

# State of the Auckland Region



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## Acknowledgement

The project team wishes to acknowledge the dedication of the various field teams who over the past 20 years have battled through intermittent periods of fine weather, rain, hail and snow to collect the data for this report.

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Front cover photo: Awana Bay, Great Barrier Island by Alistair Jamieson.

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It is with great pleasure that I introduce the latest State of the Auckland Region report.

This report presents as complete a picture as is currently possible of the state of the region's air, land, water and biodiversity. It is a picture built up over decades from the Auckland Regional Council's extensive monitoring and research programmes coupled with the knowledge of other agencies. The report will provide the new Auckland Council with information to help it adapt to ongoing and new environmental challenges.

Regular snapshots of the environment's status are important because they help local government make decisions in areas such as the management of urban growth and rural productivity, and the protection of open spaces, landscapes and biodiversity.

The Auckland Regional Council is responsible for managing Auckland's natural resources and contributing to the sustainable development of the region. In doing this our challenge is to manage the effects of a growing population and expanding urban area on Auckland's natural resources, production systems, air quality and cultural heritage.

This report is the third in a series produced since 1999. It's the last the Auckland Regional Council will produce and represents the legacy of the councillors who worked hard to establish the State of the Region programme. It also represents the work of many people past and present for whom the care and stewardship of the region's environment is an abiding passion.

The extent and comprehensiveness of our knowledge about Auckland's environment owes a lot to the foresight of the people involved in the 1985 Waitangi Tribunal deliberations on claims brought by Ngāneko Minihānīka and Te Puaha ki Manukau on the Manukau Harbour and environs.

The tribunal determined that action was needed to clean up the harbour and there was not enough information to assess the impact of development. The resulting Manukau Harbour Action Plan led to the establishment of research and monitoring programmes in 1987. These were later extended to include other areas in the region.

I wish to acknowledge the contributions of my colleagues and to thank all involved in preparing the 2009 State of the Auckland Region report.

**Cr Paul Walbran**

Chair – Regional Strategy and Planning Committee  
Auckland Regional Council

# Executive summary

## Purpose of the report

The Auckland Regional Council (ARC) prepared this report as a requirement under Section 35 of the Resource Management Act (1991). The report takes stock of the monitoring of the Auckland environment, the challenges it faces and how they are being addressed. To monitor the environment, the ARC uses data from its own monitoring programmes and works with other government agencies, educational institutes and network utility operators. Two previous *State of the Environment* reports were produced in 1999 and 2004.

## Characteristics of the Auckland region

The region covers about 16,141km<sup>2</sup>, about 2 per cent of New Zealand's total land mass. Of this, around 4,518km<sup>2</sup> is mainland, 1800m<sup>2</sup> coastline and 11,117km<sup>2</sup> (69 per cent) is sea. Auckland has abundant freshwater, three main shallow harbours and numerous islands. Weather is dominated by low pressure systems originating in the Tasman Sea to the west providing abundant rain and a mild climate. Four large cities in the region make up the region's urban area – the largest in New Zealand.

## Three main driving forces cause environmental pressure in the region – population growth, economic growth and consumption and consumerism.

Population growth is the primary driving force for change in the region. Auckland's population is predicted to grow from 1.3 to 2 million by 2035, with 90 per cent living in urban areas. In turn, this affects economic growth and resource efficiency. The region is New Zealand's largest manufacturing base, having nationally strategic transport and distribution functions. Auckland is a major employment and commerce centre, with associated active production, resource use, environmental effects, and consumption. Auckland is driven by urban activity – despite 90 per cent of land in the region being rural, the agricultural sector is in long-term decline.

The pressures of population and economic growth feed consumption in the region. High rates of employment, perceived land wealth, available credit and price reductions have all accelerated Auckland household consumption. The ARC acknowledges these driving forces through the Auckland Sustainability Framework (ASF). It works with several other groups to promote sustainable development of the region, with the ASF setting out a long term vision, goals and shifts to deal with forces driving change.

## Consumption and production pressures on Auckland's resources

These pressures affect Auckland's resources in the following ways:

Changes to land use and intensification continue. Pasture covers near half of the region's land, with most in sheep or cattle farming, followed by dairy and rural residential use, while urban areas cover 10 per cent, with 70 per cent of this in residential use. Rural land continues to fragment at the edges of the Metropolitan Urban Limits due to rural residential subdivision. Residential density has increased and growth has expanded the urban area with a loss of rural land and increase in impervious areas.

Water use appears relatively stable. Surface water from the Waitakere and Hunua Ranges provides the majority of the region's water supplies by volume. Consent holders used 76 per cent of water allocated under consent; more than in 2002 but less than during 2003-5. Applications for groundwater bores have increased over recent years as land not serviced by water supply becomes occupied.

Projections for future energy use without efficiency measures show a 65 per cent increase by 2031. Over half the energy currently used in the region is taken up by transport. Around half of transport energy is used on road transport and around a third on aviation. Non-transport energy is taken up by electricity, coal and gas, with around 70 per cent of non-transport energy used by industry and commerce, and 30 per cent by households.

Solid and liquid wastes are increasing. Solid wastes sent to landfills from the region have increased by a third since 2003/4. Much can be attributed to population growth, but solid waste disposal per person has also increased. Available recycling data indicate recycling increased with variable results. The quality and quantity of liquid wastes are strongly related to both rural and urban land uses. 133 million m<sup>3</sup> of wastewater is treated each year but non-point sources of contaminants discharge to waterways across the region through stormwater. Agricultural production continues to produce liquid wastes that degrade streams in rural areas. Land used for business generates more suspended sediment, zinc, copper and *Enterococci* bacteria than residential land; however, the sheer extent of residential land across the region contributes a larger overall tonnage of suspended sediment to stormwater networks.

Urban areas contribute most of the total regional air emissions despite representing only 10 per cent of the total land area. Motor vehicles produce the vast majority of transport-related emissions, with home heating using solid fuels also a considerable source. Industrial sources are the second biggest source of other air contaminants.

Transport currently contributes significant air emissions and non-point source liquid wastes, and increasing population and need for transportation will further exacerbate these volumes of contaminants.

The ARC uses a range of regulation methods, strategies and policies to address consumption and production pressures, drawing on a range of statutory plans and regional initiatives. It monitors the effects of environmental pressures to understand the extent and rate of changes to the environment.

## State of the region's environment and biodiversity results

Results from monitoring the Auckland environment show the following effects on the region's resources:

- Air quality – Transport contributes the greatest source of air pollution with winter domestic fires also significant. Air quality standards and guidelines are exceeded for levels of PM<sub>10</sub> and PM<sub>2.5</sub> particulates and NO<sub>2</sub> at peak traffic sites, although annual PM<sub>10</sub> levels have decreased over time, recently levelling off. PM<sub>10</sub> particulates cause the worst health problems, particularly from diesel combustion. Air pollution health costs are at least \$547 million each year. Levels of PM<sub>10</sub> and PM<sub>2.5</sub> particulates and NO<sub>2</sub> need to be reduced drastically. Levels of CO, SO<sub>2</sub>, ozone, benzene and lead currently comply with air quality standards and guidelines.



# Executive summary

- Land resources – Land is monitored for stability, soil disturbance and bare soil along with soil quality and sediment loss. Unstable land surfaces cover around half the region, with a third in stable surfaces, and the remainder extensively modified urban areas. Soil showed disturbance at nearly half of all sample areas, around a third due to land use activities. Dairy and horticulture land uses had the lowest number of sites meeting soil quality standards, while native vegetation had the highest. Soil quality issues of most concern are low macroporosity (indicating compaction) and high Olsen P (indicating high chemical fertility). Modelling of sediment yields (losses) indicates yields from forested and urban areas are well lower than pasture. Variation in sediment yield is due to catchment rainfall, mean slope and land use.
- Freshwater quality in rivers, lakes and groundwater – Most Auckland rivers are small, and over half flow through native forest. River water quality and ecological health are strongly related to land use in the surrounding catchment, with native forest catchments having the best water quality and urban catchments having the worst. Urban river water quality improved from 1995-2005. Auckland lake water quality is degraded from nutrient enrichment, but microbiological lake water quality is good compared with national recreational guidelines. Ecology of lakes is impaired, probably due to the presence of exotic species. Groundwater quality is generally good or excellent, although some aquifers rated fair or poor.
- Marine areas – These are monitored for water quality, bathing beach contamination, sediment and shellfish contamination, and ecological quality. Overall, coastal waters showed improved water quality. Open coast marine sites have the best water quality, while sheltered marine sites have the worst, receiving contaminants and sediment loads from surrounding land and suffering low flushing capability. Beaches within the Metropolitan Urban Limits more regularly experience levels of microbiological contaminants that could potentially harm human health.
- Terrestrial biodiversity is monitored through investigating native land cover, habitat loss, fragmentation and condition, threatened species, and plant and animal pests. Despite Auckland's small size, it contains a large proportion of New Zealand's threatened species. Assessment of indigenous areas found about half in very good or good condition, with the remainder in poor or very poor condition. Fragmentation of native habitats and the impacts of invasive mammal and weed species were major determinants of condition.

Integrated management is required to manage land, freshwater and marine environments against combined environmental pressures. Responses include developing targets to reduce PM<sub>10</sub> emissions, clean fuels and vehicle management, controlling sediment from land use and disturbance, controlling agricultural discharges, managing contaminated sites and urban pollution, controlling water use, stream enhancement and improving urban stormwater discharges and riparian management, lake restoration, controlling use of coastal space and protecting and enhancing terrestrial biodiversity.

## Natural hazards

These pose risk to the Auckland region in the form of geological (earthquakes, volcanic eruptions), climatic (cyclones, floods, droughts, tornadoes, landslides) and coastal hazards (coastal erosion and flooding, tsunami). Impacts of hazards are planned for to lessen the risks and effects. Between 2004 and 2008 the region suffered a range of natural climatic hazard events costing millions of dollars in damage. Climate change could increase the frequency and intensity of these events. Geological hazard events could have significant economic impacts, so advance preparation is important. Ongoing planning, civil defence management and education, along with information gathering, provide the best management of hazard risks.

## Heritage values

The region has a rich array of historical and land-based heritage places, areas and items. Preservation and protection is undertaken through monitoring and surveying new and existing sites and areas. Numbers of heritage resources recorded has increased steadily over the last decade. Ongoing land surveys are important. Due to lack of research and monitoring, the condition or extent of regional heritage values is not clear.

## Conclusions

Controlling the effects on the region's environment depends on decoupling negative effects from population and economic growth from production and consumption, requiring resource efficiency through technology and behavioural change.

Many negative trends continue despite regulation. Environmental management also requires careful planning, community and landowner engagement, public investment, inducements and initiatives. Costs and benefits of interventions need fair and equitable allocation. Results will take time to emerge.

Current priorities largely match critical issues identified in this report. Most financial resources have gone on transport management, specifically public transport. Considerable resources went on managing regional parks, followed by stormwater management and growth management strategies.

In the future, the quality of some resources looks similar, but pressures will show. Gains made so far vary. Those due to technology will be permanent but others are vulnerable, relying on behavioural change, natural system response and organisational priority setting.

Looking ahead, it is clear that some environmental gains will be seen within an overall gradual decline. Easy improvement opportunities are exhausted, so the next decade should focus on controlling at source, and requiring extraction of best environmental dividend. An effective partnership with central government will be vital. While controlling resources, consideration needs to be paid to social and economic pressures, along with the potential impacts of climate change. Auckland governance reform offers the opportunity to more effectively address many difficult historical issues.

Clear regional goals and priorities need establishing for a long-term sustainable future, because Auckland is worth the effort.



# 1.0

## Introduction

Introducing the purpose, scope and structure of this report. This section also contains a useful overview of the natural environments and physical characteristics of the Auckland region, and the major environmental changes that have occurred since human settlement and the projected impacts of climate change on the Auckland region.



## Introduction – State of the Auckland region

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Photo: Auckland city from Mt Victoria, Devonport. (Source: Shutterstock).



## About this report

### Why the need for this report?

As the population of Auckland grows, the work of maintaining and improving the quality of the land, air, freshwater and marine environments and safeguarding the rich biodiversity of life within them becomes an increasingly important and challenging task for Aucklanders.

Many agree that the environment here in the Auckland region is wonderful. We want to safeguard all that is good and improve those aspects that have been impacted over the years.

This report is a stocktake of the environment; the challenges we face and how they are being addressed. It outlines the major social and economic forces that put pressure on the region's environment and it discusses those pressures. It presents the latest results from our environmental monitoring programmes and other sources, and presents them in a single document. It also highlights current and potential environmental issues, recent changes and long-term trends, and, wherever possible, outlines the implications for the future.

All of this knowledge in one place can help councils shape effective plans and policies for the future, and target and integrate efforts towards achieving the long-term objective of a sustainable region.

This report is also required under Section 35 of the Resource Management Act (1991) which requires monitoring of the state of the environment and the effectiveness and efficiency of council's actions in relation to the environment.

### Audience and scope

This report is a useful compendium for anyone seeking data, research and information. Scientists, environmental practitioners and government workers will find it useful. The report's companion summary document picks out some of the main findings of this report and is great for anyone looking for an overview of the state of the Auckland region.

This report:

- outlines the social and economic factors that put pressure on the natural environment in the Auckland region,
- shows how these pressures impact the environment through the use of land, water and energy and the production of waste,
- provides a snapshot of the state of the land, air, marine and freshwater environments, biodiversity and historic heritage,
- describes our current knowledge about the natural hazards that threaten the region,
- contains case studies to highlight some of the environmental problems, monitoring programmes and restoration work being done,
- identifies positive and negative environmental changes detected since previous reports and, wherever possible, identifies any long-term trends,
- aims to raise public awareness of current and potential environmental issues, their causes, and any actions required to lessen their effect.

This report does not contain detailed scientific data (this can be found in the technical publications referenced at the end of some chapters and is available through council websites), also it does not discuss climate change beyond outlining the predicted consequences for the region's environment.

At the time of writing, changes to regional governance structures were taking place in the Auckland region. Much of the data gathered for this report is geographically linked to current council boundaries and occasionally refers to local councils in existence at the time of writing.

### Previous State of the Auckland Region reports

Two previous reports have been published:

- State of the Auckland Region Report 1999.
- State of the Auckland Region Report 2004.

### Information sources

In addition to the ARC's extensive environmental monitoring programmes, the council also works with other government agencies and uses their data. They include crown research institutes and the following Government departments: Department of Conservation, Foundation for Research, Science and Technology, Ministry of Agriculture and Forestry, Ministry of Economic Development, Ministry for the Environment, Ministry of Fisheries, Ministry of Health, Ministry of Research, Science & Technology, Statistics New Zealand, New Zealand Historic Places Trust, Te Puni Kōkiri and other regional councils.

At a regional level, the ARC works with the Auckland University of Technology, Auckland Regional Public Health Service, Auckland/Waikato Fish and Game Council, Massey University, mana whenua, Unitec, the University of Auckland, Waikato University, the New Zealand Archeological Association, Watercare Services Ltd and all other network utility operators (e.g. Ecowater and Metrowater), and all the district and city councils in the Auckland region.

### Environmental indicators

If we can understand the natural processes that occur in the environment, and how and why they are changing, we can better manage and protect the environment and make the correct decisions for the future. In essence, the better our data, the more useful they will be.

Along these lines, in 2007, MfE defined a new set of core national environmental indicators. These came out of concerns that different aspects of the environment were monitored in different areas, and monitoring methods often differed between regions and districts, it was therefore difficult to build up an overall picture of the environmental health of the country.

The new environmental indicators help standardise monitoring – different regional authorities and government departments throughout the country can monitor the same aspects of the environment using a common standard. This means that regional data can now be compared to data from other areas and the same area can be compared over time to detect sudden changes as well as long-term trends.

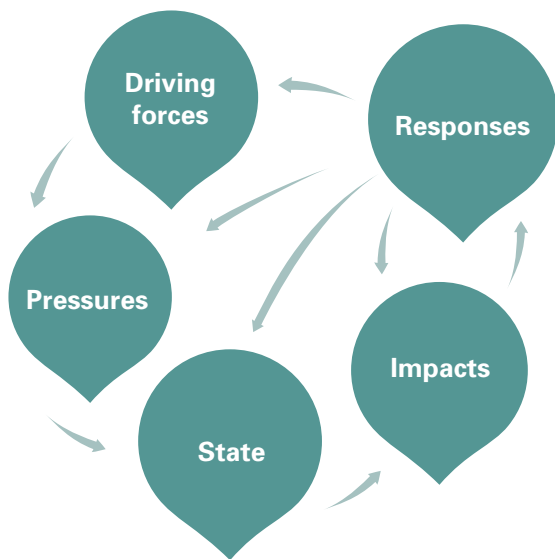
# Introduction

These indicators are precise measurements of individual physical, chemical or biological aspects of the environment. For example, air quality is measured by the amounts of five pollutants: PM<sub>10</sub> particulates, nitrogen dioxide, carbon monoxide, sulphur dioxide and ground-level ozone. However, some aspects of the environment (such as the marine environment) are more difficult to monitor than others and/or do not have appropriate core national environmental indicators; in these cases, we use indicators that are specific to the Auckland region.

In addition, as our knowledge of the environment and scientific technology has improved, monitoring methods have changed accordingly. This means that it is not always possible to directly compare the latest environmental data with earlier results that may stretch back over several decades.

## The driving forces, pressures, state, impacts and responses (DPSIR) reporting model

This report is structured using the internationally recognised DPSIR reporting model (Figure 1). This model enables complex social, economic, historic and scientific information from many different sources to be woven together in a simple and concise format.



**FIGURE 1** The DPSIR reporting framework.  
(Source: European Environment Agency, 1999).

The DPSIR reporting model identifies the various human activities that, individually and collectively, create driving forces. An Auckland example is population growth. The pressure this driving force exerts on the environment includes a greater need for housing and infrastructure, so rural land is subdivided and new housing is built. This can impact the environment and result in changes to its state. For example, existing ecosystems are destroyed or severely impacted as land is cleared for housing; sediment levels in the rivers and harbours rise as a result of building activity and the increase in urban area leads to more air, soil and water pollution.

Society can respond by developing and implementing policies and legislation aimed at protecting the environment by minimising negative impacts.

This report is divided into six main parts:

- Part 1 – Introduction.
- Part 2 – Driving forces. This outlines the various social and economic factors that contribute to environmental pressures in the Auckland region.
- Part 3 – Pressures. This describes the types of environmental pressures that arise in the Auckland region as natural resources are used and waste is produced. Changes and long-term trends in environmental pressures are outlined.
- Part 4 – State of the environment and biodiversity. This uses indicators to assess the state of the land, air, marine and freshwater environments and biodiversity in the Auckland region and discusses the future implications. It also outlines our responses in terms of environmental management plans and policies.
- Part 5 – Natural hazards and historic heritage. This summarises our current state of knowledge about the natural hazards that threaten the Auckland region and reports on natural hazard events. It also examines the state of our knowledge concerning the historic heritage within the Auckland region.
- Part 6 – Conclusion and recommendations.

## The Auckland region

### Overview

The Auckland region (Figure 2) covers about 16,141km<sup>2</sup> of both land and sea. It stretches from Wellsford in the north to Pukekohe in the south and beyond Great Barrier Island in the east, and contains about 2 per cent of New Zealand's total land mass.

Despite its relatively small size, the Auckland region offers a wide variety of landscapes, numerous sandy beaches, harbours and open coast. The abundant resources and mild climate have encouraged human settlement in the past and continue to do so today. In 2006, about 1.3 million people, roughly one-third of the national population, lived in the Auckland region.

### Land and sea

The Auckland region contains:

- **About 4518km<sup>2</sup> of mainland.** The underlying rock consists mostly of soft sandstones and mudstones (known as Waitemata Formation) with some areas of hard greywacke and volcanic basalt. Most of the land consists of low but occasionally steep hills with patches of native bush, exotic forest and scrublands. Some of the low-lying areas, such as Te Henga on the west coast, still contain their original wetland vegetation. Large areas of native bush cover the high Waitakere Ranges and the Hunua Ranges.



# Introduction

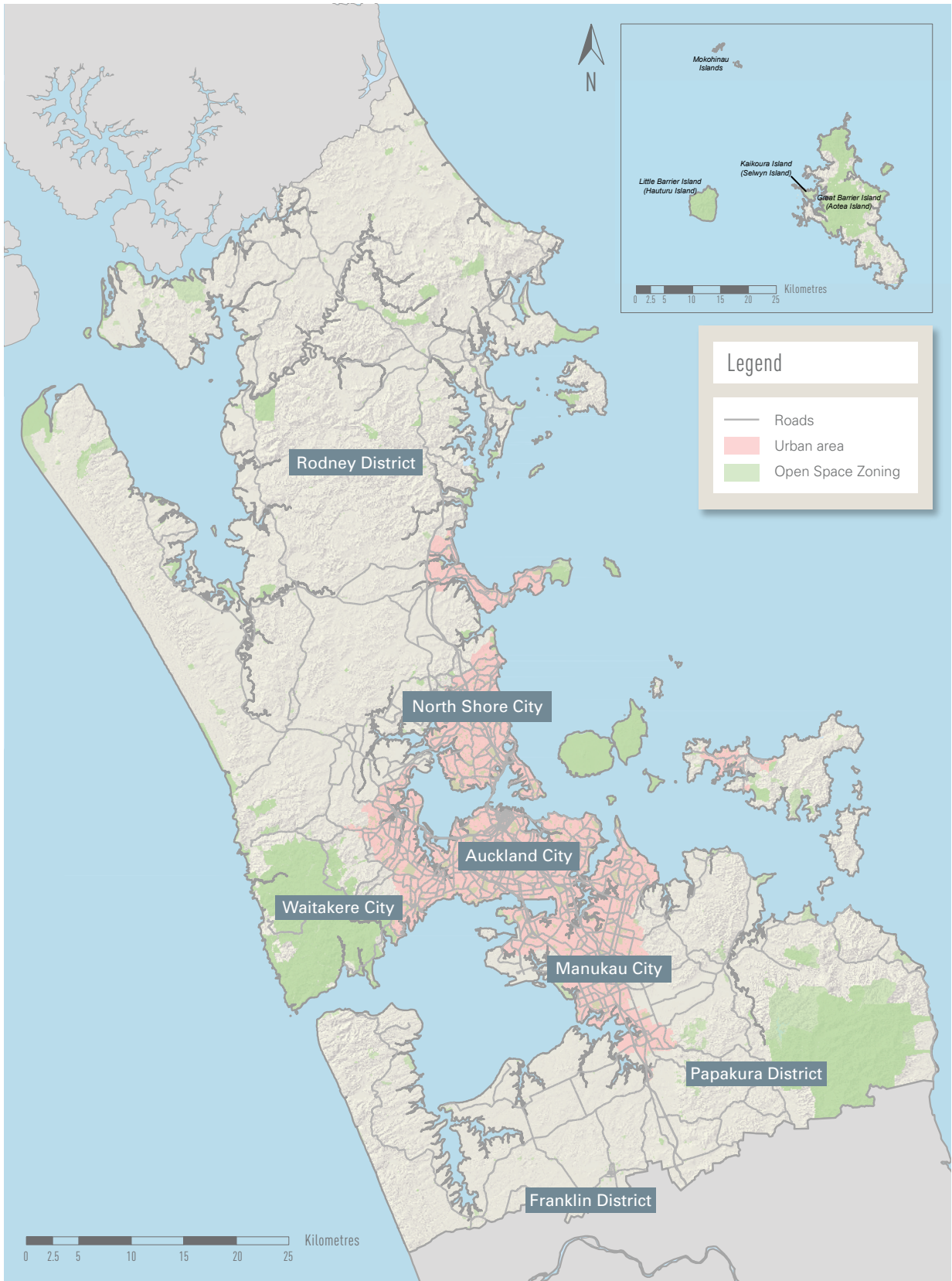


FIGURE 2 The Auckland region, 2009. (Source: ARC).

# Introduction

- **Abundant freshwater.** The numerous streams, lakes, and rivers that enhance the landscape contain only a fraction of the freshwater resource. Most of the freshwater is hidden underground and seeps slowly through the ground to re-appear in springs, ponds, lakes, streams and rivers. Most rivers are relatively short, but together they make up approximately 16,500km of permanent waterways. The flow through a variety of environments ranging from native bush and exotic forest to rural pasture and urban areas. Freshwater is stored in ten artificial reservoirs in the Waitakere Ranges and the Hunua Ranges. Hot geothermal springs are found at Waiwera and Parakai.
- **About 1,800km of coastline,** split almost equally between the west and east coasts. The rugged west coast is exposed to the prevailing winds that work with the strong currents and powerful tides to constantly shift the fine black sand, resulting in spectacular wide surf beaches, lagoons, spits and dunes often set against a backdrop of high cliffs. In contrast, the more heavily populated east coast is fairly sheltered with white and golden sand beaches, often fringed by low cliffs and sprawling pohutukawa trees.
- **About 11,117km<sup>2</sup> of sea** (about 69 per cent of the Auckland region). The Tasman Sea begins at the exposed west coast, while the east coast opens onto the island-studded, sheltered Hauraki Gulf that leads into the Pacific Ocean. While most of the marine habitats are in water more than 20m deep, about 2,400km<sup>2</sup> of marine water is less than 20m deep and there is over 600km<sup>2</sup> of intertidal area. Estuaries, harbours and small inlets make up two thirds of the coastline in the Auckland region. In addition, there are four marine reserves, but these cover only a fraction (0.2 per cent) of Auckland's sea area.
- **Numerous islands** are important refuges for native biodiversity and are popular recreational fishing, diving, boating, sailing and tourism spots. Together, the islands contain about 506km<sup>2</sup> of land, and range from tiny rocks to some that are large enough to support permanent populations, such as Great Barrier Island and Waiheke. Others, such as Tiritiri Matangi, have been made into predator-free nature reserves.
- **Three large main, shallow harbours.** The Waitemata Harbour on the sheltered east coast has become the main commercial port for the Auckland region and Auckland City developed around it. On the west coast, commercial development of the Manukau and the Kaipara harbours has been severely limited by treacherous offshore sand bars, making them hazardous to shipping. The consequent lack of commercial development has meant that the Kaipara, in particular, is relatively unspoilt even though it is one of the largest harbours in the southern hemisphere. It supports a variety of marine ecosystems and also contains huge expanses of intertidal flats that provide feeding grounds of international significance for seabirds.

- **Urban areas.** Centered between the Waitemata and Manukau harbours is the largest urban area in New Zealand, containing about 90 per cent of all the people in the Auckland region. The remaining 10 per cent live in small scattered townships, rural communities, isolated dwellings and coastal settlements.

## Weather and climate

The isthmus on which Auckland sits means the weather in the region is unpredictable and can change within a few hours. It can also differ locally due to variations in height above sea level, distance from the sea and the type of land cover.

The region's weather is dominated by low pressure weather systems originating in the Tasman Sea. These generate the prevailing west to south-westerly winds and can also produce strong wind gusts, rough seas and persistent rainfall, particularly during winter.

During summer and autumn, the Auckland region can also be affected by storms that originate in the tropics to the north of New Zealand. These can produce short periods of high winds, high seas and heavy rainfall.

In winter, the daytime air temperature ranges from 12 to 17°C. In summer, the daytime air temperature ranges from 22 to 32°C but rarely reaches 30°C. NIWA data show the long-term averages:

→ Annual sunshine:	2,046 hours (1962-2007)
→ Annual mean temperature:	15.3°C (1963-2007)
→ Annual mean wind speed:	18km/h (1966-2007)
→ Annual rainfall:	1,119mm (1963-2007)

The 2008 results (Source: NIWA) were:

→ Annual sunshine:	2,180 hours
→ Annual mean temperature:	15.4°C
→ Annual mean wind speed (2007):	16.6km/h
→ Annual rainfall (Mangere):	1,226mm

Auckland's mild, wet, climate has defined the ecosystems that have developed here. It is influenced, to some degree, by the El Niño Southern Oscillation (ENSO).

ENSO weather patterns are associated with two states: La Niña and El Niño. During the El Niño state, the Auckland region tends to experience stronger, more frequent westerly winds and more rain in summer; in winter, the winds tend to be southerly, bringing colder conditions. During the La Niña state, north-easterly winds are more common and tropical storms and cyclones are more likely to occur. The strong winds and high rainfall associated with these tropical storms and cyclones can generate coastal erosion, landslides and flooding (see Chapter 5.1 for more information).

ENSO weather patterns are known to influence some freshwater and marine ecosystems, and can result in changes to the composition and stability of these biotic communities. For example, some species living in the sediment of the Manukau Harbour show patterns that correlate to the climatic variations associated with ENSO.

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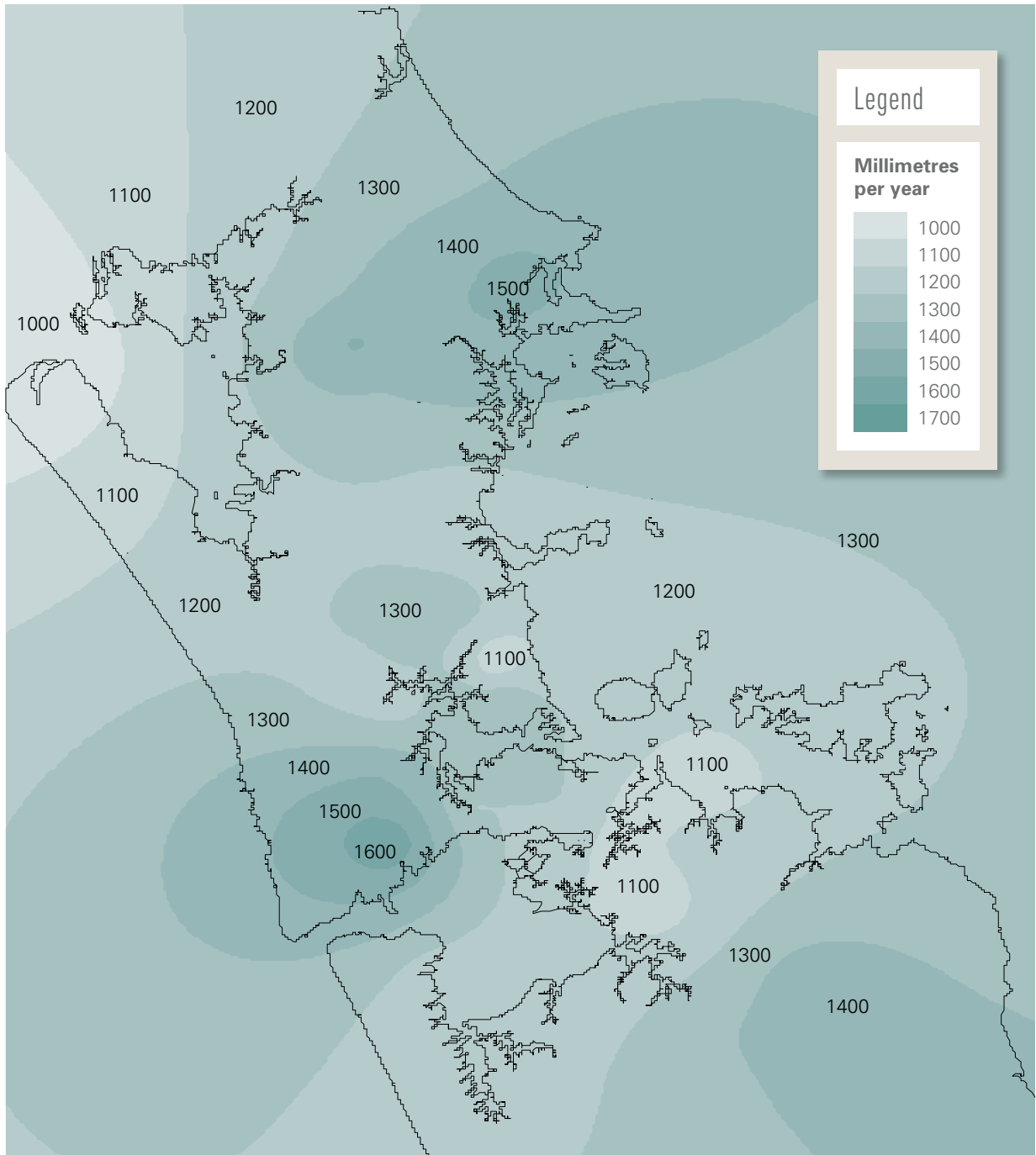


FIGURE 3 Average annual rainfall across the Auckland region (mm/year) 2004-08. (Source: ARC).

# Introduction

## Box 1 Climate Change

'Climate change' is the change in climate that can be attributed directly or indirectly to human activities that alter the composition of the global atmosphere. It is in addition to the natural variations in climate that are currently understood.

Current knowledge and moderate projections suggest that the Auckland region could experience pronounced short, medium and long-term climatic variations including:

- increased average temperatures
- more hot days during summer
- lower average annual rainfall
- increased droughts
- lower soil moisture
- increased evaporation rates
- more frequent heavy rainfall events
- more frequent westerly winds
- a rise in sea-level
- large storm surges.

These predicted changes are likely to have a range of direct and indirect impacts on the Auckland region. Some of the most significant in terms of their social, economic and environmental impact are:

- Changes to the water supply due to increasing periods of drought as well as more severe droughts. Most of Auckland's water is supplied by the reservoirs in the Waitakere and Hunua Ranges or from the Waikato River, and the opportunities to increase the large-scale water supply and storage capacity for the Auckland region are limited.
- An increased frequency of heavy rainfall events. As climate change increases the number of drought events, it is also expected to produce more frequent heavy rainfall events that increase the risk of flooding (and their associated social and economic impacts).
- An increase in the number of hot days. This may lead to photochemical smog reactions producing toxic compounds such as ozone and peroxyacetyl-nitrates (PANs), and cause an orange colouration of the air.
- Changes to the geographical range of some species, and to the composition and structure of some ecosystems. Biodiversity is critical to life on earth and ecosystems provide essential environmental services such as erosion control, carbon sequestration and crop pollination. Climate change will affect many species and ecosystems and its impact will depend on the magnitude of change, the sensitivity of a species to climate and its adaptability. Some species may be forced to shift the timing of lifecycle events, migrate outside their normal geographic range, or change their morphology and/or behaviour.

→ Increasing susceptibility to threats from invasive species and organisms, and increasing exposure to sub-tropical diseases such as malaria and dengue fever. The Auckland region is especially vulnerable to these threats as it is a major point of entry for international shipping, airlines and imported goods. It has also had limited historical exposure to disease. If these threats are not controlled or avoided, they could cause significant risk to human health. The national and regional economies could also be impacted due to New Zealand's economic dependence on horticulture, agriculture and forestry.

→ Severe damage to the Auckland urban economy due to a dramatic decline in agricultural or primary sector outputs. The national economy depends on a relatively stable climate to produce resource-based outputs and, although Auckland's urban economy might seem less vulnerable to climate change than rural regions, links between the urban and rural economies mean that any decline in agricultural or primary sector outputs will damage the economic performance of the Auckland region.

Whatever measures are taken now to reduce greenhouse gas emissions, the levels already in the atmosphere are expected to continue affecting and changing the global climate over the lifetime of the next generation. This means that, as well as working to reduce emissions, the global community needs to prepare for the effects of climate change and adapt to its projected impacts. The longer that it takes to reduce greenhouse gas emissions, the greater the changes and impacts will be.

The capacity of the Auckland region to adapt and respond to the risks, uncertainties, challenges and opportunities that will arise from climate change will be shaped by several related factors. These include the amount and speed of climate change, degree of public and institutional knowledge, level of commitment towards reducing greenhouse gas emissions, access to suitable technology, the health and resilience of ecosystems, and the amount of skills and resources available in the Auckland region.

Monitoring and research has a role to provide information to assist climate change adaptation and mitigation and to ensure that actions taken avoid adverse impacts on ecosystems.

It is the responsibility of central and local government to make policies that protect Auckland from the effects of climate change, attempt to slow it and make the most of any opportunities it brings.

### History of environmental change in the Auckland region

Before human settlement, most of the Auckland region was covered by evergreen forest. A dense tangle of tree-ferns, young trees, shrubs and lianas intertwined below the tree canopy, and a variety of ferns, mosses, fungi and lichens thrived in the cool, damp shade amidst the litter of leaf mould and decaying vegetation at ground level. A broad fringe of coastal forest swept down to the twin coastlines with their wide expanses of flat sandy beaches, extensive dunelands, rocky foreshores and spectacular cliffs. Elsewhere, shrublands of manuka and kanaka flourished wherever the soil was too poor for forest, while small lakes and wetlands formed in waterlogged ground. Auckland's many small volcanoes added to the unique landscape and habitat diversity.

Abundant rainfall throughout the year nurtured the lush vegetation and replenished the groundwater. Tiny forest streams merged into small rivers and then into larger rivers. These flowed into sheltered estuaries and five harbours, whose tidal fringes were often covered by low mangrove forest or bordered with salt marsh vegetation.

The mild wet climate enabled an incredible diversity of life to flourish on the land, in the forests, rivers and wetlands, along the coastlines, and in the estuaries and surrounding seas; all woven together within finely balanced ecosystems that had developed in harmony with the natural environment over millions of years.

A long period of geographic isolation meant that New Zealand was devoid of land mammals, apart from three types of small bat. Instead birds, insects, amphibians, reptiles, freshwater and marine invertebrates and other creatures had evolved, adapted or survived in this unique and ancient environment. As a result, much of the vegetation and many of these species are found only in New Zealand (or only in the Auckland region) and are the reason why the country is renowned internationally for its outstanding and valuable biodiversity.

New Zealand was permanently settled sometime around the thirteenth century by a wave of Polynesian explorers and pioneers. The influence of humans since then, both Māori and European, has had a dramatic and lasting impact on every aspect of the natural environment and its ecosystems. For example, by 1770 about half of the bird species were estimated to be extinct through a combination of over-hunting, habitat destruction and predation. Around the coast, the seal population was decimated within two hundred years of human settlement and has not yet recovered.

Early settlers were attracted to the Auckland region because the forests, rivers, coastline and sea provided a variety of food, while the warm climate and fertile soils were excellent for crop cultivation. Widespread Māori settlement took place, particularly around the Auckland isthmus. Many of the volcanic cones were cleared of native forest and then terraced to provide suitable sites for dwellings, crop cultivation and storage. European settlement began in the 1830s with traders attracted by the wealth of native timber, and the population has continued to expand ever since. Auckland was declared the capital city in 1840 and rapidly developed into the country's busiest commercial port. Most of the original foreshore along the Waitemata Harbour has been reshaped, reclaimed, or somehow modified by settlement since then.

As new settlements were established across the Auckland region, numerous other species were driven into local extinction or became increasingly rare. This was due to the destruction and modification of habitat, the introduction of exotic plants and birds, deliberate hunting, and predation or destruction by various new mammal species.

By the 1870s a logging and sawmilling industry was extracting areas of mature timber in the Auckland region. Only a few parts of the Waitakere Ranges, the Hunua Ranges and some of the offshore islands in the Hauraki Gulf remained relatively untouched. Areas that had been cleared of native forest were developed into pasture, while wetlands were drained to create more agricultural land. Sheep and dairy farming became increasingly important, especially after the introduction of refrigeration in the 1880s. Orchards and vineyards were established in the west, and horticulture expanded into areas that are now part of suburban Auckland. Agricultural production intensified over the previous century with widespread use of fertilisers and increasing numbers of stock. As a result, the groundwater, rivers and lakes started to become overloaded with excessive nutrients.

The land cover was progressively changed by human settlement from native forest into rural pasture and urban areas. The enormous changes in land use, particularly over the past two centuries, produced large amounts of sediment that washed into the sheltered estuaries, irrevocably altering habitat and leading to a rapid expansion of mangrove forest.

In the late nineteenth century, horses, coastal shipping and railways were the primary means of transport. Horse trams in Auckland City were replaced by electric trams in the early 1900s and these grew in popularity until competition from buses and increasing car ownership led to their closure in the 1950s. Both the railways and the growing network of roads required large amounts of aggregate and ballast and, until the 1950s, most of this was quarried from local volcanic cones and lava fields. Some were destroyed completely and at least half were modified.



# Introduction

The expansion of industrial and urban areas led to environmental degradation of the Manukau Harbour. Public concern initiated the Mangere Wastewater Treatment Plant which opened in 1960. This was recently upgraded to improve effluent quality and the oxidation ponds and sludge lagoons were removed, restoring them and 13km of shoreline to the Manukau Harbour. The Tamaki estuary also suffered heavily from industrial and urban pollution and increased sedimentation.

## Looking to the future

Today, despite the enormous modifications that have resulted from human settlement, the Auckland region still contains some relatively pristine areas that merit protection (such as the Hunua Ranges, the Waitakere Ranges and some islands in the Hauraki Gulf). In addition there are also remnants of pristine vegetation. These are important as wildlife links, corridors and habitats. Their scarcity make them all the more valuable.

Between them lies the modern world characterised by urban expansion, growing numbers of vehicles, increased impervious surface area, intensified agriculture and aquaculture, and increasing use of energy and natural resources. This has happened despite an increasing awareness of the aesthetic, economic, cultural and scientific value of the natural environment.

Although many of the environmental problems in the Auckland region are a legacy of the past, others are more recent, including:

- ongoing input of sediment into our aquatic environments
- absence of riparian vegetation alongside rivers
- poor air quality with resulting health impacts
- intensification of agriculture
- biosecurity issues
- habitat fragmentation.

The ARC is attempting to address these key environmental problems in partnership with individuals, community groups, iwi, district councils and other government agencies.

The environment, climate and variety of business, education and job opportunities within the Auckland region continue to attract new residents. It is estimated that 2 million people may be living in the region by 2035. Thoughtful planning for the future, based on a better understanding of the environment and the impacts of urban growth, industrial activities and rural land use change, is essential to avoid repeating or compounding past mistakes.

Achieving the balance between protection of the natural environment and its resources whilst providing for the social, cultural and economic needs of Aucklanders both now and in the future is an enormous challenge. This is especially so when set within the broader context of Auckland's role in the New Zealand economy, constant and rapid developments in technology, and increasing standards of living. Achieving this goal, in order to produce a durable and sustainable solution for the future, is the single greatest challenge that we are attempting to meet today.

The ARC hopes this document and its companion summary get people thinking about their environment, how special it is and how much help it needs. The ARC hopes the messages contained herein reach not only the people that make the big decisions but those of us who live here, love the place, and are therefore also its most important guardians,

*'Kia whakatomuri te haere ki mua'*

*'To walk into the future our eyes must be fixed on the past'*



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