National mapping of GHG and non-GHG emissions sources

Synthesis report for work package 2

Academic report from Department of Environmental Science

2017

Ole-Kenneth Nielsen & Marlene Plejdrup

AARHUS
UNIVERSITY

DEPARTMENT OF ENVIRONMENTAL SCIENCE

CONTENTS

Assessment and selection of geographical data for the spatial model

This report documents the work done in work package 2 of the project "National mapping of GHG and non-GHG emissions sources". The work consisted of identification of available spatial data, and, based on an assessment of these data sets, selection of the most appropriate spatial data for use in the spatial distribution model.

Acknowledgements

The project team would like to acknowledge the many contributions received. We would like to thank all members of the Steering Committee and all participants in the Stakeholder workshop in October 2016.

Additionally, the project team would like to thank the following individuals:

- Paul Duffy, Bernard Hyde, Stephen Treacy, John McEntagart, Kevin Lydon, Phillip O'Brien, Ann Marie Ryan and Kevin Delaney from the Environmental Protection Agency
- Dave Dodd from the Department of Communications, Climate Action and Environment
- Gerry Brady, Nova Sharkey, Linh Nolan, Kathryn Forskin, Dermot Corcoran and John Flanagan from the Central Statistics Office
- Willie Pierce and Mark Conroy from Irish Rail
- Mary Holland, Amanda Barriscale , Martin Howley from Sustainable Energy Authority Ireland
- John Muldowney, Ronan Gleeson and Rory Nolan from the Department of Agriculture, Food and the Marine
- David Kelleghan and Tom Curran from University College Dublin
- Eoin Gillard, Dan Brennan, Helen Hughes and Brendan Kennedy from Transport Infrastructure Ireland
- Enda Hayes from the University of the West of England
- Charles Shier from Bord na Mona
- Barry Colleary from the National Transport Authority

Identification of available spatial data

Through a survey of the Irish national emission inventory data and calculation system, the project team has identified the relevant sectors and sources and the methodology used in the previous spatial emission mapping. A list has been elaborated including spatial data that could be used in the present mapping, both on a detailed and on a more aggregated level. In the first step, the main focus was to prepare a gross list of spatial data that could be useful, without excluding any possibilities. Later the number of data sets decreased as data turned out to be non-existing or not available, the spatial data were of too poor quality, and/or more data processing were necessary than could be justified by the benefit of including the data. For example it is not beneficial to apply very extensive methodologies for minor emission sources. The level of detail to be applied to the mapping methodology is to be decided after review of the obtained data.

The data survey was focusing on spatial data covering the entire country, with relevance for emission mapping. Both general data, like national borders (land and sea area), buildings, population density and land-use, and sector specific data, like road network including mileage, agricultural areas including animal numbers, and ferry routes, were covered. These data are all going to be used to map emissions from area sources, and the features in the layers are used as proxy data to determine the share of the national total emissions to be allocated to the individual cells in the 1 km x 1 km grid covering Ireland (GeoKeys). For some area sources, there are no closely related spatial data available to use as proxy for emission mapping, e.g. emissions from domestic solvent use will be allocated following the population density, as no data are available to indicate in more detail where the product use takes place. For other emission sources more close related spatial data are available, e.g. emissions from road transport will be allocated to the road network taking into account information on mileage, where available.

The most accurate emission mapping can be made for sources that are handled as point sources in the national emission inventory. This is the case for e.g. power plants and large industrial plants for which annual emissions are available for the individual plants based on ETS reporting or other plant specific data. In those cases emissions will be allocated to the exact position (XY coordinates) of the plants. For other point sources, emissions are not calculated annually on an individual level, but instead based on plant specific data for one or few years or as a sum for all the sources based on aggregated activity data. This is the case for emissions from waste water treatment plants and solid waste disposal sites, among others.

The first step of identification of spatial data set has been a search for online geodata. The project team has been looking into relevant institutions' websites to identify which institutions have public available spatial data and to what extend the data can be downloaded from the web. Among the Irish institutions that has been surveyed are Ordnance Survey Ireland (OSi), the GeoDirectory, the Geoportal, Transport Infrastructure Ireland and IRLOGI. Also, census data provided by e.g. the

Central Statistics Office, the National Road Authority, and Transport Infrastructure Ireland are explored.

The second step has been to contact institutions that present relevant data where these are not public available. This has included a lot of input from meetings in the Steering Committee as well as input received during the stakeholder workshop. In all cases the institutions have been very positive and cooperative, and in most cases it has been possible to obtain the relevant data and explanations, in some cases in an aggregated form to comply with confidentiality conditions.

The collected data sets are listed in Annex 1.

Review and selection of the spatial data sets

Based on the analysis of the available spatial datasets, a selection of the best dataset for each category was made. Many factors were considered when selecting the best spatial dataset, e.g. whether the coverage is sufficient, if the spatial uncertainty is acceptable, and if the data format is suitable.

Below is the selected geodata and GeoKey for each of the source/sink categories currently included in the national Irish emission inventories. Each table list the source categories in the sector with a short description when relevant, and the geodata and methodology used to generate GeoKeys. Further, it is listed if the categories cover point sources (P), area sources (A), or both point and area sources (P/A). In some cases, the GeoKey will be defined for a group of pollutants where the pollutants have a similar distribution e.g. across fuels. This has been done as it is not practicable to have more than 25 different GeoKeys for a sector with only minor differences between most of the GeoKeys.

The categories that are currently reported as not estimated in the Irish inventory have been included in the discussion below to ensure completeness. Where possible, a suggested source of geodata has been provided and GeoKeys will be developed to the extent that resources allow it.

Energy industries

The sector covers public electricity and heat production, oil refining and extraction of fuels (peat and natural gas). For many pollutants the emissions are available at plant level and therefore it is possible to generate a GeoKey based on point source data.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Public electricity and heat production	P		1A1a	ETS/PRTR
Petroleum refining	P	One refinery only.	1A1b	ETS/PRTR
Manufacture of solid fuels and other energy industries	P	Two peat briquette factories. In principle also gas extraction, but currently not reported in this category.	1A1c	ETS/PRTR

Manufacturing industries and construction

The sector covers combustion emissions from manufacturing plants. The different subsectors are listed in the table below. For some of the sources the whole or majority of the sector is covered by point source data, while for others the share is low or even zero.

Part of the emissions is available at plant level and therefore it is possible to generate a GeoKey based on point source data.

The remaining emissions from area sources are not possible to allocate to each source, and spatial proxy data will be used to generate GeoKeys. In all cases industrial heat demand from the Heat Map will be used as a spatial proxy.

Currently, the emission inventory does not report emissions from mobile sources in this category and therefore, it has not been prioritised to develop this GeoKey. However, a possible methodology has been outlined, and if time permits, this GeoKey will be elaborated in case the category is reported in future inventories.

Source category	P/A*	Note	GeoKey	Geodata source and methodology
Iron and steel	P	Not occurring since 2003	1A2a	Point source: Inventory data
Non-ferrous metals	P/A	Point sources (~ 85 %) and area sources	1A2b	Point source: Coordinates for point sources Area source: Industrial heat demand
Chemicals	P/A	3 point sources (~ 25 %)	1A2c	Point source: Coordinates for point sources Area source: Industrial heat demand
Pulp, paper and print	P/A	No point source data. Only very small emissions.	1A2d	Point source: Coordinates for point sources Area source: Industrial heat demand
Food processing, beverages and tobacco	P/A	Point sources (~ 70 %) and area sources	1A2e	Point source: Coordinates for point sources Area source: Industrial heat demand
Non-metallic minerals	P/A	Point sources (~ 90 %) and area sources	1A2f	Point source: Coordinates for point sources Area source: Industrial heat demand
Other (mobile)	A	Currently included under stationary		Data for the number of machinery per county are available from the CSO. This can be combined with the dataset for industrial heat demand to create a GeoKey.
Other (stationary)	P/A	Point sources (~ 20 %) and area sources	1A2gviii	Point source: Coordinates for point sources Area source: Industrial heat demand

Non-industrial combustion

The sector covers combustion in small stationary plants and non-road mobile sources in the sectors commercial/institutional, residential and agriculture/forestry/fishing.

All emissions are treated as area sources and spatial proxy data will be used to generate GeoKeys. The most important proxy data that will be used are building use from the GeoDirectory, heat demand data from Heat Map, and land use data from the Land-Parcel Identification System (LPIS).

Currently, no data have been found that could accurately describe the spatial distribution of non-road mobile sources in the commercial/institutional and residential sectors.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Commercial/institutional: Stationary	A		1A4a	Commercial and public heat demand
Commercial/institutional: Mobile		Emissions included under stationary		
Residential: Stationary	A		1A4b_NOx_CO2_N2O 1A4b_other	Domestic heat demand for NO_x, CO_2 and N_2O For the remaining pollutants areas with a ban on smoky coal will be excluded
Residential: Household and gardening (mobile)		Emissions included under stationary		
Agriculture/Forestry/Fishing: Stationary	A		1A4ci	LPIS, Buildings and Farmyards
Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	A		1A4cii	Data on number of machinery per county combined with LPIS, cropland and improved grassland
Agriculture/Forestry/Fishing: National fishing	A		1A4ciii	ICES fishing areas and fishing statistics
Other stationary (including military)		Emission included under commercial/institutional		
Other, Mobile (including military, land based and recreational boats)		Emissions included under transport		

Transport

The sector covers aviation, road transport, railway transport, navigation and emissions from pipeline transport, which covers transmission of natural gas and fuel consumption in gas production.

Landing and take-off (LTO) will be treated as point sources and the GeoKey will be based on the location of the airports included in the Irish emission inventory. LTO emissions will be allocated to a buffer zone of 5 km around the airport.

The remaining emissions from area sources and the GeoKeys will be based on spatial proxy data. The most important spatial data sets are the road network combined with traffic data for the national roads and information on vehicle categories and road types in the Irish emission inventory, and railway network including activity data for individual routes.

It was not possible to get a spatial theme for the natural gas transmission and distribution network. The project team and the EPA have been in contact with Gas Networks Ireland, but it was not possible to get access to data for use in this pro-

ject. As a substitute the gas heat demand from the Heat Map has been used as a proxy.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Domestic aviation, LTO	P		1A3aii(i)	Inventory data and CORINE Land Cover 2012, code = '124 Airports'
International aviation, LTO	P		1A3ai(i)	Inventory data and CORINE Land Cover 2012, code = '124 Airports'
Domestic aviation, cruise	A		1A3aii(ii)	Great circle lines between airports
International aviation, cruise	A		EEZ	Even distribution on the Irish territory defined by the EEZ zone
Road transport, passenger cars	A		Road_PC	National emission inventory data for split on vehicle categories and on urban/rural/highway 2015 AADT and % Heavy Vehicles (HV) on the Irish National Road Network (Motorways, National Primary Roads and National Secondary Roads) from TII's National Transport Model OSi road network including all Irish roads Road traffic volumes from CSO Population density at county level Urban areas will be defined from Census2011_Settlements or from population density on small area level. Two-wheelers: like passenger cars as motor cycles are dominant and mopeds only a minor source
Road transport, light duty vehicles	A		Road_PC	
Road transport, heavy duty vehicles and buses	A		Road_HV	
Road transport, mopeds & motorcycles	A		Road_PC	
Road transport, gasoline evaporation	A		Road_PC	
Road transport, automobile tyre and brake wear	A		Road_PCHV	Sum of PC and HV
Road transport, automobile road abrasion	A		Road_PCHV	Sum of PC and HV
Railways	A		1A3c	Rail network and annual train passages
National navigation	A	Ferries Leisure crafts	1A3d	Ferry routes Coastal buffer zone: 6 nautical mile zone customised to include shortest path between headlands
International navigation	A		EEZ	Even distribution on the Irish territory defined by the EEZ zone
Pipeline transport	P/A	Gas transmission/ distribution Gas production	1A3e	Transmission/distribution: Total heat demand per gas distribution network Gas production: Site coordinates (Gas terminal near Midleton)

Fugitive emissions from fuels

The sector covers production, transport, storage and refining of solid, liquid and gaseous fuels, and venting and flaring associated with these activities.

Partly the emissions are available at plant level, and therefore it is possible to generate a GeoKey based on point source data. This is the case for coal mines and refineries.

The remaining emissions from area sources are not possible to allocate to each source, and spatial proxy data will be used to generate GeoKeys. Location of service stations and offshore wells, and data from the Heat Map are used as spatial proxy data.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Coal mining and handling	P		1B1a_Mining 1B1a_Handling	Coal mines, site location and site feature PS data for large scale coal consumers
Solid fuel transformation		Not occurring		
Other fugitive emissions from solid fuels		Not occurring		
Oil exploration, production and transport		Not occurring		
Oil refining and storage	P	One refinery	1A1b	ETS/PRTR
Distribution of oil products	A		1B2av	Location of service stations from CSO
Natural gas exploration		Currently included in production		
Natural gas production	A		1B2bii	Point source (Gas terminal near Midleton)
Natural gas processing		Currently included in production		
Natural gas transmission and storage		Currently included in distribution		
Natural gas distribution	A		1B2bv	Total heat demand per gas network from Heat Map
Venting		Currently not estimated or included elsewhere		
Flaring	P		1B2c	Point source

Industrial processes and product use

The emission sources from this sector cover a wide variety of different activities. For some of these activities the emissions can be distributed using point source data, while for others more generic spatial datasets have to be used. For some categories, the emissions are currently reported as Not Estimated (NE). Where possible a GeoKey has been assigned regardless to ensure the robustness of the spatial model to changes in the emission inventory.

Mineral industry

The sector covers source categories within mineral industry. Parts of the emissions are available at plant level and GeoKeys will be based on point source data.

The remaining emissions from area sources are not possible to allocate to each source, and spatial proxy data will be used to generate GeoKeys.

For storage, transport and handling of mineral products the GeoKey will be developed if time permits, based on the point source data available for the production of mineral products.

The table below shows the different source categories within mineral industry and the selected GeoKey. For each category there is a note explaining the current state of the activity in Ireland.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Cement production	P	Four plants	2A1	ETS/PRTR
Lime production	P	Two plants	2A2	ETS/PRTR
Glass production	P	Not occurring since 2009	2A3	ETS/PRTR
Ceramics	P	Not occurring since 2008	2A4a	ETS/PRTR
Other uses of soda ash	P	Currently one plant	2A4b	ETS
Other uses of carbonates	P	Mainly used at peat power plants	2A4d	ETS
Quarrying and mining of minerals other than coal	A	Currently not estimated	2A5a	Map of quarries from EPA
Construction and demolition	A	Currently not estimated	Buildings	GeoDirectory. Building use C, R and B (C=Commercial, R=Residential, B=Both)
Storage, handling and transport of mineral products	P	Currently not estimated		Based on the point source data for the sectors above an aggregated key could be made.
Other mineral products	A	Production of bricks and asphalt. No information available on exact locations	HeatDemand_Industrial	Industrial heat demand

Chemical industry

The sector covers source categories within chemical industry. Ammonia and nitric acid production, which has ceased more than 10 years ago, were point sources and GeoKeys can be based on plant level data.

The only source still occurring is storage, handling and transport of chemical products, which include emissions from storage and handling of fertilisers. Spatial proxy data will be used to generate a GeoKey for this source. The project team has been in contact with Teagasc to investigate the availability of information to allow for a spatial distribution, but without any result.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Ammonia production	P	Not occurring since 2004	2B1	PS data/inventory
Nitric acid production	P	Not occurring since 2003	2B2	PS data/inventory
Adipic acid production		Not occurring	Not considered relevant	

Source category	P/A	Note	GeoKey	Geodata source and methodology
Caprolactam, glyoxal and glyoxylic acid production		Not occurring	Not considered relevant	
Carbide production		Not occurring	Not considered relevant	
Titanium dioxide production		Not occurring	Not considered relevant	
Soda ash production		Not occurring	Not considered relevant	
Petrochemical and carbon black production		Not occurring	Not considered relevant	
Fluorochemical production		Not occurring	Not considered relevant	
Chemical industry: Other		Not occurring	Not considered relevant	
Storage, handling and transport of chemical products	A	Fertiliser	CropImpGrass	LPIS, cropland and improved grassland

Metal industry

The sector covers source categories within metal industry. All relevant sources, including iron and steel production and aluminium production, which has ceased more than 10 years ago, and ferroalloys production are point sources and GeoKeys will be based on plant level data.

For storage, transport and handling of metal products the GeoKey will be developed if time permits, based on the point source data available for the production of metal products.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Iron and steel production	P	Not occurring since 2002	2C1	PS data/inventory
Ferroalloys production	P		2C2	PS data/inventory
Aluminium production	P	Not occurring since 2007	2C3	PS data/inventory
Magnesium production		Not occurring		
Lead production		Not occurring		
Zinc production		Not occurring		
Copper production		Not occurring		
Nickel production		Not occurring		
Other metal production	P	Wide variety of production, but few plants left in operation	2C7c	PS data/inventory
Storage, handling and transport of metal products	P	Currently not estimated		

Non-energy products from fuels and solvent use

The sector covers a variety of product and solvent use.

When emissions are available at plant level, GeoKeys will be based on point source data.

GeoKeys for the remaining area sources will be based on different proxy data, e.g. road transport data, buildings and population.

For sources which include both point and area sources, a combined GeoKey will be created covering all emissions based on point source data and spatial proxy data.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Lubricant use	A	Considered mainly for road transport	Road_PCHV	Sum of PC and HV
Paraffin wax use	A	Considered as purely residential use	Population	CSO, Census2011 Small Areas
Urea used as a catalyst	A	Road transport, heavy diesel vehicles	Road_HV	Heavy vehicles
Domestic solvent use including fungicides	A		Population	CSO, Census2011 Small Areas
Road paving with asphalt	A		Road_PCHV	Sum of PC and HV
Asphalt roofing	A	Currently not estimated	Buildings	GeoDirectory, all buildings
Coating applications	A	Paint application in various subsectors	Population	CSO, Census2011 Small Areas
Degreasing	P	Mainly metal degreasing	2C7c	Data from metal industry
Dry cleaning	A	Data available through the reporting for the solvents directive	2D3f	County level data from inventory
Chemical products	A	Main source is pharmaceutical production covered by IPPC. However, as the coverage is very low, it has not been used	2D3g_ChemicalProd	AS: Industrial heat demand
Printing	A	Emissions partly covered by IPPC. However, as the coverage is very low (6/100) it has not been used	Industry	AS: Industrial heat demand
Other solvent use		Currently not estimated		

Electronics industry

The only relevant source in this sector is integrated circuit or semiconductor production, and a GeoKey will be prepared from the point source data from the national emission inventory.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Integrated circuit or semiconductor	P	Two plant operators	2E1	Emission inventory data
TFT flat panel display		Not occurring		
Photovoltaics		Not occurring		
Heat transfer fluid		Not occurring		
Other		Not occurring		

Product uses as substitutes for ODS

The sector covers sources where fluorinated gases (HFCs and PFCs) are used, with the main source being refrigeration and air conditioning. No point source data are available and all GeoKeys will be based on spatial proxy data like building data, road transport data and population data.

Currently, all emissions associated with refrigeration are reported together under commercial refrigeration. This means that the emissions include commercial, domestic, industrial and transport refrigeration. With the data available, the assumption is that the best available spatial proxy is population density. This should accurately describe domestic refrigeration and to some extent also commercial refrigeration as these tends to be more frequent in densely populated areas. Emissions from industrial and transport refrigeration are less accurately described by the use of population as a proxy, but no better spatial data has been identified.

Similar, the GeoKey for stationary air conditioning is based on commercial buildings from GeoDirectory, as domestic air conditioning is very limited.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Commercial refrigeration	A		Population	CSO, Census2011 Small Areas
Domestic refrigeration		Emissions included under commercial refrigeration		
Industrial refrigeration		Emissions included under commercial refrigeration		
Transport refrigeration		Emissions included under commercial refrigeration		
Mobile air-conditioning	A		Road_PCHV	Sum of PC and HDV
Stationary air-conditioning		Emissions included under commercial refrigeration	Buildings_Commercial	GeoDirectory, commercial buildings
Foam blowing agents		Not occurring		
Fire protection	A		HeatDemand_Industrial	Assuming that halogenated fire extinguishing is only used in larger industries
Aerosols	A	Inhalers and aerosols	Population	CSO, Census2011 Small Areas
Solvents		Not occurring		
Other applications		Not occurring		

Other product manufacture and use

The sector covers a variety of product manufacture and use covering both greenhouse gases and air pollutants. No point source data are available and all GeoKeys will be based on spatial proxy data, e.g. building data and population data.

It has not been possible at this stage to obtain data from ESB regarding the location of transformers to qualify the spatial allocation of emissions of SF_6 used in electrical equipment. Therefore the emissions will be distributed over the land area.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Electrical equipment	A	High voltage transformers	LandArea	It has not been possible to obtain spatial data on the locations of high voltage switchgear. The emissions are allocated evenly to the land area
Soundproof win-	A		Buildings	GeoDirectory, all buildings

Source category	P/A	Note	GeoKey	Geodata source and methodology
dows				
Adiabatic properties: shoes and tyres	A	Use in shoes	Population	CSO, Census2011 Small Areas
Medical applications (SF_6)	A	Eye surgery – 10 hospitals	Hospitals	Hospitals based on data from Geofabrik, Open Street Map
Tracer in leak detection	A		LandArea	As locations of use are not known, the emissions are allocated evenly to the land area
Medical applications (N_2O)	A	Anaesthesia	Hospitals	Hospitals based on data from Geofabrik, Open Street Map
Other product use	A	Mainly application of glues and adhesives and preservation of wood Tobacco use	2G3	NMVOC: Industrial heat demand and Other pollutants: population from CSO, Census2011 Small Areas

Other industrial processes

The sector covers a number of categories with limited contribution to total emissions. However, one exception is food and beverages production, where the emissions of NMVOC are significant.

It has not been possible at this stage to obtain data from ESB regarding the location of transformers to qualify the spatial allocation of emissions from leak from electrical equipment, so the GeoKey will be the land area of Ireland.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Pulp and paper industry		Not occurring	Not considered relevant	
Food and beverages industry	P/A		1A2e	Inventory data Industrial heat demand
Wood processing	A	Currently not estimated	Buildings_NonUrban	GeoDirectory, all buildings excluding urban areas from CORINE
Production of POPs		Currently not estimated	Not considered	
Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)		Currently not estimated	Not considered	
Other production, consumption, storage, transportation or handling of bulk products	A	Leaks from electrical equipment	LandArea	It has not been possible to obtain spatial data on the locations of high voltage switchgear. The emissions are allocated evenly to the land area

Agriculture

The sector covers emissions from enteric fermentation, manure management, agricultural soils, liming, and use of fertilisers and urea.

Locations of the main part of pig and poultry houses are available and will be used to create GeoKeys in combination with data from the agricultural census to include the remaining animals. GeoKeys for other animal categories will be based on data from the agricultural census.

Emissions from agricultural soils are area sources and GeoKeys will mainly be based on information in LPIS.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Dairy cattle	A		3B1a	Agricultural census, Dairy cows
Non-dairy cattle	A		3B1b	Agricultural census, Other cows
Sheep	A		3B2	Agricultural census, Sheep
Swine	P/A		3B3	Agricultural census, Pigs Location of pigs houses including animal numbers from UCD
Buffalo		Not occurring		
Goats	A		3B4d	Agricultural census, Goats
Horses	A		3B4e	Agricultural census, Horses and ponies
Mules and asses	A		3B4f	Agricultural census, Mules, jennets and asses
Laying hens	P/A		3B4gi	Agricultural census, Laying stock and Breeding birds Location of poultry houses including animal numbers from UCD for licenced laying hens houses and unlicensed poultry houses
Broilers	P/A		3B4gii	Agricultural census, Table birds Location of poultry houses including animal numbers from UCD for licenced broilers houses and unlicensed poultry houses
Turkeys	A		3B4giv	Agricultural census, Other poultry Location of poultry houses including animal numbers from UCD for unlicensed poultry houses
Other poultry	A		3B4giv	Agricultural census, Other poultry Location of poultry houses including animal numbers from UCD for unlicensed poultry houses
Other animals	A	Deer, fur, fox. Fox not occurring since 2012	3B4h	Deer: Agricultural census Fur: inventory data
Inorganic N fertilizers	A		Cropland	LPIS, Cropland
Animal manure applied to soils	A		3Da2a	Cropland combined with animal numbers from the agricultural census
Sewage sludge applied to soils	A		Cropland	LPIS, Cropland
Other organic fertilisers applied to soils	A	Currently not estimated	Cropland	LPIS, Cropland
Urine and dung deposited by grazing animals	A		Grassland	LPIS, Grassland improved, Grassland unimproved and Grassland natural
Crop residues	A		Cropland	LPIS, Cropland

Source category	P/A	Note	GeoKey	Geodata source and methodology
Mineralization/immobilization associated with loss/gain of soil organic matter	A		CropGrass	LPIS, cropland and grassland
Cultivation of organic soils (i.e. histosols)	A		3D1a6	Combination of LPIS (cropland, improved grassland, and un improved grassland) and soil map (organic soil types like peat, gley, bog, and swamp)
Atmospheric deposition	A		LandArea	
Nitrogen leaching and run-off	A		3D1b2	CORINE Land Cover, water bodies
Farm-level agricultural operations including storage, handling and transport of agricultural products	A	Currently not estimated	CropImpGrass	LPIS, cropland and improved grassland
Off-farm storage, handling and transport of bulk agricultural products	A	Handling of cereal grains	HeatDemand_Industrial	AS: Industrial heat demand
Cultivated crops	A	Currently not estimated	Cropland	LPIS, Cropland
Use of pesticides	A		Cropland	LPIS, Cropland
Field burning of agricultural residues	A	Not occurring	Cropland	LPIS, Cropland
Liming	A		CropGrass	LPIS, cropland and grassland
Urea application	A		Cropland	LPIS, Cropland

LULUCF

The sector covers sources related to land use change and forestry, all being area sources. GeoKeys will be based on CORINE Land Cover map. The only exception is harvested wood products, for which the GeoKey will be based on population density.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Forest	A		Forestry	CORINE
Cropland	A		Cropland	CORINE
Grassland	A		Grassland	CORINE
Wetlands	A		Wetland	CORINE
Settlements	A		Settlements	CORINE
Other land	A		Other	CORINE
Harvested wood products	A		Population	CSO, Census2011 Small Areas

Waste

The sector covers handling of waste, i.e. solid waste disposal, composting, incineration of waste without energy utilisation, and wastewater handling.

Parts of the emissions are available at plant level and GeoKeys will be based on point source data.

Composting and wastewater handling include both point and area sources and the GeoKey will be based on data for waste facilities and residential buildings, respectively.

Source category	P/A	Note	GeoKey	Geodata source and methodology
Solid waste disposal on land	P/A		5A	Inventory data
Composting	P/A		5B1	75 %: Licenced waste facilities (FacilityType = Composting/Anaerobic Digestion) 25 %: Residential buildings (annual variations of shares)
Anaerobic digestion at biogas facilities		Currently not estimated. Data available for sludge biogas at plant level	5B2	Inventory data
Municipal waste incineration		Not occurring (without energy recovery)		
Industrial waste incineration			5C1bi	Inventory data
Hazardous waste incineration		Included in industrial		
Clinical waste incineration		Not occurring since 1999	Hospitals	Hospitals based on data from Geofabrik, Open Street Map
Sewage sludge incineration		Not occurring		
Cremation		Currently four crematoria	5C1bv	Inventory data
Open burning of waste		Not estimated	Buildings_Residential_NonUrban	GeoDirectory, residential buildings excluding urban areas from CORINE
Domestic wastewater handling		A mix of emissions from WWTP and from septic tanks	5D1_N_2O 5D1_CH_4	N_2O: point source inventory data CH_4: Residential buildings outside sewered areas
Industrial wastewater handling		Included in domestic		
Other wastewater handling		Not occurring		
Other waste		Not occurring		

Annex 1 Identified spatial data sets (non-exhaustive list)

Sector	Priority	Data set	Parameters	Data provider	Use in model
General - Buildings	1	Buildings	Buildings address points, building use, building type	GeoDirectory	Yes
General - buildings	2	Buildings	Building footprint including type information for part of the buildings (e.g. agricultural, apartment, commercial, ferry-terminal, fuel_station, leisure, and residential)	OpenStreetMap, Geofabrik	No
General – coastline	1	Coastline	For the entire island	EPA GIS	Yes
General – coastline	2	Coastline	Coastline	OSi, Ireland's open data portal (data.gov.ie)	No
General - EEZ	1	Maritime boundaries	Exclusive Economic Zone (EEZ), Designated area	DCENR - Department of Communications, Energy and Natural Resources	Yes (modified)
General - Land use	1	Land use	Land use map (e.g. commercial, farmland, forestry, grassland, industrial, landfill, military, pasture, peat-cutting, port, residential, and wetland)	OpenStreetMap, Geofabrik	No
General - Land use	2	Natural	Land cover (forest, park, river bank and water)	OpenStreetMap, Geofabrik	No
General - Land use	2	Land cover	CORINE Land Cover 2012	European Commission, EEA	Yes
General – population	1	Population	Census2011 (aggregated by small areas) Population, permanent private housing, total housing stock	CSO	Yes
General - LPS	1	Point source data	Emissions and locations	EPA	Yes

Sector	Priority	Data set	Parameters	Data provider	Use in model
General - Heat demand	1	Heat Map	Heat demand for commercial, public, industrial and domestic sector per small areas. Further, heat demand per road, gas and water network.	SEAI	Yes
Mining	1	Mines	Sites, boundaries and spoil heaps	EPA GIS	Yes
Offshore	1	Offshore wells	Well class, operator, rig name, well status	DCENR - Department of Communications, Energy and Natural Resources	Yes
Road	1	Road network	Roads	OSi, Ireland's open data portal (data.gov.ie)	No
Road	1	Road transport	National roads, including AADT and % HV	TII	Yes
Road	2	Road network	All roads as both line and polygon shapefiles	EPA GIS	Yes
Road	2	Major roads network	Major roads	EPA GIS	Yes
Road	3	Road network	National roads	OSi, Ireland's open data portal (data.gov.ie)	No
Road	3	Road network	Road network with road classes for many roads	OpenStreetMap, Geofabrik	No
Rail	2	Railways	Railway network including type information. Many additional lines than in the OSi data set	OpenStreetMap, Geofabrik	No
Rail	2	Railways	Railway network. Main routes and a number of small networks (peat extraction)	EPA GIS	No
Rail	1	Railways	Railway network, route name and annual train passages	Irish Rail	Yes
Rail	3	Railways	Railway network (Irish Rail lines). Missing routes. No further information included	OSi	No
Navigation	1	Ferry routes	National and international ferry routes	Marine Institute	Yes
Navigation	2	Water ways	Rivers, canals, drains, streams and weirs	OpenStreetMap, Geofabrik	No
Navigation	2	WFD Water bodies	Coastal water bodies, transitional water bodies, lake waterbodies	EPA GIS	No

Sector	Priority	Data set	Parameters	Data provider	Use in model
Navigation	2	Fishing ports	Fishing ports, including tonnes of fish landed in 2012 (T2012)	MIDA	Yes
Navigation	2	Commercial ports	Commercial ports, including type of trading, vessels arrivals 1999-2012, and tonnage goods handled (2000-2012)	MIDA	No
Navigation	2	Territorial and Fisheries Limits (INSLimitsWgs)	Including 12 nautical mile territorial limit, 6 nautical mile limit, and Exclusive Fisheries Limit (200 nautical miles)	MIDA	No
Navigation	3	Ferry stations	Location, name	OSi, Ireland's open data portal (data.gov.ie)	No
Navigation	3	Main harbours	Location, name	OSi, Ireland's open data portal (data.gov.ie)	No
Navigation	3	Ferry ports	Local ferry ports including frequency for most routes	MIDA	Yes
Service stations	1	Service stations	Address list for service stations	CSO	Yes
Agriculture	1	LPIS	Land parcel identification system, including IPCC category and crop description(e.g. permanent pasture, , and building)	EPA (Ireland Department of Agriculture, Food and Rural Development)	Yes
Agriculture	1	Poultry and pig houses	Location of licensed and unlicensed poultry and pig houses and animal numbers	UCD	Yes
LULUCF	1	Soils	Soil types following the IFS soil categories (see *EPA Soil & Subsoil Mapping-Outline Procedure Document (Version 1.2)*)	EPA GIS	Yes
Waste	1	Licensed facilities	IPPC and waste facilities	EPA GIS	Yes
Waste water	1	Sewered areas	Waste water treatment plants catchment areas	EPA GIS	No
Waste water	1	Urban waste water treatment plants (UWWTPlants)	Location and treatment type (primary, secondary, tertiary N, tertiary N&P, tertiary P)	EPA GIS	Yes