

Lyons, Sean; Mayor, Karen; Tol, Richard S. J.

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Environmental accounts for the Republic of Ireland

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Environmental Accounts for the Republic of Ireland:
1990-2005

Sean Lyons^a, Karen Mayor^a and Richard S.J. Tol^{a,b,c,d}

Corresponding Author: Karen.Mayor@esri.ie

^a The Economic and Social Research Institute, Whitaker Square, Sir John Rogerson's Quay, Dublin 2, Ireland

^b Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands

^c Department of Spatial Economics, Vrije Universiteit, Amsterdam, The Netherlands

^d Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA, USA

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Environmental Accounts for the Republic of Ireland: 1990-2005

1. Introduction

Environmental accounts provide information on emissions and resource use. Environmental accounts are so-called satellite accounts to the national accounts, which provide a comprehensive framework to present economic data in a coherent, consistent, and internationally comparable manner. Environmental accounts are specifically designed to reveal the pressure the economy puts on the environment, and are therefore an essential input to policy analysis and design (Nordhaus and Kokkelenberg, 1999).

The Economic and Social Research Institute (ESRI) has been commissioned by the Environmental Protection Agency (EPA) to design and build a sustainable development model for Ireland (ISus) that will forecast environmental emissions and resource use for the Republic of Ireland up to 2030. The ISus model is driven by the HERMES model, which projects economic production and consumption per sector (e.g., Fitz Gerald *et al.*, 2002). As with any such model, data are the starting point for the development of ISus (O'Doherty and Tol, 2007). These data are gathered in the environmental accounts.

The Central Statistics Office has previously published environmental accounts for the Republic of Ireland (CSO, 2007), drawing on earlier work by Bacon (1981), Scott (1999), Curtis (2001) and Eakins and Curtis (2003). The theory goes back to Nordhaus and Tobin (1972) and Weitzman (1976). However, the CSO environmental accounts cover only six emissions to air and omit resource use altogether; the CSO environmental accounts are limited to the period 1994-2005; and the CSO environmental accounts reallocate some emissions from power generation to electricity users, on the basis of an unspecified method. It was therefore decided to develop new environmental accounts for the Republic of Ireland that (a) cover more emissions and resource use; (b) cover the period 1990-2005; and (c) relate to production without corrections for intermediate deliveries. The results are presented here.

Raw data on the environment can be difficult to accommodate in economic models. Environmental accounts are designed to 'measure objectively and consistently how

environmental functions contribute to the economy and subsequently, how the economy exerts pressures on the environment' (Pedersen and de Haan, 2006, 20). A System of Environment and Economic Accounting (SEEA; United Nations *et al.*, 2003) was developed to provide an objective system for analysing the effect of the economy on the environment and vice versa. The SEEA aims to guarantee international comparability of environmental data. The environmental accounts presented are consistent with the SEEA, but still cover only a small fraction of the full environmental accounts.

The CSO environmental accounts for Ireland are limited to the emissions to air of six substances. This is a limited set compared to that of other European countries as can be seen from Table 1. The environmental accounts presented in this paper are new accounts for the Republic of Ireland and aim to cover more emissions and a longer time period. The environmental accounts presented are consistent with the SEEA, but still cover only a small fraction of the full environmental accounts. Particularly, expenditures on environmental protection, and the monetary value of pollution and resources is omitted.

Section 2 presents data sources and imputation methods. Section 3 discusses pertinent trends in the observation. Section 4 concludes.

2. Data

Gathering the necessary data was the starting point for the compilation of the national environmental accounts. Ireland has a poor history in environmental data reporting but has improved in recent years. The quality and detail of the available data is, however, still variable and the emissions of certain pollutants still go unreported. We distinguish between 'high quality' data, which in general are reported annually in an international standard reporting format, and 'mixed quality' data, which tend to be available for only a limited number of years and to be based on a bespoke reporting format.

2.1. High quality data

Greenhouse gas and related emissions are taken from the Environmental Protection Agency, using the Common Reporting Format (CRF) for Ireland's submission to the

United Nations Framework Convention on Climate Change (EPA, 2007).¹ Table 2 specifies the concordances between the CRF and the nomenclature of economic activities (NACE), the reporting format on which the environmental accounts are based.

These emissions consist of the following pollutants: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), halofluorocarbons (HFC23, HFC32, HFC125, HFC134a, HFC143a, HFC152a, HFC227ea), perfluorocarbons (CF₄, C₂F₆, cC₄F₈) and sulphurhexafluoride (SF₆), sulphur dioxide (SO₂), oxides of nitrogen (NO_x), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOC). There is a full time series (1990 to 2005) for all of the emissions listed above.

Data on the emissions of ammonia (NH₃) are taken from Central Statistics Office's environmental accounts (CSO, 2007).² The time series covers 1994 to 2005. Data on the use of fungicides, herbicides, insecticides and other pesticides are taken from EuroStat.³ For fungicides, herbicides and insecticides, there are data available from 1992 to 2003 and for other pesticides from 1997 to 2003. All missing years are imputed from the available data. Imputed data follow from multiplying the observed economic activity level with the extrapolated emission factors. Emission factors are extrapolated using the median change in the observed emission factors. Data on the use of nitrogen fertiliser, phosphorous fertiliser, and potassium fertiliser are taken from the Department of Agriculture and Food (DAF, 2007).⁴ These uses are all attributed to the "agriculture, forestry, and fisheries" sector.

Data on the use of coal, peat, oil, natural gas, renewables, and electricity is taken from the energy balances of Sustainable Energy Ireland (SEI, 2006).⁵ The energy balances by and large follow the NACE classification.⁶

2.2. *Mixed quality data*

Water use data is taken from the Camp Dresser and McKee (2004) report for the Department of the Environment, Heritage and Local Government, which provides data on water use by sector of the economy for 2001. Eutrophying emissions are taken

¹ <http://unfccc.int/>

² <http://www.cso.ie/statistics/EnvironmentalAccounts.htm>

³ <http://epp.eurostat.ec.europa.eu/> / Environment and Energy / Agriculture and Environment.

⁴ <http://www.agriculture.gov.ie/index.jsp?file=publicat/compendium2006/listoftabs.xml>

⁵ <http://www.sei.ie/> Statistics Publications / Energy in Ireland

⁶ The only difference is the attribution of "Leather and leather products" to the textiles sector in NACE and the furniture sector in the energy balances. The "Leather and leather products" sector is a small sector and not very energy-intensive so this difference is disregarded.

from Scott (1999) and consist of biological oxygen demand (BOD), nitrogen (N), and phosphorous (P) emissions in 1994. Total emissions data was taken from the World Resources Institute (WRI) website and Scott (1999) was used to impute the regional breakdown.

The waste data in the Environmental Accounts are taken from the National Waste Reports published by the Environmental Protection Agency (EPA, 2005; le Bolloch *et al.*, 2006), and from the data collected when those reports were compiled.⁷ Although Ireland's waste data are improving, there is little historical time series information at a sectorally-disaggregated level. Even in cases where earlier years are available, compliance and reporting arrangements tend to have improved over time. As a consequence, for modelling purposes we have focused on the most recent year for which complete data are available for a given category of waste emissions (normally 2004 or 2005). The data (by NACE sector) distinguishes between the type of waste and its disposition. There are four disposal dimensions, namely, landfilled, incinerated, recovered (including recycled), and unknown disposition. We also use three categories for the type of waste: hazardous waste, biodegradable municipal waste and other waste.⁸

In some cases, we could not disaggregate the available data across all dimensions, so the categorisation needed to be simplified. For instance, the transport sector waste includes end-of-life vehicles and scrap metal. These are both assumed to be recycled. The services sector includes street cleansing waste and sludges from wastewater and drinking water services, all of which are presently assigned to the unknown disposition category.

All data can be found at:

<http://www.fnu.zmaw.de/fileadmin/fnu-files/publication/tol/EnvAcc02.xls>

2.3 *Missing data*

Although these environmental accounts are a thorough compilation of the available data on emissions and pollutants in Ireland, they are not exhaustive. Many of the limitations of the data outlined in the previous section could be dealt with by more systematic data collection and quality control. Having a more sectorally-disaggregated

⁷ Some reclassification was required from the industrial sector classifications used by the EPA for waste data to the ones we use, so we re-aggregated firm level data collected by the EPA into our sectors.

⁸ Other waste includes all waste that is not hazardous or biodegradable municipal waste.

dataset for all emissions would also be useful. However, the most important need is for information on a range of emissions for which quantities or dispositions are not presently known.

High quality data is by and large limited to emissions to air originating from energy use. Data on emissions to water are largely absent, as are observations on toxic chemicals and heavy metals. There is no data available on Persistent Organic Pollutants (POPs) in Ireland. POPs are chemicals that remain in the environment for long periods of time and can accumulate in the fatty tissue of organisms. These pollutants are contained in a variety of insecticides and pesticides but there is no published data relating to their existence or density in Ireland. Land use data is also scarce. Considering the rapid development of Ireland in the last decades, it would be an important variable to examine. It is also not possible to examine the potential effects on wildlife and the environment as well as the health effects on the population of endocrine disrupters as no data is available on their presence in Ireland.

There is also a lot of waste that is known to be generated but cannot be identified from the available data. Hazardous waste originating from the household sector, the services sector, the agricultural sector and transport cannot be identified. Only aggregate figures for hazardous waste are available, and these relate mainly to industrial sources. The proportion of waste that is allocated to the “unknown disposition” category (see Figures 21, 22, and 23) is significant. This is an unusual problem as it is possible to quantify the waste generated but not to locate it. Finally, data on agricultural waste is also problematic, with the method of disposition of organic agricultural waste being largely unknown and no data available on non-organic agricultural waste.

3. Results

The compilation of the environmental accounts, first, allows the identification of past trends in economic activity, in the emission of pollutants and in energy use by sector and, second, provides the basis for projections of future emissions and resource use. Figure 1 shows the composition of economic production in Ireland. Economic growth in the period 1990 to 2005 was dominated by growth in the services sector, and the production of chemicals, office equipment and electrical goods. Economic production across all sectors was two and a half times bigger in 2005 than in 1990. The following

section details how emissions and energy use have evolved over the period 1990 to 2005 compared to the economy.

3.1 High growth

A number of emissions have grown very fast over the period. Only one category (halocarbons) has grown faster than the economy, but the growth in energy use is also significant.

Figure 2 shows the composition of halocarbon emissions. The growth rate of emissions has been remarkable, particularly in the electrical goods sector. Chemicals and machinery are also significant contributors to emissions of halocarbon.

Figure 3 shows the composition of oil use. Transport and power generation are the dominant uses with residential use also steadily increasing. Oil consumption doubled between 1990 and 2005. Figures 4, 5 and 6 show the composition of the use of natural gas, renewable energy and electricity demand respectively, all of which more than doubled between 1990 and 2005. Natural gas has increased largely because of the growth in its use in power generation. The food and wood processing industries are the largest users of renewables, followed by households and power generation. Finally, the growth in electricity demand has been fastest in services and residential electricity consumption has also been growing steadily at 4% a year.

Figure 7 shows the origin of carbon dioxide emissions. Power generation is the largest single source of emissions. The closure of the old peat stations in 2001 is clearly visible on the graph. Transport emissions grew the fastest over the period, followed by non-metallic mineral production (cement) which is included in the construction sector. In 15 years the total amount of carbon dioxide emissions in Ireland grew by approximately 40%, which is a high growth rate compared to most other emissions but not as fast as the growth rate of the economy.

Figure 8 shows the use of pesticides. There is substantial variability (probably due to the weather), but a clear upward trend in the use of herbicides and insecticides. The agricultural and forestry industries are the only users of pesticides.

3.2 Constant

The following emissions have remained more or less constant between 1990 and 2005. Figure 9 shows the composition of the emissions of nitrogen oxides. Transport and power generation are the dominant sectors for these emissions. Figure 10 shows

the composition of ammonia emissions. Emissions from agriculture have fallen slightly, while the much smaller transport emissions have grown. So the overall trend is fairly constant over the period. Figure 11 shows the composition of methane emissions and Figure 12 shows nitrous oxide emissions. Both are mainly contributed by agriculture, and emissions of both are more or less constant, if not declining somewhat.

3.3 Decline

Despite the phenomenal economic growth experienced by Ireland over the period, emissions of certain pollutants fell due to changes in habits, legislation or substitute production methods. To give an example, emissions of nitrous oxide emissions (Figure 12) from the chemicals sector decreased substantially in 2003, due to the closure of *Irish Fertiliser Industries* in late 2002. Figure 13 shows the composition of sulphur dioxide emissions, which fell by more than half between 1990 and 2005. Emissions from power generation are most important, but less dominant than they used to be. Metal production, food and transport are sectors whose contribution to the emission of sulphur dioxide has fallen. Figure 14 shows the composition of carbon monoxide emissions. Transport is the main source, but emissions have fallen despite the growth in transport. Figure 15 shows the use of fertilisers, which declines very slowly. As with pesticides, fertilisers are used by the agriculture and forestry only. Figure 16 shows the composition of NMVOC emissions, which declined over the period and more steeply from the late 1990s. This is mostly due to a significant reduction in emissions from the transport sector and partly from the residential sector. Energy use as a whole has increased considerably since 1990, as seen by the trends above in the use of oil, natural gas and renewables. These increases have been partly compensated by falls in the use of other energy sources such as coal and peat. Figure 17 shows the composition of coal use, which is dominated by power generation. Coal use in services increased in the last five years of the period. The slight decline over time is largely due to a fall of home heating by coal. Figure 18 shows the composition of peat use, which is dominated by power generation and domestic use. Both decreased steadily over the period resulting in a 25% fall in the overall use of peat between 1990 and 2005.

3.4 Waste

There are no time series data for waste by sector. Figure 19 shows the origin of hazardous waste in 2001 and 2004. The total amount fell by 4%. Construction, chemicals, metal production and electrical goods are the largest sources. The amounts of hazardous waste generated by the chemicals and electrical goods sectors are increasing, while the amounts contributed by construction and metal production are falling.

Biodegradable municipal waste (BMW) is generated by services and the residential sector. The sectoral proportions remained broadly constant between 2002 and 2004, while the amount of BMW increased by 21% between these two years.

Figure 20 shows the origin of other waste in 2001 and 2004. The total amount grew by 16%. The output of waste grew in most sectors, but very fast in construction, which in 2004 was second only to agriculture.⁹

The next three graphs relate to the destination of different types of waste and how these changed between the two data points. Figure 21 compares the final destinations of hazardous waste in 2001 and 2004. In 2001, recovery was the most common method of disposal for hazardous waste followed by unknown destination and incineration. The change in 2004 is striking. Over half of hazardous waste is landfilled, followed by 23% for incineration and 22% for recovery. Figure 22 compares the final destinations of biodegradable municipal waste in 2002 and 2004. The structure of disposal remains largely the same, with landfill being the most popular method of disposal followed by recovery and unknown disposal. Between 2002 and 2004, the proportion of BMW waste being recycled rose from 21% to 31%. Finally, Figure 23 shows the final destinations of other waste in 2001 and 2004. Three quarters of other waste is designated as having an unknown destination. Most of this unknown segment relates to agricultural organic waste, much of which is presumably landspread. Recovery and landfilling represent 16% and 7% respectively of disposal in 2004.

4. Conclusions

We present new environmental accounts for the Republic of Ireland. The new accounts have a wider coverage than the CSO environmental accounts. Because the

⁹ The regulatory classification of organic agricultural waste has changed over time, but we enforce consistency by including it in the “other waste” category.

new accounts assign emissions and resource use to production, they can readily be used in economic models.

Emissions of carbon dioxide and particularly halocarbons have increased significantly between 1990 and 2005. Energy use has increased considerably, and there has been a marked shift away from coal and peat to oil and gas. Emissions of sulphur dioxide, carbon monoxide, and VOCs have fallen. Emissions of methane, nitrous oxide, oxides of nitrogen, and ammonia have stayed constant. Fertiliser use has declined slowly, but pesticide use has increased.

The omissions from the new accounts are informative too. Waste and water are typically listed among the major environmental issues in the Republic of Ireland. However, waste data are limited in time and in coverage. Water data, be it water use or emissions to water, are very limited. Land use data by sector are missing. Emissions to air are more complete, but the accounts exclude toxic chemicals and heavy metals. There are no data on expenditures on environmental protection. Because of these omissions, and because the data on the value of environmental damages and natural resources in Ireland is scarce, the new accounts do not allow for the estimation of the green net national product (Dasgupta and Maeler, 2000). These omissions need to be overcome in later versions of the environmental accounts.

Acknowledgements

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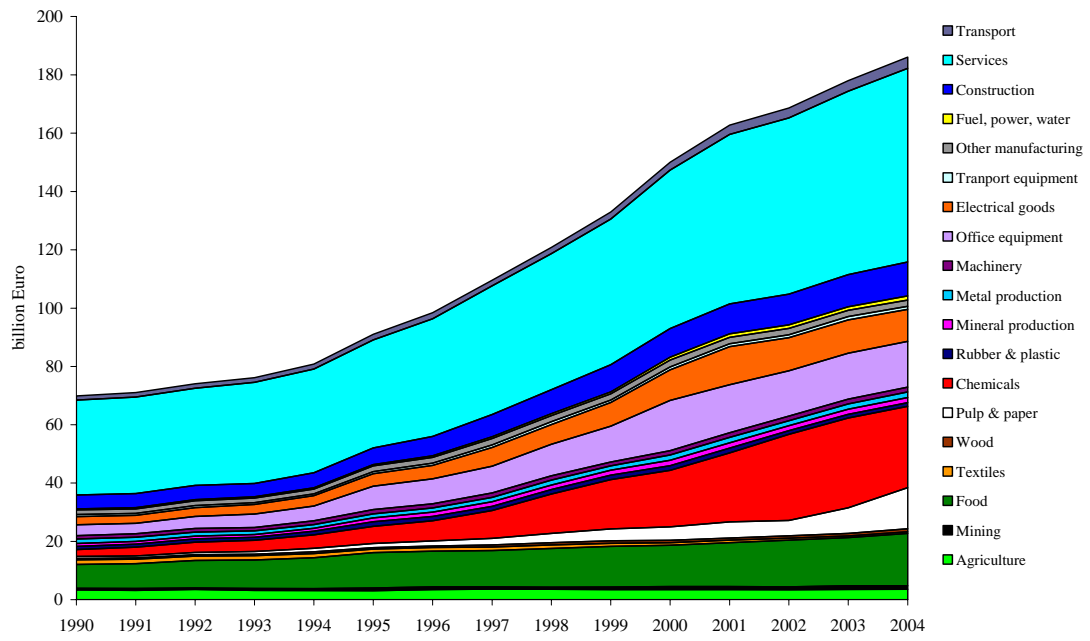


Figure 1: The composition of production in the Irish economy, 1990-2005

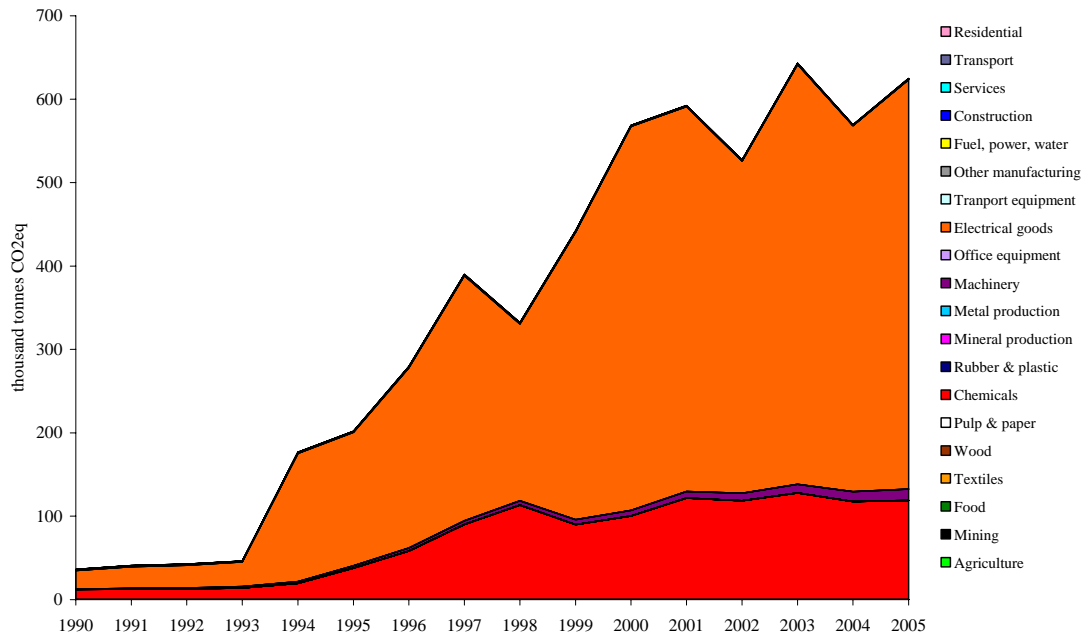


Figure 2: The composition of Irish halocarbon emissions, 1990-2005

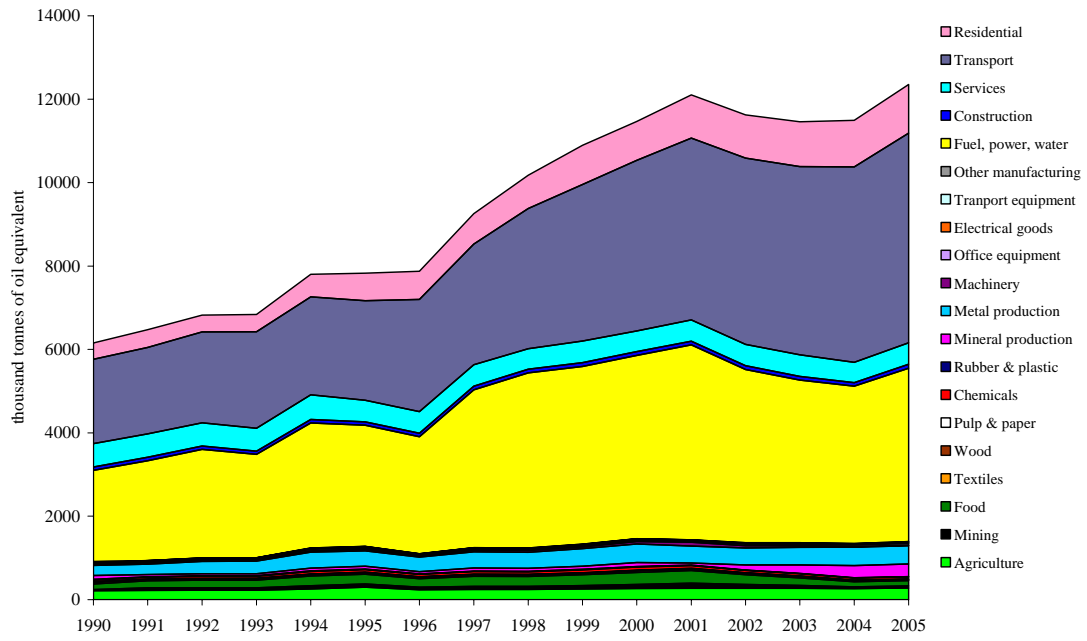


Figure 3: The composition of Irish oil use, 1990-2005

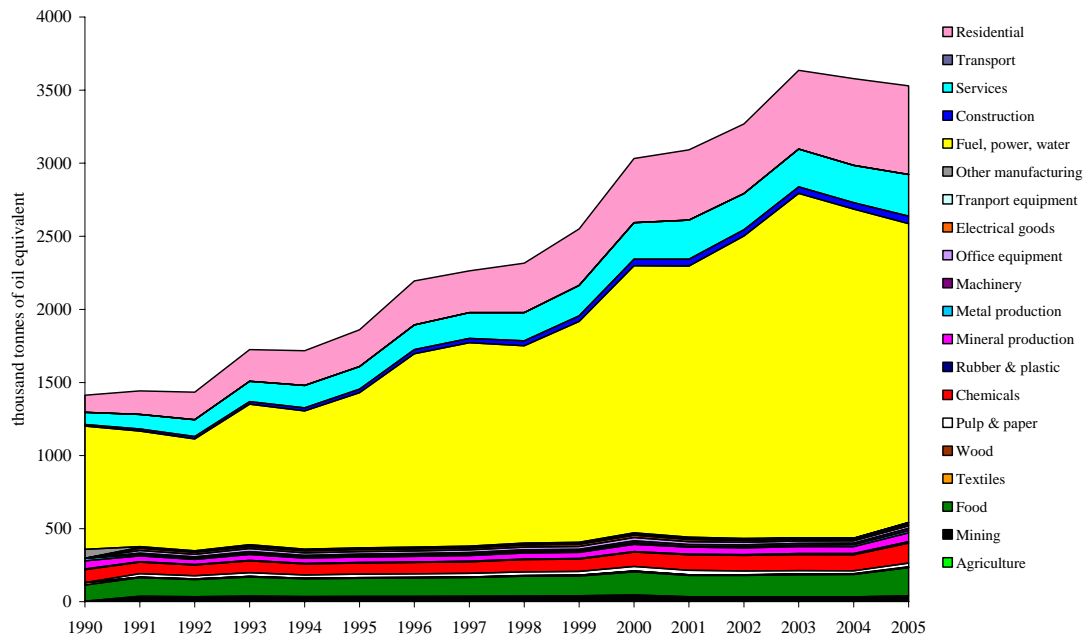


Figure 4: The composition of Irish natural gas use, 1990-2005

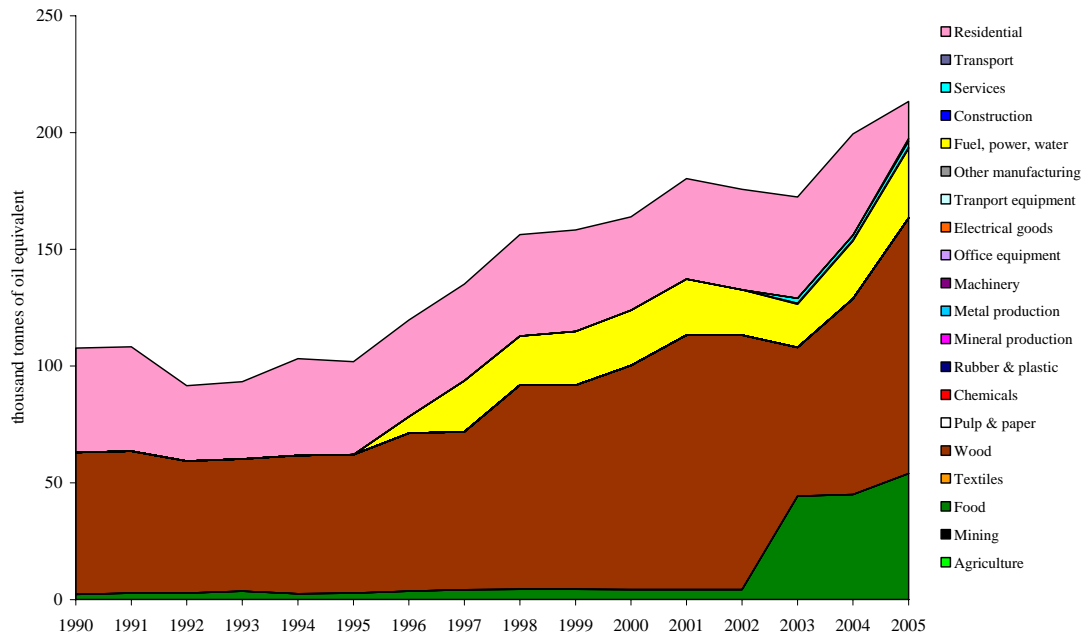


Figure 5: The composition of Irish renewable energy use, 1990-2005

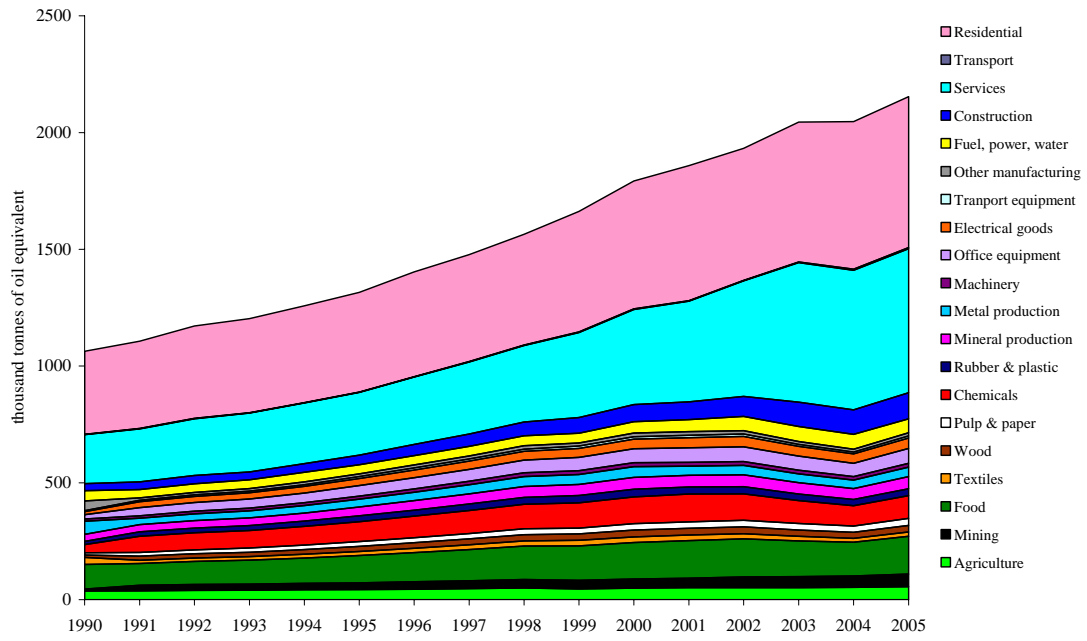


Figure 6: The composition of Irish electricity use, 1990-2005

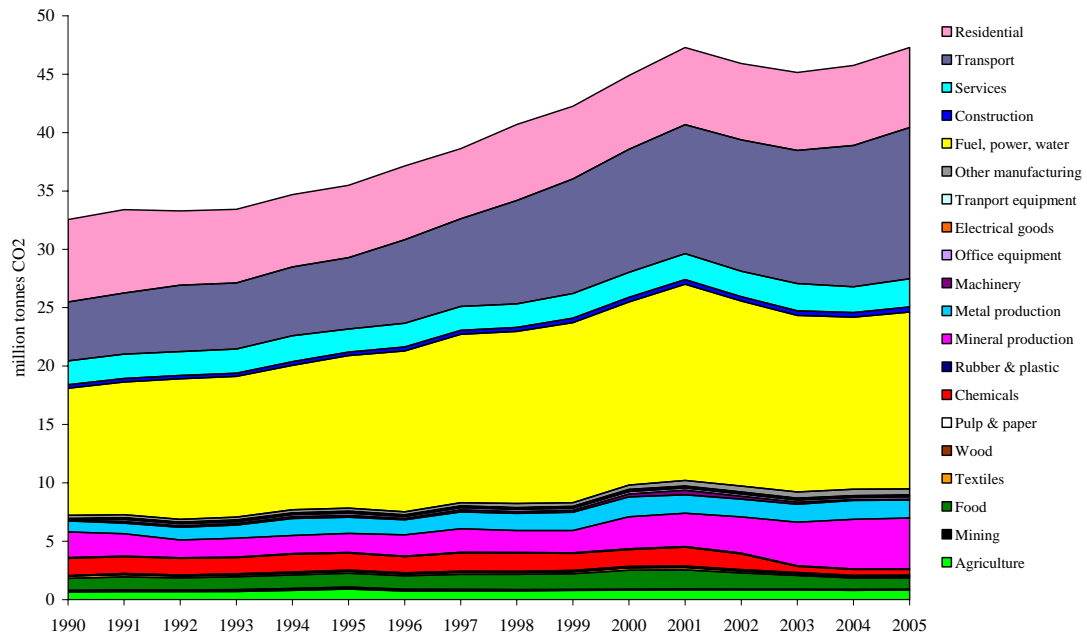


Figure 7: The composition of Irish carbon dioxide emissions, 1990-2005

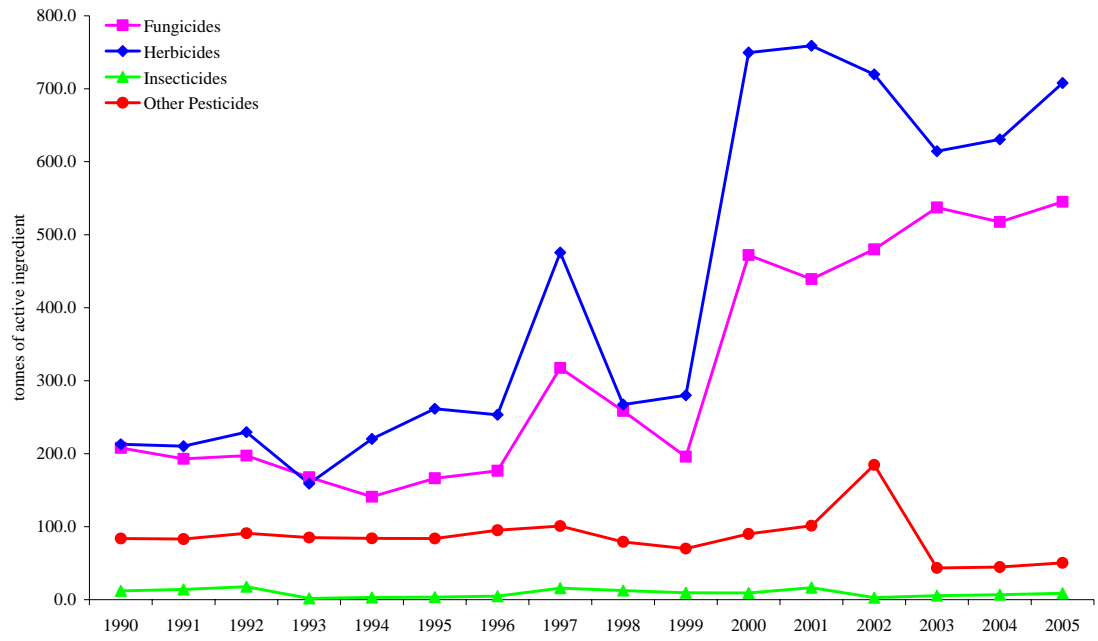


Figure 8: The use of pesticides in Ireland for 1990-2005

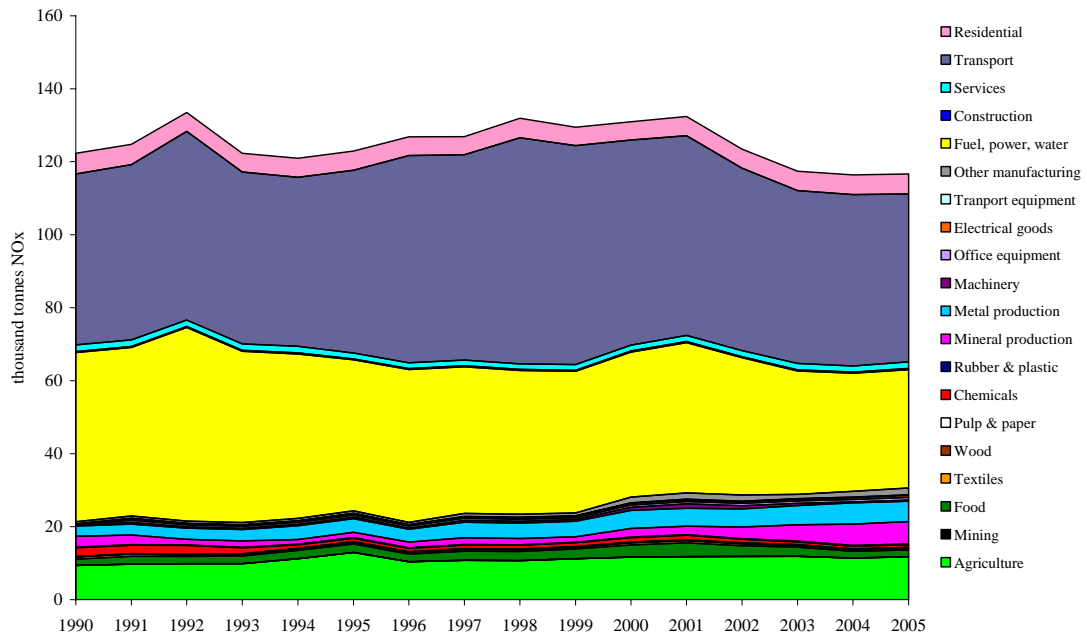


Figure 9: The composition of Irish nitrogen oxides emissions, 1990-2005

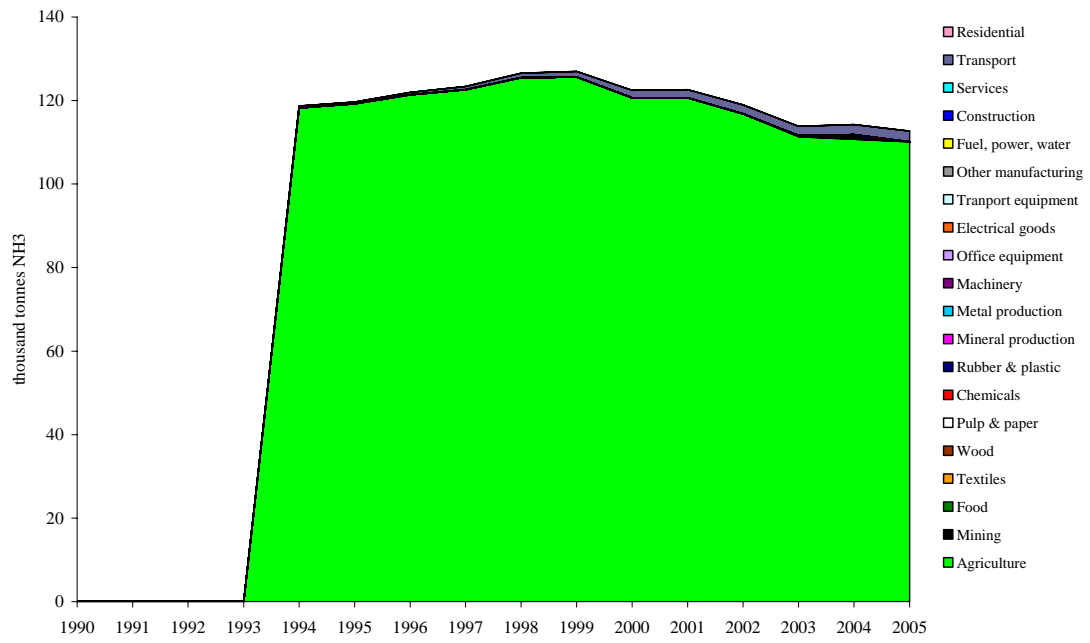


Figure 10: The composition of Irish ammonia emissions, 1994-2005

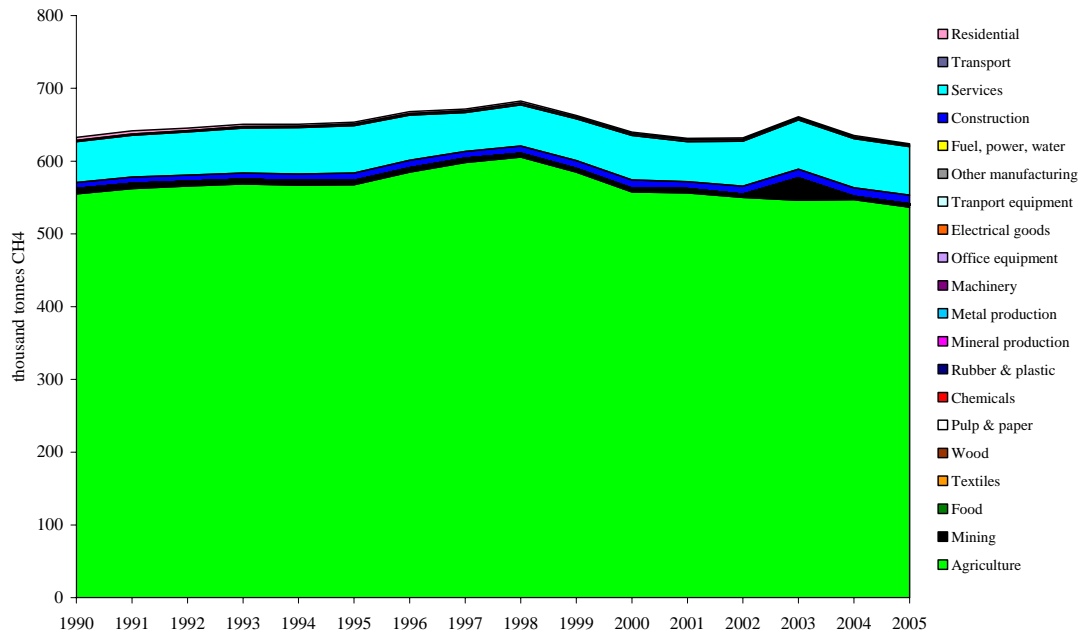


Figure 11: The composition of Irish methane emissions, 1990-2005

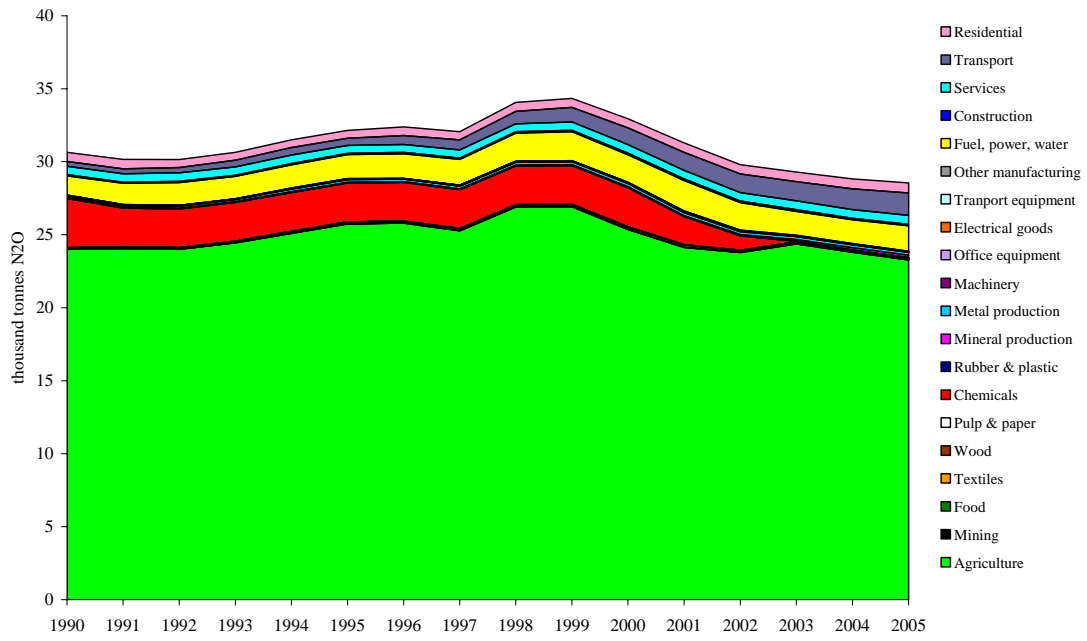


Figure 12: The composition of Irish nitrous oxide emissions, 1990-2005

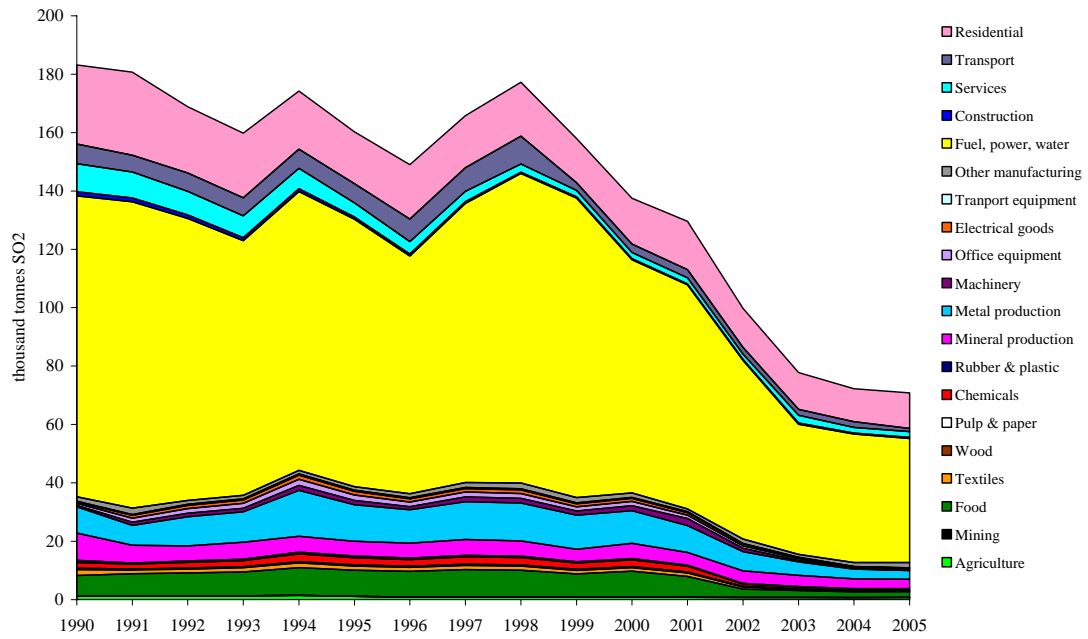


Figure 13: The composition of Irish sulphur dioxide emissions, 1990-2005

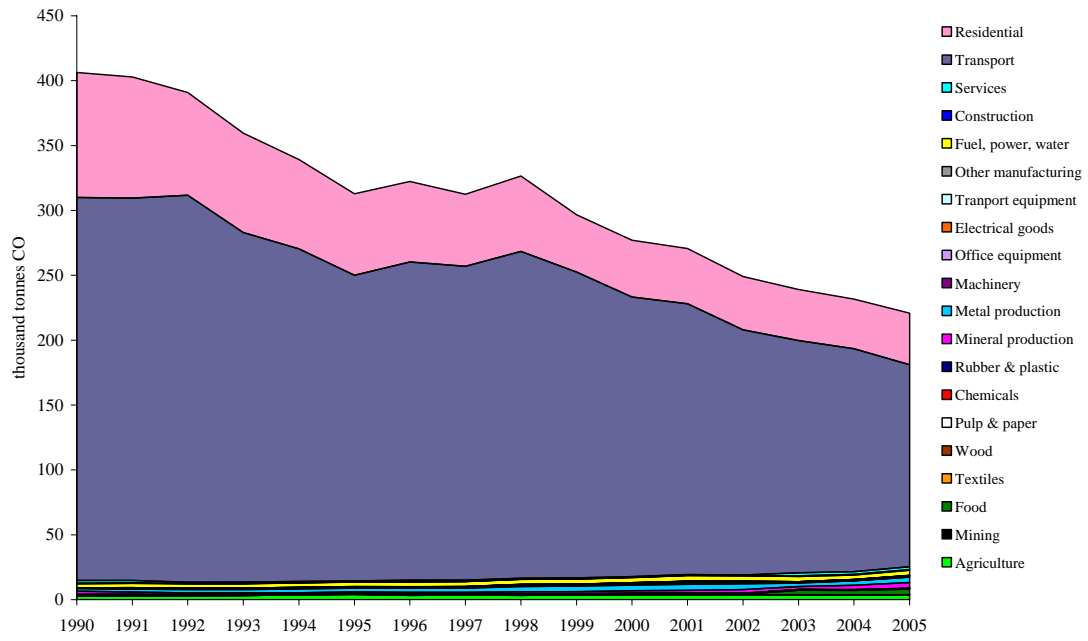


Figure 14: The composition of Irish carbon monoxide emissions, 1990-2005

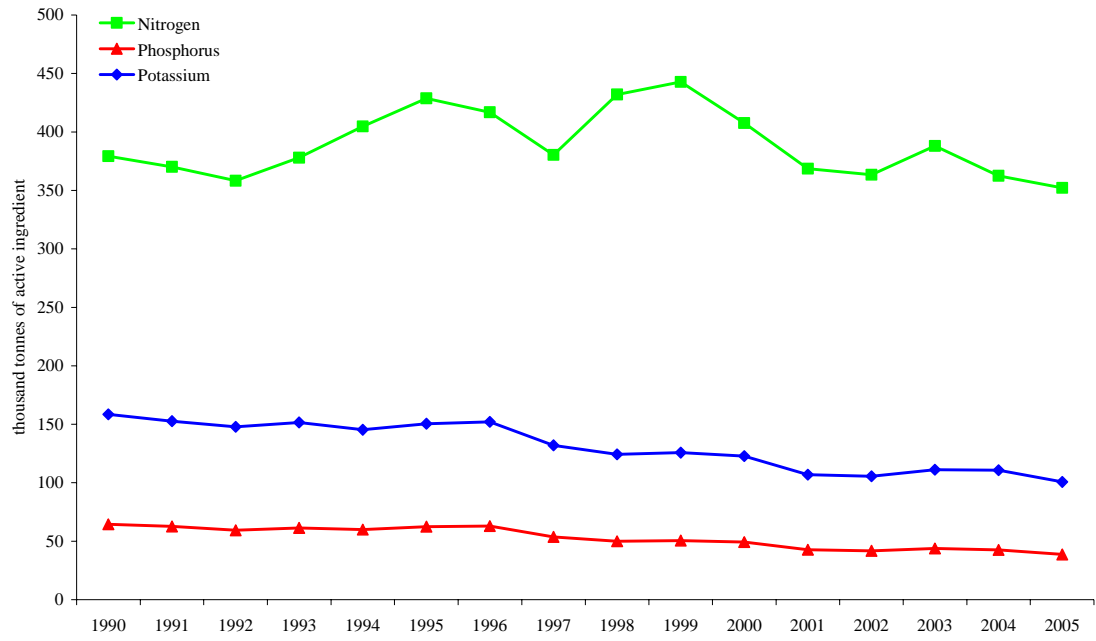


Figure 15: The use of fertilisers in Ireland for the period 1990-2005

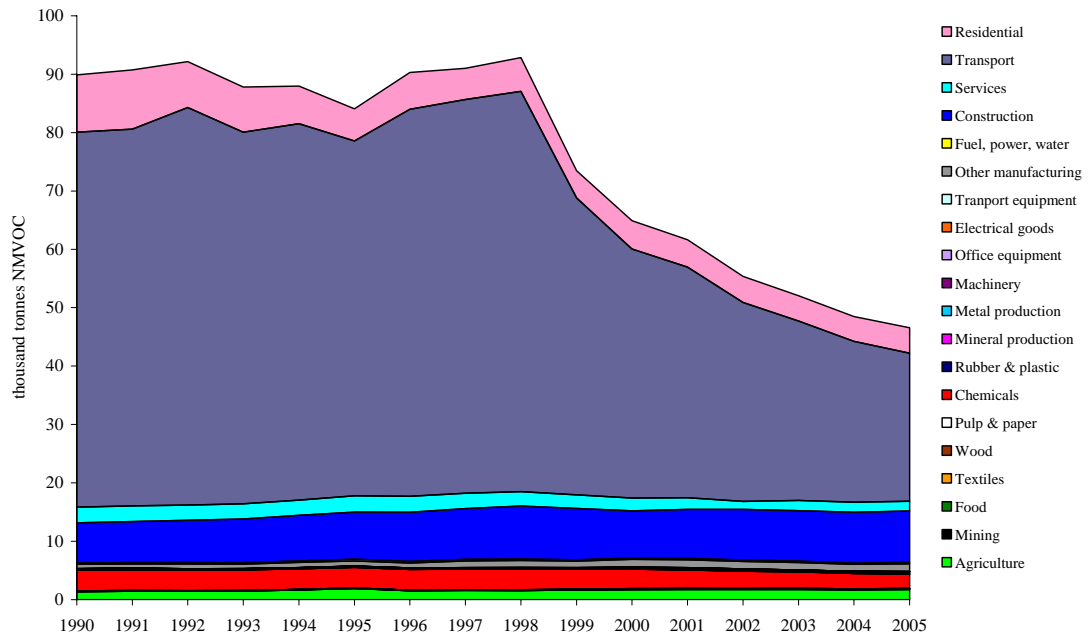


Figure 16: The composition of Irish non-methane volatile organic compound emissions, 1990-2005

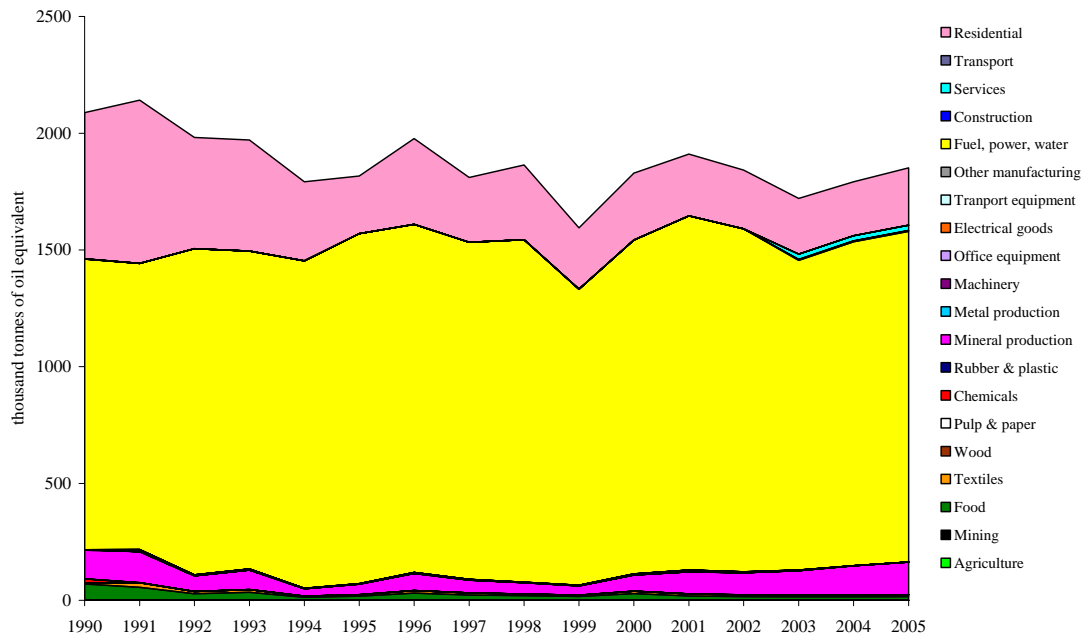


Figure 17: The composition of Irish coal use, 1990-2005

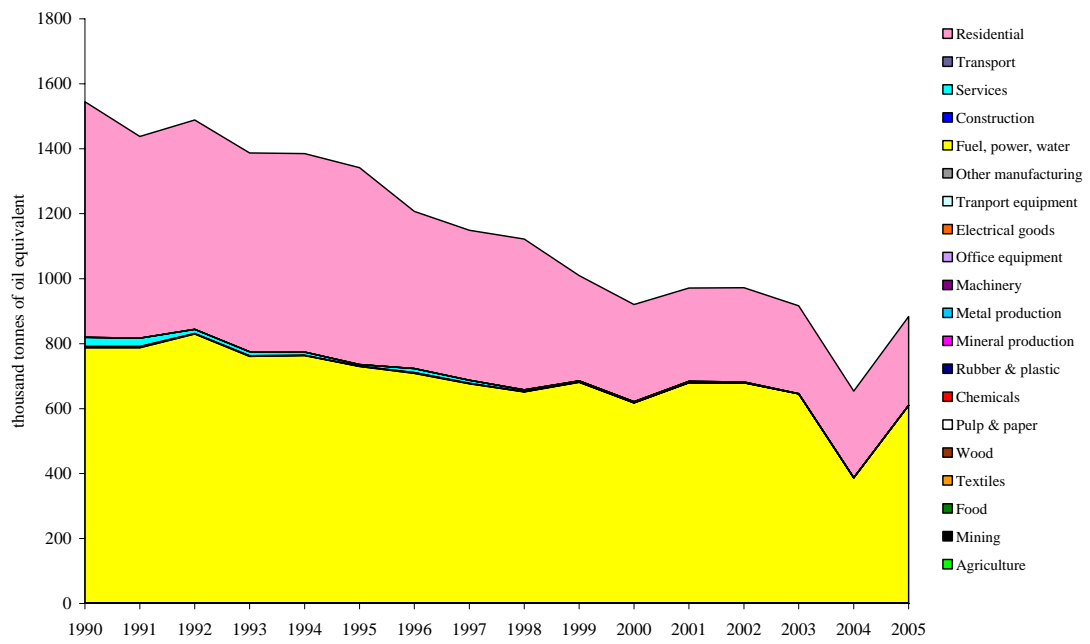


Figure 18: The composition of Irish peat use, 1990-2005

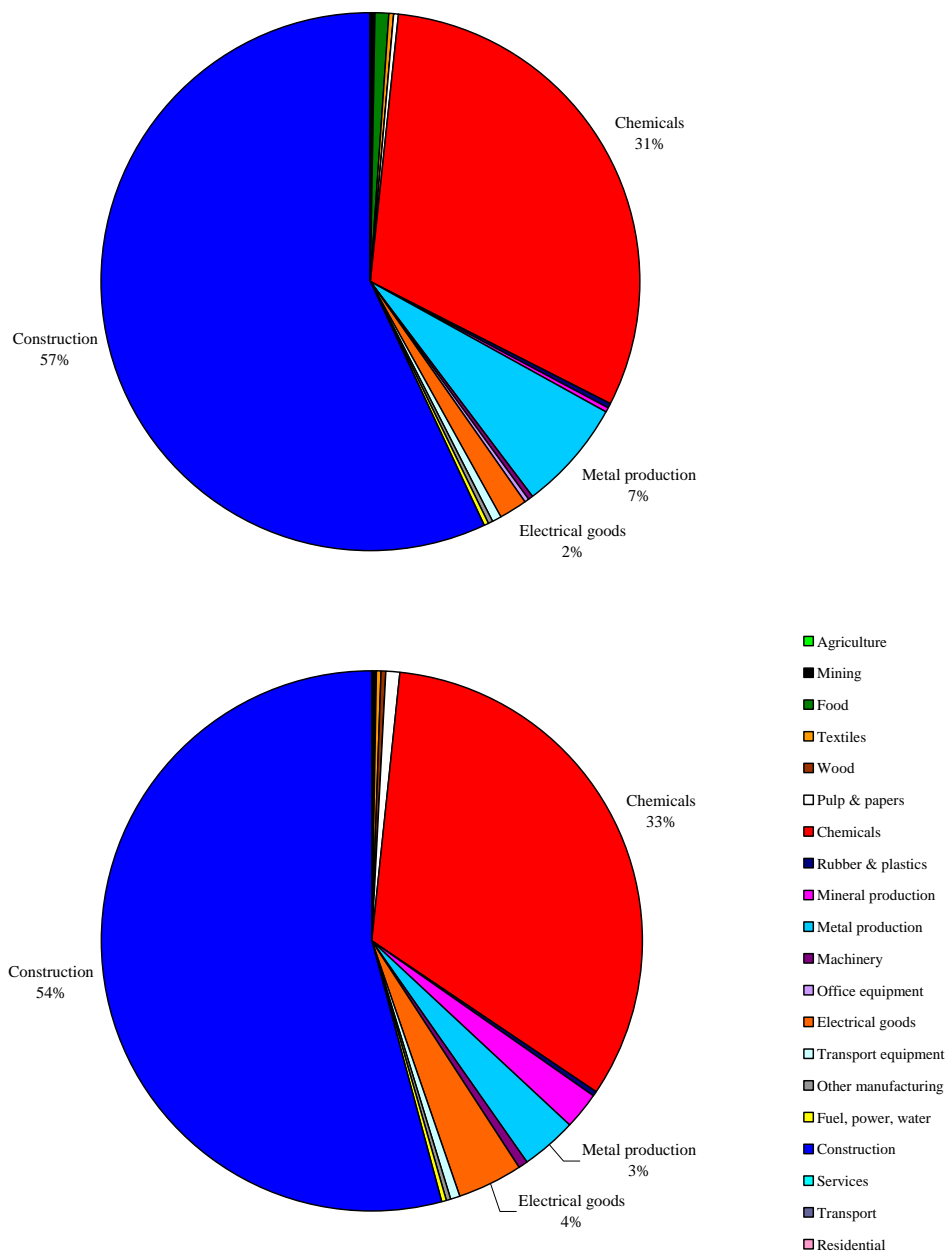


Figure 19: The sectoral origin of hazardous waste in Ireland, 2001 (top panel) and 2004 (bottom panel)

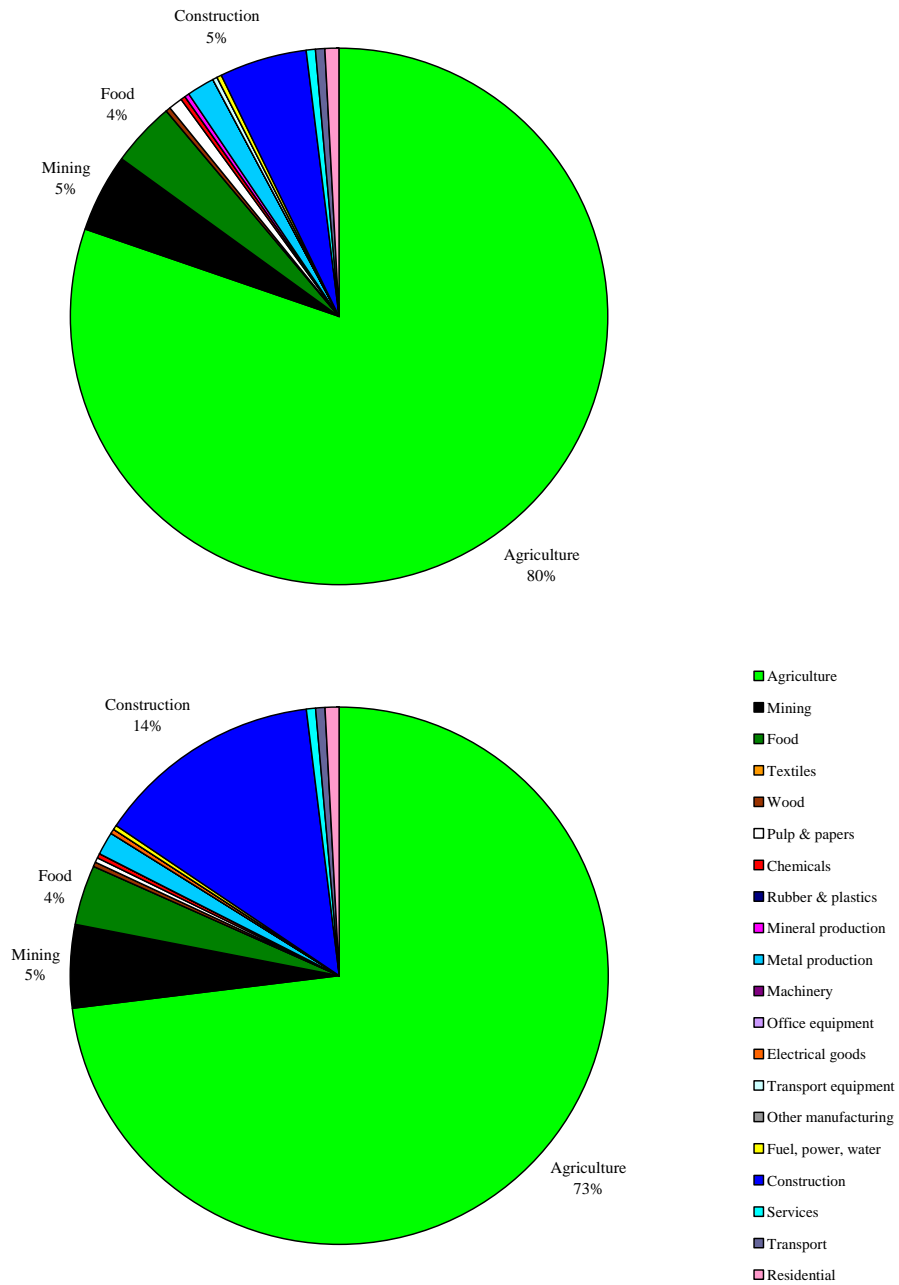


Figure 20: The sectoral origin of other waste in Ireland, 2001 (top panel) and 2004 (bottom panel)

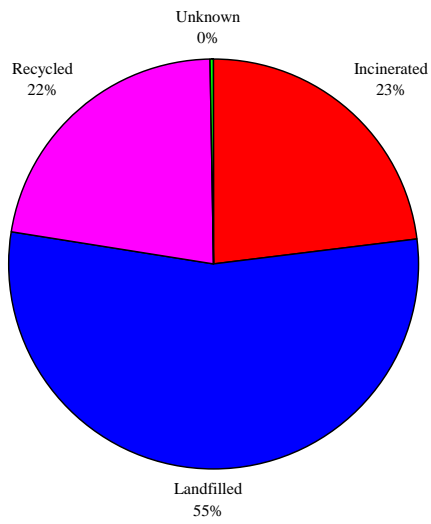
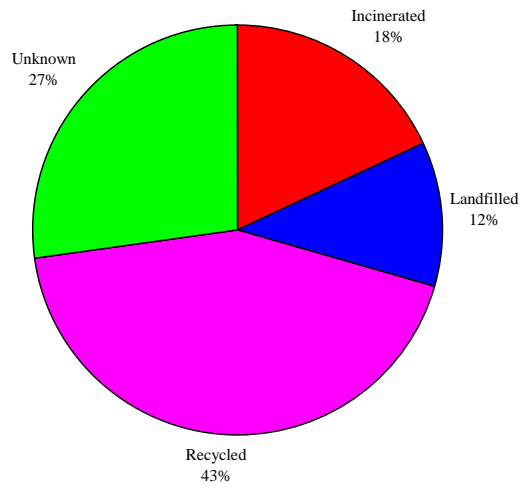


Figure 21: The destination of Irish hazardous waste, 2001 (top panel) and 2004 (bottom panel)

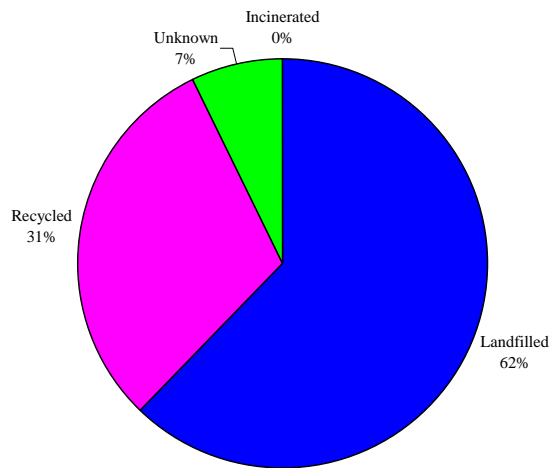
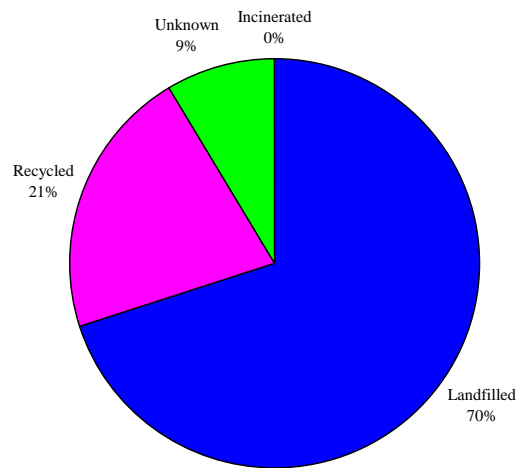


Figure 22: The destination of Irish biodegradable municipal waste, 2002 (top panel) and 2004 (bottom panel)

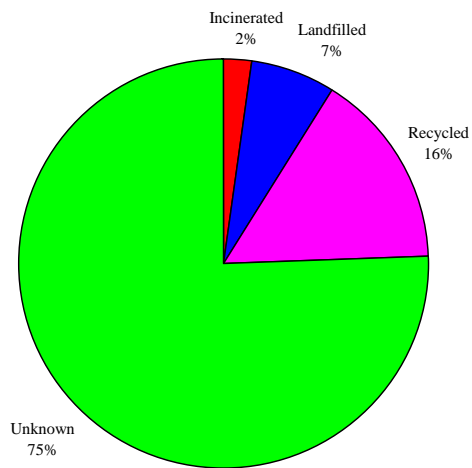
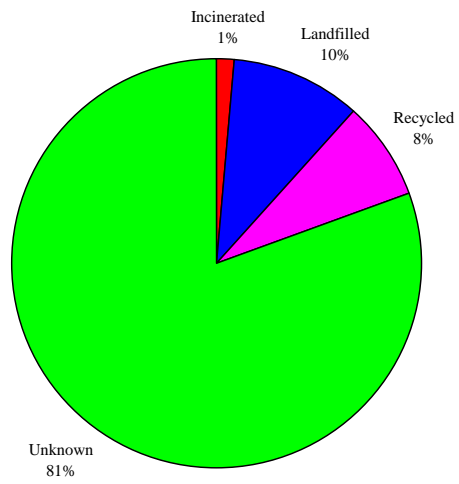


Figure 23: The destination of other waste in Ireland, 2001 (top panel) and 2004 (bottom panel).

Table 1: Comparison of the environmental accounts of selected countries

Country	Emissions	Resource use	Waste	Economics	Source
Ireland	CO ₂ , N ₂ O, CH ₄ , SO ₂ , NO _x , NH ₃	None	None	None	CSO (2006)
Brazil	CO ₂	Energy	None	None	Lenzen and Schaeffer (2004)
China	CO ₂ , NO _x , SO _x , NH ₃	Energy	Industrial waste	None	Ike (1999)
Japan	CO ₂ , N ₂ O, CH ₄ , HFCs, PFCs, CFCs, SF ₆ , SO _x , NO _x , NMVOC, NH ₃ , N, P	Energy	Industrial waste	None	Ike (1999)
Germany	CO ₂ , CO, SO ₂ , NO _x , PM, CH ₄ , N ₂ O, NMVOC	None	None	None	Tjahajdi <i>et al.</i> (1999)
Netherlands	CO ₂ , N ₂ O, CFCs, NO _x , SO ₂ , NH ₃ , P, N	Energy	Waste, wastewater	Environmental protection expenditures, taxes	Keuning <i>et al.</i> (1999)
Sweden	CO ₂ , SO ₂ , NO _x , NMVOC, NH ₃ , N, P	Energy	Industry, household, hazardous; landfilled, incinerated, recovery	Environmental protection expenditures	Hellsten <i>et al.</i> (1999)
UK	CO ₂ , N ₂ O, CFCs, HFCs, NO _x , SO ₂ , NH ₃ , black smoke, CO, NMVOC, Benzene, Lead	Energy	None	Environmental taxes	Vaze (1999)

Source: O'Doherty et al. (2007), pp. 48, Table 5.2.

Table 2: Concordance between the UNFCCC CRF and the NACE

CRF	Description	NACE	Description
1	Energy		
1A	Fuel combustion		
1A1	Energy industries		
1A1a	Public electricity and heat production	40-41	Fuel, power, water
1A1b	Petroleum refining	23,36-37	Other manufacturing
1A1c	Manufacture of solid fuels and other energy industries	23,36-37	Other manufacturing
1A2	Manufacturing industries and construction		
1A2a	Iron and steel	27	Metal production
1A2b	Non-ferrous metals	27	Metal production
1A2c	Chemicals	24	Chemical production
1A2d	Paper and print	21-22	Pulp, paper and print production
1A2e	Food processing, beverages and tobacco	15-16	Food, beverage, tobacco
1A2f	Other manufacturing	17-20,25-26,28-35	Emissions allocated on the basis of fuel use
1A3	Transport		
1A3a	Civil aviation	60-63	Transport
1A3b	Road transportation	60-63	Transport
1A3c	Railways	60-63	Transport
1A3d	Navigation	60-63	Transport
1A3e	Other transportation	60-63	Transport
1B	Fugitive emissions from fuels	10-14	Coal, peat, petroleum, metal ores, quarrying
	International bunkers		Not attributed
2	Industrial processes		
2A	Mineral products	26	Other non-metallic mineral products
2B	Chemical industry	24	Chemicals, chemical products and man-made fibres
2F	Consumption of halocarbons and SF ₆	31	Electrical machinery and apparatus nec
3	Solvent and other product use	24	Chemicals, chemical products and man-made fibres
4	Agriculture	1,2,5	Agriculture, forestry, fishing
5	Land-use, land use change, and forestry		Not attributed
6	Waste	90	Sewage and refuse disposal services, sanitation and similar services

Source: <http://unfccc.int/>

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