Emission Inventories for CO, NOx, SO_2, ozone, benzene and benzo(a)pyrene in New Zealand

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Foreword

Quantifying air pollution sources is crucial for developing effective measures to reduce emissions and improve air quality. This technical report on **carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO_2), ozone, benzene and benzo(a)pyrene** summarises what we currently know about the main sources of air pollutants in New Zealand towns and cities. Other reports in this series summarise monitoring concentrations and potential health effects.

Many councils have prepared emission inventories for urban areas in their regions and we now have a reasonable picture of the main emission sources. Domestic fires and vehicles contribute the greatest quantity of air pollutant in New Zealand, although industry can cause localised air pollution.

It is important to recognise that inventories are estimates of emissions from different sources. Usually they provide an averaged value for an area or whole airshed. Some of the inventories presented in this report are not directly comparable because different methodologies have been used. Despite this need to compare datasets cautiously, inventory information will assist in identifying sources and locations where action is required to reduce emissions. This report will also assist in developing appropriate national environmental standards for air quality.

I would like to thank all those councils and others that have contributed data and provided feedback.

Barry Carbon
Chief Executive
Ministry for the Environment

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Executive Summary

This report provides an overview of the sources contributing to emissions of carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO_2), precursors to ozone formation, benzene and benzo(a)pyrene (BaP) in New Zealand. The assessment is based on emission inventory studies that have been carried out by regional councils for most of the larger urban areas of New Zealand. An emission inventory provides a quantitative assessment of the amount of a particular contaminant emitted from selected sources. Estimates of emissions are based on information relating to the frequency and type of activity and the use of average emission rates or other emissions information applicable to the activity. Typical sources included in urban area inventories incorporate domestic solid fuel burning, motor vehicles and industrial emissions. In some emission inventory assessments of sources such as outdoor burning, lawn mowing, port, marine and rail activities and other activities have also been included. Natural sources are also a contributor to emissions of some contaminants, e.g. NO_2, and have been included in some inventory assessments.

Results of the emission inventories for CO indicate some differences between areas, although in general, motor vehicles and domestic home heating contribute the most CO emissions. Nitrogen oxide emissions primarily occur as a result of emissions from motor vehicles, and sources of SO_2 tend to be dominated by industry, or split between motor vehicles and domestic home heating in areas where industry is not prevalent.

Precursors to the formation of ozone include nitrogen oxides and volatile organic compounds. While motor vehicle emissions dominate the former contaminant, sources of VOC emissions are more variable. Domestic heating and motor vehicles tend to be dominant contributors, although in some areas natural vegetation sources and industry are dominant.

Only a limited number of emission inventories have included estimates for sources of benzene and benzo(a)pyrene. In these areas, benzene emissions tend to be dominated by motor vehicles and domestic home heating. Domestic heating is the dominant contributor to BaP emissions in both areas where inventories have included estimates for this contaminant. Similarly, monitoring data for Christchurch suggests that this source is likely to be the dominant contributor.

Limited information is available on trends in sources of emissions. Vehicle emissions projection data from the Ministry of Transport's NZTER emissions model indicates a decrease in tailpipe emissions of CO and NOx per vehicle with time. The extent to which this may result in a decrease in actual motor vehicle emissions over time, however, will also depend on changes in traffic volume. At this stage it is difficult to assess actual trends in sources of emissions as a second emission inventory assessment has only been carried out in a few locations and methodological differences between these inventories may complicate these comparisons. In the absence of additional regulation, emissions from industry and domestic heating could increase with growth in these sectors.

1 Introduction

This report provides an overview of sources of carbon monoxide (CO), oxides of nitrogen (NOx), sulphur dioxide (SO_2), ozone (O_3), benzene and benzo(a)pyrene (BaP) in New Zealand.

The assessment of sources of emissions of air contaminants is based on emission inventory studies that have been carried out by regional councils for most of the larger urban areas of New Zealand. An emission inventory provides a quantitative assessment of the amount of emissions of a particular contaminant from selected sources. Estimates of emissions are based on information relating to the frequency and type of activity as well as the use of average emission rates or other emissions information applicable to the activity. Typical sources included in urban area inventories incorporate domestic solid fuel burning, motor vehicles and industrial emissions. In some emission inventory assessments sources such as outdoor burning, lawn mowing, port, marine and rail activities and other activities have also been included. Natural sources are also a contributor to emissions of some contaminants, e.g. NO_2, and have been included in some inventory assessments.

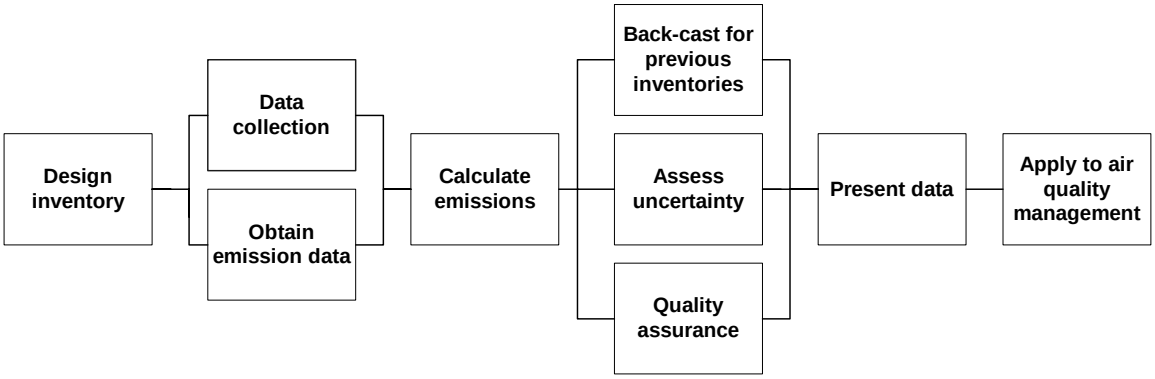
The emission inventories carried out in New Zealand have typically included an assessment of emissions of PM_{10}, CO, oxides of sulphur (SOx) as an indicator of SO_2, oxides of nitrogen (NOx) as an indicator of NO_2, volatile organic compounds (VOC) and carbon dioxide (CO_2). Some more recent inventories like Timaru, Nelson and Richmond, have included benzene, while the Timaru inventory also includes an estimate of BaP. Estimates of both benzene and BaP are flagged as indicative only in these inventories as there are high levels of uncertainty regarding emission factors for these sources.

Although no estimates of emissions of ozone are included in the inventories, the VOC and NOx data can be used for assessing potential sources of ozone, as both are precursors to ozone formation. The VOC data is collected specifically for this purpose and should exclude VOCs that do not impact on ozone, although there is some uncertainty surrounding the extent to which all emission factors account for this. Because of the impact of atmospheric chemistry in the formation of ozone, source assessments based on VOC and NOx emissions should be considered indicative only.

In addition to atmospheric chemistry, meteorology and topography also impact on the relationship between estimates of contributions to emissions and actual contributions to concentrations. The relative contribution of different sources to concentrations of contaminants across an area will depend on the temporal and spatial variations in sources and meteorology at different times of the day. It should also be noted that the inventory estimates represent an average across an area. The actual contribution to concentrations at any given point within that area will vary depending on proximity to sources and local meteorology.

To assist in the preparation of quality emission inventories, the Ministry for the Environment's Sustainable Management Fund funded the preparation of a *Good Practice Guide for Preparing Emission Inventories* in New Zealand in 2001 (Wilton, 2001a). The processes involved in preparing an emission inventory, as described in that report, are shown in Figure 1.1.

Figure 1.1: Overview of the process for preparing an emission inventory



Source: Wilton, 2001a.

2 Emission Inventories in New Zealand

A number of emission inventories have been carried out primarily in the urban areas of New Zealand since 1995. Table 2.1 summarises the most recent emission inventories carried out for different locations within New Zealand. This includes a summary of the sources and contaminants included in each inventory and some comments on the methodology employed. Readers should note that a new revised inventory for the Auckland region will be available shortly.

Table 2.1: Summary of the most recent emission inventories for New Zealand

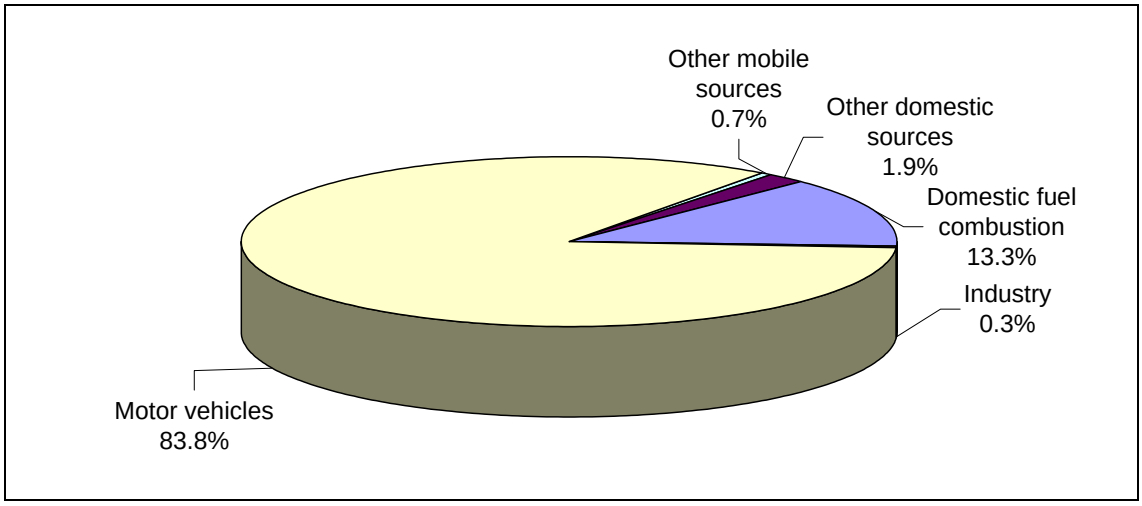
Location	Year	Sources	Contaminants	Output	Methodology
Auckland	1993	Transport, area, vegetation, industry	Particles, CO, NOx, SO_2, CO_2	t/ day	Grid square, wide range of sources, detailed data collection
Wellington	1998	Transport, industry, biogenic, domestic heating, burning and lawn mowing	PM_{10}, NOx, CO, CO_2, SO_2, NMVOC	t/ day	Grid square, wide range of sources, detailed data collection
Christchurch	1999	Motor vehicles, domestic heating, industry	PM_{10}, NOx, CO, CO_2, SO_2	kg/ winter's day	Limited spatial resolution, comprehensive data collection for major sources only
Timaru	2001	Motor vehicles, domestic heating, industry	PM_{10}, $PM_{2.5}$, CO, NOx, benzene, BaP, dioxin, SO_2, CO_2	kg/ winter's day	Comprehensive data collection for major sources only
Dunedin and 10 ORC urban areas	1999	Transport, domestic heating, industry	PM_{10}, NOx, CO, SO_2	kg/day	Detailed data collection for most sources, some limitations in motor vehicle emissions assessment
Hamilton, Tokoroa, Te Kuiti, Taupo	2001	Transport, domestic heating, industry	PM_{10}, CO, NOx, SOx, VOC, CO_2	kg/day	Detailed data collection, reliant on 1997 industry assessment
Nelson	2001	Motor vehicles, domestic heating, industry, outdoor burning	PM_{10}, $PM_{2.5}$, CO, VOC, NOx, benzene, SO_2, CO_2	kg/day	Comprehensive data collection for major sources only
Richmond	2000	Motor vehicles, domestic heating, industry, outdoor burning	PM_{10}, $PM_{2.5}$, CO, VOC, NOx, benzene, SO_2, CO_2	kg/day	Detailed data collection for most sources, some limitations in motor vehicle and outdoor burning emissions assessment
Gisborne	1996	Transport, area, industrial, agricultural, natural	TSP, SOx, NOx, VOC, CO, CO_2	t/ year	Screening approach to major sources, high potential for error
Bay of Plenty	1997	Transport, industry, domestic, pollen, agriculture, geothermal	TSP, SO_2, CO, NOx, H_2S, dioxins	t/ year	Screening approach to major sources, high potential for error
Northland	Non-specific	Motor vehicles, domestic heating, industry, agriculture	PM_{10}, CO, NOx, SOx, NMVOC, CO_2, N_2O, CH_4	t/ year	Detailed data collection for most sources, some screening methods used
Taranaki	1998	Motor vehicles, domestic heating, industry, farm animals, vegetation	PM_{10}, PM2.5, CO, NOx, VOC, BaP, CH4, N_2O, NMHC	t/ year	Screening approach to major sources, high potential for error

3 Carbon Monoxide (CO) Emissions

3.1 Auckland

Motor vehicles contribute the majority of the CO emissions in Auckland, with the 1993 inventory indicating that around 84% are likely to be attributable to this source overall (Figure 3.1). In any location however, the relative contribution from different sources will depend on factors such as proximity to roadways. For example, monitoring in areas such as Queen Street or Khyber Pass Road is likely to represent an even greater proportion of motor vehicle emissions.

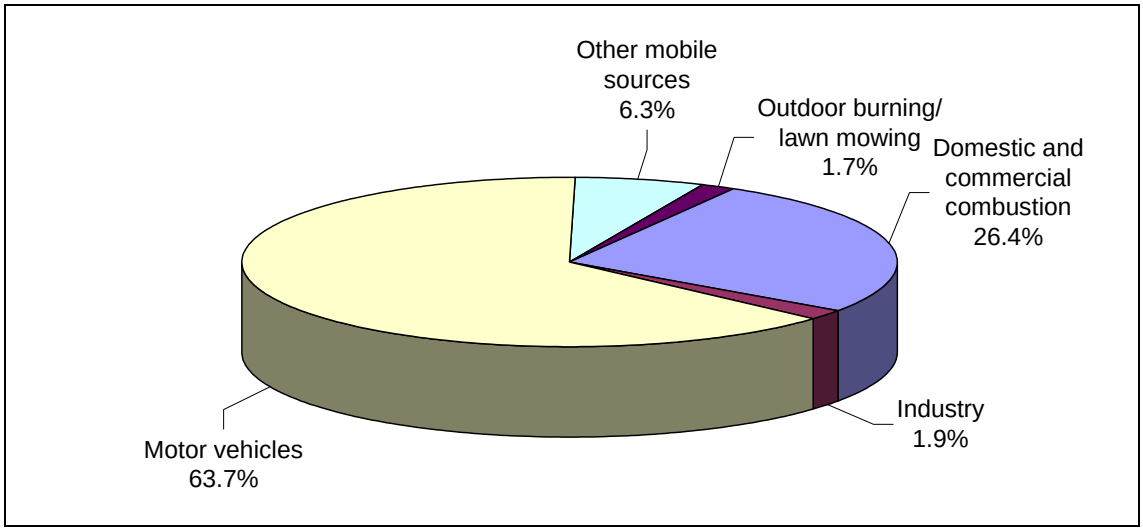
Figure 3.1: Sources of CO in Auckland (1993 inventory)



3.2 Wellington

The main source of carbon monoxide in Wellington is motor vehicle emissions, with the 1998 inventory indicating that around 64% of emissions were from this source. The other significant source of carbon monoxide is domestic and commercial combustion, which contributes around 26% of the CO emissions. These results are estimates of the relative contribution of each source averaged across the whole of the Wellington region, including both urban and rural areas.

Figure 3.2: Sources of CO in Wellington (1998 inventory)



3.3 Waikato urban areas

In Hamilton, motor vehicle emissions and domestic home heating each contribute around half of the CO emissions (Figure 3.3). Because of the very low presence of industry in the area, this source contributes less than 1% of the CO emissions. Figure 3.4 shows the relative contribution of different sources to CO emissions in Taupo and Tokoroa. In Taupo, motor vehicle emissions are the main source of CO contributing around 68%. The main source of CO in Tokoroa is domestic home heating, with motor vehicles contributing around 26% and industry around 11%. The latter contribution excludes Kinleith Pulp and Paper, which is located approximately 5 km from the Tokoroa township.

Figure 3.3: Sources of CO in Hamilton (2001 inventory)

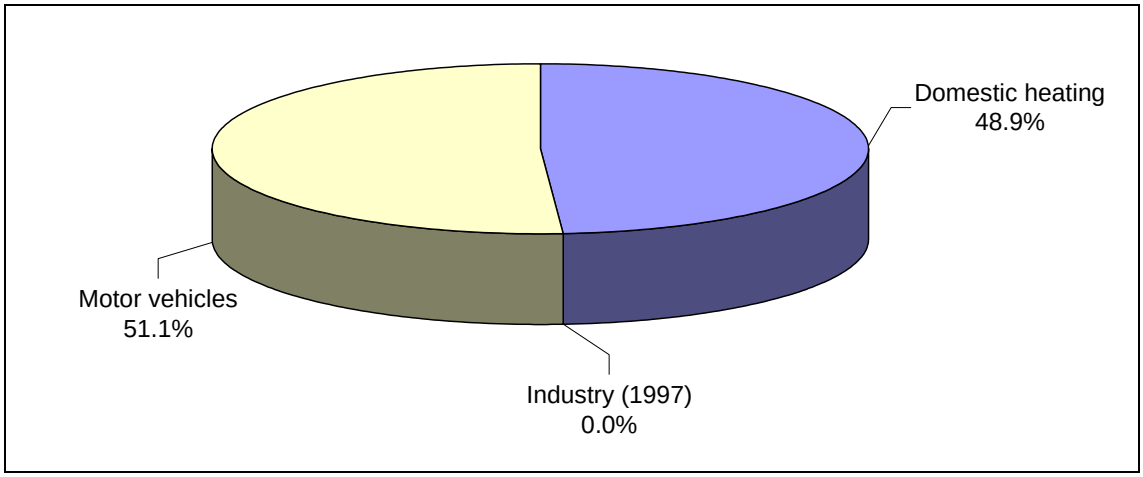
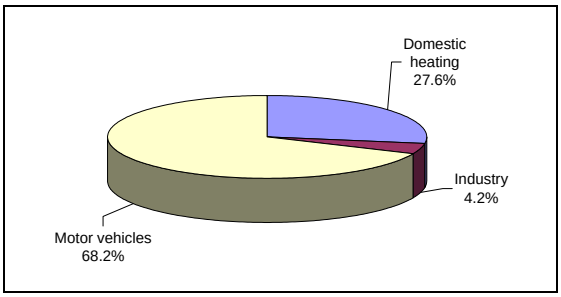
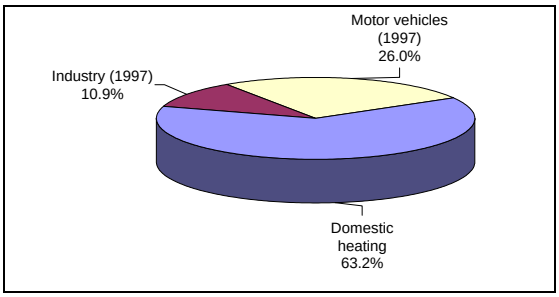


Figure 3.4: Sources of CO in Taupo and Tokoroa (2001 inventory)

Taupo



Tokoroa



3.4 Taranaki, Northland, Gisborne and Bay of Plenty

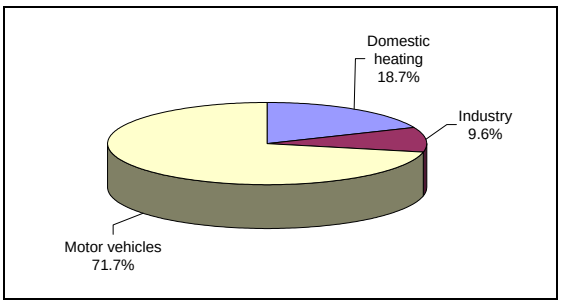
The main source of carbon monoxide in Taranaki is motor vehicle emissions. Figure 3.5 shows around 71% of the CO emissions in Taranaki are from this source, with domestic heating contributing around 19% and industry 10%. The majority of the CO emissions in Taranaki occur within the New Plymouth Bell Block Urban and the Remaining Pastoral Land (Figure 3.5).

In Northland, motor vehicles contribute around half of the CO emissions with domestic fires contributing 38% and industry 8% (Figure 3.6). Motor vehicle emissions are also the main contributor in Gisborne, although less significant at 43%. Of interest is the contribution of natural sources (19%), as this source is not included in most inventories. In the Bay of Plenty, motor vehicle emissions comprise about half of the CO, with one quarter from domestic heating and the remainder industry and agriculture (Figure 3.7). The majority of the CO emissions occur within the areas of Rotorua and Tauranga.

Unlike inventories for other areas, relative contributions to emissions in Taranaki, Northland, Gisborne and Bay of Plenty are based on annual averages, rather than winter specific data. The relative contribution from the domestic heating sector may therefore be higher during the winter months.

Figure 3.5: Sources of CO in Taranaki (left) and the proportion of CO from different areas within Taranaki (right)

Taranaki – source



Taranaki – area

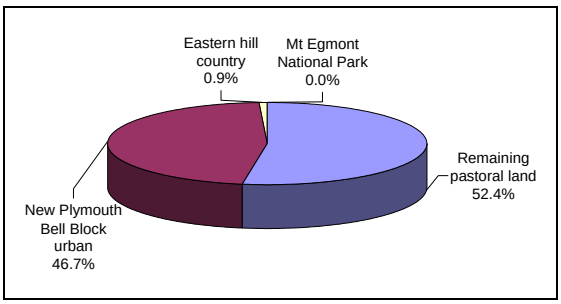


Figure 3.6: Sources of CO in Northland (non-specific year) and Gisborne (1996 inventory)

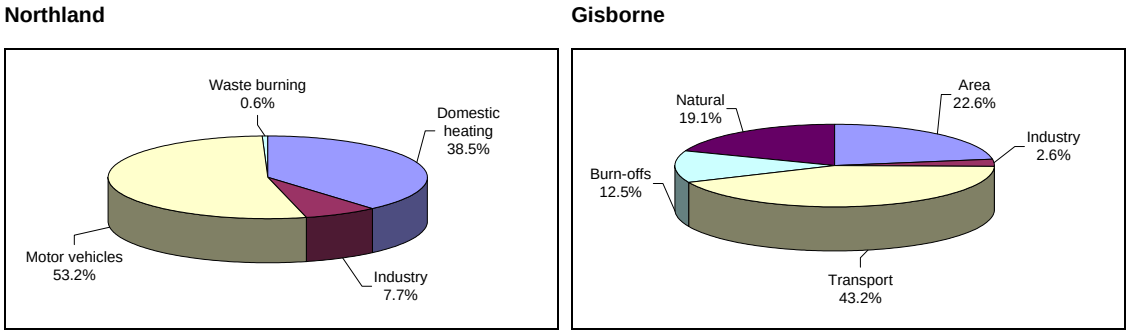
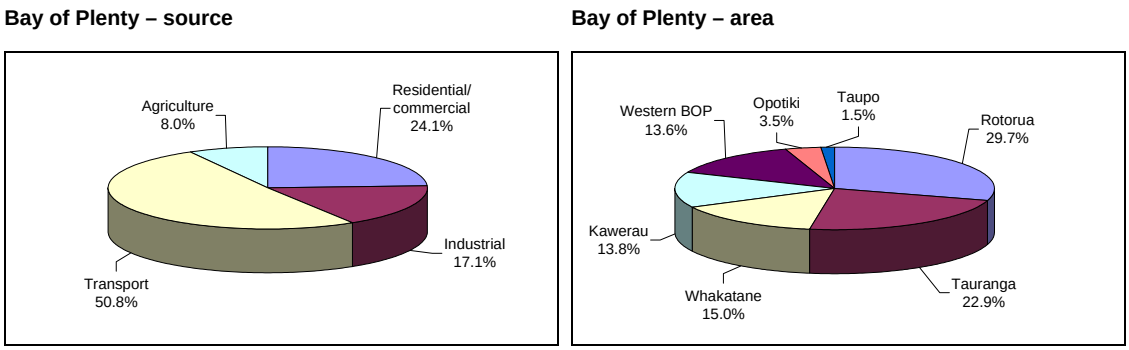


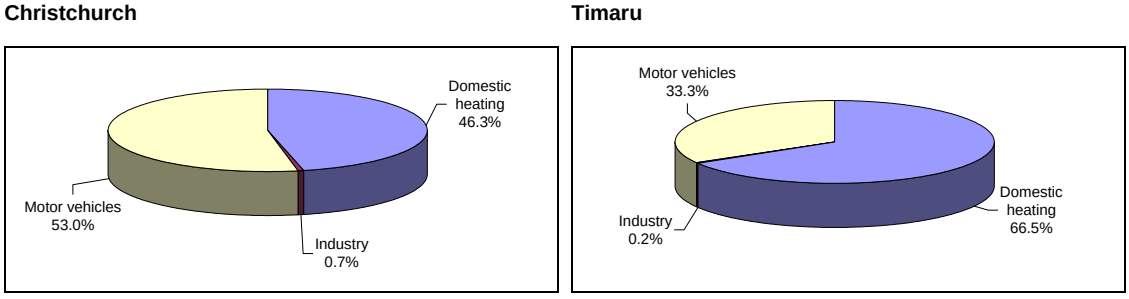
Figure 3.7: Sources of CO in Bay of Plenty (left) and the proportion of CO from different areas within the Bay of Plenty region (right)



3.5 Canterbury

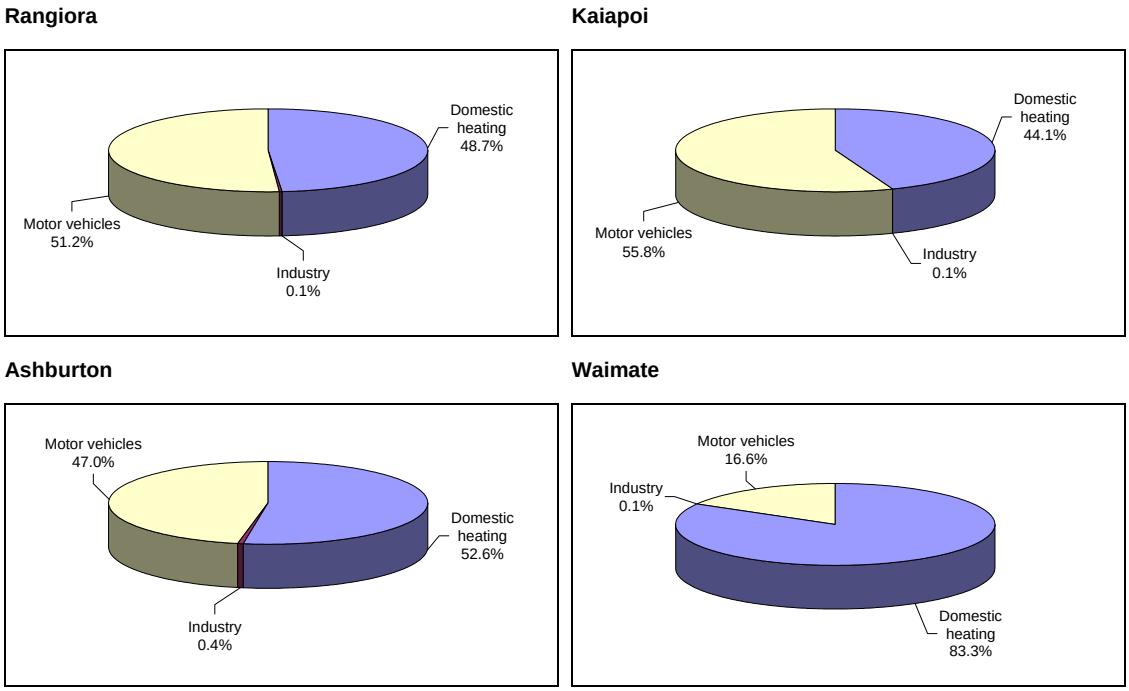
The main urban centres in Canterbury are Christchurch and Timaru. In Christchurch, about half of the CO emissions come from motor vehicles with 46% from domestic heating and 1% from industry. Motor vehicles are less dominant in Timaru, contributing about one-third of the CO emissions. Domestic home heating is the main source of CO emissions in Timaru (Figure 3.8).

Figure 3.8: Sources of CO in Christchurch (1999 inventory) and Timaru (2001 inventory)



In the smaller urban centres of Rangiora, Kaiapoi, Ashburton and Waimate, domestic heating and motor vehicles are the main contributors to CO emissions (Figure 3.9). The contribution of each source is about 50% in Rangiora, Kaiapoi and Ashburton. In Waimate domestic heating contributes 83% of the CO emissions.

Figure 3.9: Sources of CO in Rangiora, Kaiapoi, Ashburton and Waimate



3.6 Otago

The main sources of CO in Dunedin and the urban centres of Otago are motor vehicle emissions and domestic home heating (Figure 3.10), with industry contributing around 3%. Some variations do occur with location (Figure 3.11), with motor vehicles contributing a low of 9% in Arrowtown and up to 45% in Dunedin. With the exception of Balclutha, where motor vehicles contribute 44% of the CO emissions, domestic heating is the main source of CO in the urban centres of Otago, as shown in Figures 3.11 and 3.13.

Figure 3.10: Sources of CO in Dunedin and for the urban areas in Otago (1999 inventory)

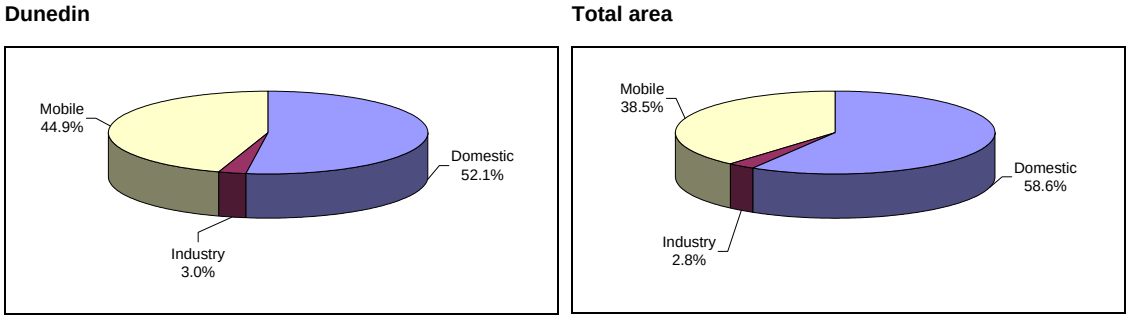
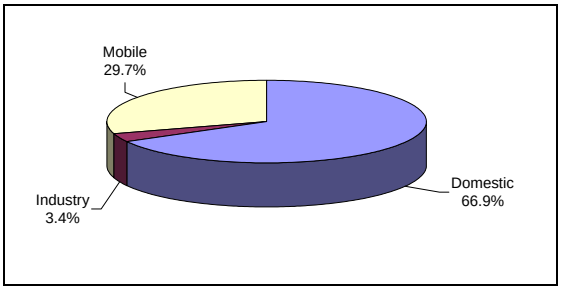
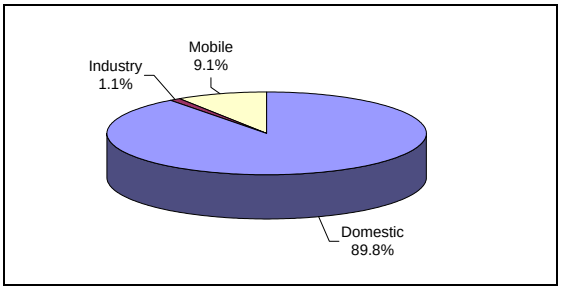


Figure 3.11: Sources of CO in Alexandra, Arrowtown, Balclutha and Clyde (1999 inventory)

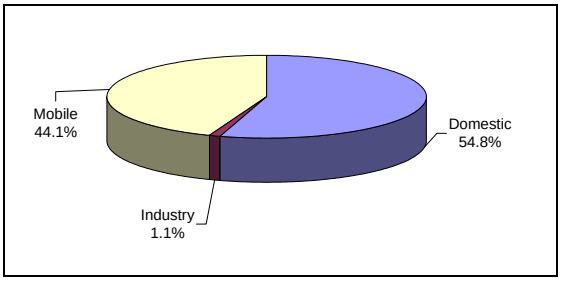
Alexandra



Arrowtown



Balclutha



Clyde

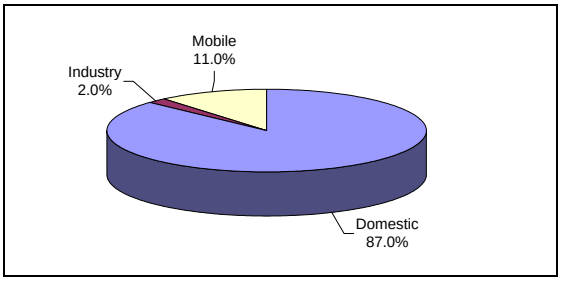
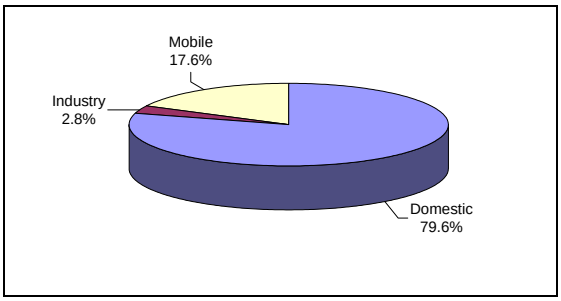
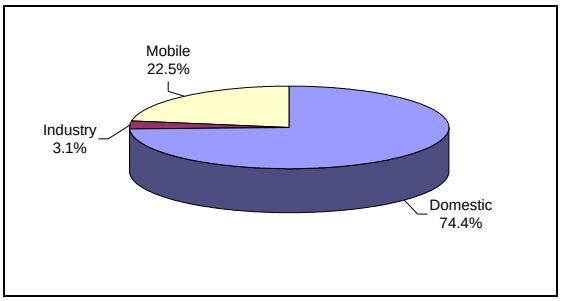


Figure 3.12: Sources of CO in Cromwell, Milton, Mosgiel and Oamaru (1999 inventory)

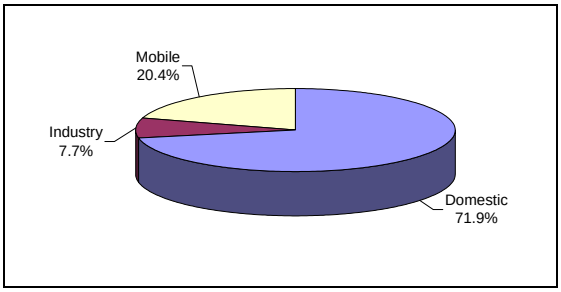
Cromwell



Milton



Mosgiel



Oamaru

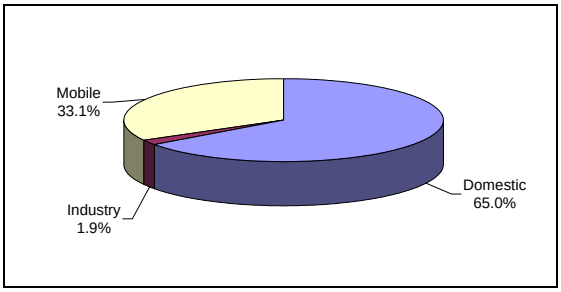
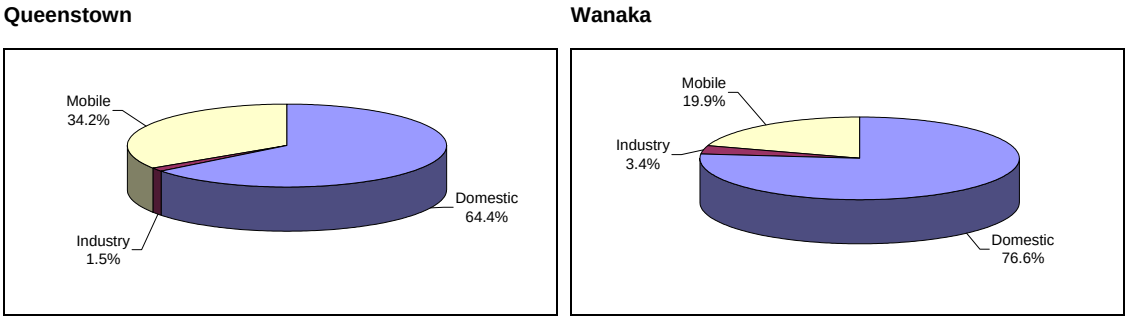


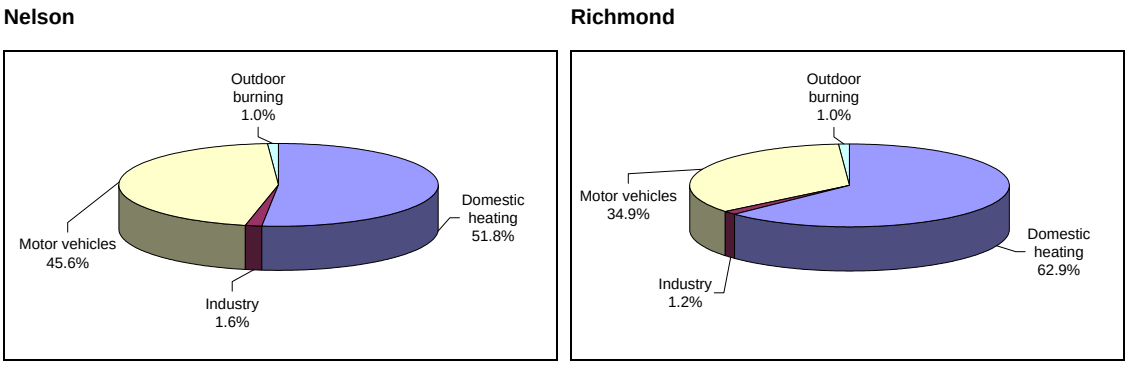
Figure 3.13: Sources of CO in Queenstown and Wanaka (1999 inventory)



3.7 Nelson and Richmond

The main sources of CO emissions in both Nelson and Richmond are motor vehicles and domestic fires, with each contributing around half in Nelson and domestic heating being slightly more dominant in Richmond at 63% (Figure 3.14). Minor sources in both areas include outdoor burning and industry.

Figure 3.14: Sources of CO in Nelson (2001 inventory) and Richmond (2000 inventory)

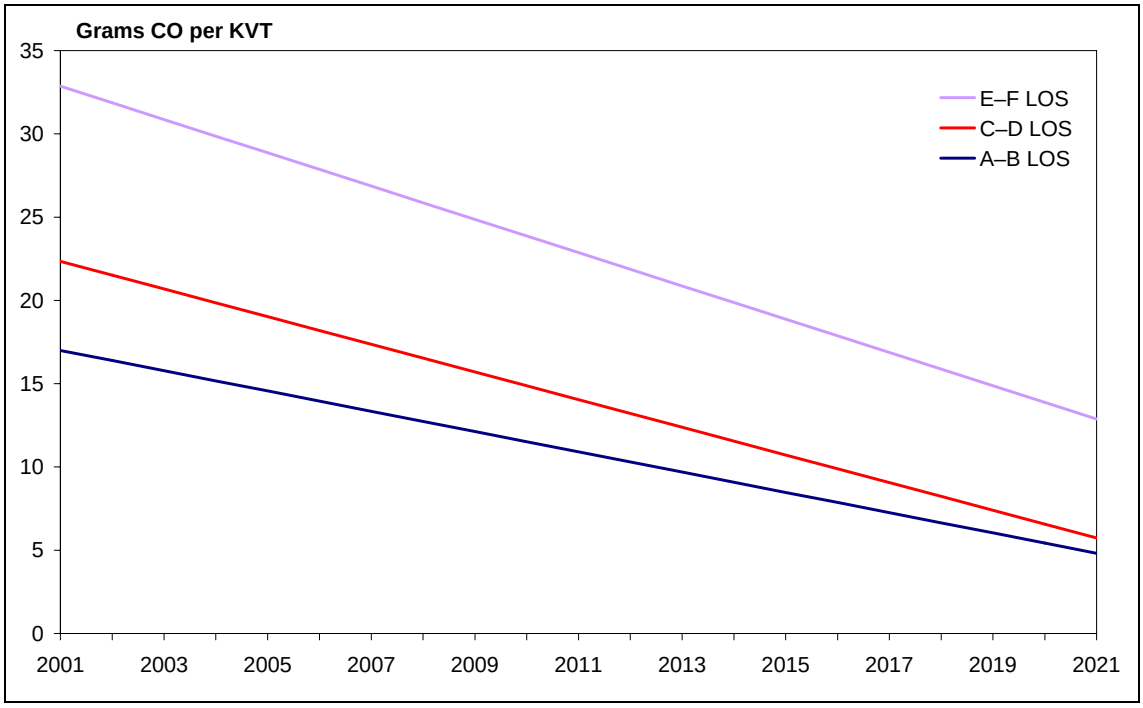


3.8 Trends in CO emissions in New Zealand

Motor vehicle emissions and domestic heating are the main sources of CO in most urban areas of New Zealand. Some trends in CO emissions from motor vehicles can be assessed based on the estimated impacts of changes in vehicle technology and fuels. The New Zealand Transport Emission Rate model (NZTER) produced by the Ministry of Transport as a part of the vehicle fleet emission control strategy indicates a reduction in carbon monoxide emissions from this source with time. The reductions are primarily associated with improved vehicle technology and are illustrated in Figure 3.15. The three levels of service (LOS) categories represent emission rates for different levels of congestion.

Changes in home heating methods will also influence trends in CO emissions in most areas. These changes are likely to be area specific, although factors such as increases in electricity prices or concerns regarding supply could have nationwide implications. Increases in the numbers of burners will increase CO emissions, however, in some areas these increases may be offset by the replacement of older burners and open fires with lower emission wood burners.

Figure 3.15: Predicted trends in CO emissions from motor vehicles



Source: From NZTER for the New Zealand vehicle fleet profile.

Notes: A–B shows free flow, C–D interrupted flow and E–F congested flow.

In a number of areas of New Zealand management measures are being proposed or implemented to reduce PM_{10} emissions from domestic home heating. It is likely that these measures will also result in a reduction in CO emissions from this source.

Only a small number of inventories have been conducted for a second time. In particular, an assessment has been carried out for Timaru, comparing 1996 and 2000, and for Christchurch, comparing 1996 and 1999. The latter area shows some changes in home heating methods, with an increase in the number of households using solid fuel burning and a decrease in the use of coal. While the impact of these changes on PM_{10} emissions is minimal, an increase in CO emissions of around 10% is estimated after adjustments for changes in methodology have been made. No significant changes in home heating trends or emissions were apparent in the 1996 and 2000 Timaru emission inventory comparison.

3.9 Summary of sources of CO in New Zealand

The main sources of CO emissions in most urban areas of New Zealand are motor vehicle emissions and domestic home heating. Emission inventories suggest that these are approximately equal contributors in many urban areas, although vehicle emissions are the dominant source in Auckland, Wellington, Taranaki and Taupo.

Table 3.1 shows estimates of CO discharges to air from different sources in kilograms per day and tonnes per year. With the exception of Bay of Plenty, Taranaki and Gisborne, this data represents the average wintertime emission sources.

For the larger cities, CO emissions of around 150 to 1000 tonnes per day are estimated, compared to around 30 tonnes or less for most of the smaller urban areas. In Auckland, over 1000 tonnes of CO is emitted per day during the winter compared to around 150 tonnes for Christchurch and 180 tonnes for Wellington.

The relative contributions to CO emissions shown in table 3.1 are based on assumptions relating to emission rates and fuel use and contain some degree of uncertainty. There is some variation from area to area in the approach taken and the subsequent confidence in the results. Further discussion on the limitations of different inventories is contained in Table 2.1.

Table 3.1: Comparison of CO emission estimates for different regions of New Zealand

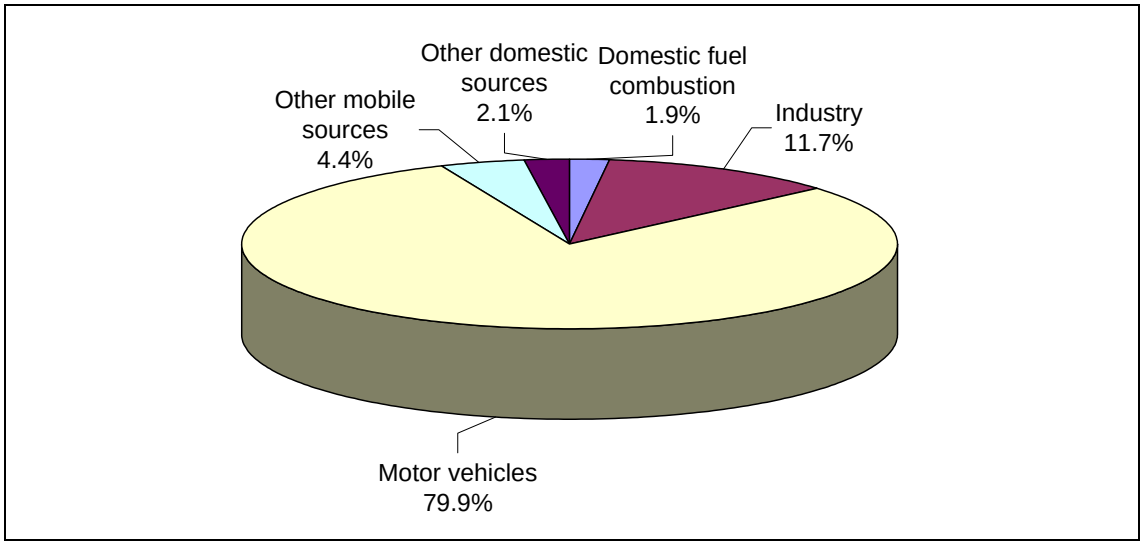
	Domestic kg/day	Mobile sources kg/day	Industry kg/day			Total kg/day
Alexandra	1,596	708	81			2,385
Arrowtown	838	85	10			933
Balclutha	880	708	17			1,605
Clyde	348	44	8			400
Cromwell	786	174	28			988
Milton	796	241	33			1,070
Mosgiel	1,965	557	210			2,732
Oamaru	6,193	3,150	178			9,521
Queenstown	4,401	2,338	100			6,839
Wanaka	1,096	285	49			1,430
Dunedin	20,215	17,416	1,173			38,804
	Domestic heating kg/day	**Motor vehicles kg/day**	**Industry kg/day**	**Other domestic kg/day**	**Other mobile kg/day**	**Total kg/day**
Christchurch	70,220	80,269	1,066			151,555
Rangiora	2,316	2,437	6			4,759
Kaiapoi	2,316	2,929	3			5,248
Ashburton	5,345	4,780	44			10,169
Waimate	1,898	371	3			2,272
Timaru	9,991	6,088	33			16,112
Nelson	14,053	12,378	438	284		27,152
Northland	30,074	41,556	6,006	1,510		79,146
Auckland	140,200	883,000	3,500	19,900	6,900	1,053,500
Hamilton	32,605	34,111	3			66,719
Taupo	3,235	8,011.078	496			11,742
Tokoroa	7,533	3,098.58	1,297			11,928
	Domestic/ commercial heating kg/day	**Motor vehicles kg/day**	**Industry kg/day**	**Other domestic kg/day**	**Other mobile kg/day**	**Total kg/day**
Wellington	47,720	115,400	3,500	3,050	7,630	177,300
	Domestic t/ year	**Mobile sources t/ year**	**Industry t/ year**	**Burn-offs t/ year**		**Total t/ year**
Taranaki	3,467	13,257	1,769			18,493
BOP	7,991	16,848	5,687	2,661		33,187
Gisborne	1,505	2,877	175	831		5,388

4 Nitrogen Oxide (NOx) Emissions

4.1 Auckland

Motor vehicles contribute the majority (80%) of the NOx emissions in Auckland, with industry producing 12% and other mobile sources, domestic fuel combustion and other domestic sources contributing the remainder (Figure 4.1). Like CO, however, the actual contribution of different sources at any location will vary, depending on factors such as proximity to roadways. Monitoring data from some of the roadside sites such as Queen Street or Khyber Pass Road will primarily represent motor vehicle emissions.

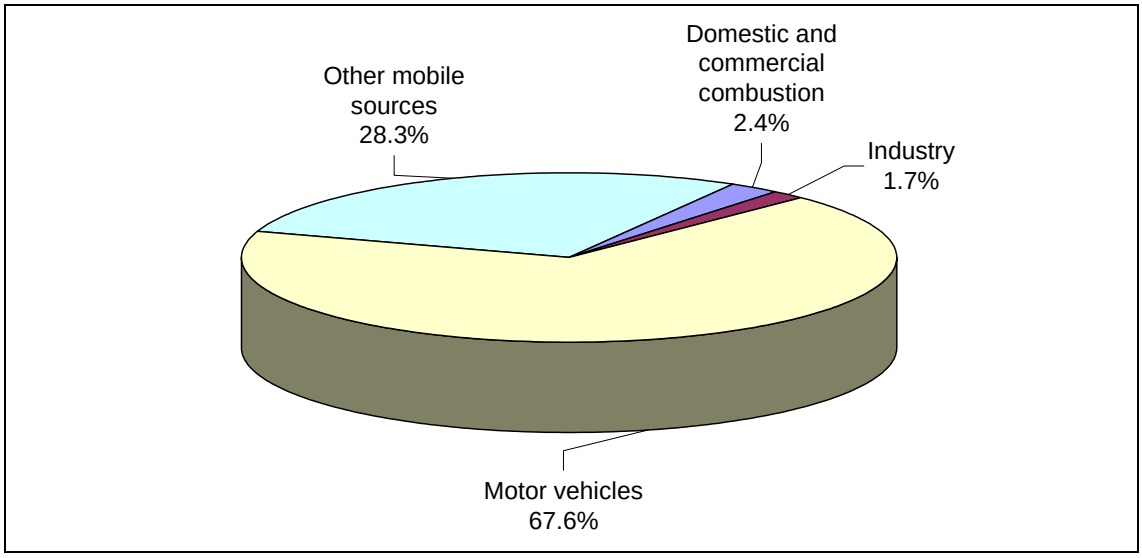
Figure 4.1: Sources of NOx in Auckland (1993 inventory)



4.2 Wellington

The main source of NOx emissions in the Wellington region is motor vehicles (68%), with other mobile sources also a significant contributor at 28%. This latter source includes aviation and commercial shipping. Domestic and commercial combustion and industry are only minor sources of NOx in the region each contributing 2% of total NOx emissions. These results are estimates of the relative contribution of each source averaged across the whole of the Wellington region, including both urban and rural areas.

Figure 4.2: Sources of NOx in Wellington (1998 inventory)



4.3 Waikato urban areas

Motor vehicles are responsible for the majority of the NOx emissions in Hamilton, Tokoroa and Taupo (Figures 4.3 and 4.4). In Hamilton, industry contributes less than 1% of the NOx emissions. The industrial contribution is greater in Tokoroa and Taupo at 9% of the NOx emissions. The domestic heating contribution is minor in all areas at around 6–7%.

Figure 4.3: Sources of NOx in Hamilton (2001 inventory)

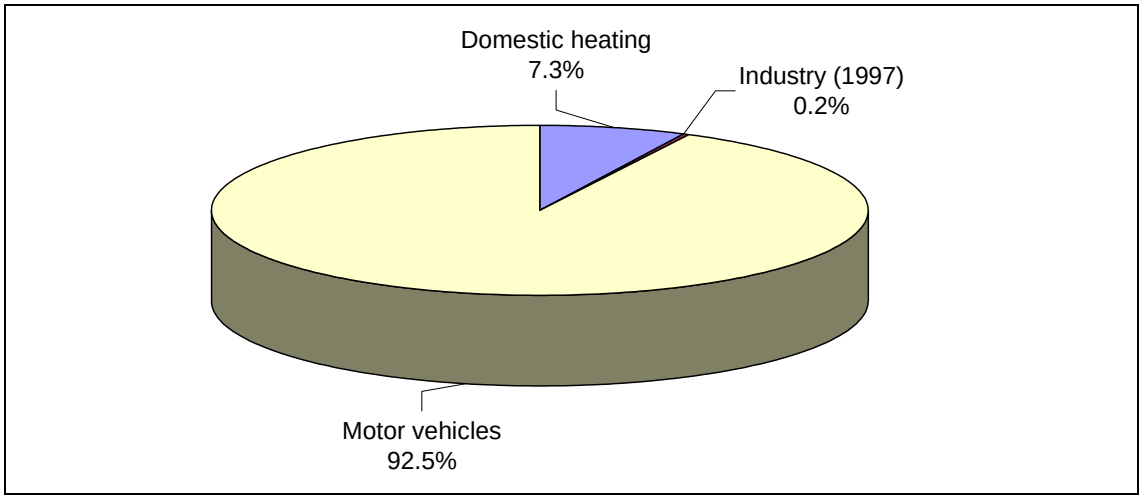
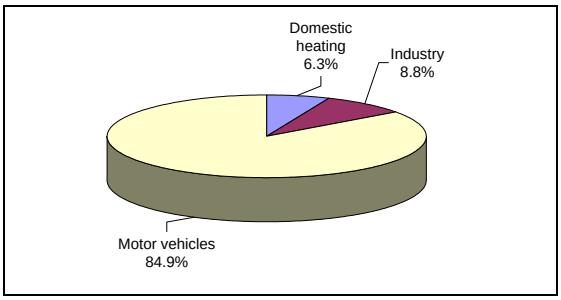
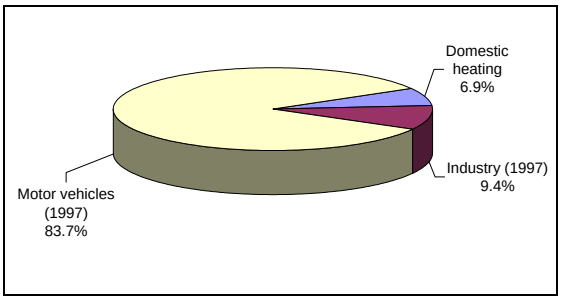


Figure 4.4: Sources of NOx in Taupo and Tokoroa (2001 inventory)

Taupo



Tokoroa



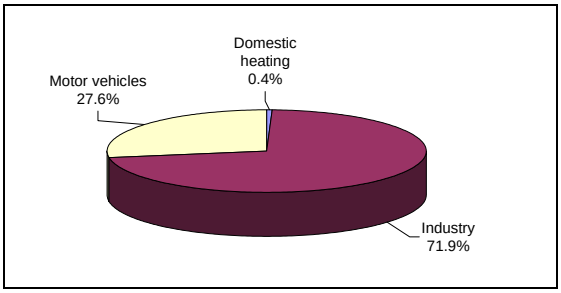
4.4 Taranaki, Northland, Gisborne and Bay of Plenty

Unlike most areas, the main source of NOx emissions in Taranaki is industry, which contributes around 72% of the NOx emissions (Figure 4.5). The NOx emissions in Taranaki occur primarily within the remaining pastoral land and New Plymouth Bell Block urban areas. Similarly, in Northland industry contributes 62% of the NOx emissions, with motor vehicles responsible for 37% (Figure 4.6). In Gisborne, burn-offs are the main source of NOx emissions, with transport contributing 32%. Motor vehicles are the main source of NOx emissions in the Bay of Plenty contributing around 87% of the NOx emissions (Figure 4.7).

The relative contributions to NOx emissions in Taranaki, Northland, Gisborne and Bay of Plenty are based on annual averages, rather than winter specific data. The main source contribution likely to change during the winter months is domestic home heating, although this is not typically a major source of NOx emissions in New Zealand.

Figure 4.5: Sources of NOx in Taranaki (left) and the proportion of NOx from different areas within Taranaki (right)

Taranaki – source



Taranaki – area

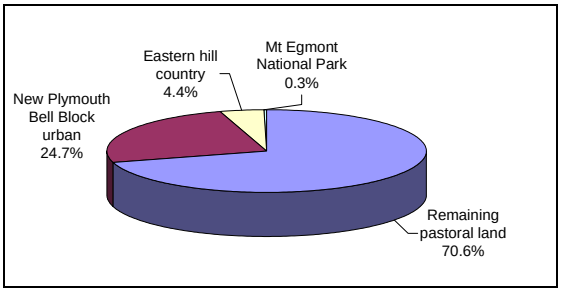
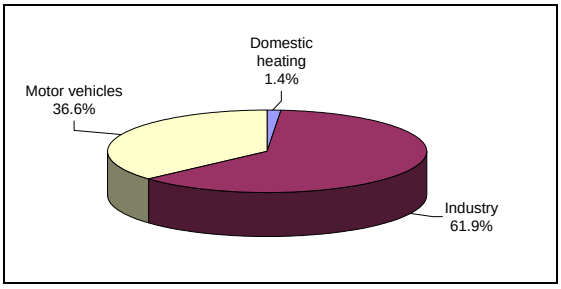


Figure 4.6: Sources of NOx in Northland (non-specific year) and Gisborne (1996 inventory)

Northland



Gisborne

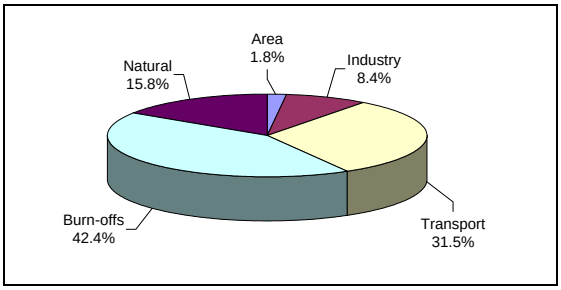
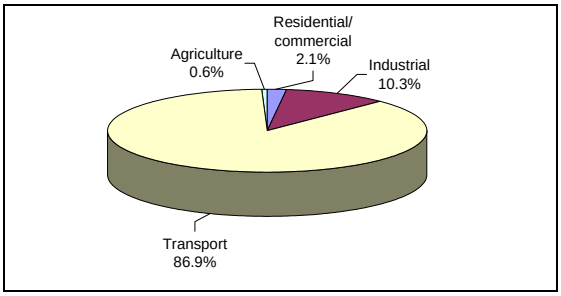
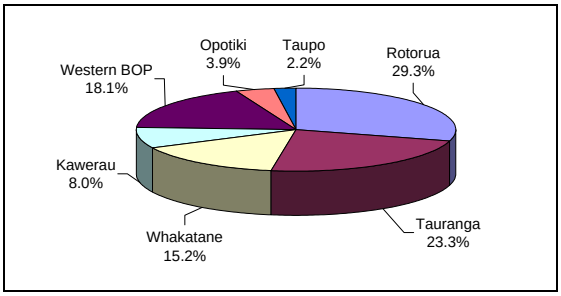


Figure 4.7: Sources of NOx in Bay of Plenty (left) and the proportion of NOx from different areas within the Bay of Plenty region (right)

Bay of Plenty – source



Bay of Plenty – area

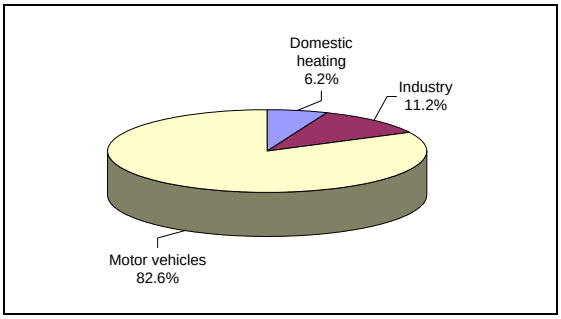


4.5 Canterbury

Motor vehicles are the dominant source of NOx emissions in Christchurch, Timaru, Rangiora, Ashburton and Kaiapoi (Figures 4.8 and 4.9). In Waimate, domestic fires and motor vehicles each contribute around 40% of the NOx emissions with industry responsible for the remainder.

Figure 4.8: Sources of NOx in Christchurch (1999 inventory) and Timaru (2001 inventory)

Christchurch



Timaru

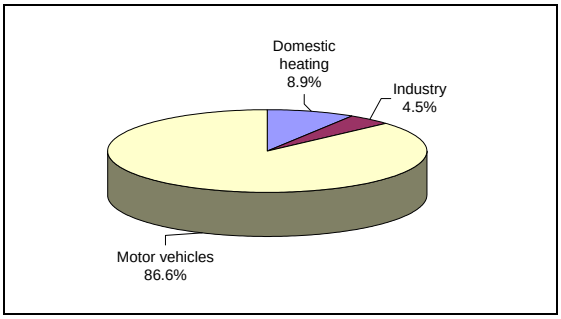
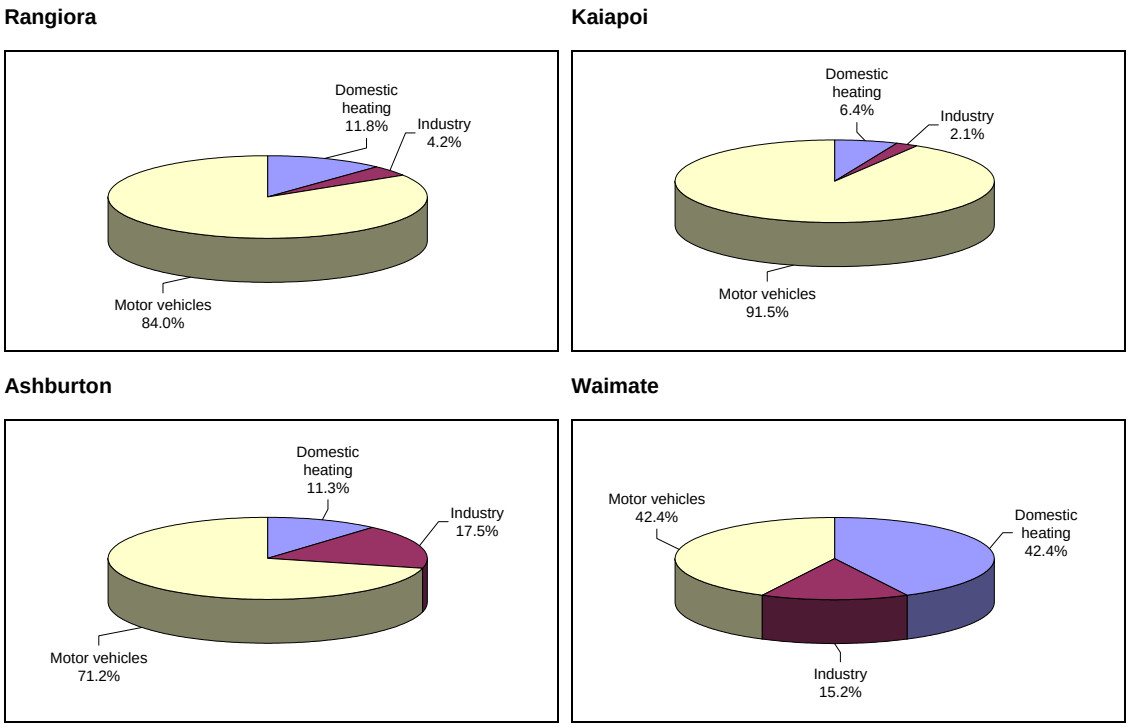


Figure 4.9: Sources of NOx emissions in Rangiora, Kaiapoi, Ashburton and Waimate



4.6 Otago

The main source of NOx in Dunedin and the urban areas of Otago are motor vehicles contributing around 60% of emissions (Figure 4.10). In many of the smaller urban areas, the contribution from motor vehicles is less, with industry and domestic heating showing some dominance (Figures 4.11–4.13). For example, in Arrowtown, Clyde and Mosgiel, motor vehicles contribute less than 30% of the NOx emissions. Mosgiel shows the greatest industrial impact with around half of the NOx emissions from this source.

Figure 4.10: Sources of NOx in Dunedin and for urban areas of Otago (1999 inventory)

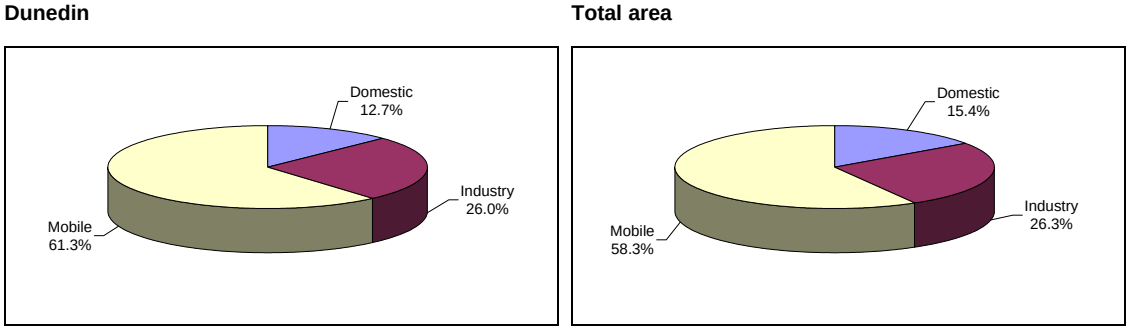
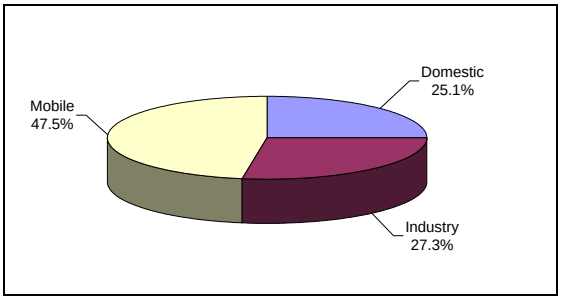
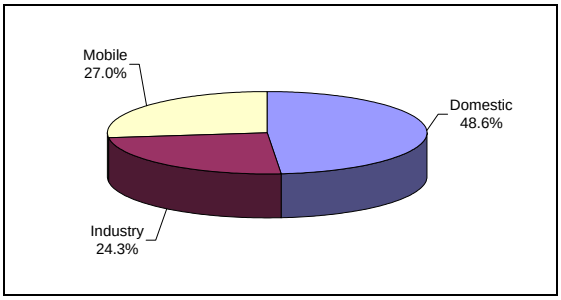


Figure 4.11: Sources of NOx in Alexandra, Arrowtown, Balclutha and Clyde (1999 inventory)

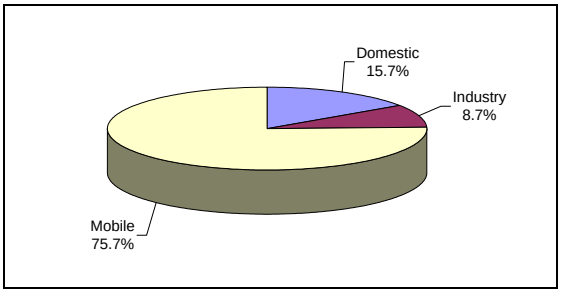
Alexandra



Arrowtown



Balclutha



Clyde

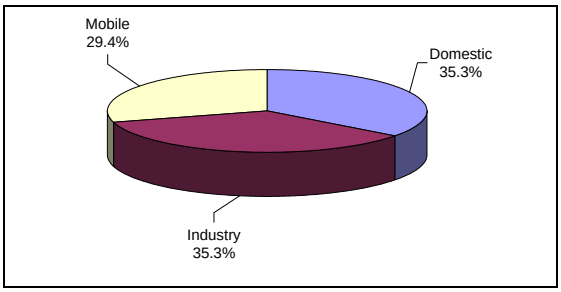
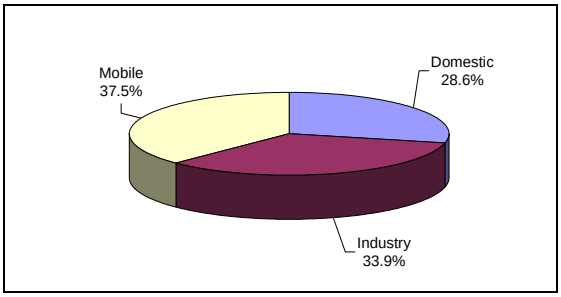
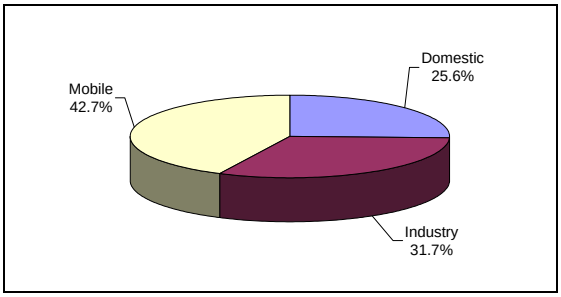


Figure 4.12: Sources of NOx in Cromwell, Milton, Mosgiel and Oamaru (1999 inventory)

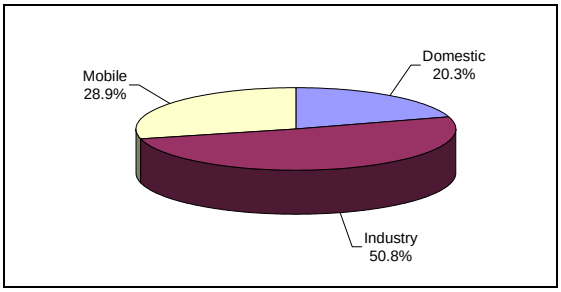
Cromwell



Milton



Mosgiel



Oamaru

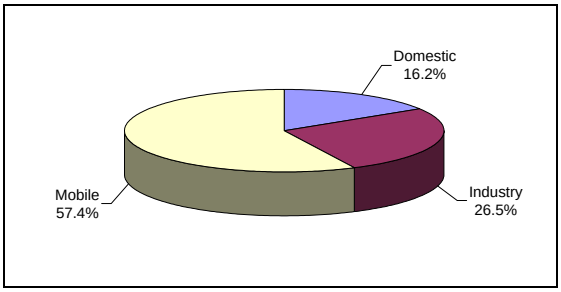
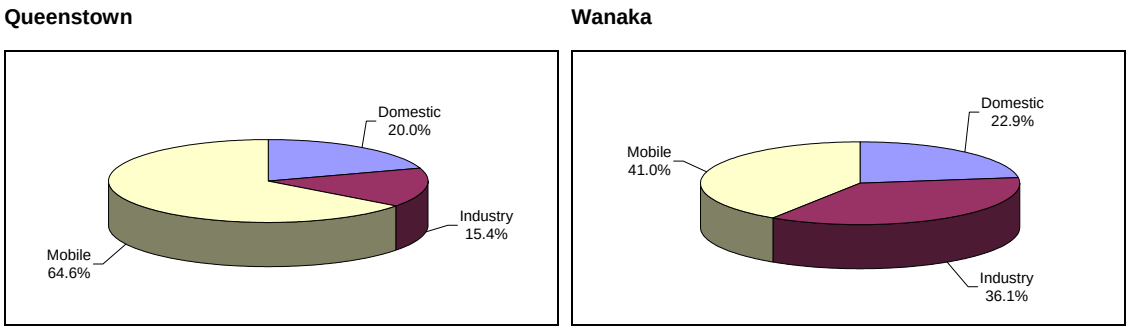


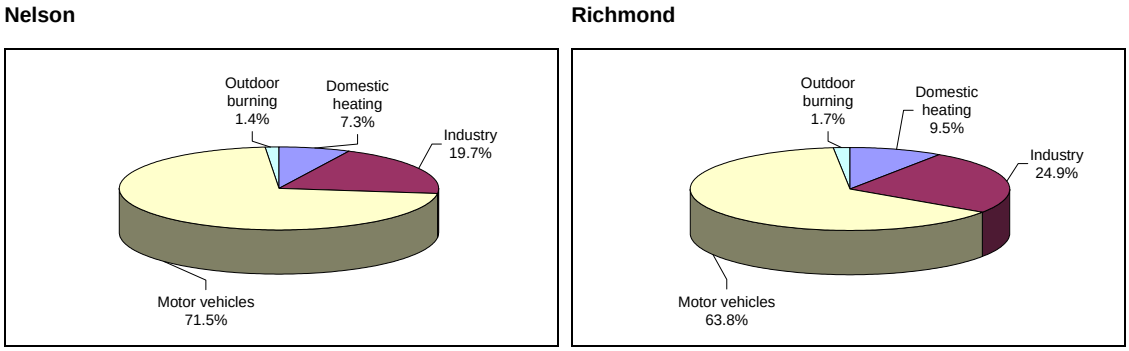
Figure 4.13: Sources of NOx in Queenstown and Wanaka (1999 inventory)



4.7 Nelson and Richmond

Motor vehicles are the main source of NOx emissions in both Nelson and Richmond, contributing about two-thirds of the emissions. Industry contributes 20–25%, with domestic heating and outdoor burning comprising the remainder (Figure 4.14).

Figure 4.14: Sources of NOx emissions in Nelson (2001 inventory) and Richmond (2000 inventory)

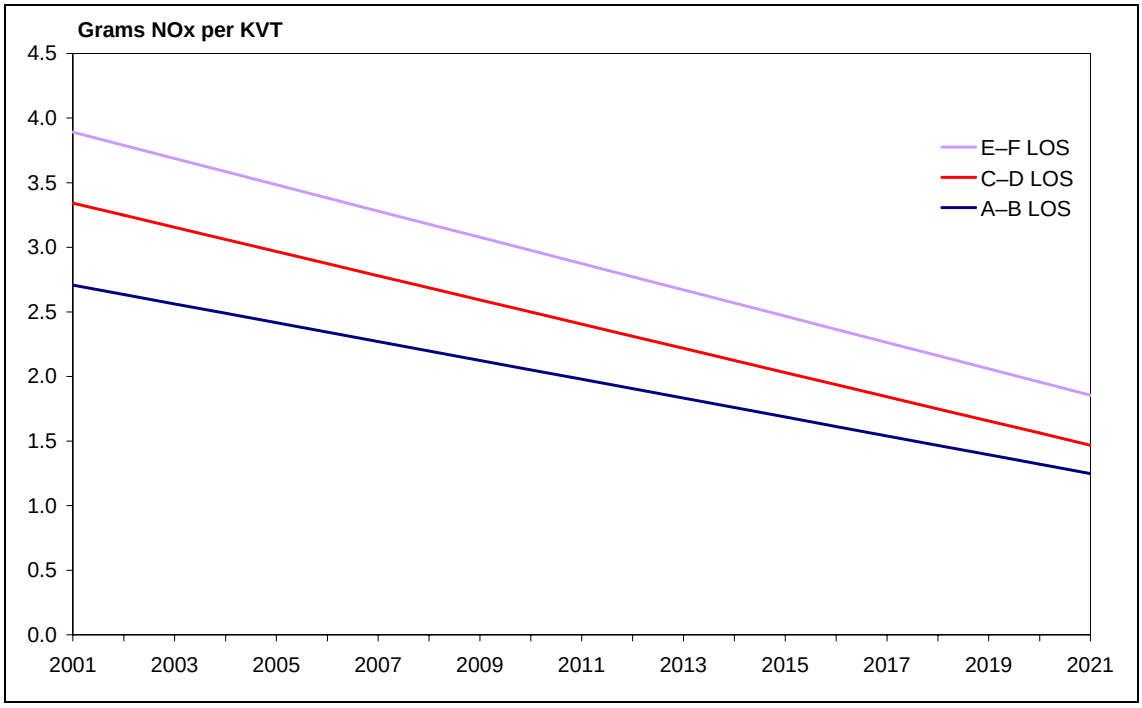


4.8 Trends in NOx emissions in New Zealand

Emission inventory studies show the main source of NOx emissions in most urban areas of New Zealand is motor vehicles, although industry is dominant in a number of locations. Changes in emissions from motor vehicles and industry will therefore be key drivers in trends in NO_2 concentrations within New Zealand.

An estimate of the impact of improved vehicle engine technology on NOx emissions in New Zealand has been provided by the Ministry of Transport. This suggests a significant decrease in NOx emissions in New Zealand over the next 20 years. Figure 4.15, which is based on the Ministry of Transport's New Zealand Transport Emission Rate model (NZTER), shows the estimated improvement in motor vehicle NOx emissions with time. The three levels of service (LOS) categories represent emission rates for different levels of congestion.

Figure 4.15: Predicted trends in NOx emissions from motor vehicles



Source: From NZTER for the New Zealand vehicle fleet profile.

Notes: A–B shows free flow, C–D interrupted flow and E–F congested flow.

Future trends in NOx emissions from industry are difficult to assess. In some areas, these are likely to be dominated by one or two major sources, for example gas fired power generation. Growth in industry is likely to be area specific and may depend on the extent of existing regulation control measures.

There is very limited trend information from emission inventory studies as Timaru and Christchurch are the only areas to have published a second inventory assessment. The Timaru inventory shows no changes in total NOx emissions from 1996 to 2000, as a slight decrease in transport NOx emissions was offset by an increase in the industrial component. A trend is also apparent in a comparison between the 1996 and 1999 Christchurch emission inventory. It is possible, however, that the increase in the industrial component reflects methodological differences in the assessment of emissions from this source between the two inventories.

4.9 Summary of sources of NOx in New Zealand

The results of the emission inventory investigations into sources of NOx in New Zealand are shown in Table 4.1. With the exception of Bay of Plenty, Taranaki and Gisborne, these data represent average wintertime emission sources. The dominant source of NOx in most urban areas is motor vehicle emissions.

In Auckland, around 100 tonnes of NOx is estimated compared to around 16 tonnes for Christchurch and 35 tonnes for the Wellington region. In most of the smaller urban areas NOx emissions of less than one tonne per day are estimated. While motor vehicles are still the dominant contributor in some of these smaller towns, the industrial contribution is sometimes greater.

The relative contributions to NOx emissions shown in Table 4.1 are based on assumptions relating to emission rates and fuel use and contain some degree of uncertainty. There is some variation from area to area in the approach taken and the subsequent confidence in results. Further information on the limitations associated with different inventories is provided in Table 2.1.

Table 4.1: Comparison of emission estimates of NOx for different regions of New Zealand

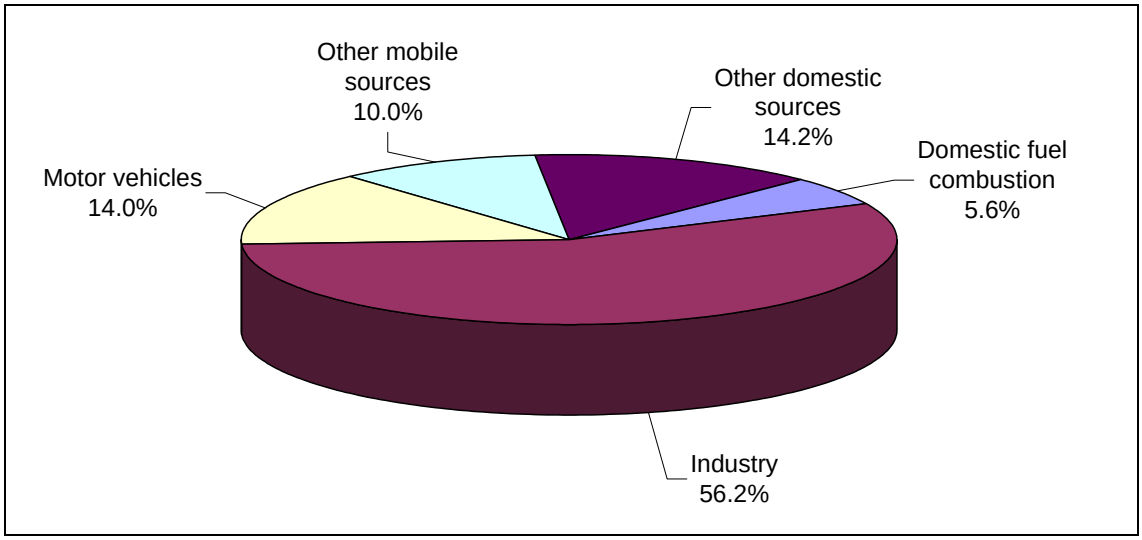
	Domestic kg/day	Mobile sources kg/day	Industry kg/day			Total kg/day
Alexandra	46	87	50			183
Arrowtown	18	10	9			37
Balclutha	18	87	10			115
Clyde	6	5	6			17
Cromwell	16	21	19			56
Milton	21	35	26			82
Mosgiel	54	77	135			266
Oamaru	111	394	182			687
Queenstown	101	327	78			506
Wanaka	19	34	30			83
Dunedin	462	2,225	945			3,632
	Domestic heating kg/day	**Motor vehicles kg/day**	**Industry kg/day**	**Other domestic kg/day**	**Other mobile kg/day**	**Total kg/day**
Christchurch	988	13,180	1,795			15,963
Rangiora	56	247	20			323
Kaiapoi	34	486	11			531
Ashburton	82	517	147			746
Waimate	28	28	10			66
Timaru	91	968	46			1,105
Nelson	107	1,045	288	20		1,460
Northland	275	6,980	11,791	27		19,073
Auckland	2,000	82,000	12,000	2,140	4,500	102,640
Hamilton	397	5,019	9			5,425
Taupo	68	920	95			1,083
Tokoroa	109	1,323	148			1,580
	Domestic/ commercial heating kg/day	**Motor vehicles kg/day**	**Industry kg/day**	**Other domestic kg/day**	**Other mobile kg/day**	**Total kg/day**
Wellington	850	23,900	600	60	10,000	35,410
	Domestic t/ year	**Mobile sources t/ year**	**Industry t/ year**	**Burn-offs t/ year**		**Total t/ year**
Taranaki	72	4,436	11,549			16,057
BOP	244	10,193	1210	76		11,723
Gisborne	72	1,246	333	1,675		3,326

5 Sulphur Dioxide (SO_2) Emissions

5.1 Auckland

The main source of SO_2 emissions in Auckland, as indicated by the 1993 inventory, is industry. This source contributes 56% of the SO_2 emissions compared to 14% from motor vehicles, 10% from other mobile sources and 20% from domestic sources (Figure 3.1). This represents the average contribution across the whole of the city. The industrial component is therefore likely to be higher nearer industrial areas and lower in residential areas located further away from industry.

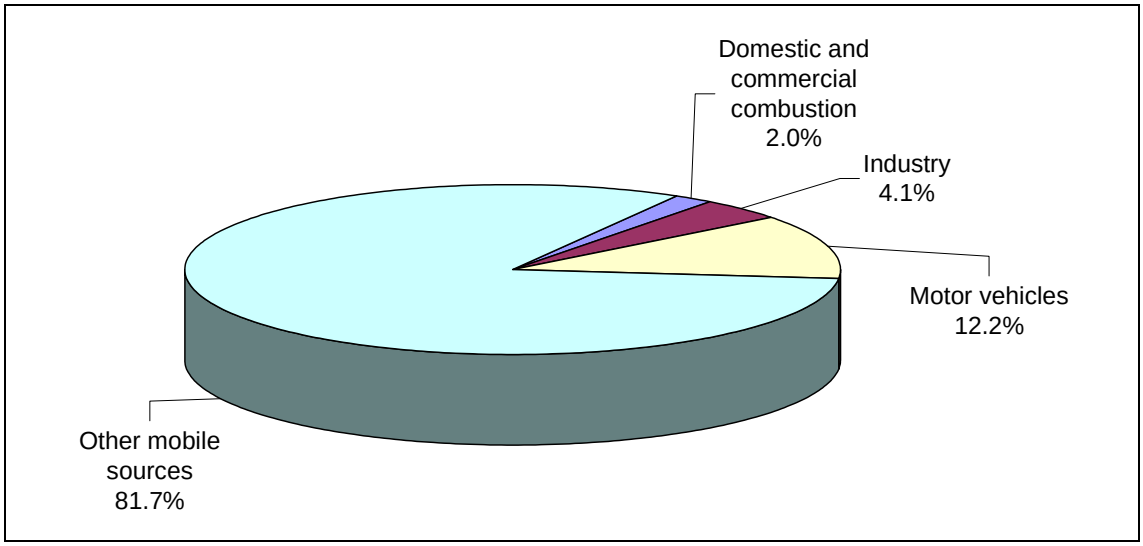
Figure 5.1: Sources of SO_2 in Auckland (1993 inventory)



5.2 Wellington

The main source of SO_2 in the Wellington region is commercial shipping, which comprises the majority of the other mobile sources category in Figure 5.2. This source accounts for around 82% of the SO_2 emissions in the Wellington region. In areas distant from the harbour, motor vehicles, industry and domestic heating are more likely to contribute to SO_2 emissions.

Figure 5.2: Sources of SO_2 in Wellington (1998 inventory)

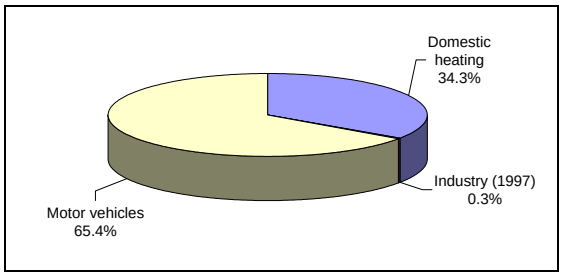


5.3 Waikato urban areas

The main source of SO_2 in Hamilton is motor vehicle emissions, which contribute 66% of the SO_2 emissions. In Tokoroa, industry contributes 41%, with motor vehicles and domestic home heating contributing about 30% each (Figure 5.3). These estimates exclude emissions from Kinleith as this is located 5 km outside of the Tokoroa township. When the wind is directing emissions from Kinleith to Tokoroa, the contribution to SO_2 emissions from industry will increase. In Taupo, motor vehicles are the major contributor to SO_2 emissions contributing 77% (Figure 5.4).

Figure 5.3: Sources of SO_2 in Hamilton and Tokoroa (2001 inventory)

Hamilton



Tokoroa

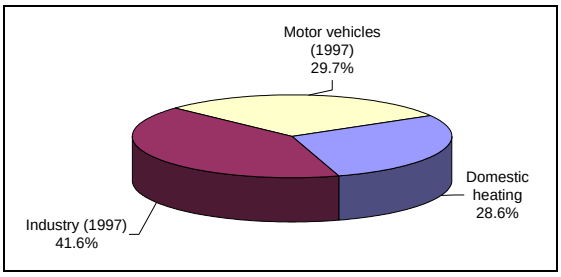
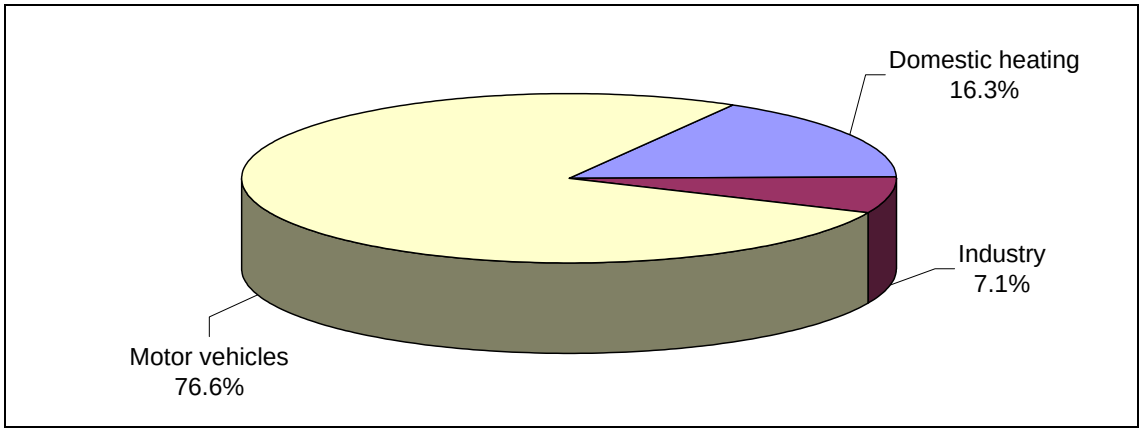


Figure 5.4: Sources of SO_2 in Taupo (2001 inventory)

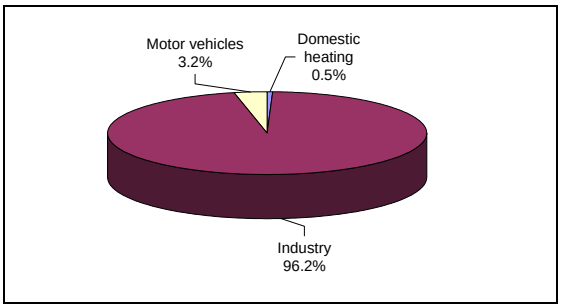


5.4 Northland, Gisborne and Bay of Plenty

The main source of SO_2 emissions in Northland is industry, contributing 96% of emissions. In Northland these emissions are dominated by the petroleum industry, which contributes 90% of the industry SO_2 emissions. In Gisborne, transport is the main source of SO_2 contributing 89%. Area sources including domestic home heating contribute the remainder of the SO_2 emissions in Gisborne (Figure 5.5).

Figure 5.5: Sources of SO_2 in Northland (non-specific year) and Gisborne (1996 inventory)

Northland



Gisborne

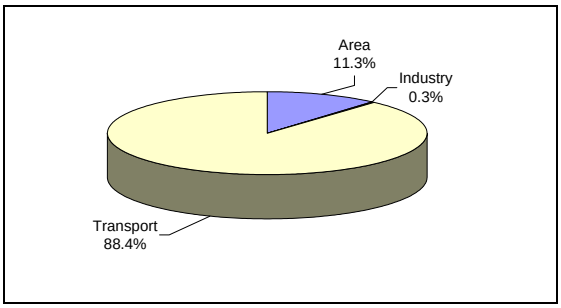
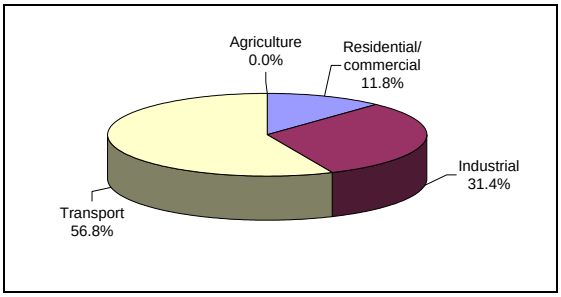
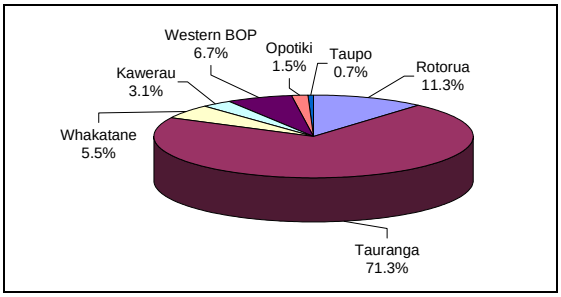


Figure 5.6: Sources of SO_2 in Bay of Plenty (left) and the proportion of SO_2 from different areas within the Bay of Plenty region (right)

Bay of Plenty – source



Bay of Plenty – area



5.5 Canterbury

The main source of SO_2 in Christchurch and Timaru is industry, which contributes 80% in Christchurch and 56% in Timaru (Figure 5.7). In Christchurch, the main industrial source of SO_2 emissions is coal-fired boilers, which comprise 60% of the industrial component. A fertiliser works is the main single source of SO_2 emissions in Christchurch, contributing 30% of the industrial component. Secondary sources of SO_2 emissions in Timaru include motor vehicles and industry, contributing 26% and 18% respectively. In Christchurch, motor vehicles and domestic heating contribute less, at 14% and 6% respectively. Domestic heating and motor vehicles contribute a greater proportion of SO_2 emissions in the smaller urban areas of the region (Figure 5.8).

Figure 5.7: Sources of SO_2 in Christchurch (1999 inventory) and Timaru (2001 inventory)

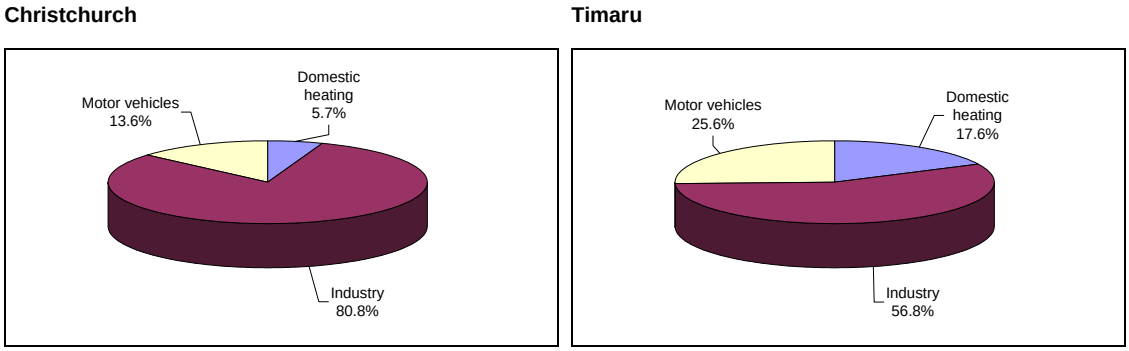
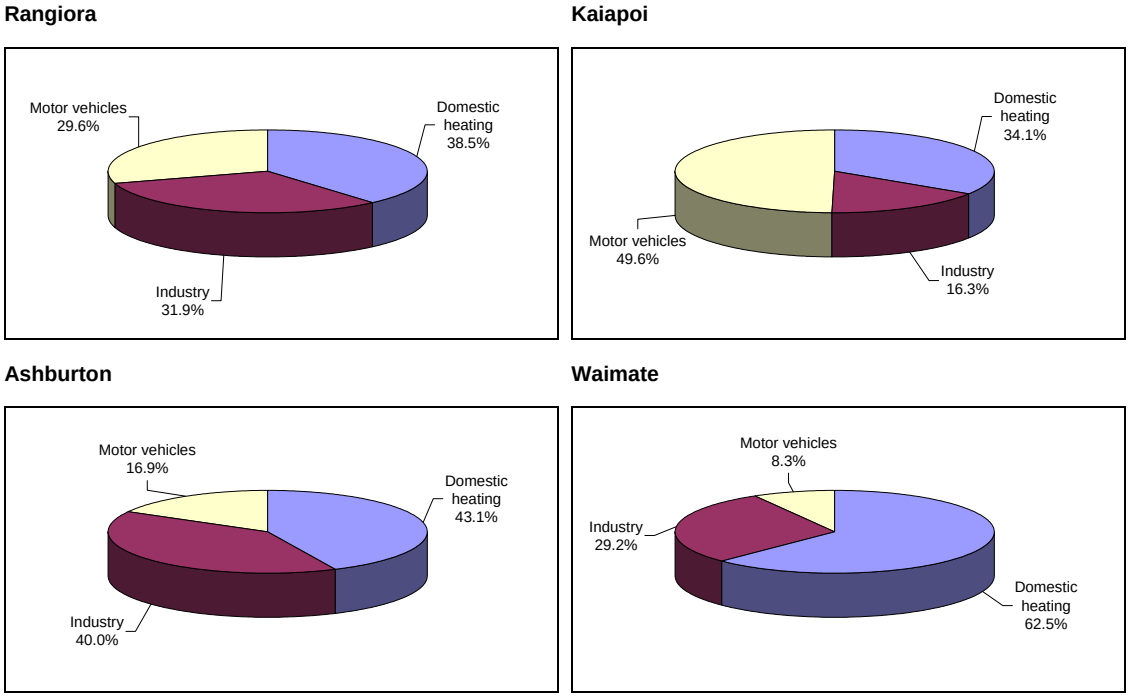


Figure 5.8: Sources of SO_2 emissions in Rangiora, Kaiapoi, Ashburton and Waimate



5.6 Otago

Industry is the dominant source of SO_2 emissions in Dunedin, contributing 89% of the emissions (Figure 5.9). Industry is also a major contributor in many of the smaller areas of the region, although the proportion of emissions from domestic heating often increases in these areas (Figures 5.10–5.12); this typically occurs because many of the smaller urban areas have limited industrial contributions.

Figure 5.9: Sources of SO_2 in Dunedin (1999 inventory)

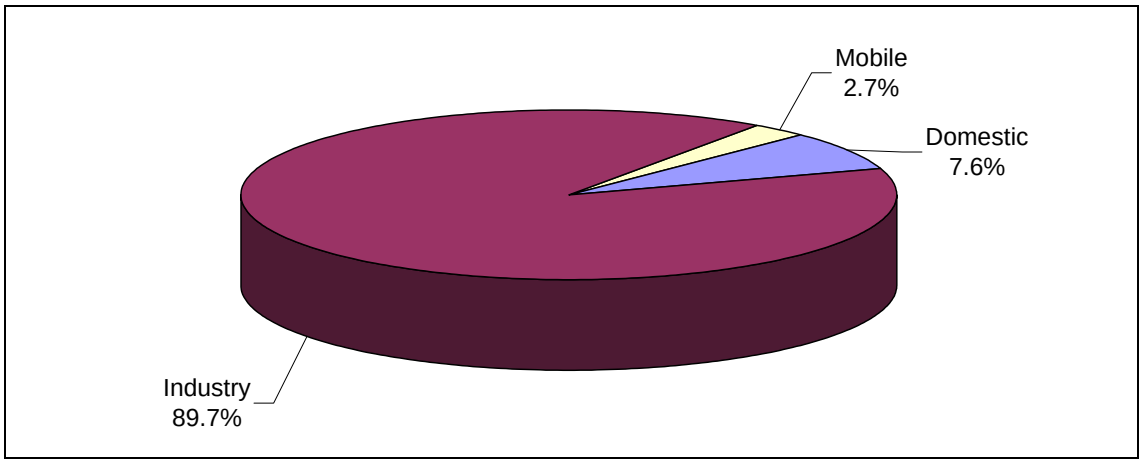
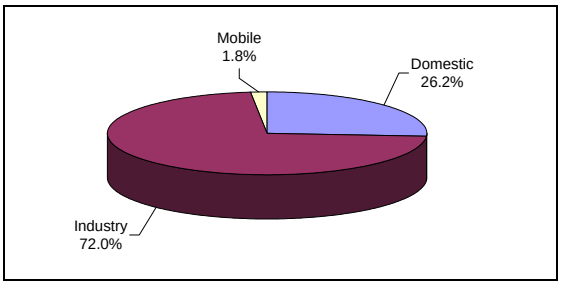
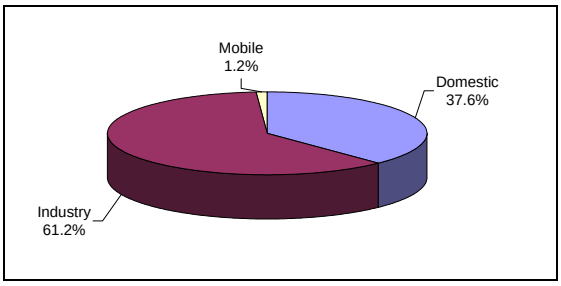


Figure 5.10: Sources of SO_2 in Alexandra, Balclutha, Arrowtown and Clyde (1999 inventory)

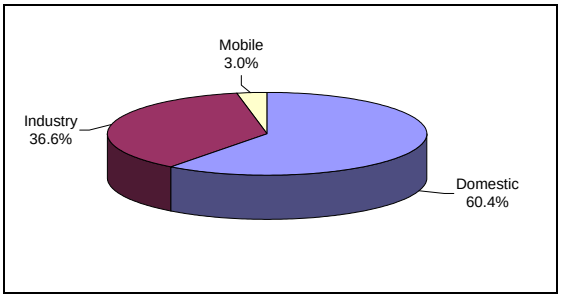
Alexandra



Balclutha



Arrowtown



Clyde

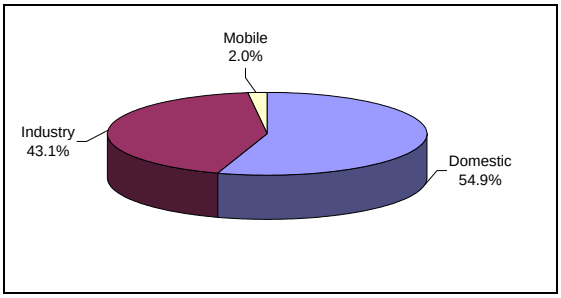


Figure 5.11: Sources of SO_2 in Cromwell, Milton, Mosgiel and Oamaru (1999 inventory)

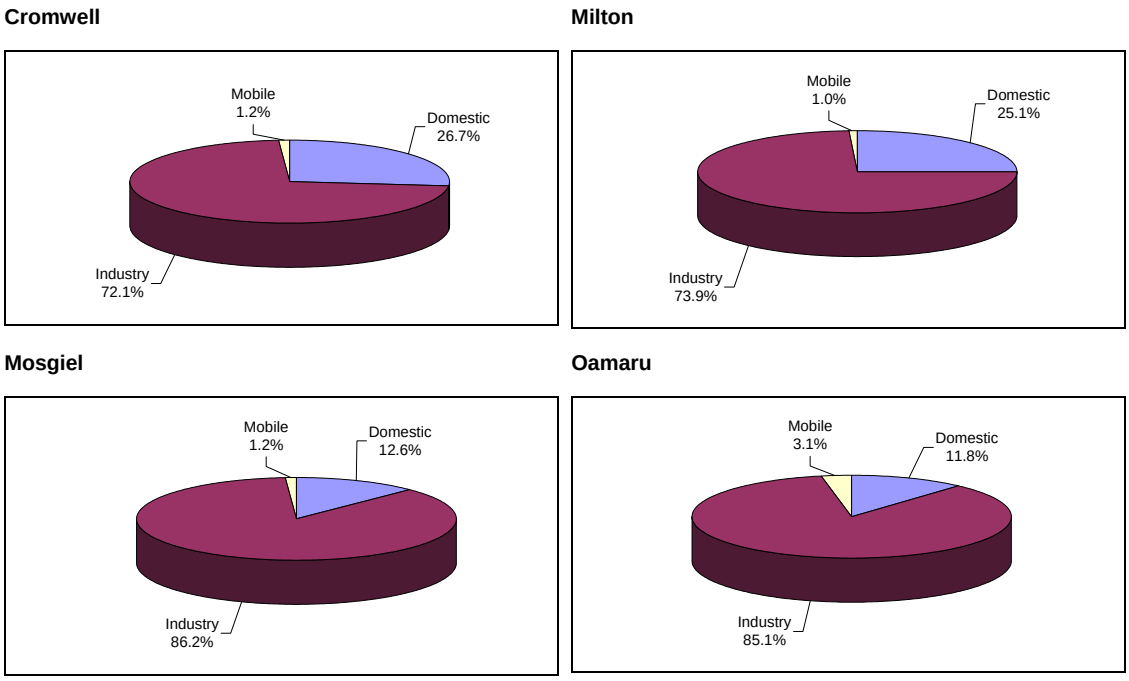
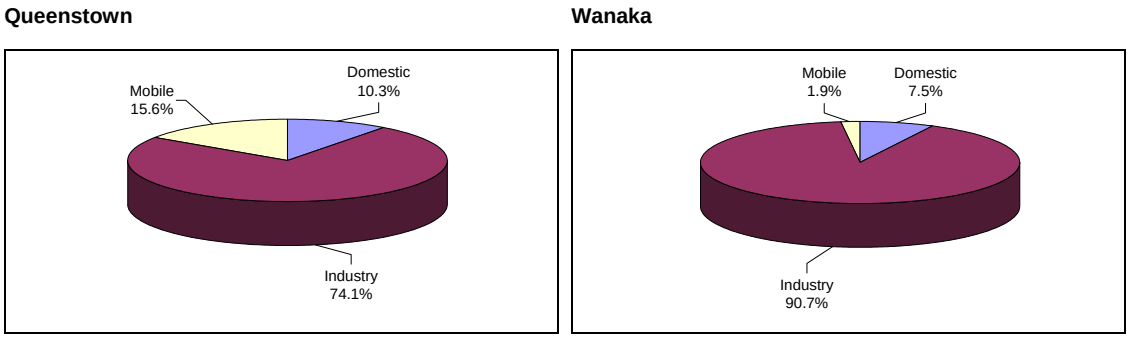


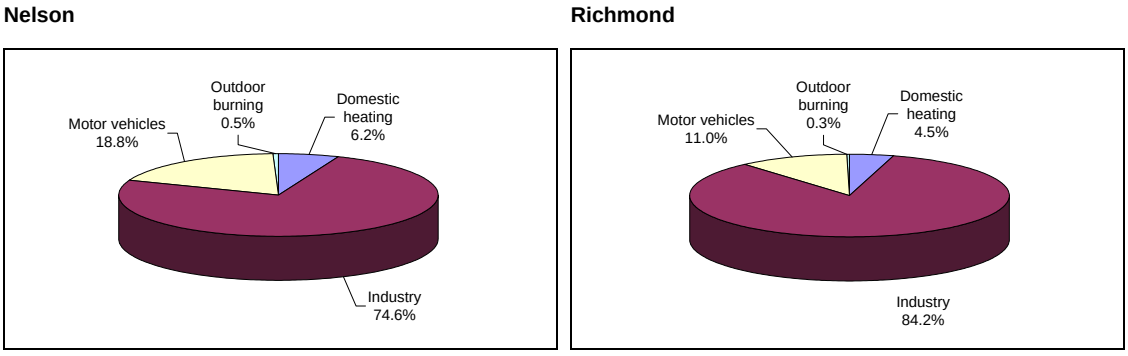
Figure 5.12: Sources of SO_2 in Queenstown and Wanaka (1999 inventory)



5.7 Nelson and Richmond

Industry is the main contributor to SO_2 emissions in both Nelson and Richmond (Figure 5.13), contributing 75% and 85% in these areas respectively. The main industrial sources of SO_2 in Nelson and Richmond are coal-fired boilers, which contribute 71% and 64% in these areas respectively.

Figure 5.13: Sources of SO_2 in Nelson (2001 inventory) and Richmond (2000 inventory)



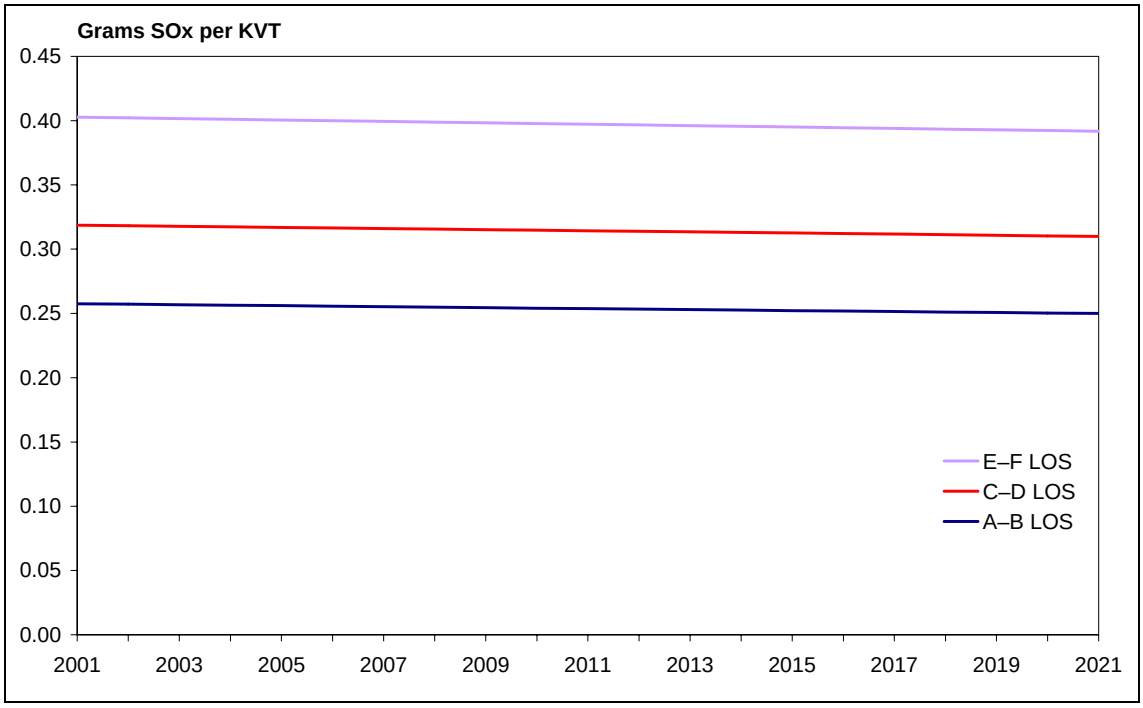
5.8 Trends in SO_2 emissions in New Zealand

The main source of SO_2 emissions in many urban areas of New Zealand is industry. However, motor vehicles are the dominant contributor in most areas where industry emissions are minimal. SO_2 emissions from motor vehicles are dominated by emissions from diesel vehicles. Changes in emissions from motor vehicles and industry will therefore be key drivers in trends in SO_2 concentrations within urban areas of New Zealand.

For motor vehicle emissions, factors such as increasing use of diesel vehicles and revisions to the fuel specifications will impact on SO_2 emissions. The 2001 Ministry of Economic Development review of the fuel specifications for petroleum products in New Zealand includes a reduction in maximum sulphur content of petrol vehicles from 500 ppm to 50 ppm.

Figure 5.14 shows an estimate of the changes in SO_2 emissions from motor vehicles with time as estimated by the Fuel and Energy Group for Environment Canterbury in 2001. The three levels of service (LOS) categories represent emission rates for different levels of congestion.

Figure 5.14: Predicted trends in SO_2 emissions from motor vehicles



Source: From NZTER for the New Zealand vehicle fleet profile.

Notes: A–B shows free flow, C–D interrupted flow and E–F congested flow.

Future trends in SOx emissions from industry are difficult to assess. In many areas, these are likely to be dominated by coal-fired boilers with some contribution from diesel boilers. Growth in industry is likely to be area specific and may depend on the extent of existing regulation control measures.

There is very limited trend information from emission inventory studies as Timaru and Christchurch are the only areas to have published a second inventory assessment. The Timaru inventory shows no changes in total SOx emissions from 1996 to 2000. A comparison of 1996 and 1999 SO_2 emission estimates for Christchurch shows a significant increase in SO_2 between the two inventories. However, methodological differences in the assessment of emissions from this source are likely to account for much of this difference.

5.9 Summary of sources of SO_2 in New Zealand

The results of the emission inventory investigations into sources of SOx in New Zealand are shown in Table 5.1. With the exception of Bay of Plenty, Taranaki and Gisborne, this data represents average wintertime emission sources.

In Northland, around 14 tonnes of SOx is estimated compared to around 8 tonnes in Christchurch and 7 tonnes in Auckland and Wellington. Unlike the other larger cities, which are dominated by industry, commercial shipping produces the majority of the SO_2 emissions in Wellington.

The relative contributions to SOx emissions shown in Table 5.1 are based on assumptions relating to emission rates and fuel use and contain some degree of uncertainty. There is some variation from area to area in the approach taken and the subsequent confidence in the results. Some limitations associated with different emission inventory assessments are discussed in Table 2.1.

Table 5.1: Comparison of SO_2 emission estimates for different regions of New Zealand

	Domestic kg/day	Mobile sources kg/day	Industry kg/day	Other domestic kg/day	Other mobile kg/day	Total kg/day
Alexandra	59	4	162			225
Arrowtown	16	0.5	26			43
Balclutha	99	5	60			164
Clyde	14	0.5	11			26
Cromwell	23	1	62			86
Milton	52	2	153			207
Mosgiel	64	6	437			507
Oamaru	75	20	543			638
Queenstown	35	53	252			340
Wanaka	8	2	97			107
Dunedin	435	153	5,108			5,696
	Domestic heating kg/day	**Motor vehicles kg/day**	**Industry kg/day**	**Other domestic kg/day**	**Other mobile kg/day**	**Total kg/day**
Christchurch	463	1,113	6,613			8,189
Rangiora	52	40	43			135
Kaiapoi	44	64	21			129
Ashburton	214	84	199			497
Waimate	45	6	21			72
Timaru	55	89	176			320
Nelson	45	138	549	3		736
Northland	72	447	13,301	6		13,826
Auckland	400	1,000	4,000	1,010	710	7,120
Hamilton	223	425	2			650
Taupo	16	75	7			98
Tokoroa	49	51	72			172
	Domestic/ commercial heating kg/day	**Motor vehicles kg/day**	**Industry kg/day**	**Other domestic kg/day**	**Other mobile kg/day**	**Total kg/day**
Wellington	150	900	300	10	6,020	7,380
	Domestic t/ year	**Mobile sources t/ year**	**Industry t/ year**	**Burn-offs t/ year**		**Total t/ year**
BOP	243	1,167	646			2,056
Gisborne	6	47	0.18			53

6 Sources of Ozone Precursors

Ground level ozone is a secondary pollutant, which is formed when the primary pollutants nitrogen oxides (NOx) and volatile organic compounds (VOC) combine in the presence of sunlight (MfE, 1994). The main VOC of interest are those with eight or less carbon atoms per molecule as these are the most reactive in the atmosphere. The exception is methane, which has one carbon atom and is relatively stable. Because sources of nitrogen oxide are considered in Section four, the focus of this section is on emissions of VOC.

Not all inventories have included estimates of VOC. Of those that have, not all specify that emission estimates have been for non-methane VOC. However, it has been assumed that unless specified, estimates of VOC in the inventories refer to non-methane VOC.

Figures 6.1 to 6.7 show the relative contribution of different sources to VOC emissions in different areas of New Zealand. In most areas, domestic home heating and motor vehicles are estimated to be the main contributors to VOC emissions. In Gisborne, natural emissions are the dominant source of VOC emissions. However, in most other areas natural source emissions were not included in the emission inventory assessment. Consequently, this source may also be a significant contributor in other areas. An estimate of natural VOC emissions for New Zealand has been made (NIWA, 1996). These results cannot easily be extended to the existing inventories because of differences in the spatial resolutions.

In Taupo, Christchurch and Kaiapoi, industry is a significant contributor to VOC emissions. Table 6.1 shows summary data for VOC emissions for different areas of New Zealand.

Figure 6.1: Sources of VOC in Wellington (1999 inventory) and Auckland (1993 inventory)

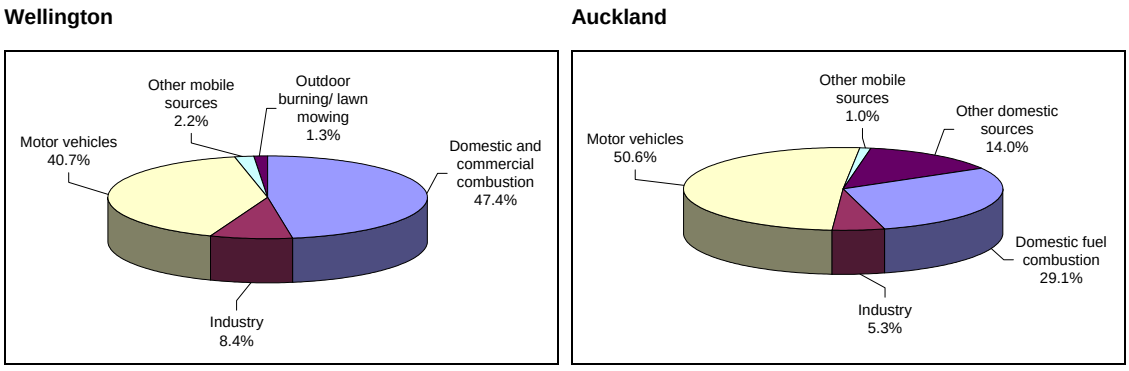
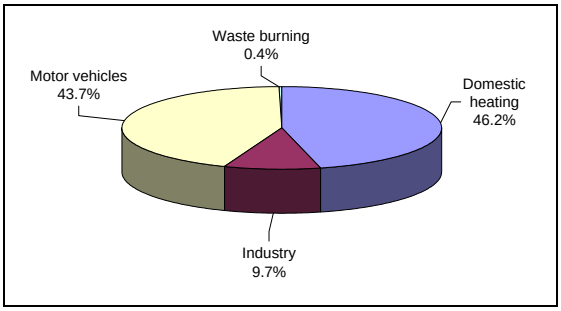


Figure 6.2: Sources of VOC in Northland (non-specific year) and Gisborne (1996 inventory)

Northland



Gisborne

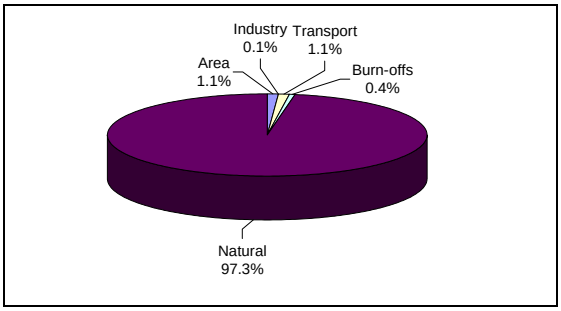
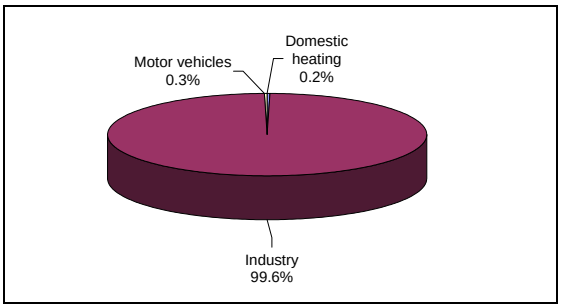


Figure 6.3: Sources of VOC in Taupo and Tokoroa (2001 inventory)

Taupo



Tokoroa

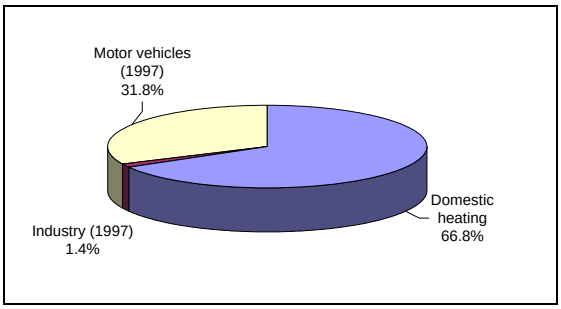
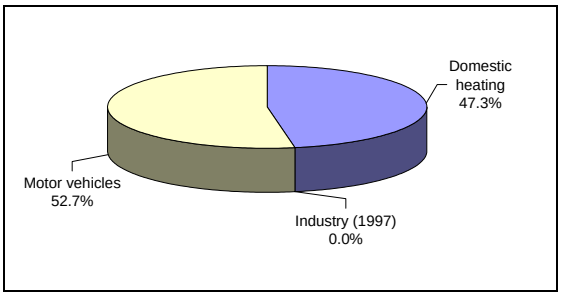


Figure 6.4: Sources of VOC in Hamilton (2001 inventory) and Christchurch

Hamilton



Christchurch

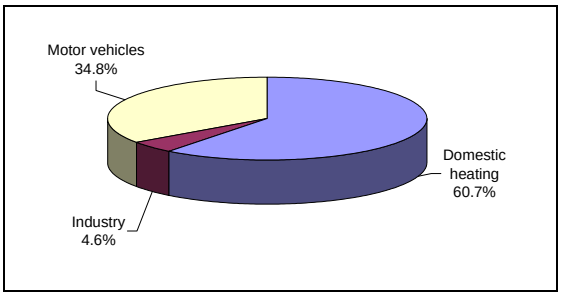
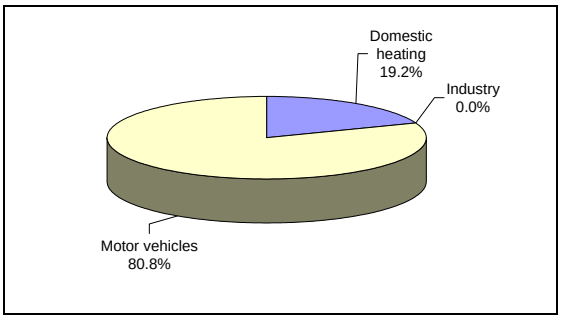


Figure 6.5: Sources of VOC in Taranaki (1998 inventory)

Taranaki – source



Taranaki – area

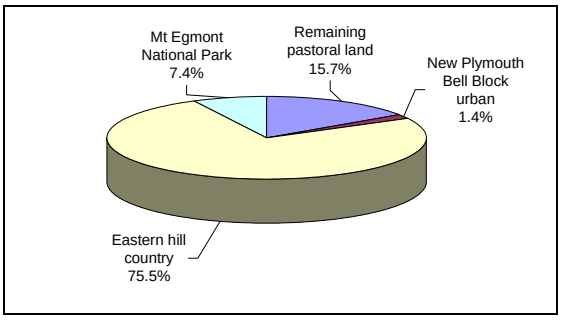
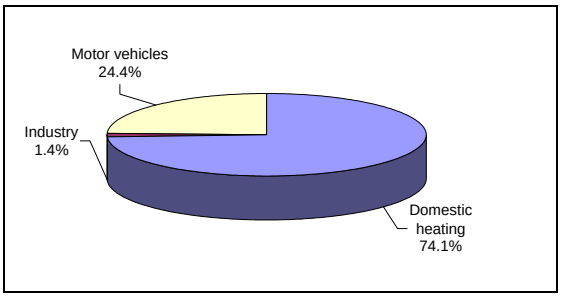
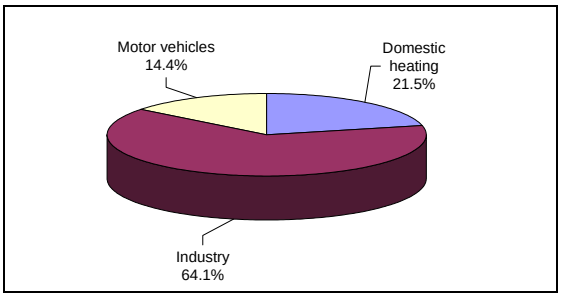


Figure 6.6: Sources of VOC in Rangiora, Kaiapoi, Ashburton and Waimate

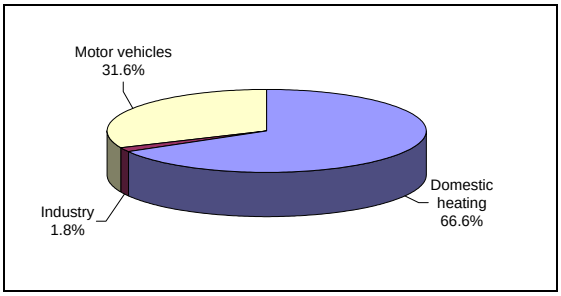
Rangiora



Kaiapoi



Ashburton



Waimate

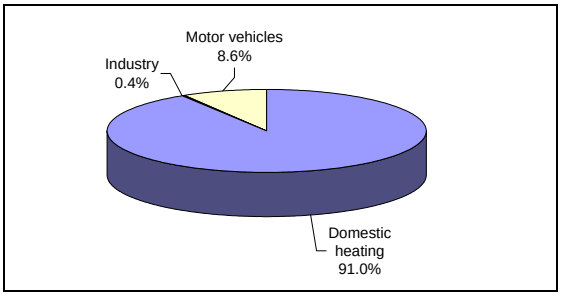
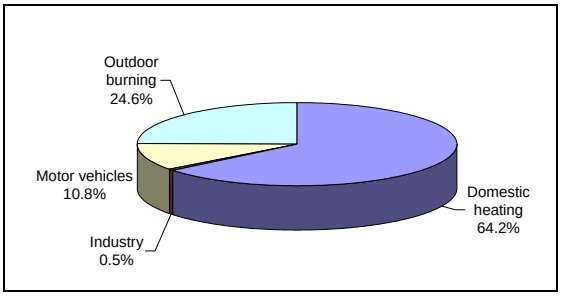


Figure 6.7: Sources of VOC in Nelson (2001 inventory) and Richmond (2000 inventory)

Nelson



Richmond

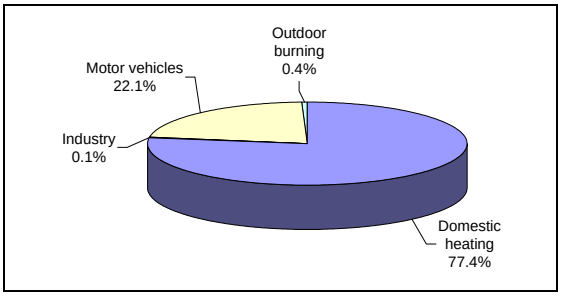


Table 6.1: Comparison of VOC emission estimates for different regions of New Zealand

	Domestic heating kg/day	Motor vehicles kg/day	Industry kg/day	Other domestic kg/day	Other mobile kg/day	Total kg/day
Christchurch	20,303	1,525	11,634			33,461
Rangiora	976	322	19			1,317
Kaiapoi	579	380	1,727			2,686
Ashburton	1,336	634	37			2,007
Waimate	474	44	2			521
Timaru	–	–	–			–
Nelson	4,120	29	1,581	692		6,423
Northland	6,929	6,784	1,509	318		15,540
Auckland	60,900	106,000	11,000	29,300	2,100	209,300
Hamilton	7,131	7,952	3			15,086
Taupo	1,232	476,100	809			478,141
Tokoroa	1,883	898	39			2,820
	Domestic/ commercial heating kg/day	**Motor vehicles kg/day**	**Industry kg/day**	**Other domestic kg/day**	**Other mobile kg/day**	**Total kg/day**
Wellington	94,600	81,200	16,800	2,500	4,800	199,900
	Domestic t/ year	**Mobile sources t/ year**	**Industry t/ year**	**Burn-offs t/ year**		**Total t/ year**
Taranaki	868	2,358	237			3,463
Gisborne	838	787	50	296		1,971

7 Benzene Emissions

Only a small number of the emission inventories carried out in New Zealand have included an assessment of sources of benzene. These inventories indicate that benzene estimates should be treated with caution because of uncertainties regarding emission factors from different sources, in particular motor vehicles. Until more robust emission rates for benzene are established specific to New Zealand fuels and vehicles, emission inventories assessments that include benzene should be treated with caution.

Figures 7.1 and 7.2 show the emission inventory assessment of sources of benzene in Nelson, Richmond and Christchurch and Timaru. The assessment for Christchurch was not included in the Christchurch 1999 emission inventory but has been estimated for this report, based on the emission factors used for the Timaru emission inventory. In each of these areas, the main contributors to benzene emissions are motor vehicle emissions and domestic home heating.

Some VOC speciation data including estimates for benzene are included in the Auckland 1993 air emissions inventory. This is not presented graphically as sufficient speciation data were not provided for industry. However, data indicates motor vehicles are the most dominant source of benzene in Auckland. Domestic heating emissions were also significant, contributing two-thirds as much as motor vehicles.

Figure 7.1: Sources of benzene emissions in Nelson and Richmond

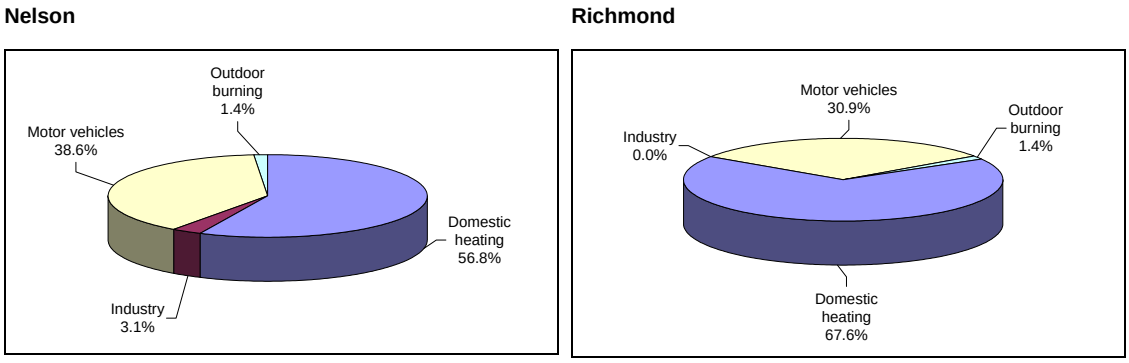
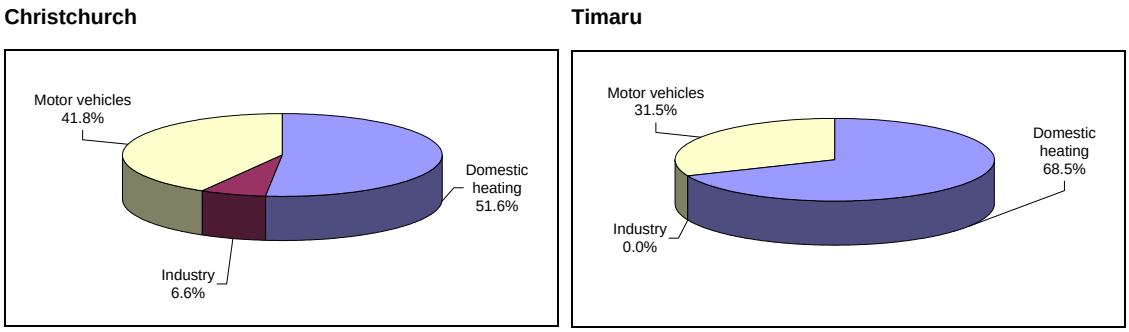


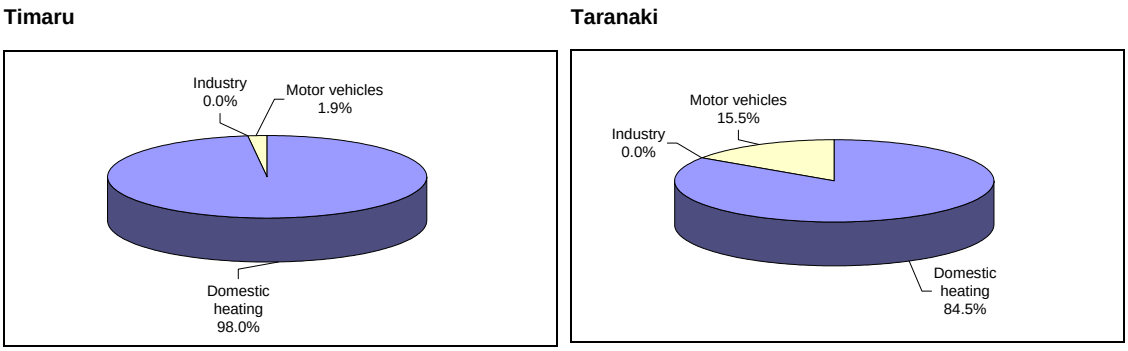
Figure 7.2: Sources of benzene emissions in Christchurch and Timaru



8 Benzo(a)pyrene Emissions

Estimates of sources of benzo(a)pyrene (BaP) emissions have been made in two inventories carried out for New Zealand (Figure 8.1). Both indicate domestic home heating is the primary contributor for these areas. This is also consistent with monitoring data for Christchurch, which shows a strong correlation between concentrations of PM_{10} and concentrations of BaP during the winter months (Gunathlika, 2002). Emission inventory studies for Christchurch show domestic heating is the dominant source of PM_{10} emissions (NIWA, 1998, Wilton, 2001c). It is therefore also most likely to be the main source of BaP.

Figure 8.1: Sources of BaP in Timaru and Taranaki



References

Environment Protection Authority of Victoria. 1997. *Auckland Air Emissions Inventory – Final Report*. Auckland Regional Council, Technical Report No. 91, 1998.

Environmental Science and Research and Pacific Air and Environment. 1999. *Otago Inventory of Domestic Emissions*. Otago Regional Council Report.

Foster E. 1998. *Ashburton Inventory of Emissions.* Canterbury Regional Council Report U98/52.

Foster E. 1998. *Kaiapoi Inventory of Emissions*. Canterbury Regional Council Report U98/48.

Foster E. 1998. *Rangiora Inventory of Emissions*. Canterbury Regional Council Report U98/49.

Foster E. 1998. *Waimate Inventory of Emissions*. Canterbury Regional Council Report U98/47.

Gimson N, Fisher G. 1997. *The Relationship Between Emissions to Air and Measured Ambient Air Concentrations of Contaminants in Christchurch.* Canterbury Regional Council Report U97(67).

Gunatilaka M. 2002. *Hazardous Air Pollutant Monitoring in Christchurch*. Environment Canterbury Report No. R01/31.

Gunatilaka M. 2003. *Hazardous Air Pollutants Concentrations of BTEX (Benzene, Toluene, Ethylbenzene and Xylene) in Christchurch (2001/2002).* Environment Canterbury Report No. R03/9.

National Institute of Water and Atmospheric Research. 1998. *National Inventory of Total Emissions*. NIWA report AK98064.

Pacific Air and Environment. 1998. *Wellington Emissions Inventory, Industrial and Mobile Sources*. Wellington Regional Council Report.

Pacific Air and Environment. 1998. *Wellington Emissions Inventory Phase 2 – Area Based Domestic and Commercial Sources*. Wellington Regional Council Report.

Weymss P. 1997. *Environment BOP Air Emission Inventory (revised).* Opus International unpublished report.

Wilton E. 2001a. *Good Practice Guide for Preparing Emission Inventories.* Sustainable Management Fund Project. Ministry for the Environment, Wellington.

Wilton E. 2001b. *Timaru Inventory of Air Emissions – 2001*. Environment Canterbury Report R01/29.

Wilton E. 2001c. *Christchurch Inventory of Air Emissions – 1999*. Environment Canterbury Report R01/28.

Wilton E. 2002. *Hamilton, Tokoroa and Te Kuiti, Domestic Heating Emission Inventory 2001*. Environment Waikato report.

Wilton E. 2002. *Sources of PM_{10} in Taupo*. Environment Waikato report.

Wright P. 1996. *Emission Inventory for the Gisborne Region – Part 1*. NIWA report AK96071.

About the Ministry for the Environment

The Ministry for the Environment works with others to identify New Zealand's environmental problems and get action on solutions. Our focus is on the effects people's everyday activities have on the environment, so our work programmes cover both the natural world and the places where people live and work.

We advise the Government on New Zealand's environmental laws, policies, standards and guidelines, monitor how they are working in practice, and take any action needed to improve them. Through reporting on the state of our environment, we help raise community awareness and provide the information needed by decision makers. We also play our part in international action on global environmental issues.

On behalf of the Minister for the Environment, who has duties under various laws, we report on local government performance on environmental matters and on the work of the Environmental Risk Management Authority and the Energy Efficiency and Conservation Authority.

Besides the Environment Act 1986 under which it was set up, the Ministry is responsible for administering the Soil Conservation and Rivers Control Act 1941, the Resource Management Act 1991, the Ozone Layer Protection Act 1996, and the Hazardous Substances and New Organisms Act 1996.

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