Environmental Health Indicators for New Zealand

Towards a National Environmental Health Information System

Prepared for the Ministry of Health

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Environmental Health Indicators for New Zealand

Towards a National Environmental Health Information System

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List of Abbreviations

AirQ  Air Quality Health Assessment Tool
C.C.  City Council
CDC  Centre for Disease Control (US)
CO  Carbon Monoxide
DALYs  Disability Adjusted Life Years
D.C.  District Council
DPSEEA  Driving forces – Pressures – State – Exposure – Effect – Action
EBD  Environmental Burden of Disease
E. coli  Escherichia coli
EHI  Environmental Health Indicator
EHIS  Environmental Health Information System
ESR  Institute of Environmental Science & Research
EpiSurv  National Notifiable Disease Surveillance System
FERET  Fast Environmental Regulatory Evaluation Tool
GI  Gastrointestinal illness
GIS  Geographical Information System
HEARTS  Health Effects and Risks of Transport Systems
IRTAD  International Road Traffic and Accident Database
LTSA  Land Transport Safety Authority
MED  Ministry for Economic Development
MfE  Ministry for the Environment
MoH  Ministry of Health
NIWA  National Institute of Water and Atmospheric Research
NO2  Nitrogen Dioxide
NOx  Nitrogen Oxide
NRL  National Radiation Laboratory
NZ  New Zealand
NZDep2001  NZDep2001 Index of Deprivation
NZHIS  New Zealand Health Information Service
O3  Ozone
PM10  Particulate Matter <10 microns
R.C.  Regional Council
SAS  Statistical Analysis Software
SO2  Sulphur Dioxide
TLA  Territorial Local Authority
UV  Ultraviolet
VTEC/STEC  Vero/shiga-toxigenic Escherichia coli
VOC  Volatile Organic Compound
WINZ  Water Information New Zealand
WHO  World Health Organisation
EXECUTIVE SUMMARY

Background

This annual report provides updated summaries and analyses of national and regional environmental and health data for New Zealand (NZ) as part of the Ministry of Health’s (MoH) Environmental Health Indicator (EHI) project. The first of its kind, the project’s purpose is to build on the Driving Force, Pressure, State, Exposure and Action (DPSEEA) framework proposed by the World Health Organisation (WHO) to facilitate national and international comparisons of the impact of environmental quality on human health. To this end, national trends and regional variations are highlighted in this EHI report.

Methods

Throughout this project, existing environmental data have been used, as collected by a wide variety of different local bodies and national government agencies. Environmental data sets in this report include those for air quality, drinking water quality, recreational water quality, traffic, and radiation. Health data sets include those available through the New Zealand Health Information Service (NZHIS), and the National Notifiable Disease Surveillance System (EpiSurv). These data have been put into the WHO software for determining the internationally comparable rate of disease for each of the health indicators. In addition, a case study highlighting the potential utility from both a national policy and local intervention perspective is included which combines environmental and health data on a national scale, focusing on drinking water quality and drinking waterborne disease rates.

Results

National statistics on disease rates of environmental relevance for air and water quality have been assembled. A fully national set of drinking water quality data obtained through the Water Information New Zealand (WINZ) system complements the corresponding health data, and significant progress has been made in collecting national data for recreational water and air quality.

A case study exploring the linkage of environmental quality and health outcomes relating to drinking water showed statistically significant national trends for drinking waterborne illness from a number of variables including percentage of the population on a registered drinking water supply and the extent of microbiological compliance with national drinking water standards. Significant local variations exist within the larger national trend, which may warrant further exploration at the local level.

Limitations

While we have endeavoured to illustrate broad trends in national data, all of the data in this report come from external sources, each with its own data quality issues. While we have noted data quality issues quality control for any particular data source is beyond the scope of this project. Statistical variations may therefore result from localised data quality problems. Although the coverage of environmental data from localities has grown considerably in 2003-2004, a number of environmental data sets from local authorities are yet to be obtained, and until this occurs nationally, geographical data gaps will exist for all indicators.
Conclusions

For the first time, nationally collected data on both environmental and related health outcome data are being systematically collected and analysed. This provides information for stakeholders to explore in terms of linkages and to evaluate the effectiveness of interventions and regulations. The case study on drinking water quality illustrates the utility of exploring the linkage of these data on a national level, and supports the importance of efforts to improve drinking water quality. A degree of caution should be taken when interpreting individual locality results within the larger context, as it is possible that data quality issues at a given locale may affect its placement in context of other regions.
1. Purpose

The goal of the project is to establish a national, functional core set of EHI’s, relevant to NZ, to provide environmental health information to local and national bodies to aid in decision-making.

This report is an extension of a pilot study conducted in 2002-2003 and is a step toward a national dataset of environmental and health indicators for NZ. In particular, applying the indicators to four topic areas; air quality, water quality, traffic and radiation. Using a standardised approach to describe the complex environmental health relationships and statistics, this project aims to provide science-based analyses of policy relevance.

The objective of this report is to show the potential of the EHI’s as a tool for environmental health decision-making. Indicators related to five environmental issues are presented: Air quality, drinking water, recreational water, traffic and radiation. The environmental, health and action indicators of these five thematic areas are presented in this report.

2. Introduction

Both Agenda 21 and the Millenium development goals highlighted the need for good quality information for decision-making. WHO, the US Centre for Disease Control (CDC) and other agencies have developed EHI’s as a starting point of an Environmental Health Information System (EHIS).

Environmental health decision-making has become an increasingly complex and at times contested process and as such there is the need for tools to facilitate and enhance the outcome of this process. The surveillance and monitoring of environmental exposures and health outcomes is a major component of an EHIS. This is facilitated by the use of a defined set of indicators.

The main questions in environmental health are:-
- What are the linkages between environmental exposures and human health outcomes?
- How do we identify and prioritise environmental health issues?
- How and when do we know whether we have an environmental health problem?
- How do we compare with other regions and countries?
- Do current actions have any impact on environmental health? What does and what does not work?

A comprehensive EHIS is needed to aid in answering the above questions. It must incorporate monitoring and surveillance data, information and communication tools and decision-making tools to enable the best action to be taken. The first step towards such a system is developing EHI’s.

The EHIS is the ongoing collation, integration, analysis, interpretation and dissemination of data on environmental hazards, exposures to these hazards and related health effects. It aims at supporting policy-making in environmental health issues by setting priorities on evidence, enhancing access to information and by facilitating communication. The goal being to provide information that can be used to plan, apply, and evaluate actions to prevent and control environmentally related diseases.

An EHIS framework has been developed based on the DPSEEA framework, utilising a suite of tools to assist better evidence-based decision-making (Figure 1).
DPSEEA framework

The DPSEEA framework is useful in designing a system of EHI’s within the decision-making context. It has been proposed to describe and analyse the links between health, environment and development and was used in analysing the global situation related to these. Within the DPSEEA framework, the driving forces component refers to the factors, which motivate and push the environmental processes involved. These result in the generation of pressures on the environment. In response to the pressures, the state of the environment is often modified. The deterioration in the state of the environment, however, only poses risks to human well being when there is an interaction between people and the hazards in the environment. Exposure therefore is rarely an automatic consequence of the existence of a hazard: it requires that people are present both at the place and at the time that hazard occurs. Exposure to environmental hazards, in turn, leads to a wide range of health effects. These range from the earliest and subtle, more intense (e.g. morbidity), to the most severe (lethal) and can be acute or chronic. Some hazards may have a rapid effect following exposure, whereas others may require long-term exposure until an adverse health effect is manifest.

Within the DPSEEA framework, the exposure and health effects components are those most visible from environmental and public health perspectives. In the face of environmental problems and consequent health effects, society may attempt to adopt and implement a range of actions. These may take many forms, and be targeted at different points within the framework. In the short term, actions are often primarily remedial, in the longer term - protective. Actions may be taken to reduce or control the hazards concerned, e.g. by limiting emissions of pollutants. The most effective long-term actions, however, are those that are preventive in approach - aimed at eliminating or reducing the forces which drive the system (Corvalán, Briggs & Zielhuis 2000).
Tools should be viewed as part of a broader EHIS framework. The objective of such tools is to facilitate assessment of the relationships between the different components of the EHIS (Figure 1). While large volumes of data are needed to support and improve decision-making, the data needs to be translated into a clear set of messages targeted at issues capable of management and control. Providing information in a form useful for decision makers requires the selection of relevant information, the translation of this information into a consistent and coherent form, and the presentation of the information in an accessible and acceptable manner. Any proposed tools should be able to achieve those requirements.

EHI’s should be viewed as an essential tool forming the evidence base for a comprehensive EHIS. They fulfil the basic functions as information, communication and decision making tools. Large amounts of data are condensed into a set of indicators to provide comprehensive information on an environmental health issue.
3. Project Summary

Scoping study
2001
Assessed various environmental health frameworks and approaches to indicator development and decided on the DPSEEA framework and WHO - Europe model as a good starting point (Phillips, Khan & Hill 2001).

Feasibility study
2002
Assessed the WHO indicator set in terms of availability, quality and utility in the NZ context (Khan 2002).

Pilot study
2003
Trialled the collection, collation and analysis of data for the proposed air and water indicator datasets in the Auckland and Marlborough regions (Khan, Fowles, Phillips & Nokes 2003).

National Roll Out
2004
Extension of air, water, traffic and radiation indicators nationally (this report).
Figure 2: Reference Map of New Zealand Featuring Territorial Local Authorities (TLA)
4. Air Quality

Figure 3: DPSEEA Framework – Air Quality indicators

Air pollutants from motor vehicles, industry, housing and commercial sources have an adverse effect on human health, moreover there is evidence that air pollution in many cities is responsible for a significant burden of disease and deaths (WHO 2003; Spix, Anderson, Schwartz, Vigotti, LeTertre, Vonk *et al* 1998; Pope & Dockery 1999). WHO (2000) estimated the annual global burden of disease attributable to urban air pollution at 13 deaths per 100 000 inhabitants. The attributable global Disability Adjusted Life Years (DALYs) from urban air pollution is 7 865 000 DALYs or 128 DALYs per 100 000 (WHO 2002).

Epidemiological evidence shows that various health effects are causally associated with air pollution. Thus there is a “chain of causality” that links our dependence on high-energy consumption, motorised transport, fires etc with pollutant emissions, ambient air pollution and health impacts. The core set of indicators above illustrates their places in this pathway.

### Highlights for NZ
- NZ has one of the highest numbers of vehicles per capita in the world.
- The transport sector is the dominant energy consumer.
- Particulate Matter <10 microns (PM_{10}) exceedances are highest in Nelson and Christchurch.
- Fuel consumption has been steadily increasing over the last ten years.
Driving Force

What was measured:
Number of vehicles per person (includes cars, taxis, trucks, buses, motorcycles and tractors).

Data Source:
Land Transport Safety Authority (LTSA).

Relevance of the Indicator:
This indicator is based on the assumption that the number of transport vehicles represent a significant source of air pollution and noise. The success of policies targeted at reducing traffic as a significant source of air pollution and noise can be assessed.

Air Quality Indicator: Air_D1
Number of Vehicles per Person

Figure 4: Number of Vehicles per Person by Region, 2002

- Nationally, the number of vehicles per person has increased from 0.72 vehicles per person in 2000 to 0.74 vehicles per person in 2002.

- Rotorua has the least number of vehicles per person with 0.3. Timaru and Palmerton North have the highest number of vehicles per person with 1.1.

- International comparisons for 2001 (Data source: International Road Traffic and Accident Database (IRTAD) - OECD):
  - United States – 0.78 vehicles per person
  - **New Zealand – 0.73 vehicles per person**
  - Germany - 0.64 vehicles per person
  - Australia – 0.62 vehicles per person
  - United Kingdom – 0.52 vehicles per person
  - Netherlands - 0.51 vehicles per person

NB: Regions used here differ from TLA’s due to different boundaries used by the LTSA.
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<th>Driving Force</th>
<th>Air Quality Indicator: Air_D2</th>
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<tbody>
<tr>
<td><strong>What was measured:</strong></td>
<td><strong>Road Transport Fuel Consumption</strong></td>
</tr>
</tbody>
</table>
| Average consumption of fuel from domestic transport per year. | ![Figure 5: Road Transport Fuel Consumption](image)

**Data Source:**
Ministry for Economic Development (MED)

**Relevance of the Indicator:**
This indicator is based on the assumption that the use of fossil fuel represents a significant source of exposure to ambient air pollutants and health risk. The indicator can be interpreted in terms of a measure of potential emission of air pollutants.

- Fuel consumption from all sectors including the transport sector, has been steadily increasing over the last ten years.
- The transport sector is the dominant energy consumer accounting for 42.5% of the total energy demand.
State Indicator

**What was measured:**
Mean and number of days exceeding WHO guidelines for PM$_{10}$.

**Data Source:**
Individual regional councils.

**Relevance of the Indicator:**
This indicator is based on the assumption that outdoor levels of air pollution represent a significant source of exposure and health risk. NO$_2$, PM$_{10}$, SO$_2$, O$_3$ give a good picture of ambient concentrations in cities and are related to health effects. It is based on the assumption that an increase of the incidence of health outcomes to a given exposure in a given population is linearly proportional to the pollutant concentration.

**Air Quality Indicator: Air_S1**
**Ambient Air Pollution**

**Figure 6:** PM$_{10}$ Annual Mean and Exceedances by Site, 2002

- Knowledge about air pollution is constrained by the limited extent of air quality monitoring carried out.

- Data was received from only Auckland R.C., Bay of Plenty R.C., Hawkes Bay R.C., Manawatu-Wanganui R.C., Nelson C.C., Marlborough D.C., West Coast R.C. and Canterbury R.C. Data was also received from Gisborne D.C. but was not included due to time constraints. Only results from the sites which have monitoring data for 30% of the year or more are presented here. This is because monitoring data for shorter periods make it difficult to compare across regions.

- The number of days the guidelines for PM$_{10}$ is exceeded and the annual average of PM$_{10}$ concentration vary considerably. In most areas the guidelines for PM$_{10}$ are exceeded in winter.

- In 2002 the annual PM$_{10}$ concentration average varied from 13µg/m$^3$ in Tauranga D.C. to 42µg/m$^3$ in Nelson C.C. The number of days PM$_{10}$ concentration exceeded the guideline value of 50µg/m$^3$ ranged from zero days in Auckland R.C., Bay of Plenty R.C. and Blenheim D.C. to 62 days in Nelson C.C. (Swift Suzuki site).

- International comparisons for Daily PM$_{10}$ averages, various years (Data sources: LeTertre *et al* 2002; Koken *et al* 2003; Wong *et al* 2001):
  - Barcelona – 55.7µg/m$^3$
  - Rome – 52.5µg/m$^3$
  - Hong Kong - 52µg/m$^3$
  - Nelson - 31µg/m$^3$
  - London – 28.4µg/m$^3$
  - Denver – 24.2µg/m$^3$
  - Auckland - 20µg/m$^3$
  - Christchurch - 20µg/m$^3$
  - Stockholm – 15.5µg/m$^3$
### Effect Indicator

**What was measured:**
Annual mortality rate due to respiratory diseases - all ages (ICD 10 codes J00-J99) per 100,000 people.

**Data Source:**
NZHIS

**Relevance of the Indicator:**
This indicator may be interpreted to show trends in mortality due to respiratory diseases. A small part of respiratory mortality can be attributed to exposure to air pollution. Mortality is also dependent upon the effectiveness of the health care system.

### Air Quality Indicator: Air_E1
**Mortality due to Respiratory Diseases**

**Figure 7: Mortality Rate due to Respiratory Diseases, 2000**

- The national mortality rate due to respiratory diseases has decreased from 69 per 100,000 in 1999 to 53 per 100,000 in 2000.
- The age standardised* mortality rate varied from 12 per 100,000 in Carterton D.C. to 108 per 100,000 in Otorohanga D.C.
- International comparisons for 1999 (Data source: WHO mortality database):
  - United Kingdom - 185 deaths per 100,000
  - Japan - 114 deaths per 100,000
  - Netherlands - 91 deaths per 100,000
  - United States - 84 deaths per 100,000
  - **New Zealand – 69 deaths per 100,000**
  - Australia - 60 deaths per 100,000

* Age standardised to NZ population.
**Effect Indicator**

**What was measured:**
Annual mortality rate due to cardio- or cerebro-vascular diseases - all ages (ICD 10 codes I00-I99) per 100,000 people.

**Data Source:** NZHIS

**Relevance of the Indicator:**
This indicator may be interpreted to show trends in mortality due to circulatory system diseases. A small part of it can be attributed to exposure to air pollution. Most of the effects of these risk factors have long latency periods. Mortality is also dependent upon the effectiveness of the health care system.

<table>
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<tr>
<th>Age standardised * rate per 100 000</th>
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<tr>
<td>0.0 - 146.5</td>
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<tr>
<td>146.6 - 292.9</td>
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<tr>
<td>293.0 - 398.0</td>
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<tr>
<td>398.1 - 503.0</td>
</tr>
</tbody>
</table>

**Quality Indicator: Air_E2**

**Mortality due to Circulatory Diseases**

**Figure 8: Mortality Rate due to Circulatory Diseases, 2000**

- The national mortality rate due to circulatory diseases has decreased from 294 per 100,000 in 1999 to 281 per 100,000 in 2000.
- The age standardised* mortality rate varied from 136 per 100,000 in Banks Peninsula D.C. to 503 per 100,000 in Wairoa D.C.
- International comparisons for 1999 (Data source: WHO mortality database):
  - United Kingdom - 421 deaths per 100,000
  - United States - 350 deaths per 100,000
  - Netherlands - 314 deaths per 100,000
  - New Zealand – 294 deaths per 100,000
  - Australia - 271 deaths per 100,000
  - Japan - 245 deaths per 100,000

* Age standardised to NZ population.
**Effect Indicator**

**What was measured:**
Annual hospitalisation (publicly funded) rate for respiratory diseases (ICD 10 codes J00-J99) per 100 000 people.

**Data Source:**
NZHIS

**Relevance of the Indicator:**
This indicator may be interpreted to show trends in hospital admissions as a result of respiratory diseases. A small part of hospital admissions for respiratory diseases can be attributed to exposure to air pollution. Hospital admissions do not include visits to the emergency department and are highly dependent upon the effectiveness of the health care system.

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**Air Quality Indicator: Air_Ext1**

**Hospital Admissions for Respiratory Diseases**

**Figure 9: Hospitalisation Rate for Respiratory Diseases, 2003**

- The national hospitalisation rate due to respiratory diseases has decreased from 1558 cases per 100 000 in 2001 to 1510 cases per 100 000 in 2003.

- The age standardised hospitalisation rate varied from 864 cases per 100 000 in Mackenzie D.C. to 2974 cases per 100 000 in Waitomo D.C.

  - New Zealand – 1562 hospitalisations per 100 000
  - England – 1510 hospitalisations per 100 000
  - United States – 1339 hospitalisation per 100 000

* Age standardised to NZ population.
### Effect Indicator

**What was measured:**
Annual hospitalisation (publicly funded) rate for asthma (ICD 10 codes J45-J46) per 100,000 people.

**Data Source:**
NZHIS

**Relevance of the Indicator:**
This indicator may be interpreted to show trends in hospital admissions as a result of asthma. A small part of hospital admissions for asthma can be attributed to exposure to air pollution. Hospital admissions do not include visits to the emergency department and are highly dependent upon the effectiveness of the health care system.

### Air Quality Indicator: Air Ext1

#### Hospital Admissions for Asthma

**Figure 10: Hospitalisation Rate for Asthma, 2003**

<table>
<thead>
<tr>
<th>Age standardised rate per 100 000</th>
<th>0.0 - 110.2</th>
<th>110.3 - 220.3</th>
<th>220.4 - 362.4</th>
<th>362.5 - 504.5</th>
</tr>
</thead>
</table>

- The national hospitalisation rate for asthma has decreased from 240 cases per 100,000 in 1999 to 207 cases per 100,000 in 2003.

- The age standardised* hospitalisation rate varied from 45 cases per 100,000 in Kaikoura D.C. to 505 cases per 100,000 in Opotiki D.C.

  - Australia – 250 hospitalisations per 100,000
  - **New Zealand – 240 hospitalisations per 100,000**
  - United States – 174 hospitalisations per 100,000
  - England – 156 hospitalisations per 100,000

* Age standardised to NZ population.
Effect Indicator

**What was measured:**
Annual hospitalisation (publicly funded) rate for diseases of the circulatory system (ICD 10 codes I00-I99) per 100,000 people.

**Data Source:** NZHIS

**Relevance of the Indicator:**
This indicator may be interpreted to show trends in hospital admissions as a result of circulatory system diseases. A small part of it can be attributed to exposure to air pollution. Hospital admissions do not include visits to the emergency department and are highly dependent upon the effectiveness of the health care system.

---

**Figure 11:** Hospitalisation Rate for Circulatory Diseases, 2003

- The national hospitalisation rate due to circulatory diseases has decreased from 1875 cases per 100,000 in 2001 to 1703 cases per 100,000 in 2003.

- The age standardised* hospitalisation rate varied from 1057 cases per 100,000 in Banks Peninsula D.C. to 2781 cases per 100,000 in Buller D.C.

  - Australia – 2330 hospitalisations per 100,000
  - United States – 2320 hospitalisations per 100,000
  - England – 2152 hospitalisations per 100,000
  - New Zealand – 1769 hospitalisations per 100,000

* Age standardised to NZ population.
<table>
<thead>
<tr>
<th>Effect Indicator</th>
<th>Air Quality Indicator: Air_Ext5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What was measured:</strong></td>
<td><strong>Prescription Rate for Asthma Medication</strong></td>
</tr>
<tr>
<td>Annual prescription rate for asthma medication per 100 000 people.</td>
<td></td>
</tr>
<tr>
<td><strong>Data Source:</strong></td>
<td>NZHIS - Pharmhouse</td>
</tr>
<tr>
<td><strong>Relevance of the Indicator:</strong></td>
<td>This indicator was developed as NZ is one of the few countries which has a national prescription database. It is a standalone indicator which illustrates symptomatic outcomes. It is a first step to move beyond mortality and morbidity statistics in order to gain a better picture of the health effects especially when environmental exposure is low and mortality and morbidity numbers are low. It assumes that diagnosed cases have equal access to prescription drugs in differing socioeconomic parts of the country.</td>
</tr>
</tbody>
</table>

**Figure 12: Prescription Rate for Asthma Medication, 2002**

- Nationally the average prescription rate for asthma medication has increased from 26229 prescriptions per 100 000 in 1999 to 27993 prescriptions in 2002.
- In 2002, Otorohanga D.C. had the lowest prescription rate for asthma medication with 13674 prescriptions per 100 000 whereas Grey D.C. had the highest rate with 44985 prescriptions per 100 000.
- This relationship has been consistent for the last three years with Otorohanga D.C. having the lowest and Grey D.C. the highest prescription rate for asthma medication.
5. Drinking Water Quality

Worldwide, it is estimated that substandard water quality, supply, sanitation and hygiene accounts for 4% of all deaths and 5.7% of the total disease burden or 84 million life years lost per year from diarrhoeal diseases, schistomiasis, trachoma, ascariasis, trichuriasis, and hookworm disease (Pruss, Kay, Fewtrell & Bartram 2002).

There was a dramatic decline in the incidence of waterborne diseases after the introduction of water treatment and disinfection in the early 1900’s. However, there are concerns for the future microbiological safety of drinking water, in both developing and developed countries. This is because a) source waters continue to receive agricultural, industrial, and municipal wastes; b) water treatment and distribution systems age and deteriorate; c) demand exceeds water supply (d) there appears to be an increase in diseases, or at least an increased recognition of disease, caused by pathogens with varying degrees of resistance to treatment and disinfection (Ford 1996: Ford & Colwell 1993).

**Highlights for NZ**
- Drinking water quality has been improving over the last three years and there has been a subsequent decrease in the drinking waterborne disease rate.
- The percentage of the population on registered water supply and the intensity of water quality monitoring has remained steady over the last three years.
**State Indicator**

**What was measured:**
Proportion of drinking water samples with *E. coli* exceeding the guideline value of 0 per 100ml water annually.

**Data Source:**
WINZ, ESR

**Relevance of the Indicator:**
This indicator is a measure of the state of the microbiological quality of drinking water, especially under conditions of inadequate water, hygiene and basic sanitation. Data on exceedances may be subject to large margins of error due to inconsistencies in reporting, sampling practices, analytical methods used, etc.

**Drinking Water Quality Indicator: DW_S1**

**Drinking Water Compliance**

Figure 14: Drinking Water Compliance, 2002

- Nationally, there has been a steady improvement in the drinking water quality from 1998 to 2002 as the percentage of *Escherichia coli* (*E. coli*) exceedances decreased from 3% in 1998 to 2% in 2002.

- In 2002, the highest exceedance of *E. coli* was observed in Waimate D.C. (13.3%) and Mackenzie D.C. (12.8%). There were no *E. coli* exceedances reported in 2002 for the following TLA’s: Carterton D.C., Gore D.C., Hamilton C.C., Kapiti Coast D.C., North Shore C.C., Papakura D.C., Porirua C.C., Queenstown-Lakes D.C., Stratford D.C., Taupo D.C., Upper Hutt C.C., Wellington C.C., and Western Bay of Plenty D.C.

- International comparisons for 2001 (Data source: WHO - Environment and Health Information System (ENHIS), provisional data):
  - Hungary – 5.5% exceedance
  - **New Zealand – 2.3% exceedance**
  - Czech Republic – 1.3% exceedance
  - Netherlands – 0.1% exceedance
Exposure Indicator

What was measured:
Percentage of the population on registered water supply.

Data Source:
WINZ, ESR

Relevance of the Indicator:
This indicator gives a crude estimate of the population with/without access to piped water supply at home, provided by a licensed and regulated water undertaker and therefore potentially exposed to water-related health risks. A low percentage suggests actions should be taken to increase population access to safe drinking water and hence, reduce exposure and health risk.

- Nationally the percentage of the population on registered water supply has remained steady over the last five years at 83%.
- In 2002, 100% of the population in the following TLA’s were on registered water supply: Hurunui D.C., Invercargill C.C., Kaikoura D.C., Kawerau D.C., Mackenzie D.C., North Shore C.C., Palmerston North C.C., Taupo D.C., and Timaru D.C. Both Rodney D.C. and Southland D.C. had the lowest percentage, both having 47% of the population on registered water supply.
- International comparisons for 2000 (Data source: WHO – ENHIS, provisional data), need caution as varying definitions.
  - Netherlands - 100%
  - Switzerland - 100%
  - Czech Republic - 87%
  - New Zealand - 83%
**Effect Indicator**

**What was measured:**
Number of outbreaks of drinking water related illness.

**Data Source:**
EpiSurv, ESR

**Relevance of the Indicator:**
This indicator is useful for evaluating the adequacy of approaches for providing safe drinking water. It demonstrates where there is a breakdown in the system and recognises that most waterborne disease occurs as linked cases relating to a single water supply.

---

**Drinking Water Quality Indicator: DW_E1**

**Outbreaks of Drinking Waterborne Diseases**

**Figure 16:** Outbreaks and Cases of Drinking Waterborne Diseases, 2000-2003, nationally

- Nationally the number of outbreaks has remained steady over the last four years between 17 in 2003 and 23 in 2001. However the total number of people affected has varied considerably.

- In 2003, Dunedin C.C. and Rodney D.C. had 3 outbreaks each.

- 65% of the outbreaks over the last four years were attributed to untreated water supply.
Effect Indicator

**What was measured:**
Annual rate per 100 000 people, of diseases which recorded drinking water as the main mode of transmission.

**Data Source:**
EpiSurv, ESR

**Relevance of the Indicator:**
This indicator may be interpreted to show trends in the communicable disease rate attributable to drinking water. Care needs to be taken due to inherent inconsistencies and inaccuracies in the available data. The disease rate does not reflect the true burden of disease due to under reporting of drinking waterborne disease and the large number of gastrointestinal diseases of unknown origin.

### Drinking Water Quality Indicator: DW_E2
**Drinking Waterborne Diseases Rate**

#### Figure 17: Drinking Waterborne Diseases Rate, 2003

- The national drinking waterborne disease rate has decreased from 85.2 cases per 100 000 in 2001 to 38 cases per 100 000 in 2003.

- The highest reported waterborne disease rate was observed in South Wairarapa D.C. and Southland D.C. with 305 and 245 cases per 100 000 respectively. No drinking waterborne diseases cases were reported in Kaikoura D.C., Wairoa D.C. and Kawerau D.C.

- 59% of the drinking waterborne cases were attributed to Campylobacter and 13% to Cryptosporidiosis.
**Action Indicator**

**What was measured:**
Total number of drinking water samples monitored per capita for *E. coli*.

**Data Source:**
WINZ, ESR

**Relevance of the Indicator:**
The intensity of monitoring reflects action taken by councils and water suppliers.

---

**Drinking Water Quality Indicator: DW_A1**

**Intensity of Drinking Water Quality Monitoring**

**Figure 18:** Intensity of Drinking Water Quality Monitoring, 2002

- Nationally, the intensity of drinking water quality monitoring has been steady at 1.2 monitoring samples for *E. coli* per person.

- The highest monitoring per person in 2002 occurred in Whakatane D.C. and Banks Peninsula D.C. at 14 and 8 samples per person respectively. The lowest monitoring per person was observed in Hamilton C.C. (0.28 samples per person) and Manukau C.C. (0.31 samples per person).
6. Recreational Water Quality

Figure 19: DPSEE Framework – Recreational Water Quality

Water contaminated by human or animal excreta poses a significant health hazard when it is used for recreational activities such as swimming, water sports and collecting food. Exposure to pathogens in recreational water have been associated with gastrointestinal, respiratory, ear, eye and skin symptoms (Cabelli, Dufour, McCabe & Levin 1982; Kay, Fleisher, Jones, Salmon, Wyer, Godfree, Zelenauch-Jacquotte & Shore 1994).

The Life in New Zealand Survey by the Hillary Commission for Recreation and Sport (1991) examining recreational water use in the 15 –18 year old age group found that 31% had been to the beach in the last four weeks (summer) and the 23% of males and 8% of females had been in the water. Hence the issue of effective monitoring of recreational water limit values is of significance in NZ.

Highlights for NZ

- In NZ the national trend suggests that over the last five bathing seasons, between 4 and 8% of the beaches monitored throughout the country exceeded the standard of 140 enterococci per 100ml on one or more occasions.
- Throughout NZ there is a significant variation in the intensity of recreational water quality monitoring. The national data suggests that on average 150 samples are taken per bathing season in each region.
State Indicator

Recreational Water Quality Indicator: RW_S1
Recreational Water Compliance

<table>
<thead>
<tr>
<th>What was measured:</th>
<th>Proportion of marine water bathing measurements exceeding the enterococci standards &gt;140 enterococci per 100ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Source:</td>
<td>Individual regional councils and TLA’s.</td>
</tr>
<tr>
<td>Relevance of the Indicator:</td>
<td>This indicator is a measure of the microbiological quality of bathing waters. Data on exceedances may be subject to large margins of error due to inconsistencies in reporting and sampling practices.</td>
</tr>
</tbody>
</table>

**Figure 20: Recreational Water Compliance, 2003-2004 Season**

- It is very difficult to gain a national picture of recreational water quality as data was not received from Taranaki R.C, and Manawatu-Wanganui R.C. Exclusive of those regions, the national trend suggests that in the last five bathing seasons, between 4 to 8% of the beaches monitored throughout the country exceeded the 140 enterococci per 100 ml standard on one or more occasions. 2 to 6% of the monitored beaches exceeded the 280 enterococci per 100ml standard on one or more occasions for the same period.

- Marine water quality varies considerably overseas with 7.6% of Spain’s beaches exceeding the standard whereas only 0.31% of Germany’s beaches exceeded the standard. This could reflect different monitoring protocols.

- Porirua C.C. had the highest percentage exceedance of 24% whereas Tauranga D.C. had the lowest of 1.5% in the 2003-2004 season.

- During the 2003-2004 season, 6.4% of the beaches monitored exceeded the 140 enterococci per 100ml standard on one or more occasions of which 4% exceeded the 280 enterococci per 100 ml standard.
| Effect Indicator | Recreational Water Quality Indicator: RW_E1  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What was measured:</strong></td>
<td><strong>Outbreaks of Recreational Waterborne Diseases</strong></td>
</tr>
<tr>
<td>Number of outbreaks of waterborne diseases where the mode of transmission was identified as recreational water and total number of cases reported separately for recreational waters.</td>
<td>- There have only been two outbreaks where the mode of transmission was identified as recreational water in the last three years. One in 2001 in Hawkes Bay with five people affected. The other in 2002 in Eastern Bay of Plenty with two cases.</td>
</tr>
</tbody>
</table>

**Data Source:**
EpiSurv, ESR

**Relevance of the Indicator:**
This indicator is useful for evaluating the adequacy of approaches for ensuring safe recreational water. It demonstrates where there is a breakdown in the system and recognises that most waterborne disease occurs as linked cases relating to a single water source.
### Effect Indicator

**What was measured:** Annual rate per 100,000 people, of diseases which recorded recreational water as the main mode of transmission.

**Data Source:** EpiSurv, ESR

**Relevance of the Indicator:** This indicator may be interpreted to show trends in the communicable disease rate attributable to recreational water. Care needs to be taken due to inherent inconsistencies and inaccuracies in the available data. The disease rate does not reflect the true burden of disease due to under-reporting of recreational waterborne disease and the large number of gastrointestinal diseases of unknown origin.

<table>
<thead>
<tr>
<th>Recreational Water Quality Indicator: RW_E2</th>
<th>Recreational Waterborne Diseases Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Figure 21: Recreational Waterborne Diseases Rate, 2003</strong></td>
<td></td>
</tr>
</tbody>
</table>

- It should be noted that recreational water for this indicator includes both marine and freshwater due to the nature of the data in EpiSurv.

- There does not appear to be a significant trend with the national average of recreational waterborne diseases. In 2001 the national average was 8.2 cases per 100,000 which dropped to 5.8 cases per 100,000 in 2002 and then increased to 7.6 cases per 100,000 in 2003.

- Queenstown-Lakes D.C. has the highest rate of recreational waterborne diseases with 53 cases per 100,000. Since the district does not have any marine water, the cases are highly likely to be from exposure to freshwater.

- Ashburton D.C. has the second highest rate of recreational waterborne diseases with 34 cases per 100,000.

- The following TLA’s reported no cases of recreational waterborne diseases for 2003:- Central Hawke’s Bay D.C., Clutha D.C., Hastings D.C., Horowhenua D.C., Kaikoura D.C., Manawatu D.C., Napier C.C., Opotiki D.C., Tararua D.C., Thames-Coromandel D.C., Waikato D.C., Wairoa D.C., Waitaki D.C. and Waitomo D.C.
**Recreational Water Quality Indicator: RW_A1**

**Intensity of Recreational Water Quality Monitoring**

**What was measured:**
Number of marine water bathing samples analysed per bathing season.

**Data Source:**
Individual regional councils.

**Relevance of the Indicator:**
The intensity of the monitoring reflects action taken by councils.

**Figure 22:** Intensity of Recreational Water Quality Monitoring, 2003-2004 Season

- Data was not received from Taranaki R.C. and Manawatu-Wanganui R.C. The national trend excluding these regions suggests that the intensity of marine water monitoring has been consistent with an average of 150 samples per bathing season.

- In 2003, North Shore C.C. had the highest number of samples being monitored (639 samples) as well as the highest number of beaches being monitored. Buller D.C. had the lowest number of samples being monitored (2 samples) with one beach being monitored.

- This indicator also reflects the percentage of the population using the beach.
7. Traffic

Injuries caused by road traffic accidents are a global public health problem. They are the leading cause of death by injury and the ninth leading cause of all deaths worldwide. In 2000, about 1,260,000 persons were killed in road crashes with an additional 10-15 million people injured every year. Road traffic accidents are the most important cause of death among young people, especially males and are a major cause of physical disability, especially among the young. Over 50% of the global mortality due to road traffic injury occurs among young adults aged 15-44 years (WHO 2004c).

WHO has identified additional indicators these are:

**Exposure:** person time spent on the road; distances travelled.

**Effect:** injury rate; potential years of life lost, number of DALYs lost from road accidents.

**Risk Factor:** percentage of safety vehicle (car/motorcycle) device use; percentage of vehicles exceeding limits; deaths due to drunk driving.

While the new indicators are not included in the current report, efforts will be made to obtain and analyse data for these indicators in the future.

---

**Highlights for NZ**

- NZ’s mortality rate from traffic accidents has declined steadily between 2000 and 2002.
- NZ’s serious injury rate from traffic accidents has increased steadily between 2000 and 2002.
- In 2002, the two leading contributory factors for both traffic fatalities and injuries were excessive speed and alcohol.
## Effect Indicator

**What was measured:**
Annual mortality rate due to transport accidents per 100,000 people.

**Data Source:**
LTSA

**Relevance of the Indicator:**
This indicator is in general relatively easy to interpret in that the link between the cause and health effect is explicit. Changes in the indicator should be due to reduction in total traffic volume, greater segregation of pedestrian from road traffic, improvement in road design, traffic management, vehicle safety, environmental conditions as well as health promotion safety campaigns.

### Figure 24: Mortality from Traffic Accidents, 2002

- There has been a steady decline in the national mortality rate due to traffic accidents between 2000 and 2002 from 12 to 10.3 deaths per 100,000.

- In 2002, the highest mortality rate due to traffic accidents was observed in Westland D.C. (101 cases per 100,000) and Hurunui D.C. (68 cases per 100,000). After standardising* for age, the rate for Westland D.C. increases to 106 cases per 100,000. For Hurunui D.C., standardising* for age also increases the rate to 92 cases per 100,000. No deaths due to traffic accidents were recorded in Banks Peninsula D.C., Kawerau D.C., Masterton D.C. and Upper Hutt C.C.

- The two leading contributing factors for traffic fatalities for 2002 were excessive speed (17%) and alcohol (14%).

- International comparisons for 2002 (Data source: IRTAD - OECD):
  - United States - 14.9 deaths per 100,000
  - New Zealand – 10.3 deaths per 100,000
  - Australia – 8.8 deaths per 100,000
  - Germany – 8.3 deaths per 100,000
  - United Kingdom - 6.1 deaths per 100,000

* Age standardised to NZ population.
Effect Indicator

What was measured:
Annual injury rate due to transport accidents per 100 000 people.

Data Source:
LTSA

Relevance of the Indicator:
This indicator is in general relatively easy to interpret in that the link between the cause and health effect is explicit. Changes in the indicator should be due to reduction in total traffic volume, greater segregation of pedestrian from road traffic, improvement in road design, traffic management, vehicle safety, environmental conditions as well as health promotion safety campaigns.

Traffic Accidents: Traf_E2
Rate of Injuries by Traffic Accidents

Figure 25: Rate of Injuries by traffic Accidents, 2002

Crude injury rate per 100 000
- 0.0 - 48.3
- 48.4 - 96.6
- 96.7 - 234.4
- 234.5 - 372.3

- There has been a steady increase in the national serious injury rate between 2000 and 2002 from 58 cases per 100 000 in 2000 to 66 cases per 100 000 in 2002. The national total (serious and minor) injury rate for 2002 was 353 cases per 100 000.

- In 2002, the highest injury rate due to traffic accidents was observed in Mackenzie D.C. (372.3 cases per 100 000) and Queenstown-Lakes D.C. (264.2 cases per 100 000). After standardising* for age, the rate for Mackenzie D.C. increases to 377 cases per 100 000. For Queenstown-Lakes D.C., standardising* for age also increases the rate to 284 cases per 100 000. The lowest injury rates were observed in Kawerau D.C. and Waimakariri D.C. (28 cases each per 100 000).

- The two leading contributing factors for traffic injuries for 2002 were excessive speed (11%) and alcohol (11%).

- International comparisons for 2002 (Data source: IRTAD – OECD):-
  (slightly difficult to compare due to different reporting systems and “injury definitions”)
  - United States - 682 cases per 100 000
  - United Kingdom – 386 per 100 000
  - New Zealand – 353 cases per 100 000
  - Finland - 119 cases per 100 000

* Age standardised to NZ population.
8. Radiation

Both UVA and UVB radiation are of importance to human health. Small amounts of ultra violet (UV) are essential for the production of vitamin D in humans, although prolonged exposure to solar UV radiation may result in acute and chronic health effects on the skin, eye and immune system. In the most serious cases skin cancer and cataracts may result.

- Globally an estimated 66 000 deaths occur annually from melanoma and other skin cancers.
- Worldwide some 12 to 15 million people become blind from cataracts annually, of which 20% may be caused by sun exposure (WHO 2004d).
- There is a growing body of evidence that suggests that environmental levels of UV radiation may suppress cell-mediated immunity and thereby enhance the risk of infectious diseases and limit the efficacy of vaccinations (WHO 2004d).

**Highlights for NZ**
- In 1987 the estimated annual radiation dose to the NZ population was 1.8mSv/year.
- NZ’s skin cancer rate is significantly higher than other countries used in the international comparisons although similar to Australia’s.
| Exposure Indicator | Radiation: Rad_Ex1  
Cumulative Radiation Dose |
|--------------------|----------------------|
| What was measured:  
Percentage of the  
population receiving a  
cumulative radiation  
dose in excess of 5  
mS/year | • The environmental radiation dose received by the NZ population is not routinely monitored. In 1987, National Radiation Laboratory (NRL) measured the natural radon and gamma radiation levels in some 700 homes throughout the country over a year. The estimated annual radiation dose to the NZ population was 1.8mSv/year. Only frequent international air travellers and aircrew could receive up to, or more than, 5mSv/year. |
| Data Source:  
NRL | |
| Relevance of the  
Indicator:  
This indicator poses considerable problems of interpretation, primarily because of the varied nature and multiple sources of radiation, the many different pathways of exposure and the limited available data. Broad trends can be detected, where monitoring is carried out consistently over several years; broad geographic patterns in radiation levels can also be identified for some forms of radiation (e.g. radon or radiation in drinking water and the ambient air). |
**Exposure Indicator**

What was measured:
Erythemal UV dose.

Data Source:
National Institute of Water and Atmospheric Research (NIWA)

Relevance of the Indicator:
The indicator provides a direct measure of the levels of exposure to UV radiation: the higher the index, the greater the level of exposure and the greater the potential of adverse health effects. The relationship between levels of UV radiation and health outcome are, however, complex: they are fundamentally affected by lifestyle and behavioral factors, such as time spent outdoors, choice of clothing and use of UV protection. Nevertheless, the indicator is already being used to: raise public awareness about the potential risks of exposures to solar radiation; but can be used to monitor the effectiveness of public information and other campaigns and at reducing exposures.

- The erythemal UV dose varies from 0.3kJ$^{-2}$ in winter to 5.3kJ$^{-2}$ in summer.

**Figure 27:** Erythemal UV Dose at Lauder, 2000-2003
**Effect Indicator**

**What was measured:**
Annual incidence rate of skin cancer (ICD 10 codes C43–C44) per 100 000 people.

**Data Source:**
NZHIS

**Relevance of the Indicator:**
This indicator can be interpreted very cautiously as an indirect health effect to exposure to UV radiation. The relationship is however rather complex: it is fundamentally affected by lifestyle and behavioural factors, such as time spent outdoor, choice of clothing and use of UV protection.

---

**Figure 28: Incidence of Skin Cancer, 2003**

- The cancer data is restricted to the data pertaining to C43 melanoma of the skin. This is because the cancers which are coded to C44 (other malignant neoplasm of the skin) are not required to be reported to the NZ Cancer Registry. As such the numbers on the Registry are only a fraction of the true number of cases in NZ.

- There has been very little change in the annual national average rate per 100 000 between 1999 to 2002. The national average for the last four years being 45.3 cases per 100 000 with a range of 44 to 46.4 cases.

- In 2003, the highest age standardised* rate was observed in Stratford D.C. with 93 cases per 100 000 and the lowest rate in Kawerau D.C. with no cases.

- International comparisons for 2000 (Data source: GLOBOCAN 2000):-
  - Australia – 46.1 cases per 100 000
  - **New Zealand – 44.0 cases per 100 000**
  - United States – 14.6 cases per 100 000
  - Netherlands - 14.5 cases per 100 000
  - Germany – 10.3 cases per 100 000
  - United Kingdom – 9.8 cases per 100 000

*Age standardised to NZ population.
### Action Indicator

#### What was measured:
Fraction of companies, according to different categories, having an actual permit for handling processing, emission etc. of radioactive substances.

#### Data Source:
NRL

#### Relevance of the Indicator:
This indicator provides a measure of the scope and implementation of legislation.

### Radiation: Rad_A1

#### Topicality of Permits on the Use of Radioactive Substances

- NRL does not license companies but rather individuals who use radioactive material, and/or irradiating apparatus, for specific purposes.

- There are no nuclear facilities in the country, nor any non-nuclear industrial processing materials with enhanced levels of naturally occurring radioactive material. There are also no companies producing consumer products containing radionuclides. There is one company producing a small number of gauges for the timber industry, which utilise radioactive material.

- There are no carriers who specialise in the carriage of radioactive material and radioactive waste per se but there are carriers who specialise in the carriage of dangerous goods who will carry radioactive material.

- There is no radioactive waste repository but there is an interim storage facility at NRL for the storage of unwanted radioactive material.

- There are 380 companies using sealed radioactive material and 61 companies using unsealed radioactive material (radionuclide laboratories). These do not include all the users of x-ray generators like dentists vets etc.

- There is a national registry of all establishments, all licensees and all licensable sources of radiation. Establishments are audited on a regular basis. The frequency of audit visits (ranges from annually to every 5 years) depending on the use of the radioactive material and/or irradiating apparatus.
<table>
<thead>
<tr>
<th>Action Indicator</th>
<th>Radiation: Rad_A2 Effective Environmental Monitoring of Radiation Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What was measured:</strong></td>
<td>Existence of effective environmental monitoring of radiation activity in compliance with national and international quality assurance programs.</td>
</tr>
<tr>
<td><strong>Data Source:</strong></td>
<td>NRL</td>
</tr>
<tr>
<td><strong>Relevance of the Indicator:</strong></td>
<td>This indicator provides a useful measure of the attention given to monitoring of radiation levels and as such shows how seriously this issue is being taken. The presence of enhancements is not a condition for the existence of a monitoring programme given the fact it has to be considered an early warning and follow-up system in case of accidents (which may have a trans-boundary effect). The indicator does not describe the actual radiation risk but the level of compliance with standards.</td>
</tr>
</tbody>
</table>

- NZ’s score is 13 out of a possible full score of 25. There is daily monitoring of atmospheric radioactivity in Kaitaia and the Chatham Islands. There is weekly monitoring of deposited radioactivity in Hokitika and monthly monitoring of radioactivity in milk in Waikato, Taranaki and Westland.
9. Case Study One: Drinking Water

A. Introduction

Approximately 3.1% of deaths (1.7 million) and 3.7% of DALYs (54.2 million) worldwide are attributable to unsafe water, sanitation and hygiene. Of this burden, about one third occurred in Africa, and another third in other developing countries with 99.8% of associated deaths in developing countries, of which 90% are in children (WHO 2002). Waterborne diseases still have a significant impact in developed countries as well, for example, in the United States, during 1999-2000, 39 outbreaks associated with drinking water were reported affecting an estimated 2068 persons and linked to two deaths (Lee, Levy, Craun, Beach & Claderon 2002).

There have been many studies examining the relationship between microbial drinking water quality and disease, mainly gastrointestinal illness. However there is a lack of studies examining this relationship on a national scale, as most studies focus on a smaller spatial level e.g. a city or a community. Similarly, very few ecologic studies have been done, those that do exist are mostly either case control or cohort studies.

A cohort study by Egorov, Naumova, Terechenko, Kislitsin & Ford (2003) illustrated that higher effluent water turbidity at the treatment plant was a significant risk factor for gastrointestinal illness (GI). Another two randomised trials by Payment, Richardson, Siemiatycki, Dewar, Edwards & Franco (1991): Payment, Siemiatycki, Richardson, Renaud, Franco & Prevost (1997) have suggested that drinking water meeting conventional standards may cause between 14 and 34% of GI in the community. However a number of studies have not found any such relationship, e.g. a cohort study by Strauss, King, Ley & Hoey (2001) found no association between the E. coli levels in rural drinking water wells and acute GI. Similarly a randomised blinded trial by Hellard, Sinclair, Forbes & Fairley (2001) found no significant difference in the incidence of GI in families with real or ‘sham’ water treatment units in their houses.

There have been a few studies in NZ investigating the relationship between water borne diseases and environmental and social risk factors. A study by Duncanson, Russell, Weinstein, Baker, Skelly, Hearnden & Woodward (1999) examining the relationship between the incidence of human cryptosporidiosis and indicators of community drinking water quality using the same datasets in this report found that the rates of notified cryptosporidiosis were highest in drinking water distribution zones that were not tested and had failed faecal coliform testing. Hales, Black, Skelly, Salmond & Weinstein (2003) found that people living in deprived areas are exposed to greater public health risks from community water supplies, specifically that in urban areas, the odds of water supplies being high risk were 3.76 times (95% CI: 2.95-4.78) greater for the most deprived decile compared with the least deprived decile. A case control study by Hoque, Hope, Kjellstrom, Scragg & Lay-Yee (2002) investigating the risk factors for Giardia infection among adults identified one of the risks being consumption of drinking water from local supplies other than metropolitan mains supplies (OR = 2.11, 95% CI: 1.36-3.27) or a PAR% of 35.2.

The aim of this case study is to examine and quantify the relationship between the three indicators within the DPSEEA framework of drinking water quality, namely the state indicator, drinking water compliance, the exposure indicator, access to safe drinking water and the effect indicator, drinking waterborne diseases.
B. Data

i. Definitions & Sources
All three indicators used for this analysis are based on the WHO EHI’s and are presented as part of the drinking water quality section in this report.

a. Drinking water compliance
The indicator comprises the percentage of *E. coli* transgressions annually by TLA and is derived from the WINZ database. The WINZ database is an electronic database system for handling a wide variety of data on the quality of drinking water. The data on WINZ is derived from local bodies, water suppliers and local health agencies.

b. Access to safe drinking water
This indicator comprises the percentage of the population by TLA, on registered water supply annually and is obtained from the WINZ database.

c. Drinking waterborne diseases
The data for this indicator is from EpiSurv and comprises the rate per 100 000 population, of the following notified diseases: enteric diseases, primary amoebic meningoencephalitis, hepatitis A, legionella, leptospirosis, vero/shiga-toxigenic *Escherichia coli* (VTEC/STEC) where drinking water was recorded as the mode of transmission.

Waterborne disease is defined by the reporting health protection officer according to their interpretation of the case information as recorded on EpiSurv. Only laboratory confirmed cases have been used for these analyses and cases with recent overseas travel have been excluded.

Population data used for denominator calculations was from the 2001 census and the attribution of cases to geographic locale was based on the domicile at the estimated time of exposure. Cases were geocoded by TLA, which are the principal loci for the monitoring and management of water quality and investigation of waterborne disease.

C. Analyses
Association of the explanatory factors with the waterborne disease rate was assessed using Poisson regression models.

Formulaically, the Poisson regression model can be described as:

\[
\log(\lambda) = \beta_0 + \beta_1 X_1 + ... + \beta_n X_n,
\]

where \( \lambda \) is the waterborne disease rate, \( X_i \) to \( X_n \) are the predictor variables, \( \beta_0 \) is the intercept, \( \beta_i \) is the regression coefficient for predictor variable \( i \), with \( i \) ranging from 1 to \( n \). Since a Poisson variate is assumed to have a mean >0, log transformation ensures that the model-based predictions of rates are constrained to be greater than or equal to zero.

Statistical analyses were performed using the Statistical Analysis Software (SAS) System version 8.2. Poisson regression analyses were performed with PROC GENMOD, in SAS.
D. Results

i. Waterborne Disease Rate: Spatial Distribution

The geographical distribution of disease rates is shown (Figure 31) by the seventy three TLA’s in NZ (excluding the Chatham Islands) for the period 1998 to 2002, as the mean annual disease rate per 100,000 population. The annual mean for NZ as a whole was 48.6 cases per 100,000 population with a range of 2.9 to 178.5. There were 17 TLA’s (23%) with a mean annual rate of waterborne disease significantly exceeding the national average, 13 TLA’s (18%) who exceeded the national average but for whom this was not significant, 16 TLA’s (22%) who had a significantly lower rate than the national average and 27 TLA’s (37%) who had a lower rate but not significantly so.

Figure 29: Drinking Waterborne Disease Rate, Annual Mean by TLA, 1998-2002

![Disease Rate Distribution Map]

Disease Rate
- High, Significant
- High, Not significant
- Low, Not significant
- Low, Significant

ii. Waterborne Disease Rates: Temporal Distribution

The national rate remained relatively constant from 1998 to 1999 (18.0 to 19.7), however, from 1999 to 2001 there was a significant increase (19.7, 51.2, 85.2, respectively) and from 2001 to 2002 a non-significant decrease in disease rates (85.2 to 68.9).

With no adjustment for other predictor variables, a simple univariate Poisson regression model was used to examine the trend over the five years. The coefficients from fitting this model are $\beta_0 = -557.6$ and $\beta_i = 0.2747$ with s.e.($\beta_0$) = 19.5 and s.e.($\beta_i$) = 0.01. This suggests that there was a significant annual increment in drinking waterborne disease rate of approximately 32% [95% CI of 29% to 34%] over the period.
iii. Waterborne Disease Rates and Explanatory Factors

The relationship between disease rates as expressed as the annual mean of the period 1998 to 2002 and the two principal ‘explanatory’ factors in the EHIS framework (Figure 1) i.e. State and Exposure. Figure 32 shows the modelling of these variables both spatially and temporally.

**Figure 30: Disease Rates and Explanatory Factors.**

<table>
<thead>
<tr>
<th>Model</th>
<th>Factors</th>
<th>Parameter Estimates (SE)</th>
<th>p-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drinking water compliance</td>
<td>0.0664 (0.0029)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>2</td>
<td>% of popln. on regstd water supply</td>
<td>-0.0209 (0.008)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Model 1 suggests that there is a significant, positive association between drinking water compliance and drinking waterborne disease rate. Hence suggesting that as *E. coli* transgressions increases (drinking water compliance indicator), the waterborne disease rate increases as well over the 5 year period nationally.

The relationship between percentage of population on registered water supply and the waterborne disease rate is significant as illustrated by model 2. However, a negative relationship is observed. This suggests that over the five years nationally an increase in waterborne disease rate is associated with a decrease in percentage of population on registered water supply.

**E. Conclusion**

This initial examination of the data illustrates that there is a statistically significant relationship between the three drinking water indicators at a national level observed over a five year period. Over this period an increase in the percentage of *E. coli* transgressions was associated with a statistically significant increase in drinking water borne disease over the five years at a national level. Similarly an increase in the percentage of the population on registered drinking water supply was also associated with a statistically significant decrease in drinking water borne disease.

This case study highlights the possible uses of national datasets as an information source for ecologic studies. However, it must be noted that that these associations apply only when considering a national scale and they cannot be extended to an individual TLA level. There are also data quality issues with both the datasets used here, namely EpiSurv and WINZ. These datasets are held at ESR but the data is provided by the local public health units and local councils respectively which have responsibility for data collection and quality.
10. Case Study Two: Index of Deprivation

The NZDep2001 Index of Deprivation (NZDep2001) was developed by Wellington School of Medicine and Health Sciences for the NZ MoH. NZDep2001 is an updated version of the NZDep91 and NZDep96 indexes. It is an index of socioeconomic deprivation which combines nine variables from the 2001 census that reflect eight dimensions of deprivation.

<table>
<thead>
<tr>
<th>Dimension of deprivation</th>
<th>Variable description (in order of decreasing weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>People aged 18-59 receiving a means tested benefit</td>
</tr>
<tr>
<td>Employment</td>
<td>People aged 18-59 unemployed</td>
</tr>
<tr>
<td>Income</td>
<td>People living in equivalised* households with income below and income threshold</td>
</tr>
<tr>
<td>Communication</td>
<td>People with no access to a telephone</td>
</tr>
<tr>
<td>Transport</td>
<td>People with no access to a car</td>
</tr>
<tr>
<td>Support</td>
<td>People aged &lt;60 living in a single parent family</td>
</tr>
<tr>
<td>Qualifications</td>
<td>People aged 18-59 without qualifications</td>
</tr>
<tr>
<td>Owned home</td>
<td>People not living in own home</td>
</tr>
<tr>
<td>Living space</td>
<td>People living in equivalised* households below a bedroom occupancy threshold</td>
</tr>
</tbody>
</table>

*Equivalisation: methods used to control for household composition.

NZDep2001 has two forms of which one is an ordinal scale that ranges from 1 to 10. One represents the areas with the least deprived scores and ten the areas with the most deprived scores (Salmond & Crampton 2002).

A special indicator has been created for this project where the percentage of the population in the three most deprived categories (i.e. categories 8 – 10) of the NZDep2001 has been calculated. With this indicator it is possible to add another layer to the analyses in order to assess whether social deprivation is associated with the state of the environment and human health outcomes.
Nationally, 29% of the population is represented by the three most deprived categories of the NZDep2001, however there is significant variation throughout the country. Selwyn D.C. has the lowest percentage of the population in the three most deprived categories at zero percent whereas Kawerau D.C. has the highest percentage of the population in the three most deprived categories at 87%.

Only one South Island TLA (Buller D.C.) is represented in the ten TLA’s with the highest percentage of the population in the three most deprived categories, whereas only two North Island TLA’s (North Shore C.C. and Rodney D.C.) are represented in the ten TLA’s with the lowest percentage of the population in the three most deprived categories.
11. Caveats & Limitations

General
All of the data presented in this report was obtained from sources external to ESR and was collected primarily for purposes other than for this report. Each data set has its own structure and processes and therefore own data quality issues. There are therefore several general considerations with regard to the data presented in this report. These include:

Data Availability
There are several limitations to the availability of data sets, for example, there are:
- times and locations within New Zealand at which data are not collected at all.
- significant variations in the time between data collection and data availability.
- situations where data that has been collected cannot be accessed, for a variety of reasons.
For this report a wide variety of data sources have been sought to develop the as comprehensive a picture as possible. Data gaps are noted as appropriate in the individual indicator sheets.

Data Consistency
Similarly, there are several limitations with respect to the consistency of data, these include:
- Variation in geographical boundaries over time and between agencies making time trend analysis imprecise. Where area boundary definitions have remained largely consistent rates of environmental compliance and health outcomes over time have been compared. However there will be small overlaps in the population being compared. Conversely when area definitions used for different types of data did not match, rates between areas were not able to be compared.

- This report relied on the definitions applied by the organisations collecting the data. For example, differing Public Health Officers may apply the criteria used to define pathogen sources differently. This may result in a greater percentage of cases attributed to one source e.g. water than another e.g. food. It would be wholly inappropriate for a central agency to ‘second-guess’ such issues as attribution once assigned by the local Public Health Officer.

- Variations in sampling protocols mean that data are not directly comparable between some areas and countries. These differences in sampling protocols have been listed when they are meaningful and apparent.

- Data collected on EpiSurv are entered by the Health Protection Officer. Differences between areas with regard to the percentage of disease cases diagnosed in comparison to the number of cases of disease contracted (and not reported) cannot be estimated. This may have a significant impact on the observed links. However it should be remembered that since over-reporting is not an issue with EpiSurv data (duplicates are identified and removed), reported data are either underestimates resulting from under-reporting or true rates in those areas. Note that cases of waterborne diseases were counted only if they were clinically observed and laboratory confirmed.

Data Comparability
Inconsistencies in, and the lack of data collection, make it difficult to report and compare results across time and locations, as discussed above. Where these have been adequately addressed, comparisons have been made.
Specific instances of limitations with respect to the various media described in this report are:
Air Quality
- Available data is limited to specific monitored sites and times, the location of the sites and times are set by TLA’s reflecting local factors of importance.
- Large variation in monitoring intensity throughout NZ means that there is a plethora of data for some sites and a paucity for others.

Drinking Water Quality
- Caution is required with international comparisons due to varying definitions for access to safe drinking water.

Recreational Water Quality
- Data is only representative of the sites monitored and not of NZ as a whole.
- There is a large variation in the intensity of monitoring throughout NZ.
- Sample monitoring protocol variation between countries means that caution should be observed when making international comparisons.

Traffic
- There are differences between definitions used for injuries and the reporting systems used to report them, by country. Accordingly, caution should be applied when comparing areas within NZ, or NZ with other countries. Within NZ, there are factors that may affect regional rates, for example, the density of police activity in an area has a significant impact on the reporting of traffic injury rates.

Radiation
- NZ skin cancer registry data only includes melanoma of the skin (ICD 10 code C43), cancers coded other malignant neoplasm of the skin (ICD 10 code C44) are not required to be reported to the NZ Cancer Registry. As such, the numbers of cases on the registry are only a fraction of the true numbers of cases of skin cancer in NZ.

Despite the limitations of the datasets, the collation of the data and the derivation of the various EHI’s still has many merits as its purpose is to examine general trends and relationships at a national level and through the use of consistent methodologies globally benchmark NZ internationally. It is not designed to be used as de facto epidemiological evidence.

Intra NZ differences may also highlight the need for a more consistent and systematic approach to data quality across organisational and geographic boundaries.
12. Discussion

This report suggests that indicators can be useful tools for communication across a broad spectrum of parties. They could assist in evaluating the effectiveness of policies and facilitate prioritising resources. As the indicators are implemented in a number of countries, they will become evidence for use in policy development. Indicator based reports will also help effective communication between stakeholders. For some indicators, inter-regional comparison is limited due to limitations of the surveillance and reporting methodology. The value of EHI’s and their ability to support environmental health decision-making can be increased by improving local data management.

None of the data used in the analyses presented here are new but what is new is the analysis layer on these datasets and the presentation of the data linkages of data spatially and temporally. This report represents the first time in NZ where both types of data have been collated and analysed on a national scale.

However, it must be noted that this is a first attempt at presenting and linking environmental and health data in NZ. Hence, the relationships are not necessarily methodologically robust but rather a ‘broad-brush’ approach representing the extent and nature of relationships within a given environmental health issue under the DPSEEA framework. However, the indicators are based on internationally recognised and accepted relationships based on epidemiological evidence. This report also differentiates itself from other similar indicator initiatives (such as that conducted by the MfE) as it is primarily concerned with adding the health dimension to the environmental data as well as adding the action /policy making responses.

This system is beginning to possess the elements necessary for an ideal surveillance system for environmental health as cited in (Picciotto 1996) being:

a) High quality mortality and morbidity data with residence information.

b) Updated population data for denominators to calculate rates with adjustment for migration between censuses.

c) A wide range of information on exposures, based on emissions data, dispersion modelling and measurements from monitoring of air, water, and other media such as soil and food, all based on temporally appropriate sampling schedules.

d) Geographic linkage of these three types of data.

e) Fine enough resolution for each (a), (b) and (c) to enable the evaluation of effects from localised exposures in small areas.

Three of the basic functions are being met currently with this project that are critical to the usefulness of a surveillance system for environmental health. These are:

- Enabling the measurement of specific hazards (e.g. air pollution), exposure (e.g. blood lead) and health outcomes (e.g. asthma).
- Producing an ongoing data record.
- Producing timely and representative data that can be used in planning, implementing and evaluating environmental health activities (Thacker, Stroup, Parrish & Anderson 1996).

The usefulness of a system would depend largely on the accepted linkage between exposure data and health statistics. Hence both data sets need to be of good quality. The other obstacles to useful linkages are inappropriate scale of data and the lack of congruence of geographical boundaries for exposure and outcome data.
One area significantly lacking in NZ is exposure data. This would normally provide an ongoing assessment of the NZ population's exposure to environmental chemicals using biomonitoring. Biomonitoring is the assessment of human exposure to chemicals by measuring the chemicals or their metabolites in human specimens such as blood or urine. This apparent lack of exposure data is an impediment to establishing linkages, and while some data may be acceptable in descriptive analyses, studies of more complex linkages require more, and better, data. Additional efforts to generate exposure data need to be formulated.

Statistical methods are available to link hazards and actions to health outcomes as illustrated in the drinking water case study earlier in the report. However, appropriate uses and limitations of each data set need to be taken into account and clearly stated to avoid possible misinterpretation.

The primary purpose of the project is to provide an analysis and dissemination mechanism for a comprehensive environmental health information data set. The future uses of this project and reports could include:

- Assessment of disease burden from a particular environmental influence
- Identification of populations at risk
- Tracking temporal and spatial trends
- Developing interventions
- Evaluating the effectiveness of actions

In fulfilling these roles, it also provides a repository of environmental health data sets, which can be then used to formulate and answer research questions arising from data in the report.
13. Future Directions

The next step in this project is to maintain the reporting annually on those EHI’s in this report, and to build on the coverage of localities towards a full national set of environmental data. As this is the first report of this nature, feedback and comments from key stakeholders will be reflected in future reports.

EHI’s provide a repository of datasets rich in information if the right questions are asked using the right tools. In the environmental health decision-making process, tools can play an important role, whether decisions are made routinely or in an atmosphere of controversy. Tools can not only improve communication, and assist information gathering and analysis but they can also frame the context of the decision by identifying relevant information and issues.

The use of integrated impact assessment methodology may prove to be a useful mechanism to aid thinking on environmental health. The core principle being that an inter-disciplinary, multi-sectoral approach to assessing the impacts of a development (project or policy) is best practice, using an approach that assesses how a development affects the ‘whole environment’ including physical, health, economic, and social aspects rather than focusing on its impact on a single dimension.

A good example of this approach is the Health Effects and Risks of Transport Systems (HEARTS) program [http://www.euro.who.int/HEARTS](http://www.euro.who.int/HEARTS), which is a WHO-Europe research project to develop and test an integrated impact assessment methodology to evaluate changes in exposure patterns in the light of different urban transport and land use policies and quantify the related health effects. This is done through the development of tools that support the integration of health impact assessments in the decision-making process. The project focuses on health risks associated with air pollution, noise and with injuries, especially within vulnerable groups such as children and elderly people. The tools being developed are based on models of exposures and health effects generated by different transport policies. Scenarios are developed and linked to provide integrated estimates of health effects. These models will be embedded into a geographical information system (GIS) specifically addressing traffic and emissions, air pollution, noise, traffic accidents, time activity and exposures, and health effects.

There is growing awareness of the links between economic growth and environmental protection, and of the need to develop strategies for sustainable development, which not only preserve the environment but also enhance human health and quality of life. In this context, decision makers need information on the health impacts attributable to environmental degradation in order to assess the consequences of their decisions. Hence the principal aim of decision making tools is to aid in answering the ‘so what’ in environmental health issues and making explicit the trade offs made in terms of dollars, opportunity costs, risk perceptions, etc.

The disease burden caused by an environmental exposure and the preventable part of it, are major elements, which can guide decision-making, priority setting and resource allocation in health and environmental management. Quantitative assessment of the burden, together with information on the effectiveness an (cost) effectiveness of interventions within a social and ethical framework, provide a rational basis for research, implementation and policy development.
Environmental burden of disease (EBD) methodology assesses the burden of disease from environmental risk factors at national or regional level. Summary measures of population health are used which combine information on mortality and morbidity outcomes to represent the health of a population in a single unit for example DALYs. Quantitative risk assessment methods have been developed which incorporate environmental burden of disease methodology with economic models especially for air quality, for example Fast Environmental Regulatory Evaluation Tool (FERET) and Air Quality Health Assessment Tool (AirQ 2.2). These models are able to estimate how a decrease in specific measures of air pollution contributes to the overall DALYs and the resulting costs and benefits.

If used properly, methods are available to begin analyses and linkage of environmental hazard, exposure, health and action data that will provide useful information to the various stakeholders.

However to ensure robust environmental health tools, there is a need to have a clear understanding of the following:

- What public health action requires supporting?
- Who will use the data, tools and the information, and how can it best be made available?
- What is the scope of environmental health surveillance?
- And most importantly what are these tools to achieve?

Careful consideration of these questions must accompany the continued development of the EHI system.
14. References


