFR and GeoKey

GNFR	NFR	NFR name	GeoKey
A	1A1a	Public electricity and heat production	1A1a_NOx
A	1A1a	Public electricity and heat production	1A1a_rest
A	1A1a	Public electricity and heat production	1A1a_SO2
B	1A1b	Petroleum refining	1A1b
B	1A1c	Manufacture of solid fuels and other energy industries	1A1c
B	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	HeatDemand_Industrial
B	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	1A2b
B	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	1A2c
B	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	HeatDemand_Industrial
B	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	1A2e
B	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	1A2f
B	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	1A2gviii
B	2A1	Cement production	2A1
B	2A2	Lime production	2A2
B	2A4a	Ceramics	HeatDemand_Industrial
B	2A4b	Other uses of soda ash	2A4b
B	2A4d	Other uses of carbonates	2A4d
B	2A5a	Quarrying and mining of minerals other than coal	2A5a
B	2A5b	Construction and demolition	Buildings_All
B	2A6	Other mineral products (please specify in the IIR)	HeatDemand_Industrial
B	2B1	Ammonia production	2B1
B	2B10b	Storage, handling and transport of chemical products (please specify in the IIR)	LPISfarmyard
B	2B2	Nitric acid production	2B2
B	2C1	Iron and steel production	2C1
B	2C2	Ferroalloys production	2C2_Cd
B	2C2	Ferroalloys production	2C2_Pb
B	2C2	Ferroalloys production	2C2_PM
B	2C3	Aluminium production	2C3
B	2C7c	Other metal production (please specify in the IIR)	2C7c_Cd
B	2C7c	Other metal production (please specify in the IIR)	2C7c_Pb
B	2C7c	Other metal production (please specify in the IIR)	2C7c_rest

GNFR	NFR	NFR name	GeoKey
B	2C7c	Other metal production (please specify in the IIR)	2C7c_Zn
B	2D1	Lubricant use	Road_PCHV
B	2D2	Paraffin wax use	Population
B	2D3b	Road paving with asphalt	Road_PCHV
B	2D3c	Asphalt roofing	Buildings_All
B	2E	Electronics industry	2E1
B	2F1a	Commercial refrigeration	Population
B	2F1e	Mobile air-conditioning	Road_PCHV
B	2F1f	Stationary air-conditioning	Buildings_All
B	2F3	Fire protection	HeatDemand_Industrial
B	2F4	Aerosols	Population
B	2F6	Other applications	Population
B	2H2	Food and beverages industry	1A2e
B	2I	Wood processing	Buildings_C_nonUrban
B	2L	Other production, consumption, storage, transportation or handling of bulk products (please specify in the IIR)	AreaLand
C	1A4ai	Commercial/institutional: Stationary	HeatDemand_CommercialPublic
C	1A4bi	Residential: Stationary	1A4b_CO
C	1A4bi	Residential: Stationary	1A4b_CO2
C	1A4bi	Residential: Stationary	1A4b_NMVOC
C	1A4bi	Residential: Stationary	1A4b_NOx
C	1A4bi	Residential: Stationary	1A4b_PM25
C	1A4bi	Residential: Stationary	1A4b_SO2
C	1A4ci	Agriculture/Forestry/Fishing: Stationary	LPISfarmyard
D	1B1a	Fugitive emission from solid fuels: Coal mining and handling	1B1a_Handling
D	1B1a	Fugitive emission from solid fuels: Coal mining and handling	1B1a_Mining
D	1B2aiv	Fugitive emissions oil: Refining / storage	1A1b
D	1B2av	Distribution of oil products	1B2av
D	1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	1B2bii
D	1B2c	Venting and flaring (oil, gas, combined oil and gas)	1B2c
E	2D3a	Domestic solvent use including fungicides	Population
E	2D3d	Coating applications	Population
E	2D3e	Degreasing	2C7c_rest
E	2D3f	Dry cleaning	2D3f
E	2D3g	Chemical products	HeatDemand_Industrial
E	2D3h	Printing	HeatDemand_Industrial
E	2D3i	Other solvent use (please specify in the IIR)	Population
E	2G	Other product use (please specify in the IIR)	HeatDemand_Industrial

GNFR	NFR	NFR name	GeoKey
E	2G	Other product use (please specify in the IIR)	Population
F	1A3bi	Road transport: Passenger cars	Road_PC
F	1A3bii	Road transport: Light duty vehicles	Road_PC
F	1A3biii	Road transport: Heavy duty vehicles and buses	Road_HV
F	1A3biv	Road transport: Mopeds & motorcycles	Road_PC
F	1A3bv	Road transport: Gasoline evaporation	Road_PC
F	1A3bvi	Road transport: Automobile tyre and brake wear	Road_PCHV
F	1A3bvii	Road transport: Automobile road abrasion	Road_PCHV
G	1A3di(ii)	International inland waterways	AreaSea
G	1A3dii	National navigation (shipping)	1A3d
H	1A3ai(i)	International aviation LTO (civil)	1A3ai(i)
H	1A3aii(i)	Domestic aviation LTO (civil)	1A3aii(i)
I	1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	1A2gvi
I	1A3c	Railways	1A3c
I	1A3ei	Pipeline transport	1A3e
I	1A4aii	Commercial/institutional: Mobile	HeatDemand_CommercialPublic
I	1A4bii	Residential: Household and gardening (mobile)	Buildings_R
I	1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	1A4cii
I	1A4ciii	Agriculture/Forestry/Fishing: National fishing	1A4ciii
J	5A	Biological treatment of waste - Solid waste disposal on land	5A
J	5B1	Biological treatment of waste - Composting	5B1
J	5C1bi	Industrial waste incineration	5C1bi
J	5C1biii	Clinical waste incineration	5C1biii
J	5C1bv	Cremation	5C1bv
J	5C2	Open burning of waste	Buildings_R_nonUrban
J	5D1	Domestic wastewater handling	5D_N2O
J	5D1	Domestic wastewater handling	Buildings_R_nonSewered
J	5D2	Industrial wastewater handling	5D_N2O
J	5D2	Industrial wastewater handling	Buildings_R_nonSewered
J	5D3	Other wastewater handling	5D_N2O
J	5D3	Other wastewater handling	Buildings_R_nonSewered
J	5E	Other waste (please specify in IIR)	Population
K	3A1a	Dairy cattle	3B1a
K	3A1b	Non-dairy cattle	3B1b
K	3A2	Sheep	3B2
K	3A3	Swine	3B3
K	3A4d	Goats	3B4d
K	3A4e	Horses	3B4e

GNFR	NFR	NFR name	GeoKey
K	3A4f	Mules and asses	3B4f
K	3A4g	Poultry	3B4gii
K	3A4h	Other animals	3B4h
K	3B1a	Manure management - Dairy cattle	3B1a
K	3B1b	Manure management - Non-dairy cattle	3B1b
K	3B2	Manure management - Sheep	3B2
K	3B3	Manure management - Swine	3B3
K	3B4d	Manure management - Goats	3B4d
K	3B4e	Manure management - Horses	3B4e
K	3B4f	Manure management - Mules and asses	3B4f
K	3B4gi	Manure management - Laying hens	3B4gi
K	3B4gii	Manure management - Broilers	3B4gii
K	3B4giii	Manure management - Turkeys	3B4giv
K	3B4giv	Manure management - Other poultry	3B4giv
K	3B4h	Manure management - Other animals (please specify in IIR)	3B4h
L	3Da1	Inorganic N-fertilizers (includes also urea application)	3Da1
L	3Da2a	Animal manure applied to soils	3Da2a
L	3Da2b	Sewage sludge applied to soils	LPIScropland
L	3Da2c	Other organic fertilisers applied to soils (including compost)	LPIScropland
L	3Da3	Urine and dung deposited by grazing animals	LPISgrassland
L	3Da4	Crop residues applied to soils	LPIScropland
L	3Da5	Mineralization	LPIScropland
L	3Da6	Cultivation of organic soils	3D1a6
L	3Db	Indirect emissions from managed soils	LPIScropland
L	3Db1	Atmospheric deposition	AreaLand
L	3Db2	Nitrogen leaching and run-off	3D1b2
L	3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	LPIScropImpGrass
L	3Dd	Off-farm storage, handling and transport of bulk agricultural products	HeatDemand_Industrial
L	3De	Cultivated crops	LPIScropland
L	3Df	Use of pesticides	LPIScropland
L	3F	Field burning of agricultural residues	LPIScropland
L	3G	Liming	LPIScropImpGrass
L	3H	Urea application	3Da1
O	1A3ai(ii)	International aviation cruise (civil)	AreaLandSea
O	1A3aii(ii)	Domestic aviation cruise (civil)	1A3aii(ii)
P	1A3di(i)	International maritime navigation	AreaSea
q	4A	LULUCF Forest land	CORINEforestland
q	4B	LULUCF Cropland	CORINEcropland

GNFR	NFR	NFR name	GeoKey
q	4C	LULUCF Grassland	CORINEgrassland
q	4D	LULUCF Wetlands	CORINEwetland
q	4E	LULUCF Settlements	CORINEsettlement
q	4F	LULUCF Other land	CORINEotherland
q	4G	LULUCF Harvested wood product	Population

Annex 3 - Correspondence list of IPCC categories and LPIS codes

Correspondence list of IPCC categories and assigned codes in the LPIS data set for County Mayo.

IPCC_Cat	AssignCode
Cropland Annual	Cropland Annual
Cropland Annual, Forestry	Complex Landscape
Cropland Annual, Forestry, Grassland Improved	Complex Landscape
Cropland Annual, Forestry, Grassland Temporary	Complex Landscape
Cropland Annual, Grassland Improved	Multiple Agriculture
Cropland Annual, Grassland Improved, Grassland Temporary	Multiple Agriculture
Cropland Annual, Grassland Improved, Grassland Unimproved	Multiple Agriculture
Cropland Annual, Grassland Improved, Settlement	Complex Landscape
Cropland Annual, Grassland Natural	Multiple Agriculture
Cropland Annual, Grassland Temporary	Multiple Agriculture
Cropland Annual, Grassland Temporary, Grassland Improved	Multiple Agriculture
Cropland Annual, Grassland Unimproved	Multiple Agriculture
Cropland Annual, Grassland Unimproved, Grassland Improved	Multiple Agriculture
Cropland Annual, Other	Complex Landscape
Cropland Annual, Settlement	Complex Landscape
Cropland Annual, Wetland	Complex Landscape
Cropland Perennial	Cropland Perennial
Cropland Perennial, Cropland Annual	Multiple Agriculture
Cropland Perennial, Grassland Improved	Multiple Agriculture
Cropland Perennial, Grassland Temporary	Multiple Agriculture
Cropland Perennial, Settlement	Complex Landscape
Forestry	Forestry
Forestry, Cropland Annual	Complex Landscape
Forestry, Grassland Improved	Complex Landscape
Forestry, Grassland Natural	Complex Landscape
Forestry, Grassland Unimproved	Complex Landscape
Forestry, Settlement	Complex Landscape
Forestry, Wetland	Complex Landscape
Grassland Improved	Grassland Improved
Grassland Improved, Cropland Annual	Multiple Agriculture
Grassland Improved, Cropland Annual, Forestry	Complex Landscape
Grassland Improved, Cropland Annual, Grassland Temporary	Multiple Agriculture
Grassland Improved, Cropland Annual, Grassland Unimproved	Multiple Agriculture
Grassland Improved, Cropland Perennial	Multiple Agriculture
Grassland Improved, Forestry	Complex Landscape
Grassland Improved, Grassland Natural	Grassland Improved
Grassland Improved, Grassland Natural, Grassland Unimproved	Grassland Improved
Grassland Improved, Grassland Natural, Other	Grassland Improved
Grassland Improved, Grassland Temporary	Grassland Improved
Grassland Improved, Grassland Temporary, Cropland Annual	Multiple Agriculture
Grassland Improved, Grassland Unimproved	Grassland Improved
Grassland Improved, Grassland Unimproved, Wetland	Grassland Improved
Grassland Improved, Other	Complex Landscape

Grassland Improved, Other, Grassland Unimproved	Grassland Improved
Grassland Improved, Settlement	Complex Landscape
Grassland Improved, Settlement, Cropland Annual	Complex Landscape
Grassland Improved, Settlement, Grassland Natural	Complex Landscape
Grassland Improved, Wetland	Complex Landscape
Grassland Improved, Wetland, Grassland Natural	Grassland Improved
Grassland Improved, Wetland, Grassland Temporary	Complex Landscape
Grassland Natural	Grassland Natural
Grassland Natural, Cropland Annual	Multiple Agriculture
Grassland Natural, Cropland Annual, Grassland Improved	Multiple Agriculture
Grassland Natural, Forestry	Complex Landscape
Grassland Natural, Forestry, Wetland, Grassland Improved	Complex Landscape
Grassland Natural, Grassland Improved	Grassland Improved
Grassland Natural, Grassland Improved, Grassland Unimproved	Grassland Improved
Grassland Natural, Grassland Temporary	Grassland Natural
Grassland Natural, Grassland Unimproved	Grassland Unimproved
Grassland Natural, Other	Other
Grassland Natural, Settlement, Other, Grassland Improved	Complex Landscape
Grassland Natural, Wetland	Complex Landscape
Grassland Temporary	Grassland Temporary
Grassland Temporary, Cropland Annual	Multiple Agriculture
Grassland Temporary, Cropland Annual, Grassland Improved	Multiple Agriculture
Grassland Temporary, Cropland Annual, Grassland Natural	Multiple Agriculture
Grassland Temporary, Cropland Perennial	Multiple Agriculture
Grassland Temporary, Forestry	Complex Landscape
Grassland Temporary, Grassland Improved	Grassland Improved
Grassland Temporary, Grassland Improved, Cropland Annual	Multiple Agriculture
Grassland Temporary, Grassland Natural	Grassland Natural
Grassland Temporary, Grassland Unimproved	Grassland Unimproved
Grassland Temporary, Settlement	Complex Landscape
Grassland Temporary, Settlement, Cropland Annual	Complex Landscape
Grassland Unimproved	Grassland Unimproved
Grassland Unimproved, Cropland Annual	Multiple Agriculture
Grassland Unimproved, Cropland Annual, Grassland Improved	Multiple Agriculture
Grassland Unimproved, Forestry	Complex Landscape
Grassland Unimproved, Grassland Improved	Grassland Improved
Grassland Unimproved, Grassland Improved, Cropland Annual	Multiple Agriculture
Grassland Unimproved, Grassland Improved, Grassland Temporary	Grassland Improved
Grassland Unimproved, Grassland Improved, Wetland	Grassland Improved
Grassland Unimproved, Grassland Natural	Grassland Unimproved
Grassland Unimproved, Grassland Temporary	Grassland Unimproved
Grassland Unimproved, Other	Other
Grassland Unimproved, Settlement	Complex Landscape
Grassland Unimproved, Wetland	Complex Landscape
Other	Other
Other, Grassland Improved	Grassland Improved
Other, Grassland Natural	Grassland Unimproved
Other, Grassland Unimproved, Grassland Natural, Grassland Improve	Complex Landscape
Other, Settlement, Grassland Improved	Complex Landscape
Other, Wetland, Grassland Improved, Grassland Natural	Complex Landscape
Settlement	Settlement
Settlement, Cropland Annual	Complex Landscape
Settlement, Grassland Improved	Complex Landscape
Settlement, Grassland Improved, Other	Complex Landscape
Settlement, Grassland Natural	Complex Landscape

Settlement, Grassland Temporary	Complex Landscape
Settlement, Wetland	Complex Landscape
Settlement, Wetland, Grassland Improved	Complex Landscape
Wetland	Wetland
Wetland, Forestry	Complex Landscape
Wetland, Grassland Improved	Complex Landscape
Wetland, Grassland Improved, Grassland Natural	Complex Landscape
Wetland, Grassland Improved, Grassland Unimproved	Complex Landscape
Wetland, Grassland Natural	Complex Landscape
Wetland, Grassland Natural, Grassland Improved	Complex Landscape
Wetland, Grassland Temporary	Complex Landscape
Wetland, Grassland Temporary, Grassland Natural	Complex Landscape
Wetland, Grassland Unimproved	Complex Landscape

Annex 4 - List of TKeys

Monthly (GNFR_NFR/CRF_Pollutant)	Daily (GNFR_NFR/CRF_Pollutant)	Hourly (GNFR_NFR/CRF_Day)
A_1A1a_All	A_1A1a_All	A_1A1a_1-6
B_1A1b_All	B_1A1b_All	A_1A1a_7
B_1A1c_All	B_1A1c_All	B_1A1b_1-7
B_1A2a_All	B_1A2a_All	B_1A1c_1-7
B_1A2b_All	B_1A2b_All	B_1A2a_1-7
B_1A2c_All	B_1A2c_All	B_1A2b_1-7
B_1A2d_All	B_1A2d_All	B_1A2c_1-7
B_1A2e_All	B_1A2e_All	B_1A2d_1-7
B_1A2f_All	B_1A2f_All	B_1A2e_1-7
B_1A2gviii_All	B_1A2gviii_All	B_1A2f_1-7
B_2A1_All	B_2A1_All	B_1A2gviii_1-7
B_2A2_All	B_2A2_All	B_2A1_1-7
B_2A4a_All	B_2A4a_All	B_2A2_1-7
B_2A4b_All	B_2A4b_All	B_2A4a_1-7
B_2A4d_All	B_2A4d_All	B_2A4b_1-7
B_2A5a_All	B_2A5a_All	B_2A4d_1-7
B_2A5b_All	B_2A5b_All	B_2A5a_1-7
B_2A5c_All	B_2A5c_All	B_2A5b_1-7
B_2A6_All	B_2A6_All	B_2A5c_1-7
B_2B10b_All	B_2B10b_All	B_2A6_1-7
B_2C2_All	B_2C2_All	B_2B10b_1-7
B_2D3b_All	B_2D3b_All	B_2C2_1-7
B_2D3c_All	B_2D3c_All	B_2D3b_1-7
B_2H2_All	B_2H2_All	B_2D3c_1-7
B_2I_All	B_2I_All	B_2H2_1-7
C_1A4ai_All	C_1A4ai_All	B_2I_1-7
C_1A4bi_All	C_1A4bi_All	C_1A4ai_1-5
C_1A4ci_All	C_1A4ci_All	C_1A4ai_6-7
D_1B1a_All	D_1B1a_All	C_1A4bi_1-5
D_1B2aiv_All	D_1B2aiv_All	C_1A4bi_6-7
D_1B2av_All	D_1B2av_All	C_1A4ci_1-7
D_1B2b_All	D_1B2b_All	D_1B1a_1-7
D_1B2c_All	D_1B2c_All	D_1B2aiv_1-7
E_2D3a_All	E_2D3a_All	D_1B2av_1-7
E_2D3d_All	E_2D3d_All	D_1B2b_1-6
E_2D3e_All	E_2D3e_All	D_1B2b_7
E_2D3f_All	E_2D3f_All	D_1B2c_1-7
E_2D3g_All	E_2D3g_All	E_2D3a_1-5
E_2D3h_All	E_2D3h_All	E_2D3a_6-7

E_2D3i_All	E_2D3i_All	E_2D3d_1-7
E_2G1_All	E_2G1_All	E_2D3e_1-7
E_2G2_All	E_2G2_All	E_2D3f_1-7
F_1A3bi_All	F_1A3bi_All	E_2D3g_1-7
F_1A3bii_All	F_1A3bii_All	E_2D3h_1-7
F_1A3biii_All	F_1A3biii_All	E_2D3i_1-7
F_1A3biv_All	F_1A3biv_All	E_2G1_1-7
F_1A3bv_All	F_1A3bv_All	E_2G2_1-7
F_1A3bvi_All	F_1A3bvi_All	F_1A3bi_1
F_1A3bvii_All	F_1A3bvii_All	F_1A3bi_2-4
G_1A3dii_All	G_1A3dii_All	F_1A3bi_5
H_1A3ai(i)_All	H_1A3ai(i)_All	F_1A3bi_6
H_1A3aii(i)_All	H_1A3aii(i)_All	F_1A3bi_7
I_1A2gvii_All	I_1A2gvii_All	F_1A3bii_1
I_1A3c_All	I_1A3c_All	F_1A3bii_2-4
I_1A3ei_All	I_1A3ei_All	F_1A3bii_5
I_1A4aii_All	I_1A4aii_All	F_1A3bii_6
I_1A4bii_All	I_1A4bii_All	F_1A3bii_7
I_1A4cii_All	I_1A4cii_All	F_1A3biii_1
I_1A4ciii_All	I_1A4ciii_All	F_1A3biii_2-4
J_5A_All	J_5A_All	F_1A3biii_5
J_5B1_All	J_5B1_All	F_1A3biii_6
J_5C1bi_All	J_5C1bi_All	F_1A3biii_7
J_5C1bv_All	J_5C1bv_All	F_1A3biv_1
J_5C2_All	J_5C2_All	F_1A3biv_2-4
J_5D1_All	J_5D1_All	F_1A3biv_5
J_5D1_N2O	J_5D1_N2O	F_1A3biv_6
J_5E_All	J_5E_All	F_1A3biv_7
K_3B1a_All	K_3B1a_All	F_1A3bv_1-7
K_3B1b_All	K_3B1b_All	F_1A3bvi_1
K_3B2_All	K_3B2_All	F_1A3bvi_2-4
K_3B3_All	K_3B3_All	F_1A3bvi_5
K_3B4d_All	K_3B4d_All	F_1A3bvi_6
K_3B4e_All	K_3B4e_All	F_1A3bvi_7
K_3B4f_All	K_3B4f_All	F_1A3bvii_1
K_3B4gi_All	K_3B4gi_All	F_1A3bvii_2-4
K_3B4gii_All	K_3B4gii_All	F_1A3bvii_5
K_3B4giii_All	K_3B4giii_All	F_1A3bvii_6
K_3B4giv_All	K_3B4giv_All	F_1A3bvii_7
K_3B4h_All	K_3B4h_All	G_1A3dii_1-7
K_3B5_All	K_3B5_All	H_1A3ai(i)_1-7
L_3Da1_All	L_3Da1_All	H_1A3aii(i)_1-7

L_3Da2a_All
L_3Da2b_All
L_3Da2c_All
L_3Da3_All
L_3Da4_All
L_3Db_All
L_3Dc_All
L_3Dd_All
L_3Dd_PM2_5
L_3Dd_PM10
L_3Dd_TSP
L_3De_PM2_5
L_3De_PM10
L_3De_All
L_3Df_All
L_3F_All
O_1A3ai(ii)_All
O_1A3aii(ii)_All
P_1A3di(i)_All
q_4A_All
q_4B_All
q_4C_All
q_4D_All
q_4E_All
q_4F_All
q_4G_All

L_3Da2a_All
L_3Da2b_All
L_3Da2c_All
L_3Da3_All
L_3Da4_All
L_3Db_All
L_3Dc_All
L_3Dd_All
L_3Dd_PM2_5
L_3Dd_PM10
L_3Dd_TSP
L_3De_PM2_5
L_3De_PM10
L_3De_All
L_3Df_All
L_3F_All
O_1A3ai(ii)_All
O_1A3aii(ii)_All
P_1A3di(i)_All
q_4A_All
q_4B_All
q_4C_All
q_4D_All
q_4E_All
q_4F_All
q_4G_All

I_1A2gvii_1-7
I_1A3c_1-5
I_1A3c_6
I_1A3c_7
I_1A3ei_1-7
I_1A4aii_1-5
I_1A4aii_6-7
I_1A4bii_1-5
I_1A4bii_6-7
I_1A4cii_1-6
I_1A4cii_7
I_1A4ciii_1-7
J_5A_1-7
J_5B1_1-7
J_5C1bi_1-7
J_5C1bv_1-7
J_5C2_1-7
J_5D1_1-7
J_5E_1-7
K_3B1a_1-7
K_3B1b_1-7
K_3B2_1-7
K_3B3_1-7
K_3B4d_1-7
K_3B4e_1-7
K_3B4f_1-7
K_3B4gi_1-7
K_3B4gii_1-7
K_3B4giii_1-7
K_3B4giv_1-7
K_3B4h_1-7
K_3B5_1-7
L_3Da1_1-7
L_3Da2a_1-7
L_3Da2b_1-7
L_3Da2c_1-7
L_3Da3_1-7
L_3Da4_1-7
L_3Db_1-7
L_3Dc_1-7
L_3Dd_1-7
L_3De_1-7

L_3Df_1-6
L_3Df_7
L_3F_1-7
O_1A3ai(ii)_1-7
O_1A3aii(ii)_1-7
P_1A3di(i)_1-7
q_4A_1-7
q_4B_1-7
q_4C_1-7
q_4D_1-7
q_4E_1-7
q_4F_1-7
q_4G_1-7