Environmental Health Indicators for New Zealand

Results of a Pilot Study in the Auckland and Marlborough Regions

Prepared for the Ministry of Health

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List of abbreviations
EHI- Environmental Health Indicator
ACC- Auckland City Council
MCC- Manukau City Council
NSCC- North Shore City Council
WCC- Waitakere City Council
MDC- Marlborough District Council
WHO- World Health Organisation
UN- United Nations
DPSEEA- Driving force- Pressure- State-Exposure-Effect-Action

EXECUTIVE SUMMARY

Health outcomes and environmental measures relevant to air and water quality were studied in the Auckland and Marlborough regions, using a framework established by the World Health Organization for Environmental Health Indicators (EHIs).

Territorial authorities including Marlborough District, North Shore City, Waitakere City, Manukau City, and Auckland City Councils as well as Auckland Regional council provided environmental data for their respective areas. Relevant health outcome data from these areas were obtained from extracts of the EpiSurv system held at ESR and the morbidity and mortality database held at NZHIS. National statistics for the WHO EHI set were obtained from a number of Government agencies including the Ministry for Economic Development and the Land Transport Safety Authority. None of the data presented in this report are new; what is new is the explicit linkages of both environmental and health data sources and related data sets temporally and geographically that have previously been separate.

The assemblage of environmental and health data in one place has allowed for consideration of possible associations. Some data sets, for example, showed apparent relationships that are consistent with an environmental link to population health both regionally and nationally. However, such apparent relationships require a thorough epidemiological analysis including consideration of confounding variables, on a region-by-region basis, before associations can be attributed.

These relationships do however illustrate the potential utility of the EHI datasets as a basis to explore the relationship of environmental quality parameters to human health outcomes and action. Thus, while the collected EHI data cannot be used to assign causality, it provides a database for exploration by public health researchers of geographical and temporal trends in environmental health in New Zealand. Ultimately, it is envisioned that this will be of use to local authorities, researchers, and central government for characterising the state of environmental health in New Zealand.

All those who were consulted, which included both environmental and health agencies expressed an interest in using the EHI's and viewed them as a useful starting point. A concern was the current lack of useable information available for decision making in terms of outcomes as well as the dire need to integrate environmental and health data.

A small number of the WHO indicators trialled were not entirely relevant to the New Zealand context and have been identified as such. Similarly, there are several gaps in the EHI data available that have been identified, and which may aid in further understanding some environmental health outcomes. Most notable among these are the lack of driving force indicators for water quality, and the lack of ambient drinking water quality data for chemical contaminants that can be used with appropriate health outcome data. We are in discussions with experts in these areas to try and fill these gaps.

Overall, this pilot study was successful and confirms the utility of the adopted EHI framework as a basis for a national EHI programme. This utility extends from the local level through to comparisons of national temporal trends and international comparisons with other countries participating in the WHO EHI initiative.

1. PURPOSE

The goal of the project is to establish a functional core set of environmental health indicators (EHI's) to provide environmental health information to local and national bodies to aid in decision-making.

The purpose of this pilot study was to trial the collection, collation, and analysis of data for the proposed air and water indicator datasets in the Auckland and Marlborough regions. We hope that the data presented in this report will provoke discussion about what data are useful for estimating environmental health impacts in New Zealand, and how data sets can or should be displayed for rapid easy analysis, with more detailed interrogation by various local and national stakeholders.

2. INTRODUCTION

Over the past ten years, there has been a growing global awareness of the need to better understand environmental impacts on population health. This collective awareness began with Agenda 21, a plan of action adopted by more than 178 Governments at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, in June 1992. Agenda 21 identified the inter-relationships of human health, the environment and development, and the need to improve health outcomes in order to achieve sustainable development. This provided an internationally agreed framework for embedding both environmental and health information in the broader context of sustainable development.

Environmental health issues are multifaceted, involving a complex interplay of environmental exposures, hazards, susceptibilities, and health effects. The challenges in establishing linkages in practice are complex and lie partly in the uncertainties inherent in the science of environmental epidemiology. This has been reflected in recent shifts from an approach based principally on the generalisation of epidemiological studies of contaminant and health effect to a more comprehensive systems-based approach to decision making.

In the process researchers and policy makers identified a need for a framework to illustrate the relationship between the state of specific aspects of the environment and human health (Sladden et al., 1999). In 1998, the Parliamentary Commissioner for the Environment identified the need to specifically understand environmental impacts on health, particularly in urban areas (PCE, 1998). However, this framework is currently lacking. Part of the challenge is that environment and health related data sets are often either collected by different organisations (Hopkinson *et al*., 1994), collected on an *ad hoc* basis and/or lack consistency of key data parameters.

The problem is further aggravated by the compartmentalisation of the various strands within environmental health practice e.g. health protection v health promotion, hazard v exposure v disease, making data linkage difficult. Some studies link data strands between environmental hazard and human health outcome but these are usually for either a single specified disease or a particular hazard.

Until now there has been no mandate to assemble these various data sets together on a national scale. However, the Ministry of Health is now exploring the utility of developing a unified framework that allows the examination of trends in the interaction between environmental quality and human health on a national and regional scale. To accomplish this, the UN/WHO Driving Force, Pressure, State, Exposure, Effect (DPSEEA) framework has been adopted with which to develop a set of New Zealand EHIs.

The utility of a national set of EHIs lies in their ability to connect previously disparate and isolated data sets. To be effective they should be: valid (they should measure what they are supposed to measure), objective (and reproducible), sensitive, timely, representative, and specific (Kriesel 1984).

Some environmental quality parameters have established relationships with morbidity and mortality, and therefore are candidates for inclusion into an EHI programme although their generalisability is uncertain. Each country may require its own analyses to determine the nature of such relationships in order to fully characterise the population attributable risk from environmental risks. The WHO EHI data set makes use of such knowledge in its framework for EHIs, but also provides the basis for more detailed research to be undertaken in order to examine underlying causes and appropriate actions.

The population attributable risk is a useful tool for assessing how much of the appropriate disease burden could be eliminated if the exposure was eliminated. The population attributable risk of the percentage of deaths and DALY's globally attributable to the environment is 25-33% and 6% respectively.[1] [2] A recent study calculated that the US federal government heath care costs attributable to the environment was $13.5 billion, using a mean attributable percentage of 3.5%. [3] Knowledge of the disease burden caused by environmental exposures, and its use in health impact assessment can be extremely useful in guiding policy choices in environmental health management.

Burdens of specific diseases from specific environmental exposures can also be estimated through risk assessment techniques, including the spatial burden, which can be extrapolated using socio-economic parameters to assess the environmental 'equity' of the exposures and risks. Such analyses have the potential to shed additional light on the role of chemical pollutants in diseases with well-defined, or well-accepted dose response relationships. There are obvious limitations of this approach e.g. an accurate emissions inventory for all polluting sources and the need for validation using epidemiological studies on health outcomes.

In addition to illustrating national trends and local variations in environmental health, the EHIs also provide a method of international benchmarking and a framework for developing other surveillance approaches e.g. New Zealand's biosecurity measures from a health perspective.

EHI's can form the starting point for a comprehensive environmental health information system that incorporates surveillance data with information, communication, and decision making tools into a coherent structure to improve understanding of the links between environmental exposures, health outcome and risk. (Refer Figure 1). Once developed, this system could aid in answering specific queries, for example:

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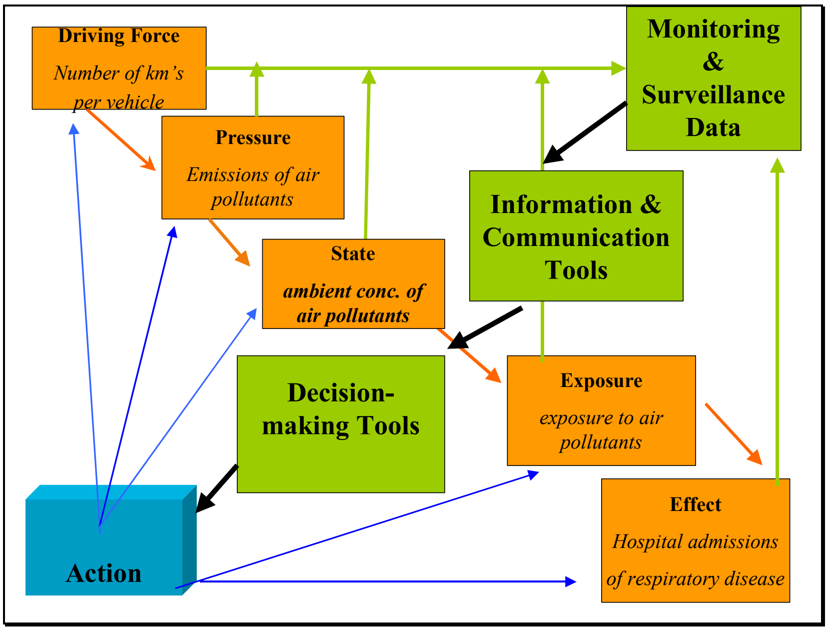
[1] Michaud Catherine M, Murray CJL, Bloom BR. Burden of disease- implications for future research. Journal of the American Medical Association, 2001; 285: 535-9.
[2] Smith KR, Corvalan CF, Kjellstrom T. How much global ill health is attributable to environmental factors? Epidemiology, 1999; 10: 573-84.
[3] Public Health Foundation. Return on investment of nationwide health tracking. Washington, D.C.,2001.

- Is there a link between a certain driving force, pollutant levels in the environment and human disease?
- Is exposure to a contaminant linked to a raised disease incidence?
- Do current actions have any impact on environmental health?
- How do regions and countries compare?
- What preventive actions work and what don't?
- What is the cost benefit value of these actions?
- How do we identify and prioritise environmental health issues?

Figure 1. Conceptual Diagram of DPSEEA Framework in Context of Surveillance and Monitoring, Information Dissemination, Policy Making, and Action



The current project began as a scoping exercise in 2001, with a feasibility study conducted in 2002. Table 1 below summarises the timeline of events since the inception of the project.

Table 1. EHI Project Development Timeline[4]

2001	A. Assessed various environmental health frameworks and approaches to developing indicators and found WHO-Europe model to be the best starting point for New Zealand.
2002	B. Conducted a feasibility study examining the WHO indicator set in a New Zealand context in terms of availability, quality, and utility.
2001-current	C. Identified the relevant New Zealand agencies and organisations, established key contacts in the environmental health area and raised awareness of EHIs within these organisations.
2002-current	D. Undertook consultation with different stakeholders at local and national level on the willingness of these organisations to actively participate in the project.
2002	E. Considered biosecurity indicators provided by the Ministry of Health for inclusion in the indicator framework.
2003	F. Piloting indicators for air and water quality areas, including health, environmental and action indicators in Auckland and Marlborough to trial the transfer of data from a local to a national database and to assess the information systems required to organise and disseminate the data. Evaluated the utility of each indicator.
2003	G. Central data collection for air and water indicators from numerous sources at both national and local (Auckland and Marlborough) level.
2002	H. Development and addition of NZ specific features to the WHO EuroIndy software
2002-present	I. Developing an environmental health information framework incorporating environmental health indicators with information, communication and decision making tools.
2003	J. Data cleaning and sorting from the original datasets so it matches the requirements of the EuroIndy.
2003	K. Consolidating all data into EuroIndy and transforming them into EHIs
2003	L. Analysing and presenting the data collected using different techniques

3. METHODS

3.1. Pilot Study

Following a feasibility study of EHI data availability, quality, and usefulness in 2002 (Khan et al., ESR 2002), it was decided to trial collecting and analysing selected datasets held by various agencies including central and local government. This involved a lengthy process of identifying individuals within agencies and in the study locations, clarifying the project's objectives, determining the availability of the data, and arranging for data to be sent to ESR for analysis.

The Auckland and Marlborough regions were chosen to assess the feasibility of implementing such a system on a national basis, with an initial focus on air and water quality and related health outcome data.

[4] The previous two reports addressed activities A and B listed above recommending the adoption of the WHO-Europe DPSEEA Indicators framework and the feasibility of using those indicators in New Zealand. Activities C and D encompassing the networking and consulting has been ongoing since the beginning of the project and will be for the next year as well due to the nature of this project. This report addressees activities listed from E to L.

The objectives of the pilot study were to assess the:

- Feasibility of the EHI system for national roll out;
- Utility of air and water EHIs;
- Utility of EuroIndy (WHO indicator software);
- Data analysis and dissemination options that are most useful to end users.

In total, thirty-three indicators from the WHO air quality and water and sanitation set comprising 16 core and 17 extended EHIs were chosen. These were chosen because they originate largely from Regional Councils who currently already collect the relevant information and it was felt this was a good opportunity to trial the transfer of data from the local authorities to a national database as well as to trial the ability to combine data from disparate sources. Among the eleven categories of EHI's, air and water have more extensive monitoring systems than most, and have been highlighted as issues by the Public Health Advisory Committee. Table 1 lists the specific data sets that we obtained during the course of the pilot study.

The pilot study also assessed the utility of the *EuroIndy* software for New Zealand, including practical aspects of data flow, resources needed, the required skill base, and the necessary processes that would be needed for a national roll out. The pilot provided a good opportunity to obtain feedback from stakeholders on both the process, the specific environmental health issues that should be covered by the core set of indicators, and the utility of the proposed EHI's.

Auckland, as the largest metropolitan area in New Zealand, and Marlborough, a more rural district expressed an interest in participating. Auckland has an extensive and well-developed environmental monitoring system. Marlborough, while much smaller in population, still collected sufficient environmental data to allow for a comparison between urban and rural areas, as well as different TLA structures. The Auckland enHealth group also provided a forum for information and discussion on the pilot. enHealth is a recently new collaborative partnership of many organisations within the Auckland region. The aim of EnHealth is to align all major environmental health stakeholders within the region and identify, prioritise and facilitate addressing environmental health policy research needs to achieve sustainable development. EnHealth is represented and supported by the following;

- University of Auckland
- Auckland University of Technology
- Auckland City Council
- Manukau City Council
- Waitakere City Council
- North Shore City Council
- Auckland Regional Council
- Auckland Regional Public Health Service
- Ministry for the Environment
- Ministry of Health
- National Institute of Water and Atmospheric Research LTD
- Environmental Science and Research LTD

3.2. EuroIndy

'EuroIndy' is a specialised software package developed by WHO-Europe that enables the establishment of a database system on environment and health indicators. The software 'forces' the user to enter data according to pre-defined data and maintains data and indicators in compatible format for ease of integration and exchange of data between and within countries.

The feasibility study had identified the datasets needed to formulate the full set of WHO indicators. The process of obtaining the data was more difficult and relatively more time consuming than anticipated. Specifically, the data sets that were received are shown in Table 2 below. Not all the data were received in time for this report.

Table 2. Environmental Health Indicator Data in Pilot Study

Issue	Indicator	Dataset	Source
Air quality	Air_E1-3 (Mortality)	Mortality from 1999	NZHIS
		More recent mortality data	Coronial office database
	Air_ext2-4 (Morbidity)	Morbidity from 1999-2002	NZHIS
	Proxy indicator AirNZ1 (proposed NZ-specific EHI)	Asthma prescriptions 1999- march 2003	NZHIS- Pharmhouse
	Air_D1	Passenger km's 1990-2000	MfE
		Vehicle numbers 2000- march 2003	LTSA
	Air_D2	Fossil fuel consumption 1994-2000	Ministry for Economic Development (MED)
	Air_P1 (Emissions inventory)	Emissions inventory 1999	Marlborough district council (MDC)
		Emissions inventory – energy sector	MED
	Air_Ex1 (Air quality monitoring data)	PM_{10} 2000-02	MDC
		SOx, Nox 2000-02	MDC
		PM_{10} 1995-2001	MfE (national)
		SOx, Nox 1995-2001	MfE (national)
Water quality	WatSan_S1 (Beach water quality monitoring)		Auckland City Council (1999-2003)
			MDC (1996-2003)
			North Shore City Council (NSCC)(1994-2003)
	WatSan_S2-3 (Drinking water quality) 2000-2003	E. coli Organics Inorganics	NSCC ACC MCC WCC
		E. coli Organics Inorganics	MDC
		E. coli Organics Inorganics	ESR (WINZ)
	WatSan_E1 (Waterborne outbreaks) 2000-2003		ESR (EpiSurv)
	WatSan_ext8 (Waterborne diseases) 2000-2003		ESR (EpiSurv)

3.3. Consultation with Government Stakeholders

The pilot relied on the goodwill of participating organisations in supplying data, as there is no legislative mandate to collect and analyse these data nationally. The Councils consulted were supportive of the project and although the arrival dates of various data sets were sporadic, by year end, most of the data requested had been supplied. Many of the individuals collecting the environmental monitoring data saw the value that an additional layer of analysis could bring to their data, and of the data forming part of a national data set.

The process of working with the various organisations provided opportunities for informal information gathering on various aspects of the indicators. A questionnaire was also sent to members of the Auckland EnHealth group. The key questions raised with the various people/ groups in the course of the consultation included:

- Were they willing to provide the necessary data?
- Are the indicators useful?
- Would their organisation use them?
- What are the main environmental health priorities and issues for their particular area?
- Are there any other indicators needed for air and water?
- Once collected, how would you like the information to be presented?
- How often would you like the information to be reported?

The process of establishing relationships with the data holders and users is a vital element of the process. Their support is pivotal to ensure the sustainability of any initiative. Presentations and meetings were conducted in various fora among different groups to increase the profile of the project and to gain support. Numerous meetings in Auckland were conducted with the Auckland EnHealth group and various individual members thereof, including representatives from the four city councils: Auckland, Waitakere, Manukau and North Shore, Auckland Regional Council, Auckland Regional Public Health Service, and locality managers for MfE.

3.4. Data Management and Quality Assurance

The data management process was arduous, with numerous datasets being received at varying times from different people in different formats. The entire process has been documented using TELARC guidelines. Data sorting and formatting was done, as were quality checks on the water quality health outcome data; it was assumed that the data providers perform quality checks for the other datasets as it was not feasible for ESR to provide independent quality control of the array of data sets from different organisations. In house algorithms were used to double-check the indicator calculations as well as to independently check EuroIndy's calculations.

3.5. Data Analyses

Each indicator was calculated using the WHO EuroIndy software, and these are shown in the results section. All indicators were recalculated to cross-check the calculations made by the EuroIndy software. For several of the indicators, so-called "linked" analyses of environmental and health outcomes are shown. In these cases, preliminary statistical analyses were performed, Fisher's Exact Test was used to determine differences in proportions, using a $p < 0.05$ cutoff value for statistical significance.

4. RESULTS

4.1. Consultation

4.1.1. Data Collection

All the organisations approached agreed to provide the data, although it generally took longer to obtain the data than anticipated. Some of the data did not arrive in the study timeframe, but has since been obtained. The final list of data sets used for this report is shown in Table 1.

The following four sections are a summary of the discussions with the various people who participated in the project, either as data providers or users. The opinions expressed do not reflect the author's opinion.

4.1.2. Needs Assessment

The majority of organisations were of the opinion that:

- The indicators were useful as a starting point
- There needed to be some NZ specific indicators
- They would be very interested in using EHI's in some form.

Some suggested there may be:

- A lack of useable information for decision making especially in terms of outcomes
- A lack of explicit linkage between various risk factors and health outcomes.
- The need to integrate the various indicators being developed by the various organisations particularly nationally.

4.1.3. Priority Issues

Discussions revealed that certain issues that were considered important tended to be so as a result of political drivers at a community level rather than as a result of evidence. Similarly many issues were considered a priority more due to the risk perception than either the assessed absolute or relative risk.

Many people expressed the need for a better evidence base to balance the current political drivers and this project was seen as a way and to enable integrating the various data strands.

Indoor air, noise, high density housing and urban planning were issues most commonly raised as priority emerging environmental health issues. The lack of indoor air quality standards was highlighted as a significant gap.

4.1.4. Additional Indicators

The following indicators (Box 1) were suggested by stakeholders as additional indicators to complement/improve upon the proposed WHO indicators (for air and water only).

Box 1.

• disaggregate enteric diseases into individual components • river catchment • vector potential • traditional foods • sale of unflued gas heaters • lead in water from brass taps • number of times a beach is closed • visibility • density of vehicle ownership • number of passenger transport meeting standards • rates of cryptosporidiosis • proportion of population served by grade A drinking water • include geothermal parameters for drinking water • vehicle age and type • stream water quality

4.1.5. Information

Everyone felt that annual reporting of the indicators was sufficient. They all expressed the wish of environmental and health information to be "linked" for example the number of days with poor air quality to increased respiratory attacks.

A few were keen that a predictive surveillance component might be added whereby it is possible to identify either incipient outbreaks or environmental degradation. It was interesting as health authorities were keen for a system, which could detect and predict possible disease outbreaks using transgressions of environmental monitoring data. Whereas environmental agencies were interested in a system that could assign health outcomes to a particular environmental exposure as well as a system that can detect pollution events from significant increases in morbidity from disease surveillance.

4.2. Data Collation

Estimations of data that would be available and provided were based on a feasibility study done in 2002 (Figure 2). According to this ambient air quality and water quality indicators had good levels of availability, quality and usefulness. This was influential in the decision to pilot these two broad indicator areas.

Figure 2. Feasibility Study Results

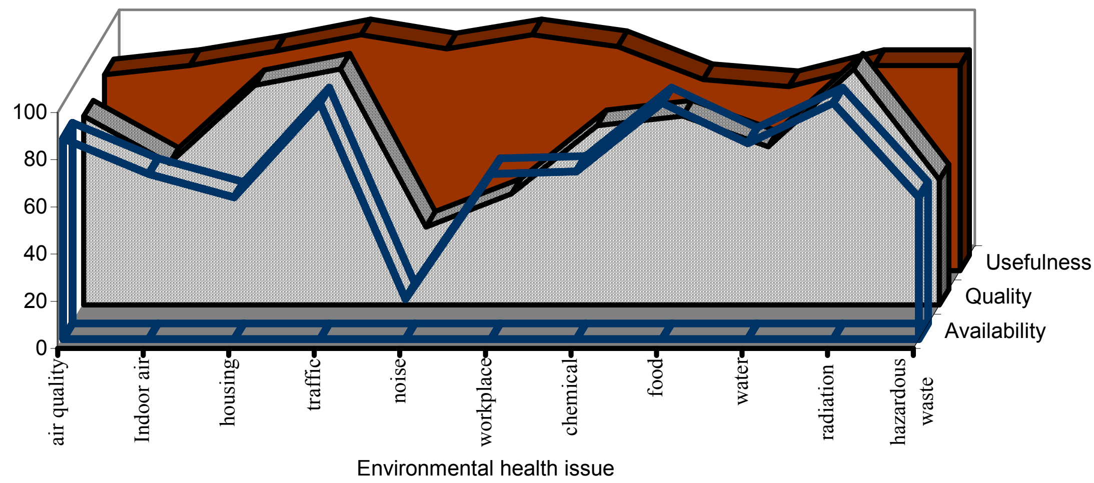
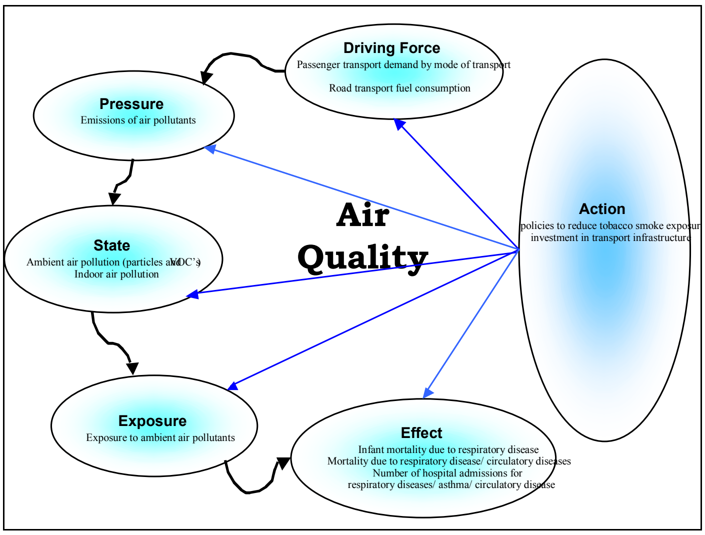


Figure 2 above is a summary of the 2002 feasibility study (Khan et al., 2002). There were differences between the data that organisations said was available and what was actually delivered. Countries in Europe who have piloted the indicators have found a similar situation where it was easier to obtain information about datasets for their feasibility study than to actually obtain the data in practice.

4.3. Air Quality

Figure 3 summarises the indicators that were trialled for air quality and where they are placed within the DPSEEA framework. The following section describes the individual indicators in detail in terms of definition, source and the analyses.

Figure 3. DPSEEA Framework – Air Quality



4.3.1 Environmental Indicators

The WHO air quality environmental indicators in this group included the following:

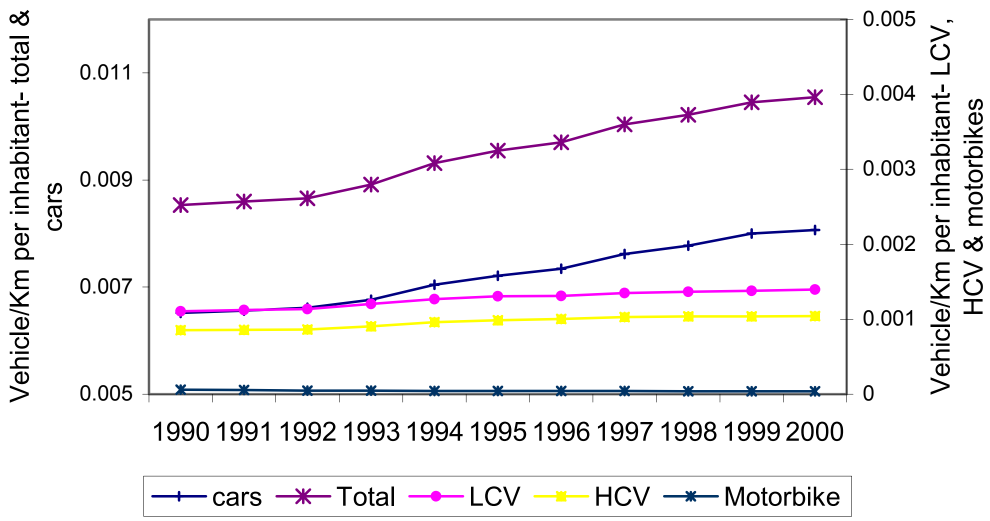
- Passenger transport demand by mode of transport (Driving force)
- Road transport fuel consumption (Driving force)
- Emissions of air pollutants (Pressure)
- Exposure to ambient air pollutants (Exposure)

A. Indicator title: Passenger transport demand by mode of transport (Figure 4)

Indicator definition: Number of passenger-kilometres travelled per year by the following modes of transport: personal cars, motorbikes, bus/coach, tram/ metro, train, human powered (walking, bicycling).

Comment: - This indicator is part of MfE's EPI programme under 'transport'. A proxy indicator that might be useful is to compare the number of vehicles per person (Figure 4) as the data for the proxy indicator is more up to date and can be broken down to regional level in contrast to the WHO indicator, which is more useful for international benchmarking. Both indicators are complementary to each other (Pearson correlation = 0.993).

Figure 4. Passenger Transport Demand by Mode of Transport (National Data)



In Figure 4, cars dominate the vehicular distance travelled per person. This has increased over the last 10 years for all vehicle types and is a function of the increasing number of domestic cars, rather than commercial vehicles.

Figure 5. A Possible Alternative Driving Force Indicator for Air Pollution: Number of Vehicles Per Person

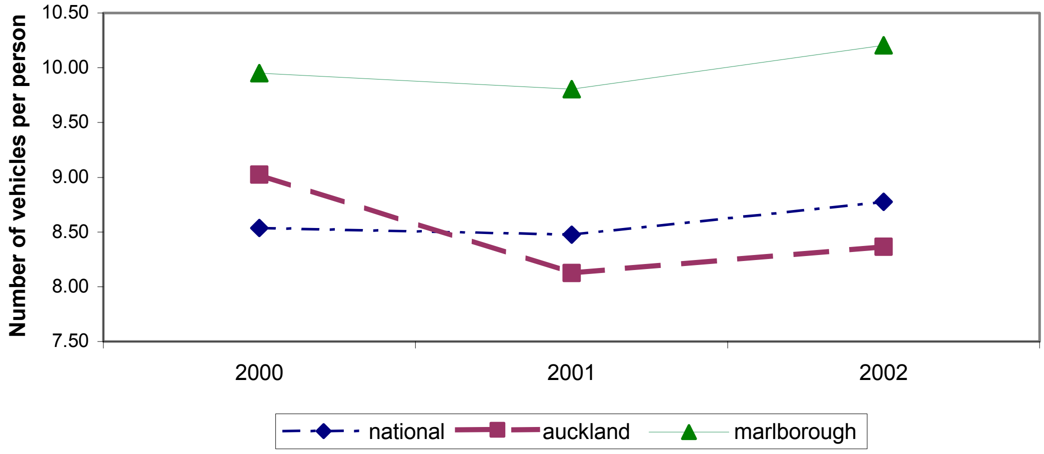


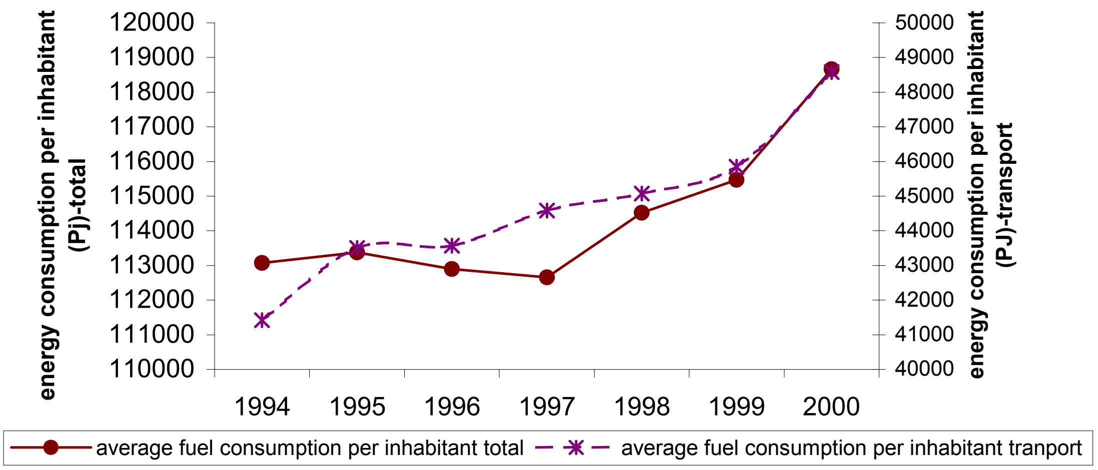
Figure 5 shows that the number of vehicles per person is significantly greater in the Marlborough District than in Auckland or nationally. Whether this is an adequate driving force indicator is an issue for further consideration. An assumption underlying this indicator is that ownership of an increasing number of vehicles is related to an increasing amount of vehicle emissions.

B. Indicator title: Road transport fuel consumption (Figure6)

Indicator definition: Average consumption of fuel by type from road transport per year.

Comment: -The data for this indicator comes from the Ministry for Economic Development. This indicator is already a part of the MfE EPI programme and is available at a national level only. While there is a slight trend toward increasing fuel consumption per person nationally since 1997, there is clearly a significant upward trend for energy consumption per inhabitant for transport from 1994 to 2000

Figure 6. Road Transport Fuel Consumption (National Statistics)



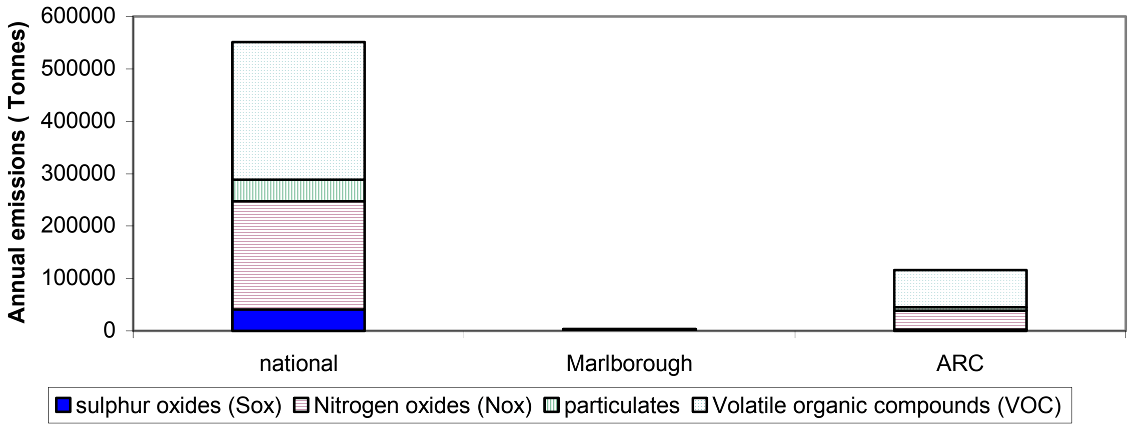
C. Indicator title: Emissions of air pollutants (Figure 7)

Indicator definition: Annual emissions of SO2, PM10, secondary PM10, NOX, VOC total and by the following economic sectors: industry-process and energy, energy industry, domestic and services, transport, agriculture.

Comment: - This is a fairly complex indicator as some of the national data for this indicator is available from MED with the remainder to come from Stats NZ by the end of this year. The data currently available does not cover all the economic sectors. The data to compute the indicator as illustrated in the Figure below are from the last decade. The national figure is from 1995.

Regional Councils conduct a periodic emissions inventory. Marlborough has an emissions inventory for 1999 whereas Auckland's available inventory is for 1993. There is no estimate of secondary PM10 in the emissions inventory as required by the WHO methodology, as this data is unavailable in the pilot areas.

Figure 7. Emissions of Selected Air Pollutants in Marlborough, Auckland & NZ



D. Indicator title: Exposure to ambient air pollutants (urban)

Indicator definition: Population – weighted exceedance of reference concentration of selected air pollutants - NO_2, PM_{10}, SO_2 , TSP, Black smoke, O_3

Comment: - The data, when expressed in the WHO Europe context, did not provide useful information. The reason being that the main component of this indicator was the exceedance of the WHO reference concentration of the annual mean of the above mentioned pollutants. None of the pilot areas exceeded the WHO reference value. Hence the indicator value was zero.

This probably reflects the generally cleaner air in most parts of New Zealand compared with many European urban areas. Another possibility is to use maximum daily or weekly peaks as they might be more likely to be associated with an increase in adverse health outcomes.

4.3.2. Health Indicators

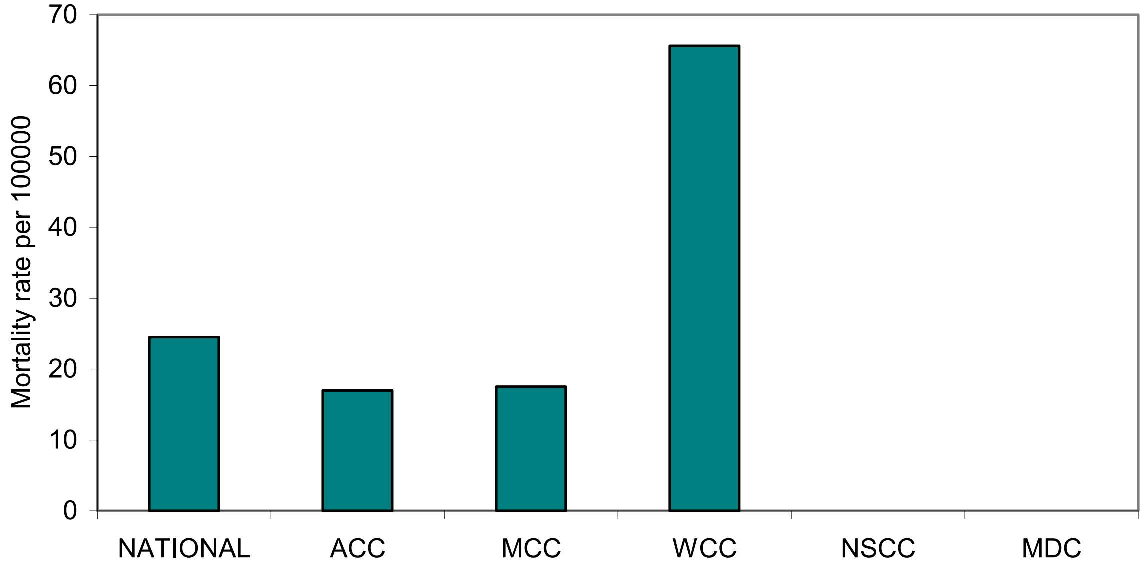
- Infant mortality due to respiratory diseases
- Overall mortality due to respiratory diseases
- Overall mortality due to circulatory diseases
- Number of hospital admissions for respiratory diseases (ICD10: J00-J99).
- Number of hospital admissions for asthma (ICD10: J45-J46).
- Number of hospital admissions for diseases of the circulatory system (ICD10 :I00-I99).

The most recent available mortality data from the NZHIS is from 1999. The data that is used to compute the morbidity indicators is from NZHIS and is derived from publicly funded hospital discharge data from 1999 to end of 2002. Hospital discharge data has been used instead of hospital admissions data to avoid over counting as not all admissions are discharged and would already be included in the mortality indicators.

A. Indicator title: Infant mortality due to respiratory diseases (Figure 8)

Definition: Annual mortality rate per 100 000 due to respiratory diseases (ICD10 –J00-J99) in children older than one month and under one year of age.

Figure 8. Infant mortality rate due to respiratory diseases-1999

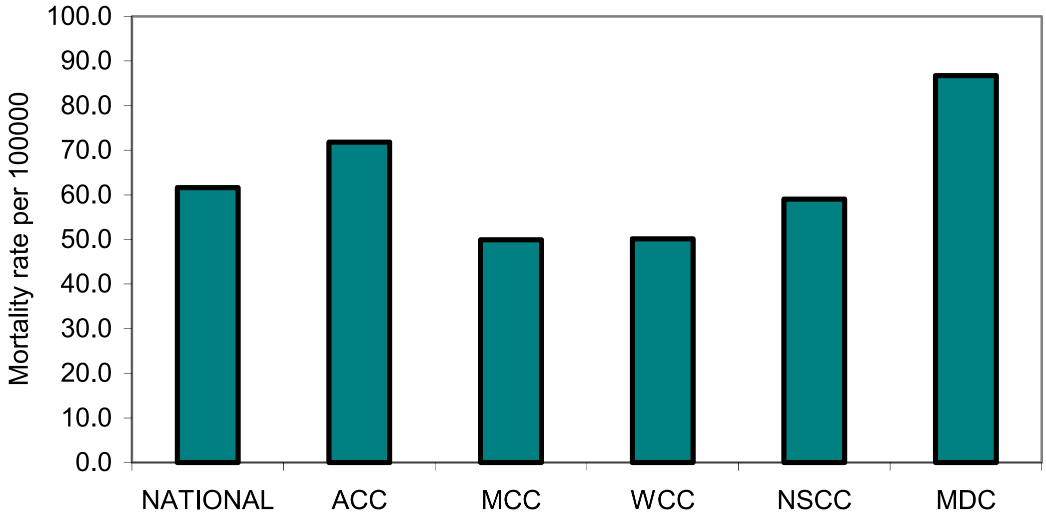


This indicator needs to be interpreted with caution due to the very small numbers of infant mortalities due to respiratory diseases.

B. Indicator title: Mortality due to respiratory diseases (Figure 9)

Definition: Annual mortality rate per 100 000 due to respiratory diseases (ICD10 –J00-J99)- all ages

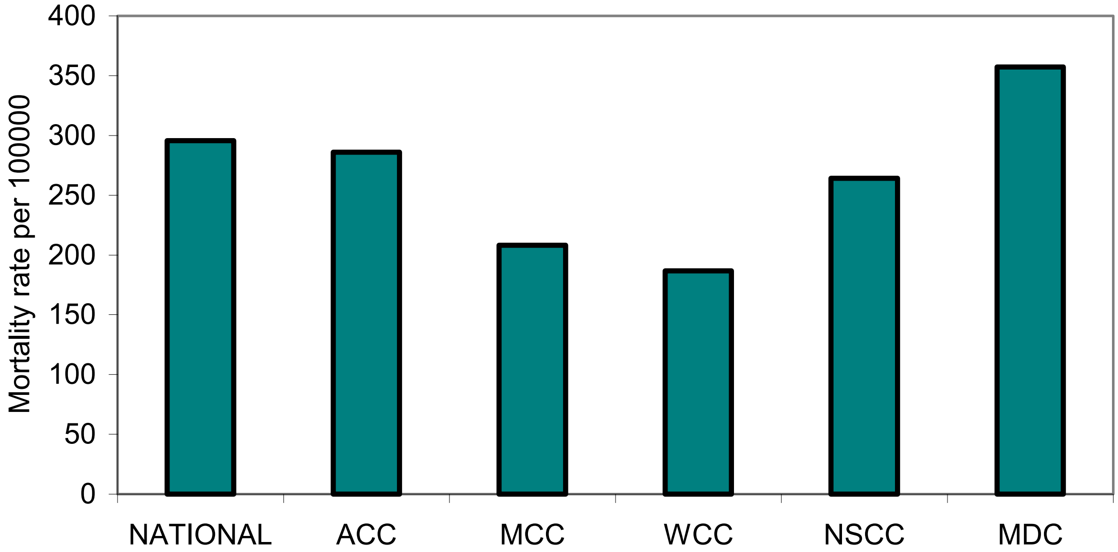
Figure 9. Mortality Rate Due to Respiratory Diseases -1999



Comment: - As figure 9 illustrates, Marlborough district council and Auckland city council have a higher mortality rate due to respiratory diseases than the national average and the three other pilot TLA's. The national mortality rate of 62 deaths per 100 000 due to respiratory diseases is similar to Australia's (60 deaths per 100 000) and Canada (72 deaths per 100 000) but much lower than the US (84 deaths per 100 000), Netherlands (91 deaths per 100 000), Japan (115 deaths per 100 000) and the UK (185 deaths per 100 000).

C. Indicator title: Mortality due to diseases of the circulatory system (Figure10)
Definition: Annual mortality rate per 100 000 due to cardio- or cerebro-vascular diseases (ICD10 codes I00 – I99) -all ages

Figure 10. Mortality rate due to Circulatory Disease -1999

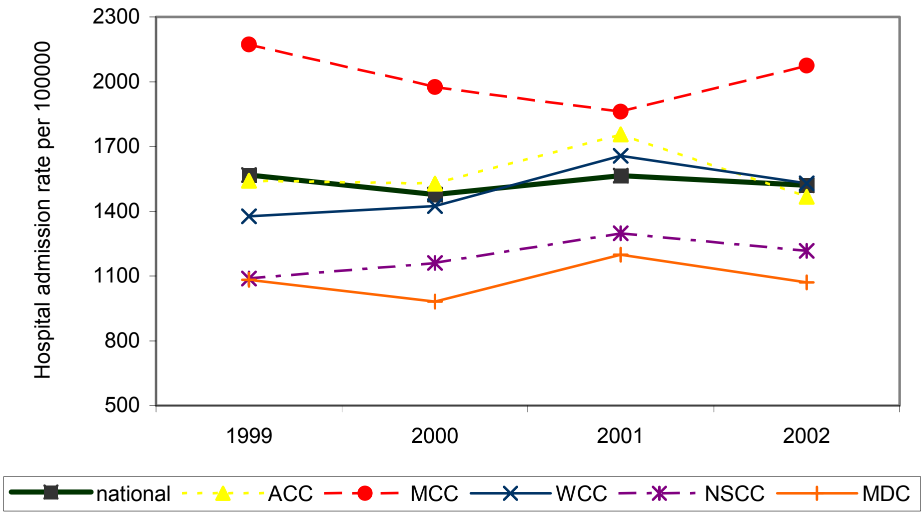


Comment: -The spatial distribution for mortality due to circulatory diseases is similar to the respiratory diseases for the piloted areas as figure 10 shows both Marlborough district council and Auckland city council have a higher mortality rate due to circulatory diseases than the national average and the three other pilot TLA's. The national mortality rate of 296 deaths per 100 000 due to circulatory diseases is slightly higher than Japan (247 deaths per 100 000), Canada (263 deaths per 100 000), and Australia's (271 deaths per 100 000) and but much lower than the Netherlands (314 deaths per 100 000), US (350 deaths per 100 000), and the UK (421 deaths per 100 000).

D. Indicator title: Number of hospital admissions for respiratory diseases (Figure 11)

Definition: Number of hospital admissions for respiratory illness (ICD10 J00-J99) per 100 000 people per year.

Figure 11. Hospital Admissions rate for Respiratory Diseases, 1999-2002

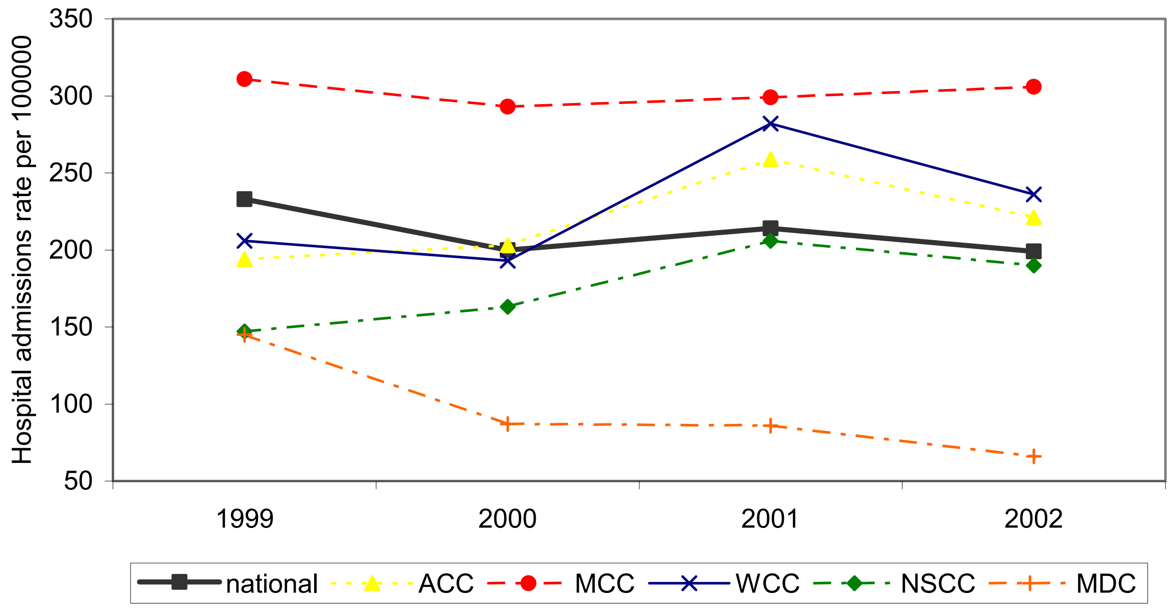


Comment: - Figure 11 shows that while there is a steady national rate for respiratory morbidity, there are some regional fluctuations. Manukau showing a consistently higher rate of hospital admissions, while Marlborough showing the lowest. This relationship is the reverse of the mortality rates where Marlborough had a higher and Manukau had a lower mortality rate due to respiratory diseases.

E. Indicator title: - Number of hospital admissions for asthma (Figure 12).

Definition: Number of hospital admissions for asthma (ICD10 J45-J46) per 100 000 people per year.

Figure 12. Hospital Admissions rate for Asthma, 1999-2002

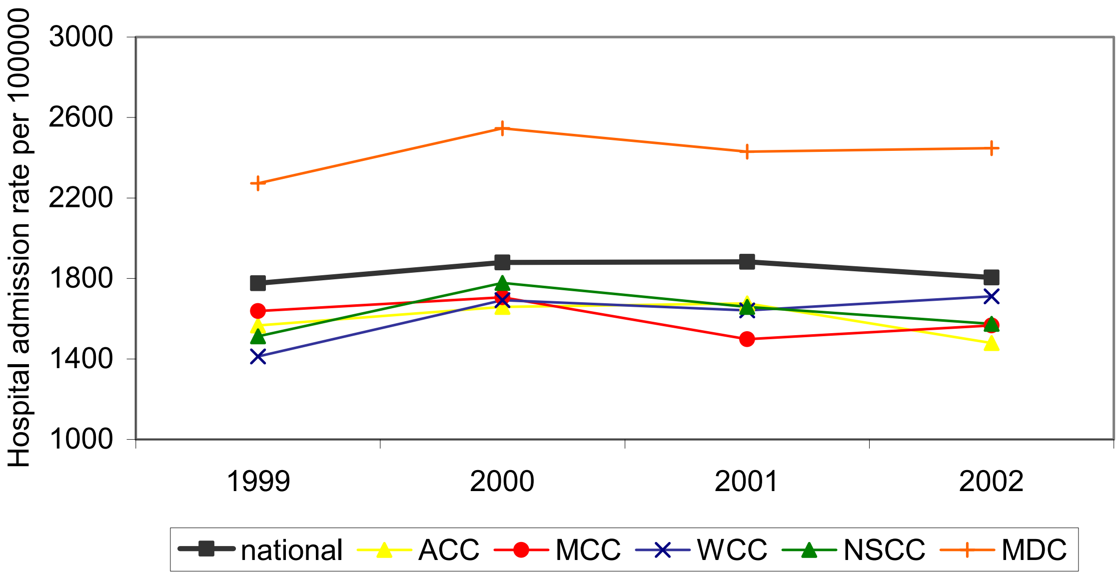


Comment: - There are significant differences over time and between regions with a similar interregional pattern.

<u>**F. Indicator title**: - Number of hospital admissions for diseases of the circulatory system (Figure 13)</u>

Definition: Number of hospital admissions for diseases of the circulatory system (ICD10 I00-I99) per 100 000 people per year.

Figure 13. Hospital Admission Rates for Circulatory Diseases, 1999-2002



Comment: - Figure 13 shows regional differences in hospital admissions for circulatory diseases, with Marlborough having significantly higher rates of hospital admissions and mortality due to circulatory diseases than the Auckland TLAs.

Proxy indicator
A proxy health outcome indicator was trialled. It was the prescription rate for asthma medications rate per 100 000. The data was obtained from NZHIS and the results are presented below. This indicator was developed, as New Zealand is one of the few countries, which has a national database of prescription data. The prescription indicator is a first step to move beyond morbidity and mortality statistics to gain a better picture of the health effects especially when environmental exposure is low and the morbidity and mortality numbers are low.

Figure 14. Prescription Rate for Asthma Medication, 1999-2002

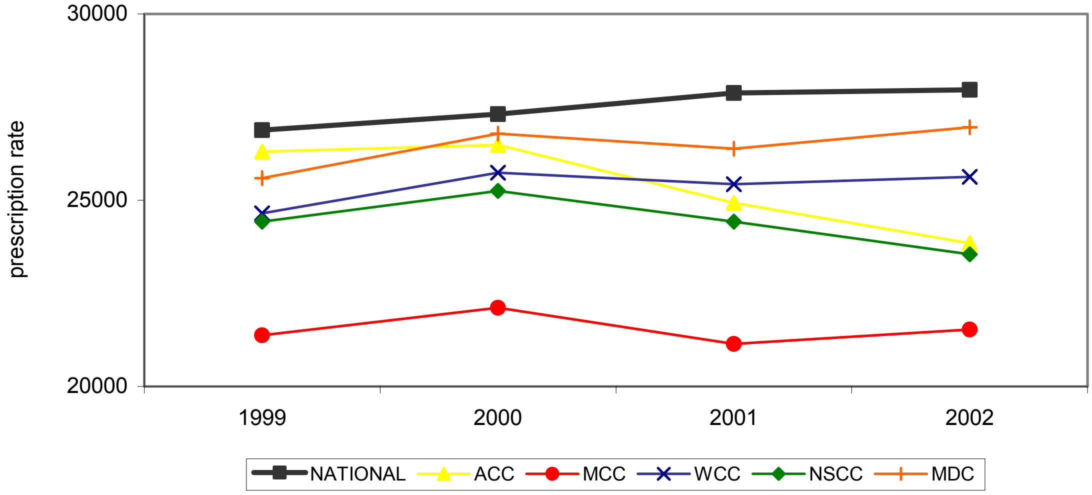


Figure 14 illustrates strong regional differences in prescription rates for asthma, with Manukau City Council much lower than the national average. To compare how well this proxy indicator reflected changes in morbidity and mortality data, prescription rate was compared to the hospital admissions for respiratory disease, asthma and mortality rates for respiratory diseases.

Figure 15. Comparison of Proxy Indicator to Other Health Indicators (Air Quality)

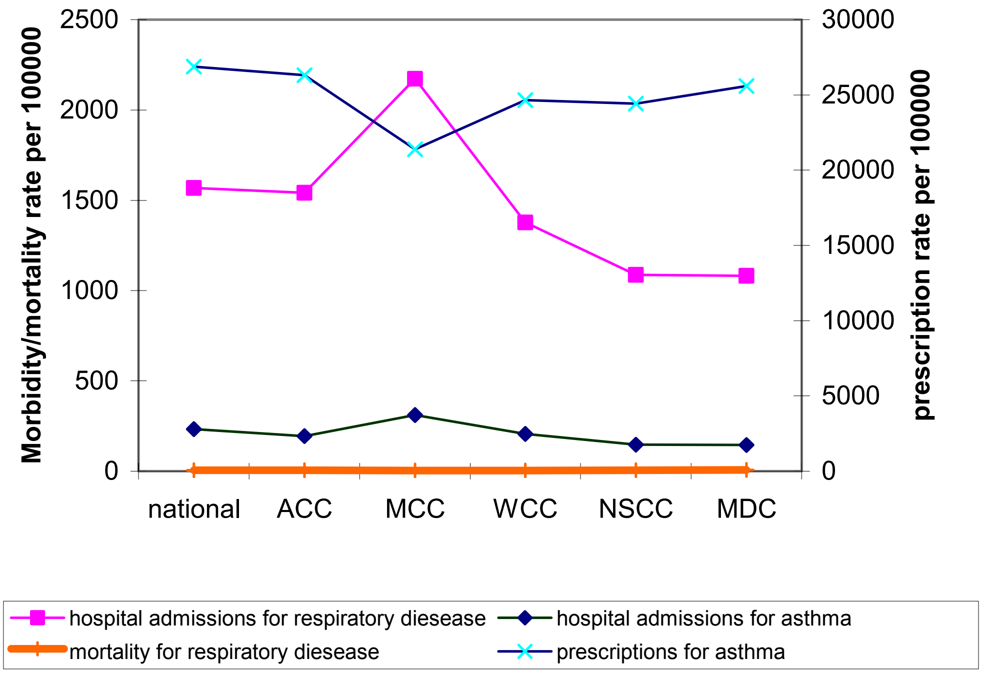
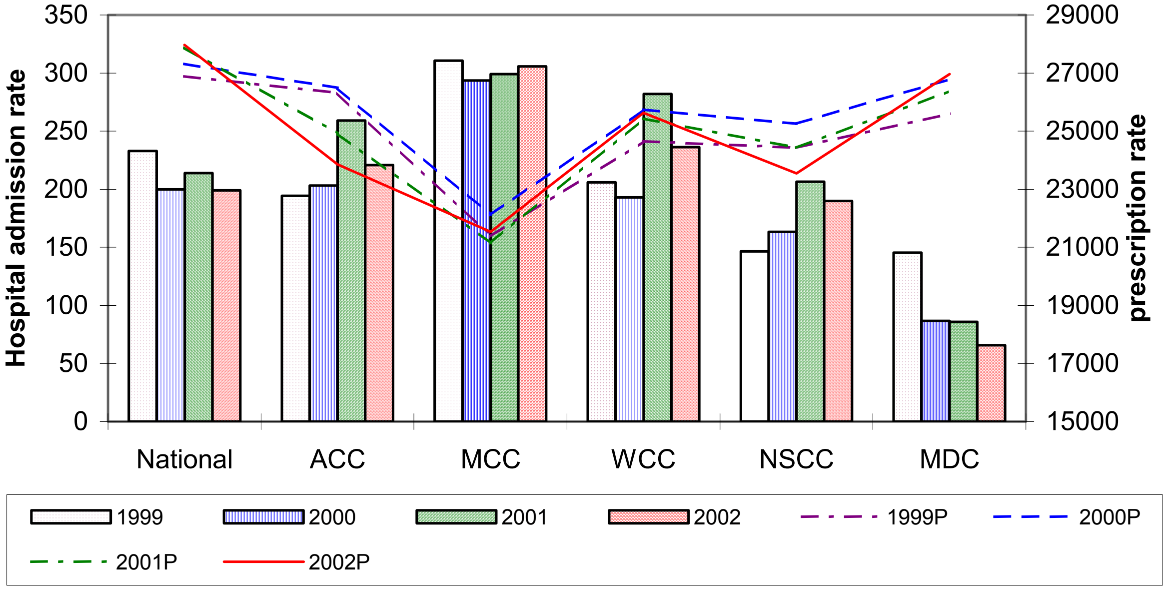


Figure 16. Comparison of Asthma Prescriptions and Hospital Admissions for Asthma per 100 000



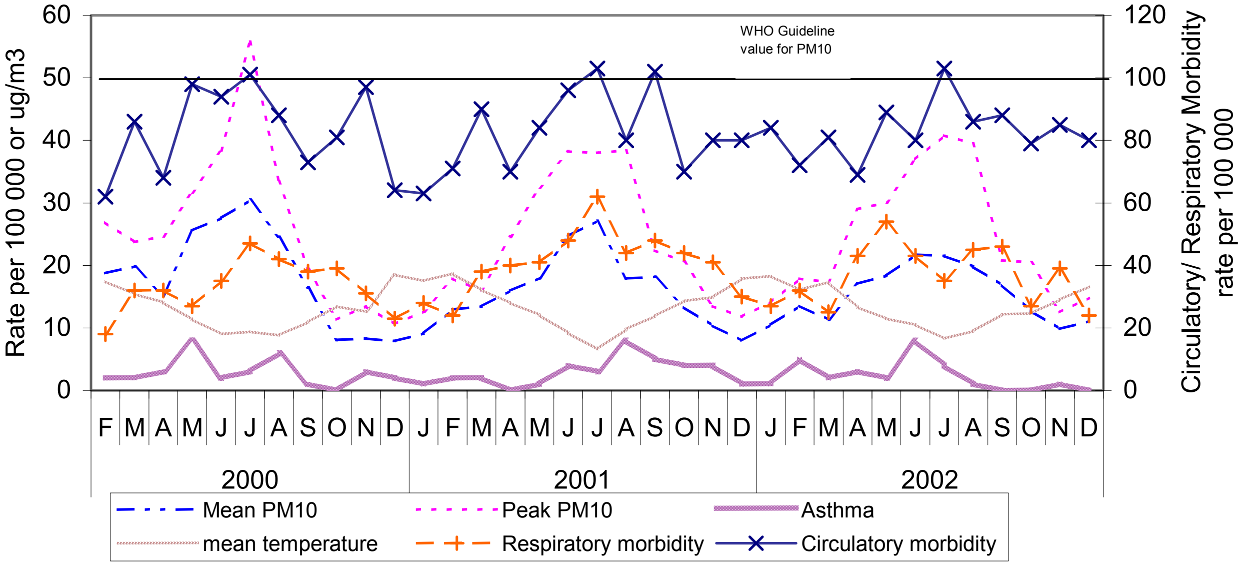
Figures 16 illustrates the relationship between asthma prescription rate and morbidity and asthma hospitalisation rate in the pilot study, and nationally. Of note is the large difference in this relationship between Manukau and the national average, with a much lower prescription rate per hospitalisation in Manukau. While these differences are of interest, the regional variation does indicate that using asthma prescription rates as a proxy indicator is potentially problematic, as there are socioeconomic and other determinants that drive the relationship of prescription rates and disease. Hence, it might be more useful to use the prescription data indicator as a separate, additional indicator to obtain a more complete spectrum of related health effects.

Linking air pollution levels with morbidity and mortality outcomes is one way to estimate the burden of disease from the air quality in a given area. Figure 17 illustrates an apparent relationship between PM_{10} measurements taken in Blenheim and hospitalisations in Marlborough District for respiratory disease, asthma, and circulatory diseases. For both PM_{10} and respiratory disease and asthma, there is a strong seasonal relationship. Mean temperature data obtained from NIWA has also been added to the analyses, as temperature is known to affect both PM10 concentrations and morbidity and mortality. The total number of asthma cases in this region may be too small for a meaningful comparison of statistical trends. There is a less pronounced pattern visible with PM_{10} and circulatory diseases. Time series analysis was not done on the data as it is beyond the scope of this report but the association between PM10 concentrations and morbidity and mortality due to respiratory and circulatory diseases is well established even at concentrations below guideline values (McGowan et al 2002) (Lipsett et al 1997). While such graphics usefully allow for rapid visualisation of coincident patterns, care must be used in using these to assign causality, and a good deal of detailed epidemiological and statistical analysis should accompany such endeavours. However, such efforts are, we hope, facilitated by the availability of the EHI data.

It should be noted that Blenheim only is shown, which does not reflect the air quality of the entire Marlborough district. However, the assumption was that Blenheim represented the greatest population centre, and therefore the greatest population-wide exposure to the air quality measurements that were available. Another monitoring station existed in Picton, but the air quality was typically better in Picton, and the population base is smaller, and therefore Picton air quality was not used. It had been hoped to obtain similar information from Auckland regions, but these were not available to us in the timeframe of this report.

Clearly, the measured health outcomes have multiple causal factors; making it important to determine the attributable fraction of disease due to environmental quality alone, in this case, PM_{10}. Such investigations are beyond the scope of this project, an aim of which is to highlight possible associations and trends between environmental quality and health outcome for further study and possible action at local or national levels.

Figure 17. An Example of a Linked Environmental and Health Indicator: Respiratory and Circulatory Morbidity in Marlborough vs PM_{10} in Blenheim for 2000-2002



4.3.3. Action Indicators

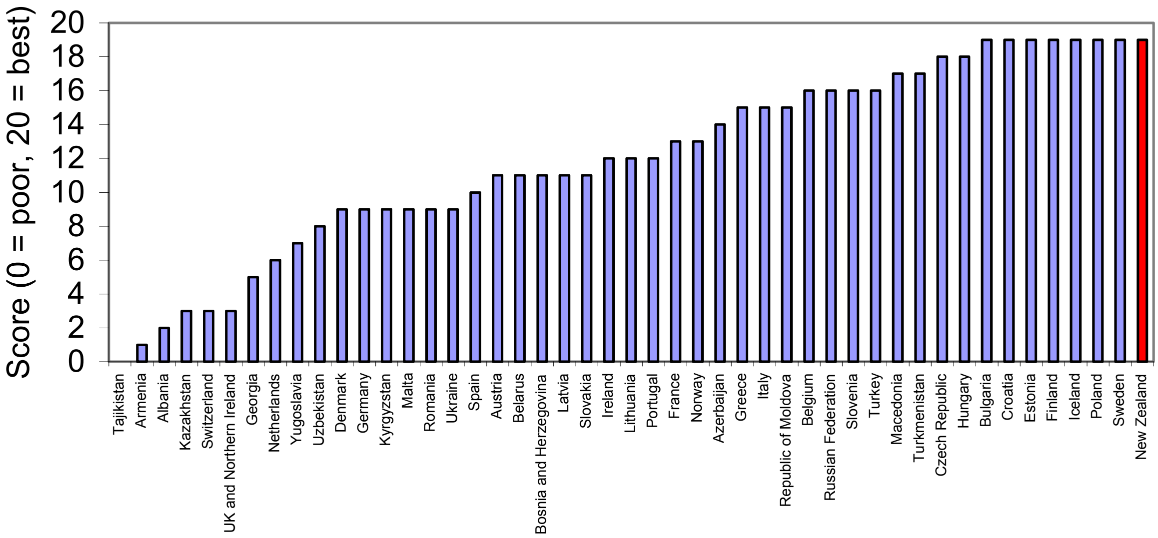
- Policies to reduce tobacco smoke exposure
- Investment in transport infrastructure

<u>**A. Indicator title**: Policies to reduce tobacco smoke exposure</u>

Definition: Composite index of capability for implementing policies to reduce environmental tobacco smoke exposure and promoting smoke free areas.

Comment: - This indicator examines the presence of national legislation to reduce environmental tobacco smoke exposure. As the figure below illustrates New Zealand has a very high score.

Figure 18. Capability of Countries to Reduce Environmental Tobacco Smoke Exposure

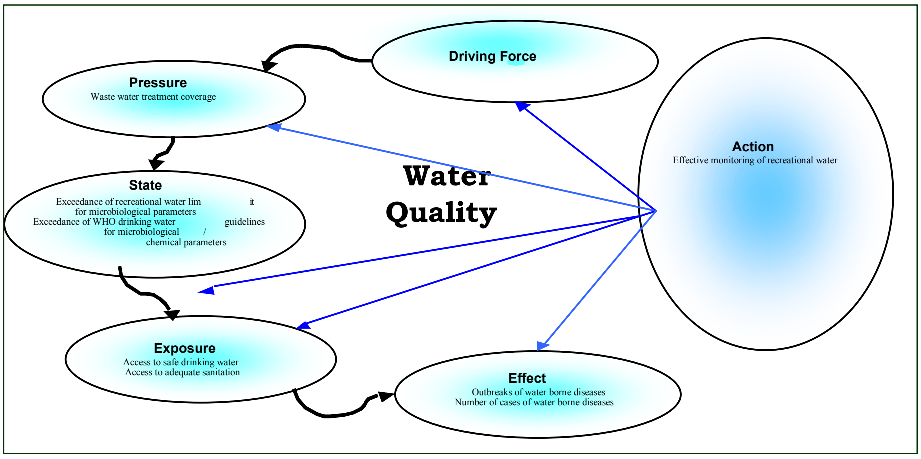


The action indicators suggested by WHO for air do not seem adequate for linkages with the environmental and health indicators. The air quality action indicators suggested by the Australians for their national environmental health indicators may be useful for NZ to adopt and adapt. The indicators include the following

- Quality of national monitoring system
- Government actions to monitor and reduce urban air pollutants
- Number of local government associations that have programmes to monitor and regulate air quality

4.4. Water Quality

Figure 18. Water Quality



The above figure summarises the indicators that were trialled for water quality and their place within the DPSEEA framework. The following section describes the individual indicators in detail in terms of definition, source and the analyses.

4.4.1. Environmental Indicators

The WHO water quality environmental indicators in this group included the following:

- Waste water treatment coverage (Pressure)
- Exceedance of recreational water limt for microbiological parameters (State)
- Exceedance of WHO drinking water guidelines for microbiological parameters (State)
- Exceedance of WHO drinking water guidelines for chemical parameters (State)
- Access to safe drinking water (Exposure)
- Access to adequate sanitation (Exposure)

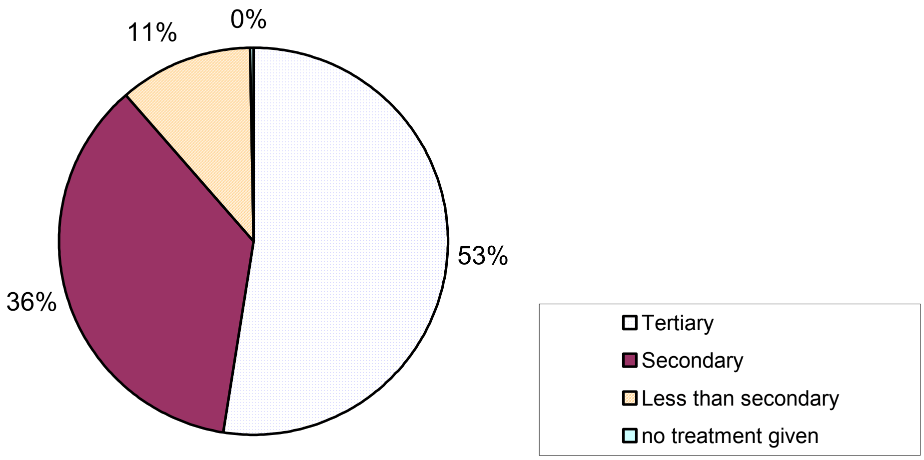
A. Indicator title: Waste water treatment coverage (Figure 20)

Definition: Percentage of the population served by sewerage connected to a wastewater treatment facility of at least biological (secondary) grade or whose wastewater is safely disposed of locally.

Comment:- The community sewerage survey (Cosinz) indicates that 95% of the population are connected to a reticulated sewerage system, of which, 87% have their wastewater treated by a facility of at least secondary grade.

A large proportion of those not connected to a treatment facility of at least secondary grade are likely to have safe local disposal facilities. If the indicator is to be useful then information would have to be gathered on the 5% of the population who are not connected to a reticulated sewerage system and have no adequate local disposal facilities. This indicator also does not take into account contamination from other sources of faecal material, particularly that of farm animals, which is particularly relevant to NZ.

Figure 20. Waste Water Treatment Coverage - National

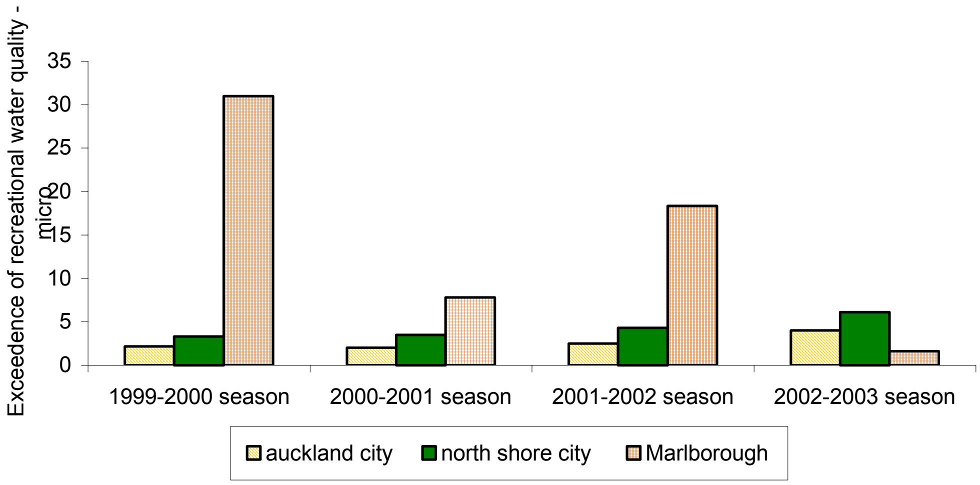


B. Indicator title: Exceedance of recreational water limt for microbiological parameters (Figure 21)

Definition: Proportion of the bathing water analyses exceeding the current imperative and guideline values specified by the European Commission under the bathing water Directive (76/160/EEC) or the US EPA over the bathing season

Comment: - Monitoring is done weekly during bathing season, from November to March, while some councils monitor a proportion of their beaches throughout the year. The comparison between New Zealand and the other countries would be difficult due to differences in seasons in the two hemispheres.

Figure 21. Exceedance of Recreational Water Quality

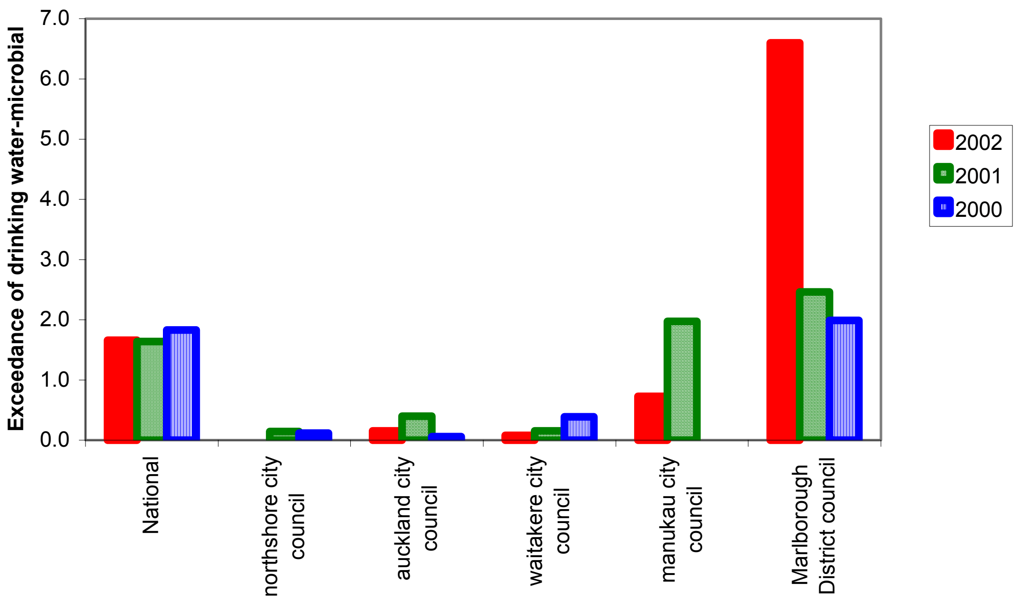


As the figure above illustrates, the recreational water quality is constant over time for the three TLA's for which data was received. Despite MDC having a higher exceedance rate from 1999 to 2002, it has decreased markedly in the 2002-03 bathing season.

C. Indicator title: Exceedance of WHO drinking water guidelines for microbiological parameters (Figure 22)

Definition: Proportion of drinking water samples with *E coli* or *faecal streptococci* exceeding the guideline value of 0 / 100 ml water over a given time period

Figure 22. Exceedance of Drinking Water for Microbiological Parameters.



Comment: - Both nationally and within the five TLA's, the intervariation between the three years is small except for Marlborough district which has a higher exceedance than the other four TLA's and the national average.

D. Indicator title: - Exceedance of WHO drinking water guidelines for chemical parameters

Indicator definition: Proportion of the drinking water analyses with chemical parameters exceeding the respective WHO guideline values over a given time period

Comment: - The way New Zealand has structured its drinking-water standards will result in a distorted indication of the quality of the country's drinking waters if chemical compliance monitoring data are used as an EHI. To protect public health, while conserving resources, the *Drinking-water Standards for New Zealand*, prioritise the monitoring that must be undertaken for compliance with the Standards.

As a result, although microbiological quality data are collected from all of the country's registered drinking-water supplies, the monitoring of chemical determinands is only required for supplies in which a determinand is considered likely to appear at potentially health-significant concentrations (exceeding 50% of their maximum acceptable value (MAV).

Further, only supplies providing water to more than 500 people are required to undertake this monitoring. Chemical compliance monitoring, therefore, does not provide a full dataset, in terms of either the number of supplies or the full list of determinands contained in the *Standards*.

Some water suppliers, usually the large local authorities, may undertake monitoring of determinands additional to those they may be required to monitor for compliance. Monitoring of this type will therefore also result in an incomplete dataset.

The Priority 2 Chemical Determinands Identification Programme (P2 Programme), which identifies the chemical determinands that have to be monitored by each supplier for compliance purposes, does collect water quality data. However, this dataset is also inadequate for providing monitoring information for the development of EHIs, because sampling for a particular determinand is only undertaken in supplies judged to be at risk of containing that determinand at elevated levels.

The only two groups of determinands for which there is extensive coverage by the P2 Programme dataset, are the heavy metals, measured in all supplies, and the disinfection by-products, measured in all chlorinating supplies. The usefulness of the P2 programme data is also limited by the fact that data from each supply are only collected during the year it takes to carry out the assessment, and a maximum of three samples are taken for a determinand during this period, most determinands being sampled only twice.

The short-coming of New Zealand's chemical determinand dataset for developing chemical determinands as an EHI arises because the monitoring requirements of the Standards were established to protect public health at minimum cost, and not for the purpose of making regional, or international comparisons. If the collection of chemical data for the latter purpose is considered important, other mechanisms need to be put in place to gather data from a more representative set of supplies. Such a programme would not require analysis of all determinands for which MAVs are listed in the *Drinking-water Standards for New Zealand*. From the data already to hand, the determinands that are most likely to appear at health-significant concentrations are known, and these are the determinands for which data are required.

E. Indicator title: Access to safe drinking water

Definition: Percentage of the population with continuous access to adequate amount of safe drinking water in the home.

Comment: - The indicator shows the percentage of the population with access to safe drinking water nationally being 82% for 1999, 86% for 2000 and 70% for 2001; for the Auckland region it ranged from 84% to 98% over the three years and for Marlborough, it was constant at 78%. The national decline in 2001 reflects the changes towards more stringent drinking water standards that were adopted at that time.

F. Indicator title: Access to adequate sanitation
Definition: Percentage of the population with access to an adequate excreta disposal facilities

Comment:- This indicator has very little relevance to New Zealand.

4.4.2. Health indicators

- Outbreaks of water borne diseases
- Number of cases of water borne diseases

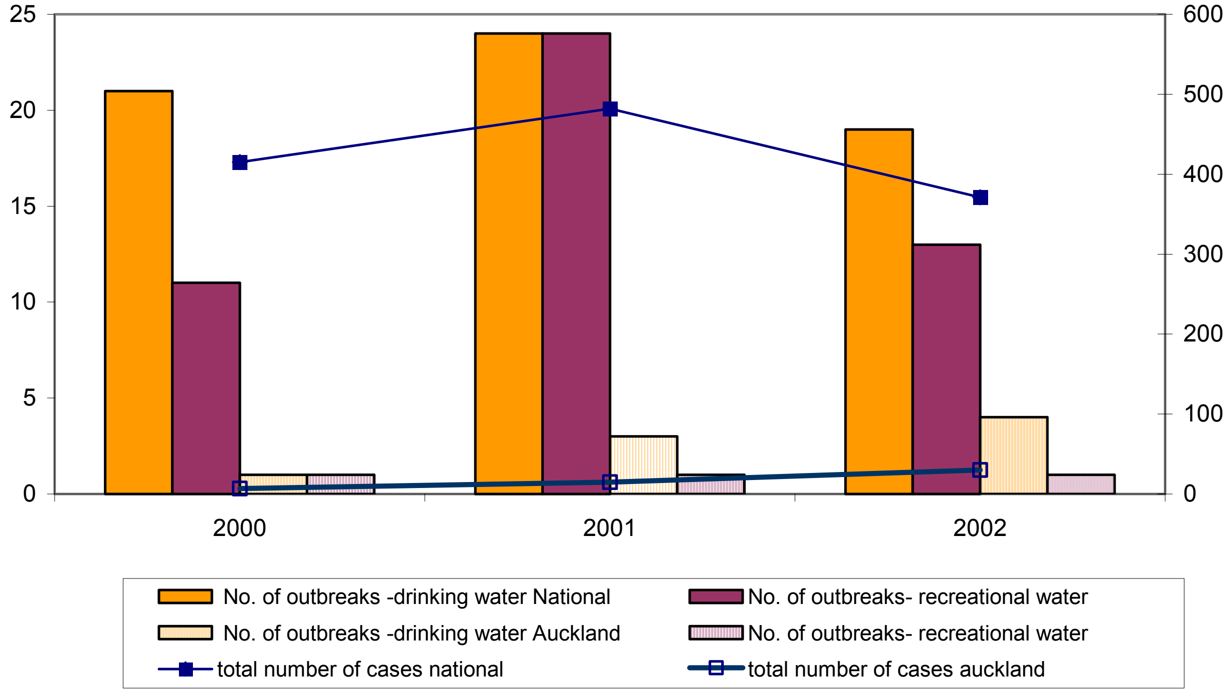
The data for this indicator was derived from the national communicable disease database-EpiSurv. The results are presented separately for drinking water and recreational water.

A. Indicator title: - Outbreaks of water borne diseases (Figure 23)

Definition: - Number of outbreaks of water-borne diseases and total number of cases reported separately for drinking water and recreational waters

Comment: - The number of outbreaks where the mode of transmission is listed as either water borne or environmental exposure to recreational water was the variable used to extract the data from Episurv.

Figure 23. Outbreaks and Number of Cases in Outbreaks for Water Borne Outbreaks



This indicator is only available at district health board level. There were no water borne outbreaks in Marlborough from 2000 to 2002. A higher proportion of water borne outbreaks were attributed to drinking water in comparison to recreational water. The rate in Auckland for drinking water increased steadily over the time period but not for recreational water.

B. Indicator title: Number of cases of proven water borne diseases (Figure 24 & 25)

Definition: Number of cases where mode of transmission was identified as water borne.

Comment: - Data for the specific diseases of interest namely: enteric diseases, primary amoebic meningoencephalitis, hepatitis A, legionella, leptospirosis, VTEC/STEC where the mode of transmission was identified as being water- recreational and drinking were obtained. In the figures rates have been used to better reflect the different populations in the TLA's. There does not appear to be any apparent consistent difference between the years or localities for drinking water borne diseases. The five TLA's that participated in the pilot study had considerably lower rates than the national average for recreational water borne diseases. It should be noted that underreporting as well as investigations into the mode of transmission of the diseases of interest are known to be infrequent and inconsistent and vary considerably across time and areas.

Figure 24. Drinking Water Borne Diseases

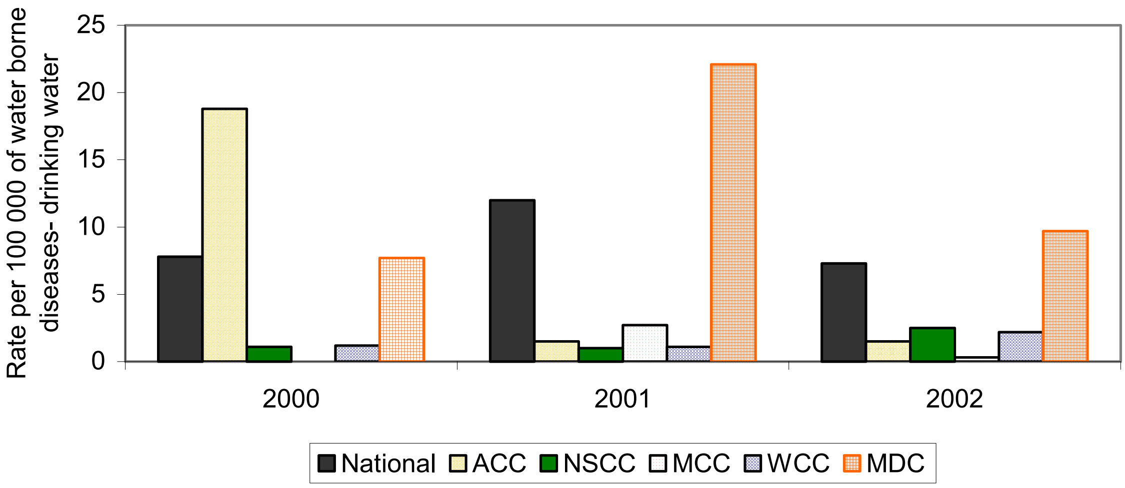


Figure 25. Recreational Water Borne Diseases

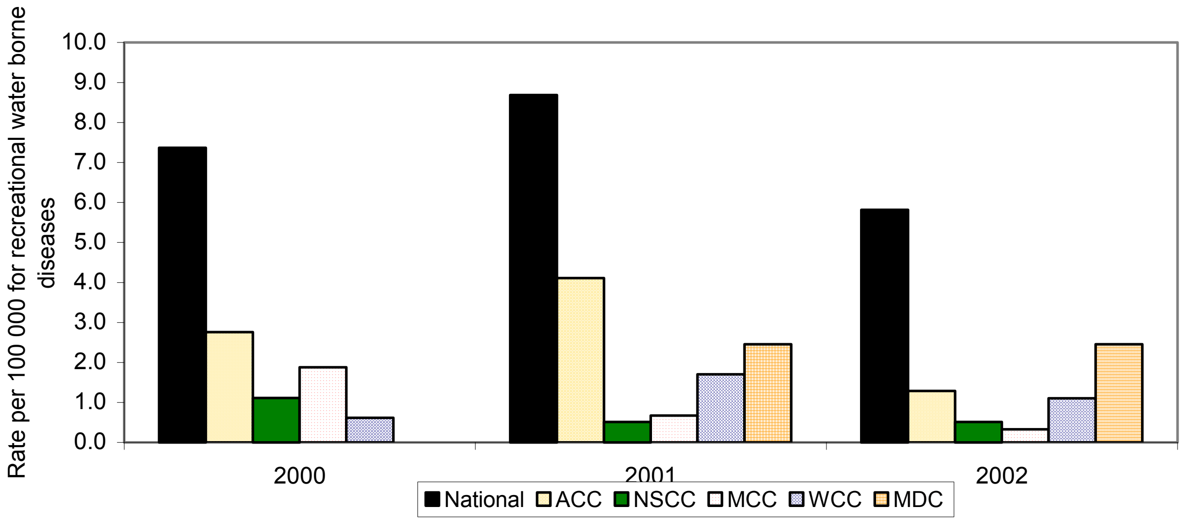
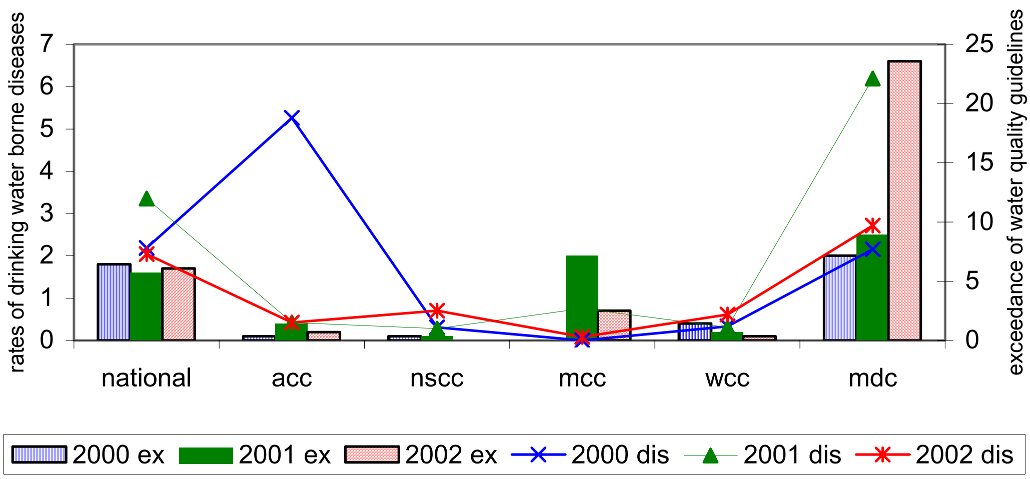


Figure 26 suggests a linear relationship between rates of drinking water borne diseases and the exceedance of water quality guidelines for microbiological parameters.

Figure 27 explores the statistical significance of the relationship between incidence of drinking water standard excursions and rates of drinking water borne disease. While in this pilot study, the number of data points is limited, there does appear to be a relationship with a linear component between the environmental quality measure and the corresponding health outcome, which is strengthened if three-yearly data are averaged. It should also be noted that the national average is included as the sixth point on the plot.

Figures 26 & 27. Relationship Between Drinking Water Standard Failures for E. coli and Rate of Water Borne Disease in Five TLAs and Nationally



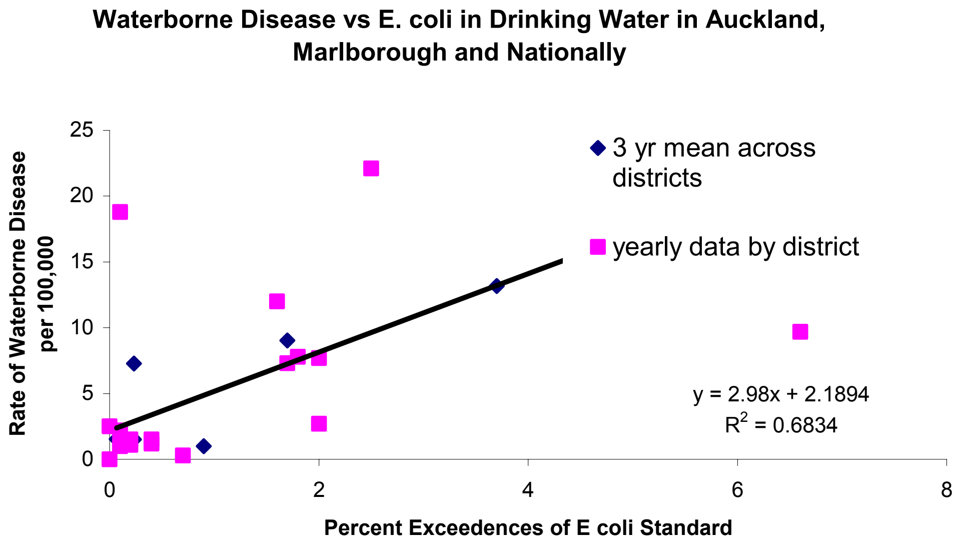
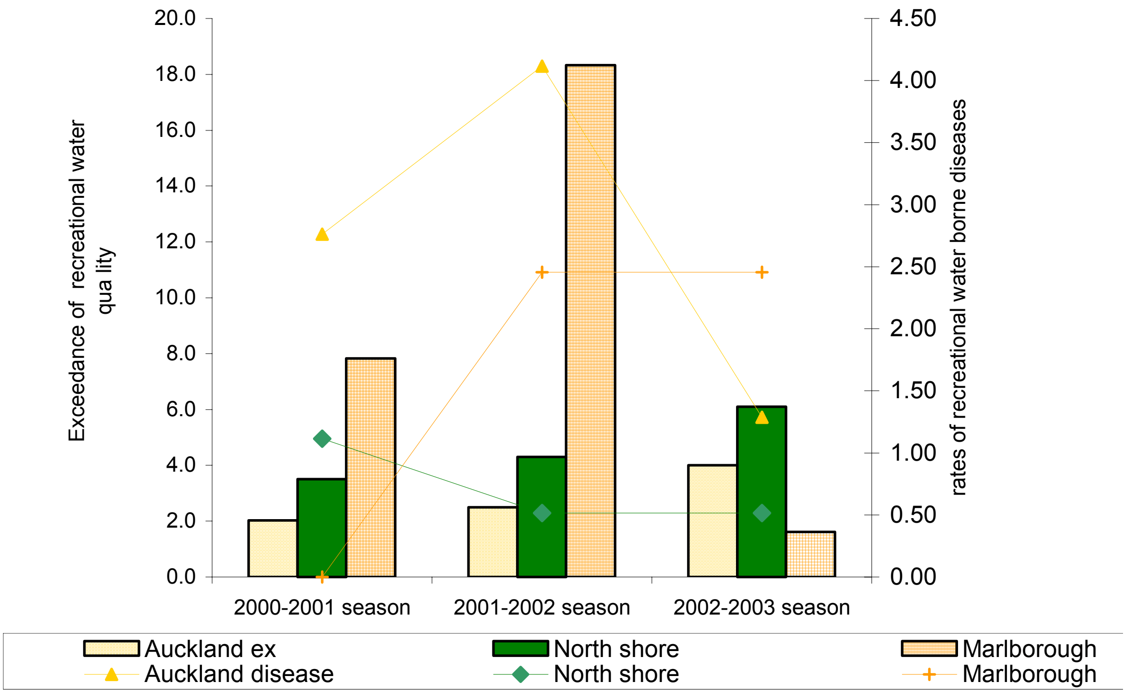


Figure 28. Relationship Between Recreational Water Quality and Disease



A similar analysis was done to investigate an association between recreational water quality and recreational water borne diseases as in figure 28. No consistent pattern appeared between the two variables. One of the limitations is that there are only three areas being analysed (i.e. data were made available for only these three).

4.4.3. Action Indicators

- Effective monitoring of recreational water

A. Indicator title: - Effective monitoring of recreational water

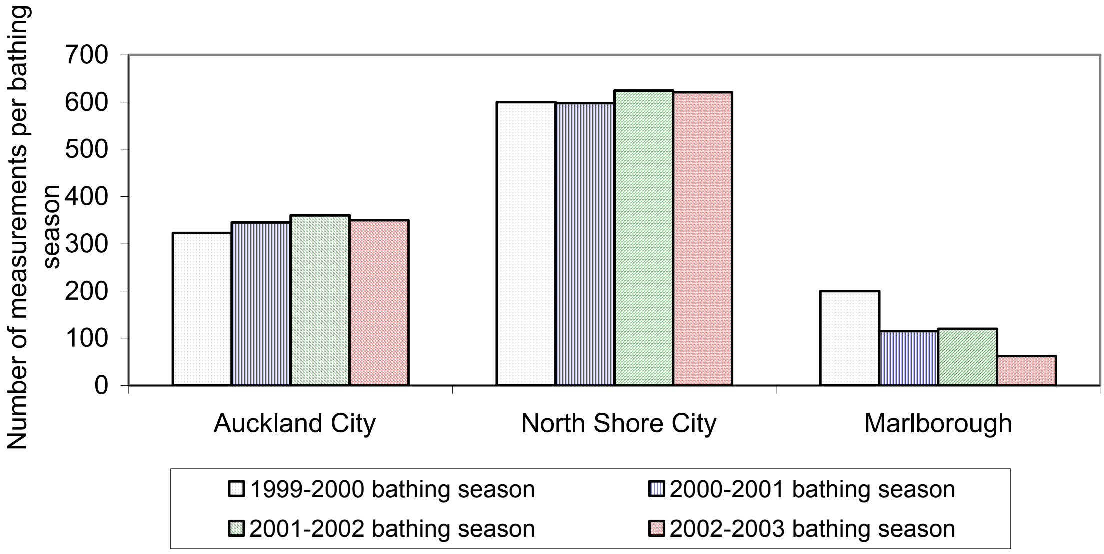
Definition: - Proportion of the bathing waters that are monitored and subject to systematic control.

Comment:- This indicator definition needs further clarification as to what constitutes a bathing site. If the indicator is calculated as defined by WHO, both North Shore and Auckland city council monitor 100% of their bathing beaches and Marlborough, approximately 80% of its beaches.

B. Indicator title: Intensity of recreational water quality

Definition: Number of measurements per pollutant per bathing season

Figure 29. Intensity of Recreational Water Quality



Comment: - Figure 29 shows there has been a decrease in monitoring in Marlborough district council over the four bathing seasons. However, there has been consistent monitoring in Auckland city council and North Shore city council, which are relative to the number of beaches that are monitored by these councils. The intensity of monitoring by an authority might reflect the number of people using the beaches.

4.5. Summary of Pilot Study Results

Table 2. Summary of Air Quality Indicators

Indicator	Feasibility study results			Pilot study results	
	Availability 0-2	Quality 1-3	Usefulness 1-3	Successfully obtained in pilot study	Alternative indicator
Kilometres driven per transport mode per person	2	3	3	Yes	Yes[5]
Consumption of fuel by type from road transport	1	2	3	Yes[6]	No
Emissions of air pollutants	2	2	3	Yes[7]	No
Ambient concentrations of air pollutants (urban): population-based exposure	2	2	3	Yes	Yes[8]
Infant mortality due to respiratory diseases	2	3	3	Yes[9]	No
Mortality due to respiratory diseases, all ages	2	3	3	Yes	No
Mortality due to diseases of the circulatory system, all ages	2	3	3	Yes	No
Policies to reduce environmental tobacco smoke exposure	2	3	3	Yes	No
Emissions of Lead, primary PM10, NO x and benzene in urban regions	1	1	3	No	No
Number of hospital admissions for respiratory diseases.	2	3	3	Yes	No
Number of hospital admissions for asthma	2	3	3	Yes	No
Number of hospital admissions for diseases of the circulatory system	2	3	3	Yes	No
DALY due to morbidity and mortality as a result of ambient air pollution	0	N/A	3	No	No
Investments in transport infrastructure	0	N/A	2	No	No

**Extended sets of indicators are italicised.*

[5] Alternative suggested as the data for the EHI is only available at a national level and the available till 2000.
[6] Only available at national level.
[7] Data only available for the 1990's and not regularly updated.
[8] The indicator value is zero because annual average did not exceed WHO guidelines.
[9] Very few cases of infant mortality due to respiratory diseases are observed in NZ.

Table 3. Summary of Water Quality Indicators

Indicator	Feasibility study results			Pilot study results	
	Availability 0-2	**Quality 1-3**	**Usefulness 1-3**	**Available**	**Alternative indicator suggested**
Waste water treatment coverage	2	2	3	Yes[10]	No
Exceedance of recreational water limit values for microbiological Parameters	2	3	3	Yes[11]	No
Exceedance of WHO drinking water guidelines for microbiological parameters	2	2	3	Yes	No
Exceedance of WHO drinking water guidelines for chemical parameters	2	2	3	Yes[12]	No
Access to safe drinking water	2	3	3	Yes	No
Access to adequate sanitation	1	1	1	No[13]	No
Outbreaks of water-borne diseases	2	2	3	Yes	No
Effective monitoring of recreational water	2	3	3	Yes	No
Proportion of coastal or freshwater bathing sites for recreational use.	2	3	3	No	No
Mortality rate due to drowning	2	3	3	No	No
Capability of management of enclosed water generally available for bathing	1	2	3	No	No
Intensity of recreational water quality monitoring	2	3	3	Yes	No
Mean and percentile concentrations of selected chemical contaminants	2	3	3	No	No
Percentage of population receiving piped water at home.	1	2	2	No	No
No. of discontinuities of public drinking water supply > 12hrs.	1	3	2	No	No
Number of cases of water borne diseases	2	2	3	Yes	Yes
Intensity of drinking water quality monitoring	2	3	3	No	No
Capability of water resources quality management	2	3	3	No	No
Good practice drinking water management	2	3	3	No	No

[10] Reported at national level as 95% of population are connected to a reticulated sewerage system.
[11] Data received for ACC, NSCC and MDC.
[12] Data received for NSCC.
[13] Irrelevant for NZ.

5. DISCUSSION

The study demonstrated the ability to acquire and collate the majority of the routinely collected environmental and health data for the Auckland and Marlborough regions for the WHO EHI core data set for air and water quality indicators.

It also established a workable process for obtaining environmental data necessary for the derivation of these air and water EHIs from the five councils, and connecting this information with relevant health outcomes [thereby facilitating the examination of temporal and regional differences]. The evidence from the pilot suggests that EHIs can be further developed and extended to cover all TLAs in the country, and for a larger range of indicator types.

Beyond this primary aim, the analyses show some of the indicators demonstrate associations consistent with their hypothesised placement in a hazard, exposure and outcome framework. Expressing specific environmental and health indicators in a “linked” manner allowed for easy visualisation of relationships, particularly for drinking waterborne diseases in relation to E. coli water standard exceedences, and for respiratory diseases as a function of PM_{10}. These linkages are largely descriptive and illustrative for the purposes of this report, but more complex analyses, including consideration of other factors [confounding etc] could be applied to determine the nature of these relationships and the associated risks and their possible attributions.

The EHIs are, by necessity a ‘broad brush’ approach that serves to efficiently convey information on trends of environmentally related disease and environmental quality measures. Therefore, while it was found that the hypothesised association between microbial water quality and rate of waterborne disease was generally consistent, this did not hold true for Auckland City in 2000, these observations merit further consideration by those with local knowledge as there are almost certainly well described local causes and explanations (eg large outbreak). EHI’s are therefore able to illustrate expected trends as well as highlighting unexpected departures from those trends, but any further consideration of local departures requires both local knowledge and perspective.

During the course of the project, the use of some novel and proxy indicators of potential relevance to New Zealand were explored where the WHO indicator was clearly unsuitable/inappropriate eg asthma medication prescription rate for asthma severity. While one could postulate that asthma medication prescriptions might in part reflect hospital discharge data, in practice there are some marked regional differences in this relationship such that observed differences in medication rate are likely to have a socioeconomic basis rather than any other and any proposed proxy indicators would need to be able to take these other factors into account.

While ESR did not generate most of the primary data used in the EHI analysis, some data quality issues were explored as part of the study. For example, by collecting data directly from Councils and comparing this with the WINZ data, it was found that there was a 100% concordance in the data between the two sources for microbiological testing. However, a wide discrepancy between the number of samples tested for chemical contaminants in WINZ and those supplied from the Councils was found. This discrepancy merits further investigation.

In conclusion, the vast majority of the WHO air and water indicators can be confidently moved into a national scale trial, and there is every reason to believe in the value of so doing. Some of the indicators trialled showed interesting spatio-temporal trends and relationships which can be further explored by local authorities, researchers, and policy makers. Even with the limited data available in the pilot study "linked" environmental and health data show consistency with hypothesised relationships between environmental data and health outcomes derived from epidemiological studies.

The collation and analysis of both environmental and health data for such "linked" indicators can be of value at both the local and national level. This project is the first mechanism to provide a central framework for regularly reporting, analysing, and further understanding the role that the environment plays in the health outcomes of New Zealanders. In so doing the project starts to bridge a widely acknowledged gap.

One major limitation of the data in this pilot study is that driving force or pressure indicators are usually only available on national or large regional basis. However, it should be possible to find ways to disaggregate these data sets so they can be overlaid with environmental and health data. There may be the need to explore novel driving force or pressure indicators that fit the New Zealand context; for example, WHO assumes that vehicle emissions are the main source of ambient air pollution, and while this might be true for the main population centres, other areas in New Zealand may be more greatly influenced by the number of households using wood burning or coal burning stoves as the main source of heat. These types of country-specific driving force indicators need to be more fully explored in order to best inform policy makers at the local and national levels.

Other indicators that are unable to be disaggregated into regional components, but are only available nationally will have utility limited to international benchmarking and/or observing national trends over time.

Some indicators do not appear to be relevant to New Zealand, and these have been identified as suggested candidates for removal from further study, or for modification in order to suit the New Zealand context. Similarly, several proxy indicators were examined in this study, and a number of additional indicators have been identified through discussion. It is important that each of these is discussed and the feasibility considered as a national EHI data set for New Zealand evolves.

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Appendix 1: List of Pilot Study Indicators

Issue	Environmental Indicator	Health Indicator	Action Indicator
Air Quality	• Kilometres driven per transport mode per person • Consumption of fuel by type of road transport • Emissions of air pollutants • Ambient concentrations of air pollutants (urban): population based exposure • *Emissions of Lead, primary PM10, NO x and benzene in urban regions*	• Infant mortality: respiratory disease • Overall mortality: respiratory disease • Overall mortality: circulatory diseases • *Number of hospital admissions for respiratory diseases (ICD10 –J00-J99).* • *Number of hospital admissions for asthma (ICD10 –J45-J46).* • *Number of hospital admissions for diseases of the circulatory system (ICD10 –I00-I99).* • *DALY due to morbidity and mortality as a result of ambient air pollution*	• **Policies: environment tobacco smoke exposure** • *Investments in transport infrastructure*
Recreational water	• waste water treatment coverage • Exceedance of recreational water for microbiological parameters • *Proportion of coastal or freshwater bathing sites for recreational use.*	• *Mortality rate due to drowning*	• **Effective monitoring of recreational water** • *Capability of management of enclosed water generally available for bathing* • *Intensity of water quality monitoring* • *Level of management response to pollution incident.*
Drinking water	• Exceedance drinking water for microbiological parameters • Exceedance drinking water for chemical parameters • Access to safe drinking water • Access to adequate sanitation • *Mean and percentile concentrations of selected chemical contaminants* • *Percentage of population receiving piped water at home.* • *No. of discontinuities of public drinking water supply for > than 12 hours.*	• Outbreaks of water-borne diseases • *Number of cases of water borne diseases*	• *Intensity of water quality monitoring* • *Capability of water resources quality management*