Ministry for the
Environment
Manatū Mō Te Taiao

Visibility in New Zealand

National Risk Assessment

Final Draft Report

Prepared by the National Institute of Water and Atmospheric Research and others for the Ministry for the Environment

October 2000

Air Quality Technical Report No. 18

Foreword by the Ministry

This report, *Visibility in New Zealand – National Risk Assessment (Air Quality Technical Report18)* is the second of two documents prepared for the Ministry for the Environment on the effect of air pollution on atmospheric visibility in New Zealand.

The first, *Visibility in New Zealand: Amenity Value, Monitoring, Management and Potential Indicators (Air Quality Technical Report 17)* discusses the importance of visibility in New Zealand, reviews appropriate monitoring methods and discusses potential management approaches.

This second report presents a preliminary approach to determining where visibility may be at risk in New Zealand. As a relatively new and innovative approach, it needs to be examined carefully, discussed and reviewed.

This is a final draft report. It has been amended to take into account comments made by participants at a workshop in May 2000 and submissions received on the first draft. Copies of the presentations made at the workshops on visibility degradation can be viewed on the Ministry's website at:

http://www.mfe.govt.nz/monitoring/epi/airqualtech.htm

Please email, fax or send your comments on this final draft report to the Ministry by **20 February 2001**.

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- Participants at the workshops in May 2000.

1. Introduction

This report presents preliminary work to examine the potential development of a visibility risk index for New Zealand. It should be recognized that this is a new exercise and that this methodology is a trial exercise that needs to be scrutinized and discussed.

This report is one of two on visibility management that the Ministry is currently developing and seeking final input into. The first document entitled *Visibility Management – Amenity Value, Monitoring, Potential Indicators and Management*, should be reviewed before examining the exercise outlined in this report.

The document is structured as follows:

Chapter 2	describes the methodology, assumptions and proposes the visibility risk assessment index.
Chapter 3	contains a discussion on refinements and enhancements to the approach of assessing areas at risk from visibility degradation that will need to be considered in future.
Chapter 3	summarises the findings and conclusions of the report and recommends possible future work.

2. Determining Visibility Degradation Risk

2.1 Need for a risk index

The question of whether any particular region of New Zealand is currently suffering a visibility problem, or may in future, has never been fully assessed. Some urban areas – for instance Auckland and Christchurch – have relatively well defined issues that have been investigated.[1,2] Other areas, such as Hamilton, are aware of the potential problems but have not yet developed research and monitoring programmes. However, for most regions in New Zealand there has been no specific visibility monitoring and no attempt to quantify any future risks.

Some form of risk index would be useful for several purposes, such as providing:

- a guide to councils, to help prioritise resources
- information to the Ministry for the Environment to assess the state of New Zealand's environment and prioritise policy development
- data for the national Environmental Performance Indicators Programme [3]
- information to assess national research and development needs.

It is important to understand that the development of a risk index does not necessarily imply that visibility degradation in New Zealand is a serious problem. Indeed, the country generally has excellent visibility, except for a few areas and under particular weather conditions. The problem is more that there is currently no quantitative way to assess trends, nor to assess whether particular areas may be more susceptible to visibility degradation with a growth in emissions.

2.2 Development of criteria

It is difficult to find the appropriate criteria to use for a risk assessment.

For a start, there is very little research being done, either in New Zealand or internationally. Research that has been completed is invariably very specific to a particular location and particular set of problems. There is currently no usable generic model of visibility.

Secondly, the causes of visibility degradation are many and complex. They range from wind-blown sea spray, dust, fine particulates, gases, haze, rain, fog and clouds. These have both natural and anthropogenic sources.

Thirdly, visibility degradation can be caused by emissions within a region, but also by emissions well outside the region. A particularly striking example of this is the haze that sometimes appears over New Zealand's west coast from forest fires in Australia. This implies that a proper assessment of visibility degradation risk must include all potential downwind sources out to hundreds, or even thousands, of kilometres.

Finally, it is very difficult to correlate visibility (which in many cases is a matter of perception) with a quantified emission or concentration of a contaminant. There is no unit of 'visibility per cubic metre', and emissions inventories or models cannot assess visibility directly.

2.3 Criteria used

Despite all the problems discussed above, an attempt has been made to develop several criteria which will give an index of the risk of visibility degradation. These are:

- emissions of oxides of nitrogen – anthropogenic only
- emissions of fine particulates (PM_{10}) – anthropogenic only
- a subjective weather/geography factor
- a 'special' factor, to reflect particular circumstances, such as the occurrence of two or more adjacent high emissions areas, where emissions from one area can obviously impact on an adjacent one (this occurs in the Auckland territorial local authorities).

Other factors were considered, such as emissions of hydrocarbons, but not included in the current development. The rationale behind each of the chosen factors is explained below.

The whole exercise has been conducted on the basis of the 73 territorial local authorities in mainland New Zealand. In addition, only anthropogenic emissions are assessed at this stage; this includes industrial, domestic and transport emissions. The period used for the emissions, available from the National Total Emissions Inventory,[4] is one whole year, based on the 1996 year. The inventory was conducted using standard survey and analysis techniques, and represents a good first-order idea of contaminant emissions. It must be recognised, that territorial local authorities are not necessarily the best units for this assessment. There will be many with individual hotspots, say in valleys, or around significant emissions sources. However, these are subjects for further work, and do not detract from the concepts being trialled here.

It must be clearly recognised that there is nothing 'absolute' about these criteria. They are all somewhat arbitrary, based on the range of conditions currently found in New Zealand, and adjusted to give a final index that scales from 0 to 125. The applicability and usefulness of such an index can only be judged after a suitable trial period, and it is highly likely that a revision will be needed.

2.3.1 NOx

Oxides of nitrogen, particularly NO_2, constitute a relevant indicator of visibility degradation because:

- NO_2 directly affects visibility, giving the sky a distinct 'brown' appearance. It is likely that NO_2 is a primary component of visibility degradation over major cities such as Auckland.
- NO_2 is a good secondary indicator of anthropogenic combustion processes, which themselves can affect visibility in several ways. The natural sources of NO_2 are relatively minor.
- NO_2 is a major component in the atmospheric chemistry leading to secondary particulate production and photochemical smog.

The index used is the total annual emissions of NO_x (= NO plus NO_2, but most NO will convert rapidly to NO_2). This is banded into six categories:

> 16,000 tonnes per annum
> 8,000 tonnes per annum
> 4,000 tonnes per annum
> 2,000 tonnes per annum
> 1,000 tonnes per annum
> 100 tonnes per annum

These categories are set so that each is approximately two times the one below, with the critical urban areas falling into the maximum category.

2.3.2 PM_{10}

Particulate emissions are used as the second criterion. These are assessed by using PM_{10} data, as these are generally available whereas data on fine particulates ($PM_{2.5}$) are not currently. However, since there are no specific relationships between PM_{10} and NO_x, this component of the index is treated as an alternative to NO_x rather than an additive factor. For the purposes of the final index, the greater of either the NO_x index, or the PM_{10} index is taken. This applies to just three of the territorial authorities.

The index used is the total annual emissions of PM_{10}. This is banded into five categories:-

>2,500 tonnes per annum
>1,000 tonnes per annum
>400 tonnes per annum
>100 tonnes per annum
>40 tonnes per annum

These categories are set so that each is approximately 2.5 times the one below, with the critical urban areas falling into the maximum category.

2.3.3 Weather and geography

There is no question that both the weather of a region and its particular geography have a major influence on visibility. For instance, it is well known that Christchurch suffers because of its sheltered position and propensity for temperature inversions. A similar level of emissions in, say, the highly exposed New Plymouth region, would have a much lesser effect.

The index used is based on a fairly subjective assessment of the prevailing weather and the overall geography of the region. This is banded into four categories, each acting as a simple multiplier to the NO_x or PM_{10} index:

4 – low wind exposure and/or hilly terrain
3 – low wind exposure and/or flat terrain
2 – high wind exposure and/or hilly terrain
1 – high wind exposure and/or flat terrain

These criteria are set to provide a level of discrimination between regions. Ideally they should be based on more quantified factors, such as an in-depth analysis of winds and terrain. But this is not a trivial task, and the connection between the results and visibility degradation potential is completely undefined.

Some exposed places can experience reduced visibility due to wind-blown dust and sea salt. These factors have not been taken into account because there is not enough information on the extent or concentrations of the contaminants responsible, and most people do not regard ‘natural’ causes of reduced visibility as serious. In addition there is very little that can be done about them. They are significant only to the extent that they might provide a high background upon which other emissions are added.

2.3.4 Special factor

The final factor used is a 'special' factor, which is required because the above factors do not fully represent all possible influences on visibility. The main ones included here are:

Special weather	**for instance, if sea breezes can act to concentrate emissions more than might otherwise occur**
Adjacent regions	**for instance, if one or more adjacent regions are high emitters, then they could contribute extra amounts to the other**

A 'special' factor of x 2 has been applied to the four central Auckland territorial authorities. For convenience, this factor is incorporated into the Weather / Geography index in the calculations.

2.3.5 Other possibilities

Other factors that affect visibility could also be considered as contributing to the index. These might include hydrocarbons, sulphur oxides, and other types of particulates.

In addition, at this stage, only anthropogenic emissions are included, although, strictly speaking, in many cases natural emissions should be incorporated. This will be difficult, because the way natural emissions contribute is unclear, and these may bias the index in non-sensible ways. This will have to be addressed in future.

Hydrocarbons do contribute to visibility degradation, both directly, and through their role in photochemistry. Indeed volatile hydrocarbons may be the main contributor in forested areas to the formation of 'blue haze', which is largely composed of terpenes and other hydrocarbons emitted by trees. However, the nature of this role is very poorly understood, and impossible to estimate in New Zealand at this stage, even crudely.

Other contaminants could be incorporated in a more sophisticated index, but, for the level proposed here, are unlikely to add significantly more information.

2.3.6 Spatial dimension

The whole exercise has been conducted on the basis of territorial local authorities. This is a compromise, based on the resolution and availability of suitable data.

Ideally, a visibility risk index should be based on some concept of 'affected airshed'; that is, the unit of assessment should be over an area which is likely to be affected in a reasonably uniform way – a classic example being the Auckland 'brown cloud' which appears over the central city, and may drift a few kilometres, but not tens of kilometres. However, the manner in which such an airshed might be defined is not obvious, nor easy to determine. This would require an in-depth study of the air flows over all of New Zealand, which is simply not available. At least data on emissions are available at the scale of territorial local authorities.[4]

2.4 Indicators of risk

A final step must be to determine how to assess the risk factor; that is to determine whether some action might be needed, or to indicate to the community the appropriate level of concern they should have over visibility degradation in their region.

The model taken for this is from the primary air quality categories developed through the Environmental Performance Indicators Programme.[3] These categories are used for assessing the "acceptability" of the main atmospheric contaminants, in the following way:

Action	exceeds the guideline, *completely unacceptable*
Alert	between 66% and 100% of the guideline, *warning*
Acceptable	between 33% and 66% of the guideline, *watch*
Good	between 10% and 33% of the guideline, *no action*
Excellent	less than 10% of the guideline, *no concern*

It is proposed that visibility risk be assessed using similar criteria. There is currently no guideline for visibility, so a somewhat arbitrary classification is proposed, based on the following argument. New Zealand has two extremes:

- regions with almost perfect visibility, in areas with low emissions and good exposure – this will be 'defined' as the 'excellent' category.

- regions with noticeably degraded visibility (such as Auckland and Christchurch in winter), but probably not in the category of severely degraded – this will be 'defined' as the 'alert' category.

The other categories will be built around these as follows:

Risk Index	Category
>125	Very high risk *(action)*
25-125	High risk *(alert)*
5-25	Medium risk *(acceptable)*
1-5	Low risk *(good)*
0-1	Very low risk *(excellent)*

Each category is increased over the previous one by a factor of 5. As visibility degradation is a non-linear process, such geometric progression is appropriate. The factor of 5 has been used to provide a sensible spread across New Zealand regions.

2.5 Risk index components

Maps, by territorial local authorities, of each of the three input factors to the risk index are given in Figures 1, 2 and 3.

(Note that although the four central Auckland territorial local authorities rate a Weather/Geography risk multiplier of 2 on the basis of their good exposure, the final factor used is 4, being the result of multiplication by the special factor as discussed above). Figures for each region are given in Appendix B.

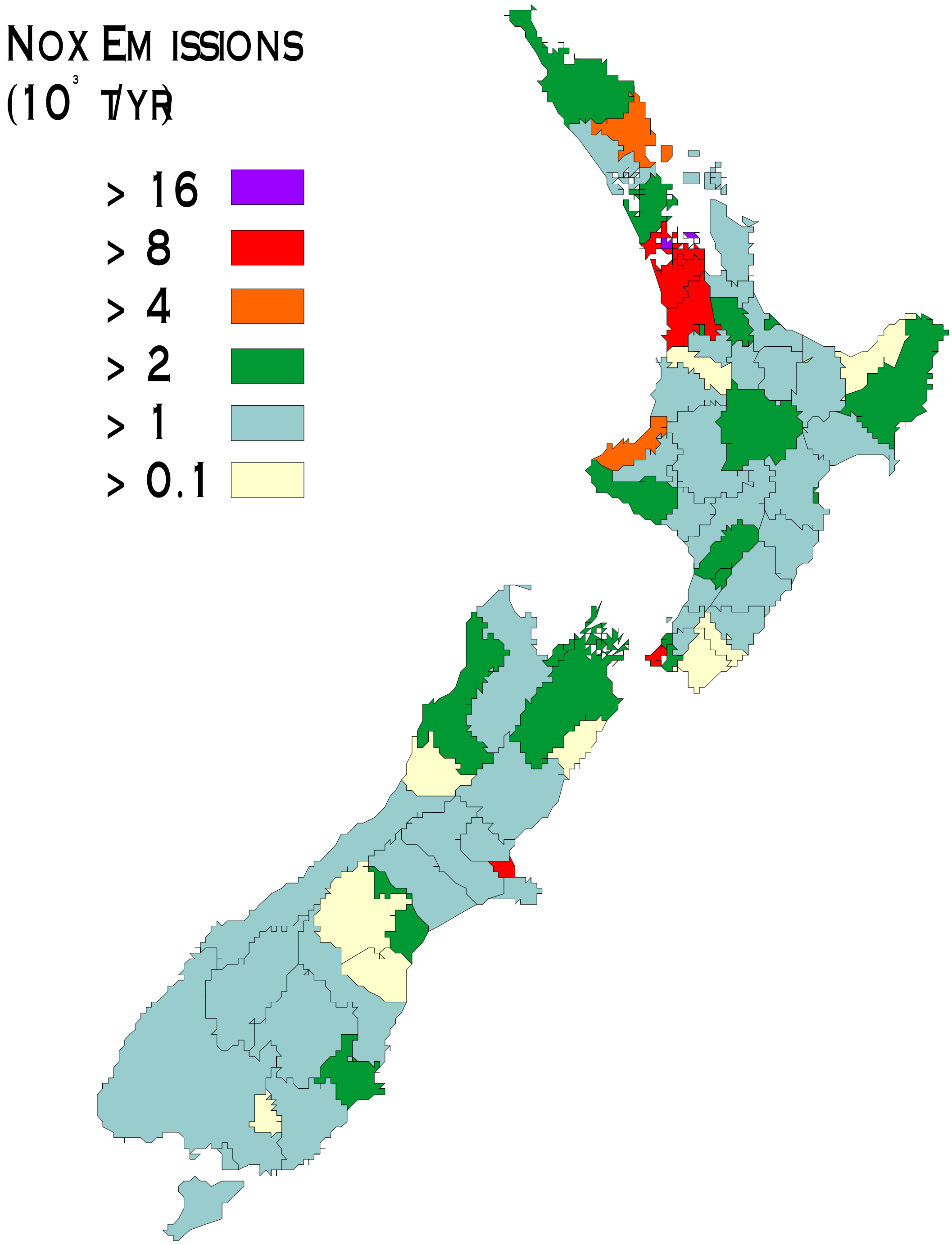

Figure 1: Emissions quantities of NO_x by territorial local authority, per annum.

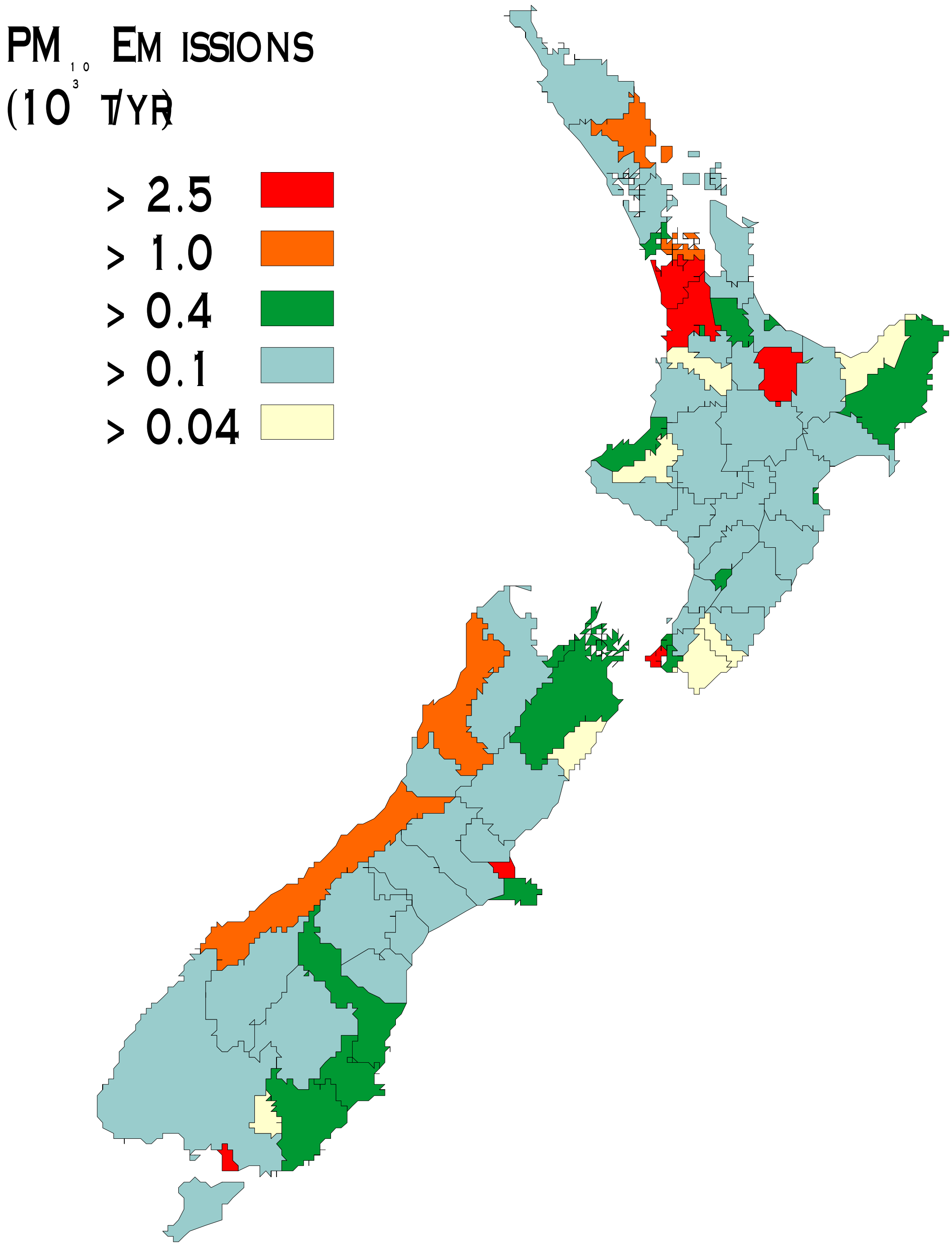

Figure 2:Emissions quantities of PM_{10} by territorial local authority, per annum.

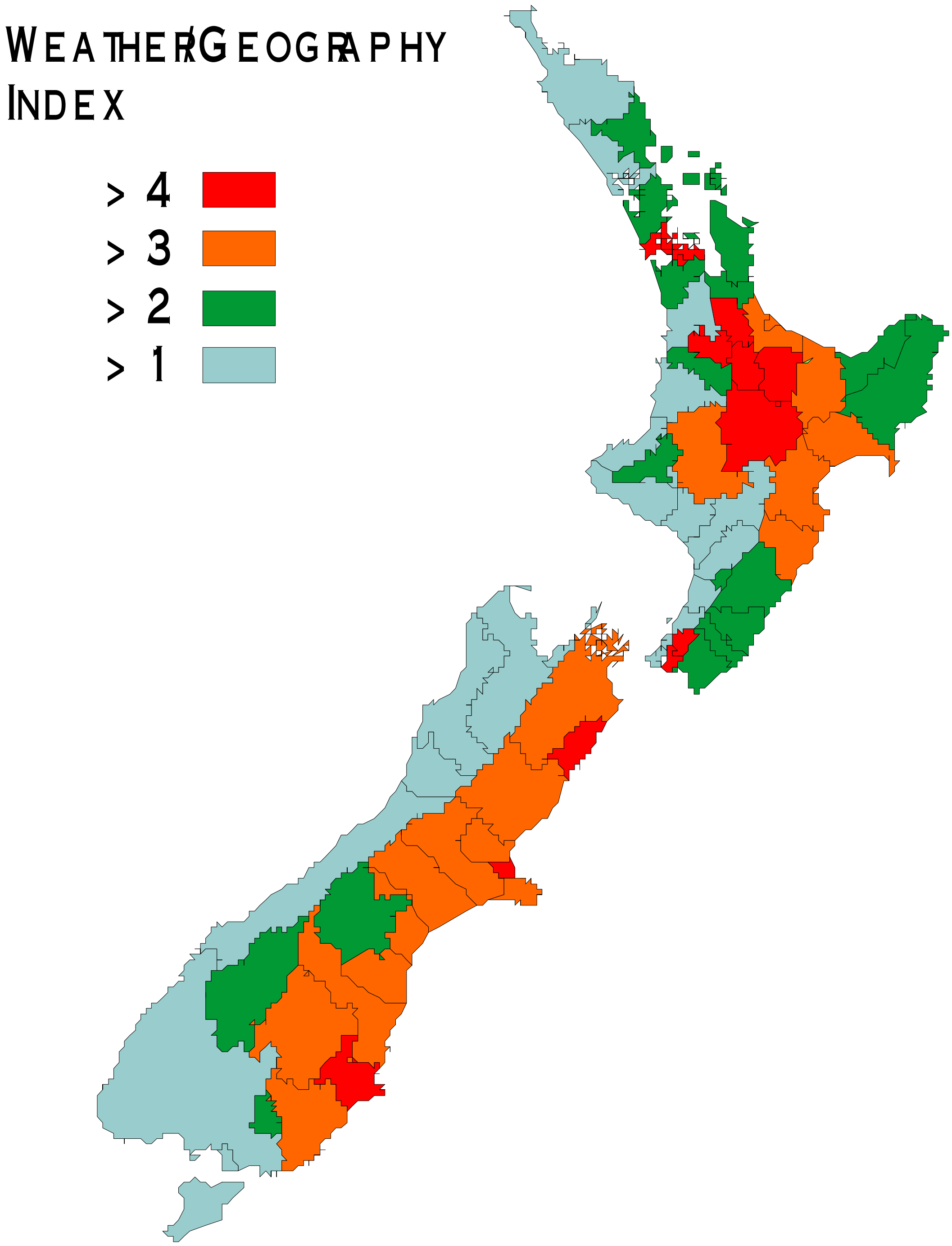

Figure 3: Multiplying factor for risk to visibility on the basis of weather and geography (including 'special' factor).

2.6 National Visibility Risk Index

The final national Visibility Risk Index is created in the following way.

For each region:

STEP 1. Determine the:
NO_x emissions in 1000's tonnes per annum
and
PM_{10} emissions in 1000's tonnes per annum

STEP 2. Multiply this by:
Weather/Geography Index
which includes the:
Special Factor – if applicable

STEP 3. Arrive at a total risk figure for NO_x and PM_{10}:
0.04 – 10 for PM_{10}
to
0.1 – 64 for NO_x

STEP 4. Assign a final risk factor as the higher of these two, classify this into the appropriate indicator category, and plot.

The resulting risk index for each territorial local authority is plotted in Figure 4. Note that the scale is not absolute, but relative to New Zealand conditions. (For instance, if this methodology were to be applied to a large overseas city, the index could be much higher).

Figure 4 shows a reasonable pattern across the country, largely reflecting what might be expected, especially in regions where some information is available. For instance, it shows that the Auckland region does indeed have one of the highest risks in the country, as confirmed by observation. It also shows some other areas that might be anticipated to have higher risks. At the other end of the scale, it shows areas that have very low risks, due to low emissions and good exposure to winds.

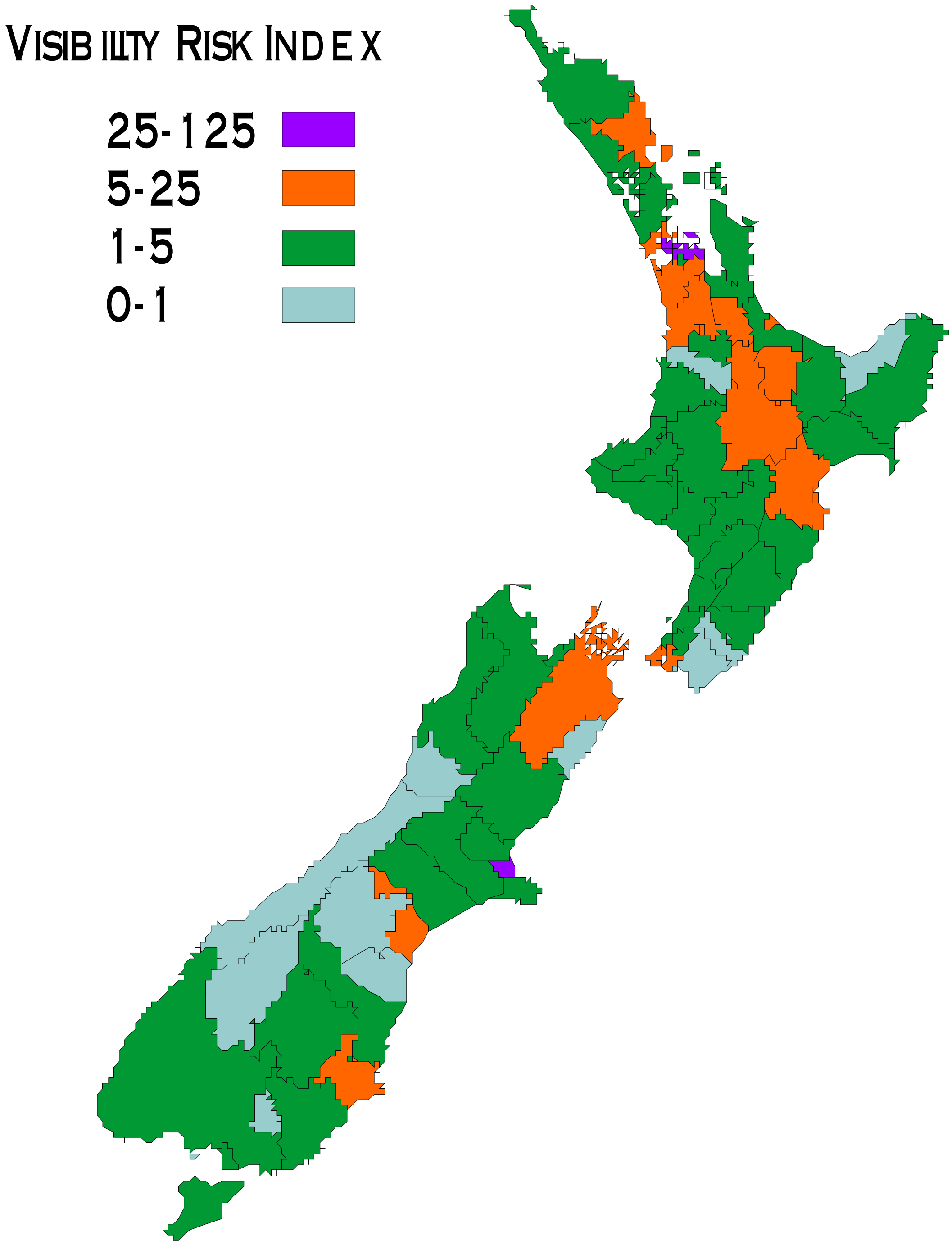

Figure 4: Visibility Risk Index for New Zealand.

3 Discussion

The preliminary and qualitative nature of this exercise is emphasised. It is an attempt to develop visibility as a useful indicator of environmental quality, as required in the Ministry for the Environment's Environmental Performance Indicators Programme.[3] The proposed index has been developed based on experience gained on visibility in New Zealand through several previous studies. [eg 1, 2, 5]

Although the index as proposed provides a useful quantitative indication of visibility risk throughout the country, there are several obvious refinements that could be made:

- revise the national emissions inventory, for more accurate estimates, and for future predictions
- include natural emissions
- include effects due to sea salt, which is a significant portion of the particulate mass in New Zealand and a main contributor to visibility degradation in coastal areas
- use more refined spatial scales, either at the city level, and/or airsheds
- use more refined time scales, say, seasonal or monthly emissions
- incorporate more contributing factors, especially hydrocarbons
- use fine particles (say $PM_{2.5}$) instead of PM_{10}
- model visibility, and compare to the risk index.

A next step is to undertake a trend analysis, to see which areas might become more or less susceptible to the risk of visibility degradation in the future. It is relatively common for contaminant emissions inventories to explore this, with projections of up to 20 years. This involves determining social trends, population shifts, estimates of technology improvements, increases in traffic volumes, and industrial development. However, at this stage such a projection has not been completed for the national inventory used here, and it is not a trivial exercise.

In addition, the overall risk assessment should ideally take some account of the different 'value' that visibility might have in different areas. For instance, in national parks and areas with scenic vistas admired by visitors and tourists, the protection of visibility might have a greater value to the community and the economy than, say, farming areas. This is a very subjective feature though, and it is beyond the scope of this discussion to attempt to determine what this 'value' might be. There is obviously a wide range of socioeconomic factors. One method might be to use the number of tourist visits – information that is readily available. However, this only recognises one dimension of the issue.

It is clear that a trial period is required, ideally in conjunction with visibility monitoring programmes. This may take several years. Other developments will arise as the issue of visibility is investigated more thoroughly. These include further studies by the Ministry for the Environment, a current research programme being funded by the Foundation for Research, Science and Technology, and new postgraduate studies being undertaken by several universities. In addition, overseas research may well provide useful new information.

Finally, it must be emphasised that the use of visibility risk indicators is simply one tool in a suite of environmental management tools. It must not replace the development of emissions inventories and direct monitoring of the relevant air quality parameters affecting visibility. Indeed, direct and long-term monitoring is the key indicator and by far the most powerful method of assessing and understanding the nature of visibility in New Zealand.

4 Summary

Good visibility is highly valued in New Zealand. It contributes substantially to amenity values for the community and is a significant contributor to high tourism revenues.

A quantitative method is needed for assessing which areas of New Zealand are currently subject to visibility degradation, and which might have some risks of suffering poorer visibility in the future.

An initial, preliminary, attempt has been made here to establish a "National Visibility Risk Index", which can be used to assess the risk of visibility degradation. New Zealand currently has very good overall visibility, and the development of this risk index is part of a larger programme aimed at providing tools to manage and maintain New Zealand's excellent air quality.

The risk index is based on total annual emissions to air of contaminants that affect visibility, combined with factors describing the weather and geography of the area. It has been constructed on the basis of the 75 territorial local authorities in mainland New Zealand.

The risk index shows that a few areas of the country have some risk of poor visibility, most are acceptable, but many remain in the excellent category.

It is expected that the many assumptions used in developing this risk index, will be subject to debate and refinement. However, this is the first time such an analysis has been attempted in New Zealand (and perhaps anywhere in the world), and does serve to raise awareness of the issues, and provide at least one tool for management and policy development at both the national and local level.

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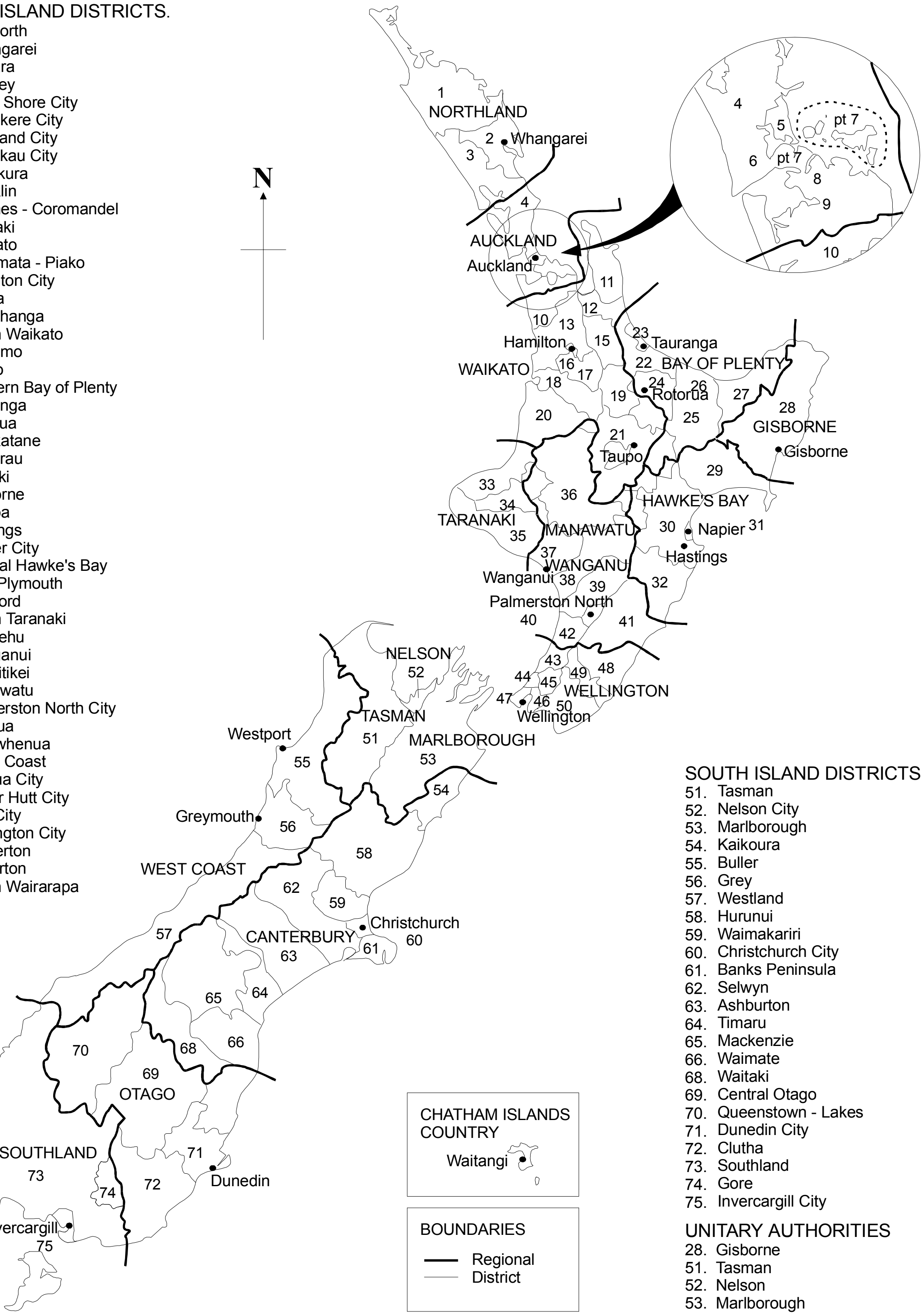
Appendix A

Territorial local authorities

NORTH ISLAND DISTRICTS.

1. Far North
2. Whangarei
3. Kaipara
4. Rodney
5. North Shore City
6. Waitakere City
7. Auckland City
8. Manukau City
9. Papakura
10. Franklin
11. Thames - Coromandel
12. Hauraki
13. Waikato
15. Matamata - Piako
16. Hamilton City
17. Waipa
18. Otorohanga
19. South Waikato
20. Waitomo
21. Taupo
22. Western Bay of Plenty
23. Tauranga
24. Rotorua
25. Whakatane
26. Kawerau
27. Opotiki
28. Gisborne
29. Wairoa
30. Hastings
31. Napier City
32. Central Hawke's Bay
33. New Plymouth
34. Stratford
35. South Taranaki
36. Ruapehu
37. Wanganui
38. Rangitikei
39. Manawatu
40. Palmerston North City
41. Tararua
42. Horowhenua
43. Kapiti Coast
44. Porirua City
45. Upper Hutt City
46. Hutt City
47. Wellington City
48. Masterton
49. Carterton
50. South Wairarapa



SOUTH ISLAND DISTRICTS

51. Tasman
52. Nelson City
53. Marlborough
54. Kaikoura
55. Buller
56. Grey
57. Westland
58. Hurunui
59. Waimakariri
60. Christchurch City
61. Banks Peninsula
62. Selwyn
63. Ashburton
64. Timaru
65. Mackenzie
66. Waimate
68. Waitaki
69. Central Otago
70. Queenstown - Lakes
71. Dunedin City
72. Clutha
73. Southland
74. Gore
75. Invercargill City

UNITARY AUTHORITIES

28. Gisborne
51. Tasman
52. Nelson
53. Marlborough

Appendix B

Emissions data and index calculations

Total annual emissions by North Island territorial local authority

Territorial Local Authority	Contaminant (tonnes/year)			Multipliers for:		Weather & Geography	Pollutant	Visibility
North Island	VOC	NOx	PM_{10}	NOx	PM_{10}	risk factor	risk factor	"RISK No."
Far North District	3373	2516	329	2.0	0.1	1	2.0	2.0
Whangarei District	5868	5697	1672	4.0	1.0	2	4.0	8.0
Kaipara District	1451	1353	143	1.0	0.1	1	1.0	1.0
Rodney District	4285	3435	389	2.0	0.1	2	2.0	4.0
North Shore City	9046	5218	910	4.0	0.4	4	4.0	16.0
Waitakere City	7636	4003	786	4.0	0.4	4	4.0	16.0
Auckland City	24831	20507	2285	16.0	1.0	4	16.0	64.0
Manukau City	13868	8497	1378	8.0	1.0	4	8.0	32.0
Papakura District	2583	1848	246	1.0	0.1	2	1.0	2.0
Franklin District	3545	9015	3536	8.0	2.5	2	8.0	16.0
Thames-Coromandel District	1674	1445	172	1.0	0.1	2	1.0	2.0
Hauraki District	1793	1868	169	1.0	0.1	2	1.0	2.0
Waikato District	5781	15225	360	8.0	0.1	1	8.0	8.0
Matamata-Piako District	2893	2704	245	2.0	0.1	4	2.0	8.0
Hamilton City	5662	3088	578	2.0	0.4	4	2.0	8.0
Waipa District	5076	1947	253	1.0	0.1	4	1.0	4.0
Otorohanga District	3210	672	75	0.1	0.0	2	0.1	0.2
South Waikato District	2058	1620	2988	1.0	2.5	4	2.5	10.0
Waitomo District	997	1098	104	1.0	0.1	1	1.0	1.0
Taupo District	4795	2762	249	2.0	0.1	4	2.0	8.0
Western Bay of Plenty District	2367	1946	214	1.0	0.1	3	1.0	3.0
Tauranga District	4239	3532	483	2.0	0.4	3	2.0	6.0
Rotorua District	4157	2829	394	2.0	0.1	4	2.0	8.0
Whakatane District	2324	1833	231	1.0	0.1	3	1.0	3.0
Kawerau District	1052	100	2847	0.1	2.5	3	2.5	7.5

Total annual emissions by North Island territorial local authority

Territorial Local Authority	Contaminant (tonnes/year)			Multipliers for:		Weather & Geography	Pollutant	Visibility
North Island	VOC	NOx	PM_{10}	NOx	PM_{10}	risk factor	risk factor	"RISK No."
Opotiki District	630	588	78	0.1	0.0	2	0.1	0.2
Gisborne District	3137	2976	405	2.0	0.4	2	2.0	4.0
Wairoa District	917	1210	136	1.0	0.1	3	1.0	3.0
Hastings District	4585	3563	460	2.0	0.4	3	2.0	6.0
Napier City	3239	2336	342	2.0	0.1	3	2.0	6.0
Central Hawke's Bay District	1304	1327	121	1.0	0.1	3	1.0	3.0
New Plymouth District	4262	5419	450	4.0	0.4	1	4.0	4.0
Stratford District	721	1256	70	1.0	0.0	2	1.0	2.0
South Taranaki District	2700	2439	262	2.0	0.1	1	2.0	2.0
Ruapehu District	1550	1526	149	1.0	0.1	3	1.0	3.0
Wanganui District	2733	1617	265	1.0	0.1	1	1.0	1.0
Rangitikei District	1754	1688	138	1.0	0.1	1	1.0	1.0
Manawatu District	2548	2293	214	2.0	0.1	1	2.0	2.0
Palmerston North City	3935	2134	403	2.0	0.4	2	2.0	4.0
Tararua District	1858	1789	171	1.0	0.1	4	1.0	4.0
Horowhenua District	2008	1407	192	1.0	0.1	1	1.0	1.0
Kapiti Coast District	2343	1644	226	1.0	0.1	1	1.0	1.0
Porirua City	2939	1813	285	1.0	0.1	1	1.0	1.0
Upper Hutt City	2079	1126	213	1.0	0.1	4	1.0	4.0
Lower Hutt City	5559	3176	562	2.0	0.4	4	2.0	8.0
Wellington City	10070	8625	1104	8.0	1.0	1	8.0	8.0
Masterton District	1549	1187	162	1.0	0.1	2	1.0	2.0
Carterton District	501	382	45	0.1	0.0	2	0.1	0.2
South Wairarapa District	796	806	87	0.1	0.0	2	0.1	0.2

Total Annual Emissions by South Island TLA

Territorial Local Authority	Contaminant (tonnes/year)			Multipliers for…		Weather + Geography	Pollutant	Visibility
South Island	VOC	NOx	PM_{10}	NOx	PM_{10}	Risk Factor	Risk Factor	"RISK No."
Tasman District	5234	1913	398	1.0	0.1	1	1.0	1.0
Nelson City	2375	2119	455	2.0	0.4	1	2.0	2.0
Marlborough District	2606	3141	513	2.0	0.4	3	2.0	6.0
Kaikoura District	349	363	44	0.1	0.0	4	0.1	0.4
Buller District	3448	1829	1074	1.0	1.0	1	1.0	1.0
Grey District	3495	696	155	0.1	0.1	1	0.1	0.1
Westland District	872	947	127	0.1	0.1	1	0.1	0.1
Hurunui District	1333	1552	154	1.0	0.1	3	1.0	3.0
Waimakariri District	2136	1510	317	1.0	0.1	3	1.0	3.0
Christchurch City	19107	10554	3086	8.0	2.5	4	8.0	32.0
Banks Peninsula District	592	1414	160	1.0	0.1	3	1.0	3.0
Selwyn District	2106	1973	287	1.0	0.1	3	1.0	3.0
Ashburton District	2025	1526	288	1.0	0.1	3	1.0	3.0
Timaru District	3011	2124	486	2.0	0.4	3	2.0	6.0
Mackenzie District	473	579	71	0.1	0.0	2	0.1	0.2
Waimate District	779	699	97	0.1	0.0	3	0.1	0.3
Waitaki District	1942	1497	260	1.0	0.1	3	1.0	3.0
Central Otago District	1574	1493	208	1.0	0.1	3	1.0	3.0
Queenstown-Lakes District	956	802	125	0.1	0.1	2	0.1	0.2
Dunedin City	7595	4623	1254	4.0	1.0	4	4.0	16.0
Clutha District	1985	1766	232	1.0	0.1	3	1.0	3.0
Southland District	5217	2943	411	2.0	0.4	1	2.0	2.0
Gore District	1062	748	153	0.1	0.1	2	0.1	0.2
Invercargill City	3425	1988	3695	1.0	2.5	1	2.5	2.5