

Climate Change, Water Supplies and Health

A resource for health professionals, planners
and small water suppliers





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Prepared as part of a Ministry of Health contract for scientific services

by

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Introduction

CLIMATE CHANGE AND HEALTH

CLIMATE CHANGE is one of the most significant challenges we face over the coming century. Scientists from many different specialities are reaching a consensus that the increased atmospheric concentration of greenhouse gases will warm the earth's surface. The Ministry for the Environment states that despite the measures we take now to reduce greenhouse gas emissions, the levels of carbon dioxide already in the atmosphere are expected to continue to affect and change the climate. This means that as well as working to reduce emissions, we need to prepare for climate change and adapt to its impacts. Forward planning is more effective and less costly than reacting to crises when they occur.

THE HEALTH IMPACTS of climate change are expected to be many and varied. It is anticipated that climate change will cause temperatures and sea levels to rise, and it will change the frequency of extreme events such as droughts and floods. All of these changes will impact on health.

This resource focuses specifically on planning for the health impacts of climate change in relation to **DRINKING-WATER SUPPLIES**. The impacts of climate change on water supplies are predicted to be extensive, and have serious implications for human health. For example, increased flooding and drought events may affect water quality and quantity, with consequential increased rates of some waterborne diseases. Floods and droughts may also have wider impacts on health through social and economic impacts.



RESOURCE AIMS

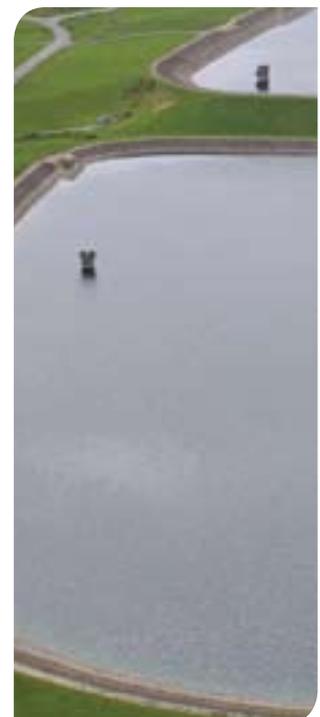
New Zealand water suppliers, health professionals, environmental practitioners and planners are making good progress towards planning for the impacts of climate change, and resources are available to help them achieve this. What is lacking however is a resource that summarises the links between climate change impacts on water supplies and health. This resource provides a framework for linking the potential impacts of New Zealand-specific climate change scenarios on water supplies and health and aims to:

PROVIDE GUIDANCE FOR HEALTH PROFESSIONALS, ENVIRONMENTAL PRACTITIONERS AND PLANNERS WITH LITTLE OR NO WATER SUPPLY EXPERTISE, SO THAT THEY CAN PLAN FOR THE HEALTH IMPACTS OF CLIMATE CHANGE AND CONSIDER WATER-SUPPLY RELATED HEALTH ISSUES IN LONG TERM COUNCIL COMMUNITY PLANS, HEALTH IMPACT ASSESSMENTS AND OTHER PLANNING PROCESSES

The resource may also be useful for small water suppliers when they consider the possible impacts of climate change on their water supplies.

The first section provides a brief summary of future climate predictions for New Zealand, a description of the structure and management of water supplies, and a summary of links between climate change and health.

The second section provides a series of worksheets that summarise the links between climate change impacts on water supplies and health.



A snapshot of climate change predictions for New Zealand

CLIMATE CHANGE PREDICTIONS FOR NEW ZEALAND

CLIMATE CHANGE PREDICTIONS ARE DIFFICULT AND UNCERTAIN. Despite an anticipated global trend, regional differences within countries are expected to be large. Predictions for New Zealand include:

- Temperature increases, but only by about two-thirds as much as the global mean.
- Temperatures to rise faster in the North Island than the South Island and faster in the winter than in the summer
- Average rainfall to increase in the west of the country and decrease in many eastern regions
- Prevailing westerly winds to increase in intensification and prevalence
- Fewer frosts over most of the country
- Sea level rise

What is evident from these predictions and from the differences between regions is that even in a country as small as New Zealand, it is extremely difficult to produce predictions with any high degree of certainty.

(Drawn from Ministry for the Environment's (2004) "Impacts Report: Climate Change Impacts on New Zealand" and the National Institute of Water and Atmospheric Research's (NIWA), (2008) "Climate Change Projections For New Zealand" leaflet. The projections represent the most up-to-date scientific knowledge about likely effects of climate change in New Zealand, and are based on the 4th Assessment Report of the Intergovernmental Panel on Climate Change, and the global climate modeling results produced for that report.)



POTENTIAL SCENARIOS RELEVANT TO WATER SUPPLIERS AND HEALTH:

1. **DRIER CONDITIONS EXPECTED IN EASTERN AREAS** – in tandem with expected increases in temperature will likely lead to decreased runoff into rivers and increased evaporation causing drought and increased competition amongst water users.
2. **MORE FREQUENT FLOODS ON THE WESTERN COASTS OF NEW ZEALAND** – causing more flooding, landslides, avalanches and mudslides; increased soil erosion; and increased pressure on government and private flood insurance schemes and disaster relief.
3. **RETREATING SNOWLINES AND GLACIERS** – affecting seasonal river flows.
4. **CHANGES IN CLIMATE EXTREMES** – the greatest negative impact of climate change on New Zealand could arise from more frequent and more intense droughts, extreme winds, fire risk and floods.

Changes in climate extremes are the focus of this resource. The two likely scenarios described are:

- * **MORE INTENSE OR FREQUENT HEAVY RAIN EVENTS**
- * **MORE SEVERE OR FREQUENT DROUGHT**

Climate Change and Water Supplies

STRUCTURE OF WATER SUPPLIES

Water supplies comprise three components: source, treatment plant and distribution system:

SOURCES

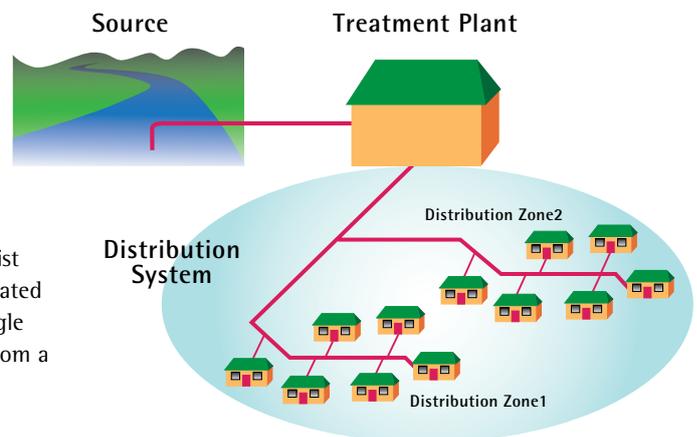
The three main sources of drinking-water are surface water (e.g. streams, rivers lakes), groundwater (drawn from bores or wells) and roof catchments (rainwater collected on roofs)

TREATMENT PLANTS

Treatment plants range from large operations that consist of a series of treatment processes running under automated control, to small plants using a manually controlled single treatment process, to a single pump that draws water from a source without treatment.

DISTRIBUTION SYSTEMS

Distribution systems carry water from treatment plants to consumers. The Ministry of Health defines the distribution system as the pipes, water storage facilities (tanks or reservoirs) and any other components situated between the treatment plant and the consumer's property boundary.



Source: Chris Nokes, ESR

WHO IS RESPONSIBLE FOR WATER SUPPLIES & HEALTH?



A range of organisations and groups are responsible for the quality (source), distribution, treatment and management of drinking-water. Those responsible for planning for impacts of climate change on health and water supplies will need to consider who might need to be involved. The following are some of those who have a part to play:

- Drinking-water suppliers
- Health protection officers and drinking water assessors working within the public health units of district health boards
- Ministry of Health
- Ministry for the Environment
- Maori health providers
- Emergency management or Civil Defence
- Territorial local authorities (regional-, district- and city- councils and unitary authorities which have both regional and district/city functions)

HOW MIGHT CLIMATE CHANGE CAUSE UNSAFE DRINKING-WATER?

The biggest direct threat to water supplies will likely come from heavy rainfall (and associated floods), low river flows and drought, and strong winds. Water supplies must be prepared to cope with less as well as more precipitation. In other words, **THERE WILL BE A HEIGHTENED NEED TO RESPOND TO INCREASED VARIABILITY AND FREQUENCY OF EVENTS.**

The two scenarios described in this resource begin to identify potential threats to water supplies and to health. The resource leaves room for users to add their own information and ideas that will be specific and relevant to their own context.

Climate Change and Health

WHAT ARE THE HEALTH IMPACTS OF CLIMATE CHANGE?

Climate change in New Zealand and around the world will have significant and wide-ranging impacts on many aspects of people's daily lives. Societies and their climates are inextricably linked, both directly and indirectly. Climate change is expected to have five main impacts on human health: temperature-related illnesses, mortality and morbidity as a result of extreme weather events, air pollution-related illnesses, vector-borne illnesses and waterborne and food-borne illnesses.



IMPACTS ON HEALTH AND WELL-BEING

Climate change scenarios may have wider impacts on the health and well-being of groups and individuals. For example, increased severity and/or frequency of extreme events such as floods, droughts or storms can have major impacts on safety (e.g., risk of drowning or trees falling) and on stress levels (being separated from friends and family by flooded roads or coping with the impacts, business decisions or competition over scarce resources related to a drought). Colder and damper conditions may lead to an increase in respiratory illness and conversely warmer and drier conditions may result in heat-related illness e.g. heat stroke.

Maori have important spiritual and cultural connections to waterways based on whakapapa. This kinship-based connection establishes a reciprocal relationship, requiring local hapu and iwi to care for and sustain the natural environment as it has for them. The potentially damaging effects of climate change to the environment combined with an only recently improving economic position may make Maori more vulnerable to some aspects of climate change than non-Maori. For example, floods that uncover urupa (burial sites) can cause stress and a sense of loss, as can contamination of kaimoana due to flooding, increased farmland run-off or drought. This can cause illness within the community or for manuhiri (visitors), impacting on the mana of local hapu, compounding whakama (cultural shame).

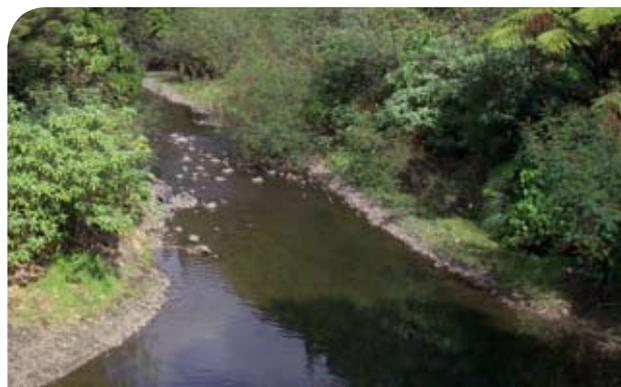
It is important to note that for planning to prevent, respond to or adapt/manage the health impacts of climate change, the context is very important; different groups will have different health impacts and different methods for coping. The degree of community spirit, for example, may be difficult to assess, but very important for helping a community to manage adverse effects of climate change. The severity of health impacts will depend upon much more than climate change alone. Changing demographics such as an increasingly elderly population will also have a strong impact on the extent of the health impact, and on people's ability to cope.

WATERBORNE ILLNESSES

Climate change scenarios may increase the risk of contracting gastrointestinal disease caused by ingestion of pathogens (disease-causing microbes) in drinking-water. For example, increased water temperatures and/or decreased precipitation may result in growth of waterborne bacteria, and increased frequency and severity of precipitation can wash pathogens into the water supply source. These pathogens can be fast-acting, usually causing sickness in a few days or weeks, can multiply within their hosts, are contagious, and may cause severe illness. Common symptoms are diarrhoea or vomiting – these are particularly dangerous for vulnerable groups such as babies, older people, and people with compromised immune systems.

In New Zealand three main types of waterborne pathogens cause gastroenteritis:

1. **BACTERIA** (e.g. *Campylobacter*, *Salmonella*, *Shigella*, *Yersinia* and toxigenic *Escherichia coli*)
2. **PROTOZOA** (e.g. *Giardia* and *Cryptosporidium*)
3. **VIRUSES** (e.g. *enteroviruses* and *noroviruses*).



Climate change scenarios may also result in the presence of pathogens that are not a current health risk (new or re-emerging), causing increased incidences of diseases such as Hepatitis A, Hepatitis E, Legionella or cholera. Scenarios that include warmer temperatures and low water levels may increase cyanobacterial levels leading to a rise in health impacts of cyanotoxins (on humans and animals).

FORMAT OF THIS RESOURCE

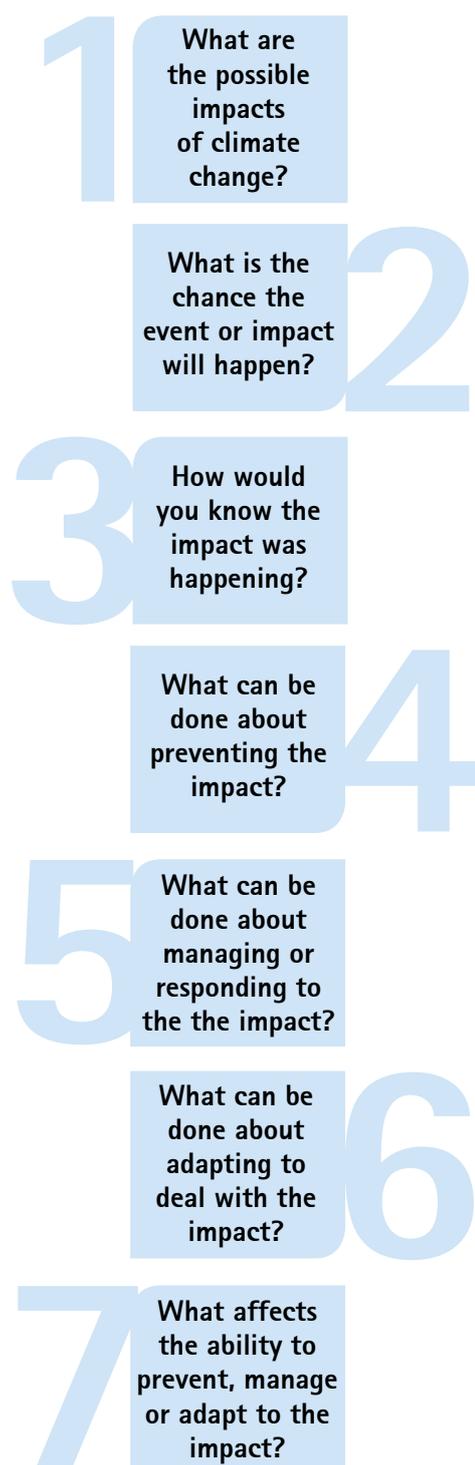
This resource aims to provide guidance for health professionals, environmental practitioners and planners with little or no water supply expertise, so that they can plan for the health impacts of climate change and consider water-supply related health issues in Long Term Council Community Plans, Annual Plans, Asset Management Plans, Health Impact Assessments, Assessment of Environmental Effects (Environmental Impact Assessments) and other planning processes. The resource may also be useful for small water suppliers when they consider the possible impacts of climate change on their water supplies.

The resource is based on information obtained from drinking-water scientists, water suppliers, health professionals, emergency response staff, planners, farmers, iwi and community members about their preparedness for climate change. Much of this information was obtained through qualitative interviews in the Taranaki region in April 2009.

The information is presented as a workbook styled resource that will support adaptation planning. The workbook styled resource enables the user to add their own examples and ideas relevant to their own context. The worksheets will be useful as prompts and questions for the user to consider when preparing, contributing to or assessing plans. The information is organised in worksheets using the principles of risk assessment and management, as seen in the diagram opposite:

VECTOR-BORNE ILLNESSES

Changes in temperature and precipitation are expected to alter the distribution of a range of vector-borne diseases such as dengue fever and West Nile virus. Whilst not the focus of this resource, some vector-borne illnesses such as dengue fever (spread by container breeding mosquitoes) may be more easily spread due to the provision of increased water storage (e.g. storage dams or tanks) for coping with severe drought.



RATIONALE

The principles of risk assessment and management are a familiar part of the work of public health professionals, planners and water suppliers:

- Public health professionals are often required to carry out a Health Impact Assessment (HIA). The HIA is a process to identify, predict and evaluate the human health impacts of a proposed policy, plan, programme or project. The seven recognised steps in the HIA process fall into three areas: preliminary analysis (screening, scoping and profiling), risk analysis (risk assessment, communication and management), and implementation analysis (decision-making and monitoring).
- Planners, environmental practitioners and regional council staff may be required to carry out an assessment of environmental effects (AEE) under the Resource Management Act 1991 (risk-based legislation) (equivalent to an environmental impact assessment (EIA) overseas), a process for identifying, predicting and monitoring potential impacts of a development project on the environment. Steps in an EIA include: describing the environment, scoping and identifying the effects on the environment, describing measures to avoid, remedy or mitigate the effects, identifying alternative designs, and monitoring. HIA is a cousin of EIA; both are related to integrated impact assessment.

- Water suppliers in New Zealand develop a Public Health Risk Management Plan (PHRMP) to provide assurance of consistently safe drinking-water. A PHRMP involves a systematic assessment of every aspect of providing safe drinking-water, identifying the events that could cause water to become unsafe to drink (including impacts of climate change), and developing plans to manage these.

THIS RESOURCE PRESENTS THE INFORMATION USING THESE FAMILIAR PRINCIPLES OF RISK ASSESSMENT AND MANAGEMENT TO ENABLE USERS TO CLEARLY SEE HOW SPECIFIC IMPACTS ON WATER-SUPPLIES MIGHT BE RELATED TO HEALTH, AND TO SHOW HOW PLANNING (PREVENTING, RESPONDING OR ADAPTING TO AN IMPACT) BY DIFFERENT GROUPS AND INDIVIDUALS MIGHT IMPACT ON OTHERS. THE FIRST TWO TABLES DESCRIBE THE POSSIBLE IMPACTS OF MORE INTENSE OR FREQUENT HEAVY RAIN EVENTS OR MORE SEVERE OR FREQUENT DROUGHTS. THE SUBSEQUENT TABLES FOLLOW THE FORMAT SHOWN IN THE DIAGRAM ON PAGE 7, FINISHING WITH 'WHAT AFFECTS ABILITY TO PREVENT, MANAGE OR ADAPT TO POTENTIAL IMPACTS?'

FURTHER INFORMATION

NEW ZEALAND WEBSITES:

Ministry for the Environment

The New Zealand Ministry for the Environment has a wide range of publications, technical manuals, summaries and guides for local government planning.

www.mfe.govt.nz/publications/climate

NIWA National Climate Centre

The national climate centre issues monthly, seasonal and annual climate summaries and forecasts, as well as climate updates for pacific islands.

www.niwa.co.nz/our-science/climate

New Zealand's Climate Change Solutions Website

This site has information about the causes of, the evidence for and the effects of climate change. It describes the actions being taken to reduce emissions and the work being done to help people prepare for and adapt to climate change.

www.climatechange.govt.nz

Local Government New Zealand

The Local Government website has a number of publications relating to climate change and planning.

www.lgnz.co.nz/library/

Ministry of Civil Defence and Emergency Management

This site lists other organisations doing climate change research in New Zealand, and has links to reports on engineering lifelines and critical infrastructure

<http://www.civildefence.govt.nz>

Public Health Surveillance – Information for New Zealand Public Health Action

The Institute of Environmental Science and Research Ltd (ESR) under contract to the Ministry of Health (MoH) contributes to the national public health surveillance effort. This website provides access to selected New Zealand public health surveillance data and information.

<http://www.surv.esr.cri.nz/>

INTERNATIONAL WEBSITES:

World Health Organization (WHO)

WHO is the directing and coordinating authority for health within the United Nations system. The climate change section of the WHO website provides general information, technical information, publications, statistics and information on health impacts of climate change in regions around the world.

<http://www.who.int/topics/climate/en/>

The Intergovernmental panel on climate change (IPCC)

The IPCC was established to provide the decision-makers and others interested in climate change with an objective source of information about climate change. This website has a range of informative papers, reports and documentation, including the (2008) Technical paper 'climate change and water'.

<http://www.ipcc.ch/>

Worksheet 1A: SCENARIO 1

In relation to climate change, what event could happen that would impact on access to safe drinking-water and health? More intense or frequent heavy rain events		
Possible Impacts on Physical Environment	Possible Impacts on Drinking-Water Supply	Possible Impacts on Health
<ul style="list-style-type: none"> • HIGH RIVER LEVELS AND FLOWS IMPACTING ON WATER QUALITY AND QUANTITY including <ul style="list-style-type: none"> – The catchment does not fully recover between events. – The water quality does not fully recover between events. – The landscape is altered. – Change in course of river. – Surface flooding and ponding. • STRONG WINDS CAUSING TREES TO BLOW OVER AND DAMAGE TO BUILDINGS ETC • LIGHTENING STRIKES CAUSING FIRES. <p>ADD YOUR OWN EXAMPLES:</p>	<ul style="list-style-type: none"> • HIGH AND PERSISTENT RUN-OFF FROM FARMLAND, INDUSTRIAL ACTIVITIES, URBAN STORM-WATER, AND/OR OVERFLOWING SEWERAGE SYSTEMS IN THE SOURCE WATER that needs to be removed because they carry chemicals and pathogens into rivers and bores. • HIGH AND PERSISTENT TURBIDITY IN THE SOURCE WATER that needs to be removed because of its adverse effects on the efficacy of the disinfection process and on the aesthetic properties of the water. • HIGH AND PERSISTENT LEVELS OF DISSOLVED ORGANIC MATTER IN THE SOURCE WATER that need to be removed because of the adverse effects on the efficacy of the disinfection process and on the aesthetic properties of the water, and the potential to form hazardous by-products when the water is disinfected. • CHANGE IN COURSE OF RIVER THAT IMPACTS ON ABILITY TO ABSTRACT WATER. • DETERIORATION OR FAILURE OF SURFACE WATER INTAKE STRUCTURES that disrupts abstraction of drinking-water. • FAILURE OF DISTRIBUTION SYSTEM (e.g. breakages of pipes and reservoirs) that disrupt provision of any drinking-water (safe or otherwise). • FAILURE OF WATER SUPPLY TO PROVIDE (SAFE) WATER that results in individual households using an alternative potentially contaminated water supply (e.g. stored rainwater, bore water). • DAMAGE TO WATER-SUPPLY BUILDINGS, INFRASTRUCTURE, AND ACCESS ROUTES/ROADS (from floods, strong winds or slips). • LOSS OF ELECTRICITY, SWITCHING OFF TREATMENT EQUIPMENT, PUMPS, AND PROCESS CONTROL (from lightning strike or damage to power lines). • DAMAGE TO THE INFRASTRUCTURE (e.g. roof, pipes) of water supplies of households or community purpose buildings with their own water supply. <p>ADD YOUR OWN EXAMPLES:</p>	<ul style="list-style-type: none"> • WATERBORNE ILLNESS: <ul style="list-style-type: none"> – Widespread community illness via reticulated water supplies. The illness may be highly apparent (as in an outbreak situation), or present in the community at all times but at a relatively low frequency (endemic). – Severity depends on the pathogens present (e.g., Campylobacter, Salmonella, norovirus, Legionella). – Increased sporadic illness for households with their own water supply, or for people who use self-supplied community purpose buildings, (e.g. education facilities, marae, community halls, private camping grounds, hospitals, public recreational facilities). • INCREASE IN NUMBERS AND VARIETY OF DISEASE VECTORS (e.g. mosquitoes) caused by change in environmental conditions (e.g. ponding on pasture), resulting in spread of vector-borne disease (e.g., dengue fever). <p>ADD YOUR OWN EXAMPLES:</p>

Worksheet 1B: SCENARIO 2

In relation to climate change, what event could happen that would impact on access to safe drinking-water and health?
More severe or frequent droughts

Possible Impacts on Physical Environment	Possible Impacts on Drinking-Water Supply	Possible Impacts on Health
<ul style="list-style-type: none"> • INCREASED WATER TEMPERATURE • LOW RIVER LEVELS AND FLOWS IMPACTING ON WATER QUANTITY AND QUALITY, e.g., <ul style="list-style-type: none"> – Less dilution of contaminants in water bodies e.g. eutrophication. – Development of algal blooms or Didymo. – Salt-water intrusion. • STRONG WINDS causing trees to blow over and damage to buildings etc e.g., Norwesters in Canterbury <p>ADD YOUR OWN EXAMPLES:</p>	<ul style="list-style-type: none"> • RESTRICTIONS IMPOSED ON RIVER AND BORE ABSTRACTION RATES, disrupting provision of an adequate amount of drinking-water, requiring water use restrictions to be imposed on the community. • INSUFFICIENT RAIN TO REPLENISH STORED RAINWATER SUPPLIES. • WATER LEVEL TOO LOW FOR RIVER INTAKE STRUCTURE TO FUNCTION, disrupting provision of an adequate amount of drinking-water. • LOW RIVER FLOWS REDUCE ABILITY OF RIVER TO DILUTE CONTAMINANT CONCENTRATIONS, placing greater dependence on drinking-water treatment effectiveness. • DRINKING-WATER AT RISK FROM INCREASING AMOUNTS OF DIFFICULT-TO-REMOVE CYANOBACTERIA AND CYANOTOXINS WHEN ALGAL BLOOMS ARE PRESENT. • INDIVIDUAL HOUSEHOLDS NEEDING TO USE AN ALTERNATIVE POTENTIALLY CONTAMINATED WATER SUPPLY (e.g., stored rainwater, bore water). • INSUFFICIENT RAIN FOR CLEANING ROOF AND RAINWATER STORAGE TANKS. • INCREASED DEMAND FOR WATER BY THE FARMING SECTOR FOR STOCK AND IRRIGATION, increasing tension between users of the limited water resource. • DAMAGE TO WATER-SUPPLY BUILDINGS, INFRASTRUCTURE, POWER, AND ACCESS ROUTES/ROADS (from strong winds). <p>ADD YOUR OWN EXAMPLES:</p>	<ul style="list-style-type: none"> • WATERBORNE ILLNESS: <ul style="list-style-type: none"> – Widespread community illness in reticulated water supplies. The illness may be highly apparent (as in an outbreak situation), or present in the community at all times but at a relatively low frequency (endemic). – Severity depends on the pathogens present (e.g., Campylobacter, Salmonella, norovirus). – Increased sporadic illness for households with their own water supply, or for people who use self-supplied community purpose buildings, (e.g., education facilities, marae, community halls, private camping grounds, hospitals, public recreational facilities). • INCREASE IN NUMBERS AND VARIETY OF DISEASE VECTORS (e.g., mosquitoes) caused by change in environmental conditions (e.g., warmer water temperatures), resulting in spread of vector-borne disease (e.g., dengue fever). • TOXIC EFFECTS FROM CYANOTOXINS IN DRINKING-WATER AND RECREATIONAL WATER. <p>ADD YOUR OWN EXAMPLES:</p>

Worksheet 2

In relation to either of the climate change scenarios (more intense or frequent heavy rain events or more severe or frequent droughts):		
What is the chance the event (heavy rain or drought) and associated impact on the environment will happen?	What is the chance the impact on the water supply will happen?	What is the chance the impact on health will happen?
<ul style="list-style-type: none"> • HAVE YOU EXPERIENCED THESE EVENTS BEFORE OR SEEN INCREASED FREQUENCY OF THESE EVENTS IN THIS LOCATION? • WHO MIGHT HAVE LOCAL KNOWLEDGE OR EXPERIENCE OF HIGH OR LOW RAINFALL EVENTS, FLOODS, OR DROUGHTS THAT YOU COULD USE TO ASSESS THE CHANCE THAT THE EVENT OR ASSOCIATED IMPACT WILL HAPPEN? • WHAT ARE NATIONAL, REGIONAL, LOCAL CLIMATE CHANGE PREDICTIONS FOR YOUR AREA? • ARE THERE HISTORICAL RAINFALL DATA, FLOOD, OR DROUGHT RECORDS FOR YOUR REGION THAT YOU CAN USE TO ASSESS THE CHANCE THAT THE EVENT OR ASSOCIATED IMPACT WILL HAPPEN? • WHO IS LIKELY TO HOLD RELEVANT DATA AND HOW CAN YOU ACCESS IT? E.g., NIWA, Regional Council, Ministry for the Environment. • HOW WILL THE INHERENT UNCERTAINTY OF CLIMATE CHANGE PREDICTIONS IMPACT ON YOUR ASSESSMENT OF THE CHANCE THAT INCREASED EVENTS WILL HAPPEN? E.g., some extreme events may not have happened before and may be difficult to predict. <p>ADD YOUR OWN EXAMPLES:</p>	<ul style="list-style-type: none"> • HAVE PAST EVENTS OR EXPERIENCES (IN YOUR OWN OR IN OTHER REGIONS) SHOWN THAT THE CHANCE OF IMPACT ON THE WATER SUPPLY IS HIGH OR LOW? E.g., how often are water restrictions imposed on the region? • HOW DOES KNOWLEDGE ABOUT THE GEOGRAPHY AND GEOLOGY OF YOUR REGION HELP YOU TO PREDICT THE LIKELY CHANCE OF THE IMPACT HAPPENING? E.g., are there areas prone to slips or flooding or do rivers drain very quickly after flood? • HAS THE WATER SUPPLY ALREADY PUT MECHANISMS IN PLACE TO PREVENT THE IMPACT ON THE WATER SUPPLY FROM HAPPENING? How do you know they will be successful? • HAVE THERE BEEN RECENT CHANGES TO THE CATCHMENT THAT MIGHT INCREASE THE CHANCE OF THE IMPACT ON THE WATER SUPPLY HAPPENING? E.g., residential development resulting in increased storm-water runoff, or intensification of farming resulting in increased demand for water. <p>ADD YOUR OWN EXAMPLES:</p>	<ul style="list-style-type: none"> • HAVE PAST EVENTS OR EXPERIENCES (IN YOUR OWN OR IN OTHER REGIONS) SHOWN THAT THE CHANCE OF IMPACT ON HEALTH IS HIGH OR LOW? • DOES THE WATER SUPPLY HAVE MEASURES IN PLACE TO PREVENT THE IMPACT ON HEALTH FROM HAPPENING? WHAT ARE THESE? E.g. treatment, alternative water supply. How do you know these measures will be successful? E.g., records of compliance with DWSNZ. • ARE THERE NATIONAL, REGIONAL OR LOCAL HEALTH RECORDS THAT SHOW HEALTH IMPACTS OF WATER SUPPLY-RELATED INCIDENTS? • WHO IS LIKELY TO HOLD THE RELEVANT DATA AND HOW CAN YOU ACCESS IT? • HOW DOES KNOWLEDGE ABOUT THE GEOGRAPHY AND GEOLOGY OF YOUR REGION HELP YOU TO PREDICT THE CHANCES OF THE IMPACT HAPPENING? E.g., are there sewage or other waste discharges in the catchment? • WHAT KNOWLEDGE/RESEARCH/ SCIENCE IS AVAILABLE TO HELP YOU PREDICT HOW SERIOUS POTENTIAL HEALTH IMPACTS MIGHT BE? E.g., are some people likely to become immune to different pathogens? <p>ADD YOUR OWN EXAMPLES:</p>

Worksheet 3

In relation to either of the climate change scenarios (more intense or frequent heavy rain events or more severe or frequent droughts):

<p>How would you know the event (heavy rain or drought) and associated impact on the environment was happening? <i>(in time to take appropriate action)</i></p>	<p>How would you know the impact on the water supply was happening? <i>(in time to take appropriate action)</i></p>	<p>How would you know the impact on health was happening? <i>(in time to take appropriate action)</i></p>
<ul style="list-style-type: none"> • WHAT DATA OR INFORMATION WILL NOTIFY YOU THAT THE EVENT IS HAPPENING? E.g., River or rain gauges and flow monitoring, visual changes such as increase in turbidity, or historical knowledge of flood-prone areas • HOW WILL YOU ACCESS THIS DATA/ INFORMATION? E.g., information sharing between agencies, publicly accessible databases such as regional council websites • HOW WILL YOU MAKE SENSE OF THIS DATA/INFORMATION? • DO YOU NEED TO SHARE THIS DATA/ INFORMATION? WITH WHOM? HOW? 	<ul style="list-style-type: none"> • WHAT DATA OR INFORMATION WILL NOTIFY YOU THAT THE IMPACT IS HAPPENING? E.g., Pathogen indicator monitoring in distribution system, low/empty reservoirs/storage tanks, consumer complaints or rates of treatment chemical consumption (e.g. coagulant, chlorine). • HOW WILL YOU ACCESS THIS DATA/ INFORMATION? • HOW WILL YOU MAKE SENSE OF THIS DATA/INFORMATION? E.g., comparison of water quality monitoring data with Drinking-water Standards. • DO YOU NEED TO SHARE THIS DATA/ INFORMATION? WITH WHOM? HOW? 	<ul style="list-style-type: none"> • WHAT DATA OR INFORMATION WILL NOTIFY YOU THAT THE IMPACT IS HAPPENING? E.g., reported illnesses – e.g. school attendance records, medical centre records, calls to Public Health Unit, consumer complaints, anecdotal evidence, media notification • HOW WILL YOU ACCESS THIS DATA/ INFORMATION? • HOW WILL YOU MAKE SENSE OF THIS DATA/INFORMATION? • DO YOU NEED TO SHARE THIS DATA/ INFORMATION? WITH WHOM? HOW? E.g., between water supplier and Public Health Unit.
<p>ADD YOUR OWN EXAMPLES:</p>	<p>ADD YOUR OWN EXAMPLES:</p>	<p>ADD YOUR OWN EXAMPLES:</p>

Worksheet 4

In relation to either of the climate change scenarios (more intense or frequent heavy rain events or more severe or frequent droughts):

What can be done about preventing the impact on the water supply?	What can be done about preventing the impact on health?
<ul style="list-style-type: none"> • DOES THE DESIGN OF WATER SUPPLY INFRASTRUCTURE HELP TO PREVENT THE IMPACT ON THE WATER SUPPLY? E.g., well designed and located intake structures, infrastructure designed for a 1-in-10, a 1-in-50 or a 1-in-100 year event. What design redundancy features exist? E.g. pipes located both under and over critical river crossings? • WHAT PROCESSES EXIST TO HELP PREVENT THE IMPACT ON THE WATER SUPPLY? E.g., Process control to shut off intake when turbidity reaches predefined level, or a coarse screen to prevent debris from entering system. • ARE ROLES AND RESPONSIBILITIES FOR SPECIFIC TASKS CLEAR? E.g., who is responsible for shutting off the intake? <p>ADD YOUR OWN EXAMPLES:</p>	<ul style="list-style-type: none"> • HOW CAN WATER SUPPLIERS HELP TO PREVENT THE IMPACT ON HEALTH? CAN THEY: <ul style="list-style-type: none"> – Operate a well controlled and maintained treated drinking-water supply. – Organise adequate pre or post treatment stored water for times when production is limited or nil. – Implement incident or emergency plans such as boil water notices in order to prevent people from receiving contaminated water that would make them ill. – Respond in a timely manner to regular water quality test results of rain-water tanks for domestic rural supplies, marae, schools and community halls. – Manage a well maintained and operated system that produces safe drinking-water for households or community purpose buildings with their own water supply. • HOW CAN HEALTH AGENCIES HELP TO PREVENT THE IMPACT ON HEALTH? E.G., <ul style="list-style-type: none"> – Helping water suppliers to respond to results of DWSNZ compliance, for example through revisions to the PHRMP. – Provide relevant and timely public health information (e.g. providing advice to council staff on how an urban or rural development proposal might affect drinking-water quality or providing support to water suppliers through the Drinking-water Assistance Programme). • HOW CAN HOUSEHOLDS HELP TO PREVENT THE IMPACT ON HEALTH? E.g., <ul style="list-style-type: none"> – Have an adequate supply of safe stored drinking-water, or a means of making it safe (e.g. boiling water). • WHO IS RESPONSIBLE FOR ORGANISING THESE PREVENTION MEASURES? ARE ROLES AND RESPONSIBILITIES CLEAR? E.g. <ul style="list-style-type: none"> – Health Protection Officers, Drinking-Water Assessors, the Ministry of Health, water suppliers etc. <p>ADD YOUR OWN EXAMPLES:</p>

Worksheet 5

In relation to either of the climate change scenarios (more intense or frequent heavy rain events or more severe or frequent droughts):

What can be done about managing or responding to the impact on the water supply?	What can be done about managing or responding to the impact on health?
<ul style="list-style-type: none"> • WHAT EXISTS TO HELP MANAGE OR RESPOND TO THE IMPACT ON THE WATER SUPPLY? E.g., <ul style="list-style-type: none"> – Treatment and process control to remove turbidity or pathogens (coagulation, filtration, disinfection). – Capable staff. – Operations and maintenance procedures (e.g., flushing water mains). – Incident and emergency plans (e.g., plan to use tankers and prearranged distribution points to distribute clean drinking-water, configure water storage so that bottom 15% of reservoir water can only be accessed manually in emergency?). – Communication strategy (e.g. initiate water restrictions). – Use alternative source of water if usual source is contaminated. (E.g., groundwater supply, stored water, treated industrial supply). • ARE ROLES AND RESPONSIBILITIES FOR SPECIFIC TASKS CLEAR? E.g., who is responsible for the communication strategy? • WHAT AGENCIES OR INDIVIDUALS MIGHT NEED TO BE INVOLVED IN THIS RESPONSE? E.g., water supplier, health agency, community members etc • HOW WILL THE RESPONSE BE COORDINATED AND BY WHOM? 	<ul style="list-style-type: none"> • WHAT EXISTS TO HELP MANAGE OR RESPOND TO THE IMPACT ON HEALTH? <ul style="list-style-type: none"> – Emergency health services. – Communications strategy with the public e.g. issue boil water notices, provide health advice about symptoms of illness, who to contact, what precautions to take. – Alternative supply of water. • ARE ROLES AND RESPONSIBILITIES FOR SPECIFIC TASKS CLEAR? E.g., who is responsible for the communication strategy? • What agencies or individuals might need to be involved in this response? E.g., water supplier, health agency, community members etc • HOW WILL THE RESPONSE BE COORDINATED AND BY WHOM?
<p>ADD YOUR OWN EXAMPLES:</p>	<p>ADD YOUR OWN EXAMPLES:</p>

Worksheet 6

In relation to either of the climate change scenarios <i>(more intense or frequent heavy rain events or more severe or frequent droughts):</i>	
What can be done about adapting to deal with the impact on the water supply?	What can be done about adapting to deal with the impact on health?
<ul style="list-style-type: none"> • WHAT CONSIDERATION HAS BEEN GIVEN TO INFRASTRUCTURE IMPROVEMENTS (OR NEW DESIGN FEATURES)? E.g., <ul style="list-style-type: none"> – Geology and soil stability impacts on design and maintenance of infrastructure – Vulnerability of intake structures and vulnerable points on the network e.g., build flood barriers, build infrastructure to cope with floods, re-route pipes, reconfigure network connections, relocate reservoirs to reduce vulnerability, install redundant pipes/network around vulnerable locations. – Increased storage capacity to be able to shut off intake during high turbidity events or supply water during drought. – Finding an alternative water supply for emergencies or a less vulnerable supply for normal use. – Mechanisms for conserving/collecting water e.g. grey-water reuse or rainwater tanks that includes a regulatory inspection regime (enforcement) to prevent and manage associated environmental and health impacts. – The water supply infrastructure having to cope with variability in rainfall. • WHAT CONSIDERATION HAS BEEN GIVEN TO TREATMENT AND MONITORING PROCESS IMPROVEMENTS OR NEW DESIGN FEATURES? E.g., <ul style="list-style-type: none"> – Ensuring the treatment is appropriate for the expected source water quality and variability. – Optimising existing treatment operations and maintenance, including documenting procedures and staff training. – Treatment process and water quality monitoring, and associated incident and emergency responses. • WHAT CONSIDERATION HAS BEEN GIVEN TO IMPROVING POLICY AND PLANNING FOR CLIMATE CHANGE? E.g., <ul style="list-style-type: none"> – Evaluating the possibilities of extreme events for your region e.g., multi-year droughts or flooding, and assess various system vulnerabilities. – Including planning for climate change in LTCCP and other regional or local planning processes e.g. develop land-use/water-use controls & planning and drinking-water supply Public Health Risk Management Plans (PHRMP). – Developing cooperative climate change-relevant emergency response plans between Local Authorities, District Health Boards, water supplies, Civil Defence, and Maori Health Providers etc for community-purpose supplies and vulnerable communities. 	<ul style="list-style-type: none"> • WHAT CONSIDERATION HAS BEEN GIVEN TO PROVIDING 'HEALTH SUPPORT' TO THOSE WHO MIGHT NEED IT? E.g., <ul style="list-style-type: none"> – Local rural support trusts to help those impacted on by heavy rain events or drought. – Connecting important welfare centres such as marae and schools to town water supplies where possible. • WHAT CONSIDERATION HAS BEEN GIVEN TO IMPROVING MONITORING AND DISEASE SURVEILLANCE SYSTEMS? E.g., <ul style="list-style-type: none"> – Sharing and responding to local and cultural measures of water quality, disease and well-being such as school absenteeism as a measure of waterborne illness. – Collecting a more complete and up-to-date set of national disease statistics. – Lessons learned from international, national or regional preparedness and response e.g. Australia's experience with droughts. • WHAT CONSIDERATION HAS BEEN GIVEN TO IMPROVING POLICY AND PLANNING FOR CLIMATE CHANGE? E.g., <ul style="list-style-type: none"> – Contributing health perspectives to planning for climate change to LTCCP planning, DHB's District Strategic Plan and other regional or local planning processes. E.g. importance of alternative water use (grey-water reuse, rainwater tanks). – Contributing health perspectives to (often non-notifiable) RMA decisions e.g., building/development on high risk flood plains. – Providing health information about health risks of drinking contaminated water (to community, councils etc). – Supporting 'no-regrets' strategies which deal with climate change as well as health and other issues so that there are multiple benefits regardless of future impacts of climate-change. • WHAT CONSIDERATION HAS BEEN GIVEN BY HEALTH AGENCIES TO WORKING AND COMMUNICATING WITH OTHERS? E.g., <ul style="list-style-type: none"> – Identifying appropriate agencies to work with e.g. work with water suppliers to assess and manage the likely impacts of climate change on water supplies and health, create and foster links with existing community networks and groups or forge relationships between local decision-makers and research institutions to understand what the data means and how climate change may impact on health. – Clear roles and responsibilities for agencies working together.
<p><i>Continued over next page</i></p>	<p><i>Continued over next page</i></p>

Worksheet 6 *continued*

In relation to either of the climate change scenarios
(*more intense or frequent heavy rain events or more severe or frequent droughts*):

What can be done about adapting to deal with the impact on the water supply?

What can be done about adapting to deal with the impact on health?

Continued from previous page

- **WHAT CONSIDERATION HAS BEEN GIVEN TO CAPACITY BUILDING?** E.g.,
 - Up-skilling and providing funding to help water suppliers operate and manage supplies (e.g. the Drinking Water Assistance Programme).
 - Improving community capacity to provide safe drinking-water so households can cope for limited periods on their own.
 - Improving peoples' understanding of how different weather events affect different parts of the water supply.
 - Improving the sharing of information and resources between water suppliers.

ADD YOUR OWN EXAMPLES:

Continued from previous page

ADD YOUR OWN EXAMPLES:

Worksheet 7

In relation to either of the climate change scenarios

What affects the ability to prevent, manage or adapt to the water supply impact or health impact?

Interviewees in Taranaki described a range of issues that impact on the ability to prevent, manage or adapt to the impacts of climate change on health and on water-supplies. The following section raises some issues to think about although it is acknowledged that every location and water supply will have their own set of issues.

This section uses quotes from interviews to illustrate each issue and then provides some questions to help you think about the relevance of the issue to your situation and how you might make progress towards preventing, managing or adapting to the impacts of climate change.

PAST EXPERIENCE

“Experience is everything”

“crises build social capital”

“past experiences influence coping capacity”

“in general we are not vulnerable to intense storms because we have had practice”

“experienced farmers know how to deal with drought”

- What useful lessons have been learned from previous heavy rain or drought events? E.g., has the community developed a system for distributing clean drinking-water when it is needed?
- What useful lessons have been learned from previous contaminated water events? E.g., how has the community responded to hearing that their water might be unsafe for drinking, or does not comply with drinking-water standards?
- If there have not been previous events, what impact might this have on a community’s ability to prevent/manage/adapt?

ADD YOUR OWN EXAMPLES:

GEOGRAPHY AND GEOLOGY

“The river banks are too steep for surface water flooding”

“Water drains away very quickly – we don’t have floods”

“The supply was affected by a shift in the mountain and debris in the stream”

“In [town built on flood plain], floods take out houses, bridges, destroys infrastructure”

“Droughts in [this area] last for no more than 6–8 weeks”.

- How does the water supplier or community define ‘flood’ or ‘drought’? E.g., does a river have to burst its banks to be considered a flood? Does the pasture have to brown off to be considered a drought?
- What impact will the geography and geology have on ability to adapt the water supply treatment processes or infrastructure?
- How does geography dictate weather patterns and water flow?
- How does geography impact on ability to distribute safe drinking-water or evacuate a community in an emergency?

ADD YOUR OWN EXAMPLES:

Worksheet 7 *continued*

In relation to either of the climate change scenarios

What affects the ability to prevent, manage or adapt to the water supply impact or health impact?

TYPE/MAGNITUDE/DURATION OF EVENT AND SIZE/SOPHISTICATION OF WATER SUPPLY

“Smaller water supplies are used to adapting to adverse events”

“the tornado was a short term event so the community helped each other, the homeless were taken in by neighbours”

“droughts need key decisions to be taken early, floods need quick decisions”

“the biggest headache is dealing with rain events and treatment”

“It’s a fairly old system so climate change is not being planned for”

- How might the size or sophistication of the water supply affect ability to prevent/manage/adapt? E.g., can the water treatment and distribution systems be adapted or modified (retrofitted)?
- What broader consequences of changes to water supply have been considered? E.g., changes to ensure that end-of-line houses receive water with adequate pressure can cause problems with internal plumbing not designed for that pressure.
- How might the type, magnitude or duration of the heavy rain or drought event affect ability to prevent/manage/adapt?

ADD YOUR OWN EXAMPLES:

HOW WELL PEOPLE AND ORGANISATIONS WORK TOGETHER

“There is a farmer’s liaison committee which has a good relationship with the council”

“there are mechanisms between councils to communicate and discuss deterioration of water courses but they don’t listen, parochial north vs south and, arrogance”

- What kinds of relationships exist between organisations, individuals, neighbouring regions etc? How could these relationships be enhanced, to share knowledge, expertise, resources?
- In times when organisations need to work together, are roles and responsibilities of different organisations and individuals well-defined?
- What kinds of information or communication systems are currently in use? E.g., dairy industry communication systems to provide advice and support

ADD YOUR OWN EXAMPLES:

Worksheet 7 continued

In relation to either of the climate change scenarios

What affects the ability to prevent, manage or adapt to the water supply impact or health impact?

INSTITUTIONAL CAPACITY

“We have institutional knowledge of about 30 years”

“there is some reluctance from councillors to spend money on water infrastructure/ treatment”

“water is the highest priority in the next ten years for the council – they’re committing \$90 Million”

“For the council, climate change is not a huge priority”

“newer staff members pick up history from farmers, contractors, the CEO – people who have been here for years”

- How much time, knowledge, funding, skills etc do water supply, council or health staff have for contributing to prevention/management/adaptation?
- What priority is given to preventing/managing/adapting to climate change? How will this influence actions?
- Where and how does planning for climate change fit within existing planning processes?

ADD YOUR OWN EXAMPLES:

COMMUNITY SPIRIT AND CAPACITY

“Farmers are independent, get out there and help one another”

“Local knowledge is important and useful for identifying alternative water sources”

“people there are reasonably isolated so more reliant on each other”

“we talk about climate change but not in terms of a mainstream perspective”

“there is a lot of local knowledge in communities – often the old people who have historical knowledge”

“part of the notion of well being for Māori is being able to carry out cultural activities”

- What features of the community will impact on ability to prevent/manage/adapt? E.g. Do people in urban areas have more reliance on health and local authorities than people in rural areas, and why? Are there identifiable groups of people that may have more or less of an ability to prevent/manage/adapt?
- What community networks currently exist that could be useful for helping to prevent/manage/adapt? E.g., liaison groups, water committees, churches etc
- What types of knowledge and values do different communities have? E.g., Māori communities have important cultural indicators for the health of rivers and waterways.
- What is the community’s capacity for working together, for sharing different types of knowledge, for contributing to planning etc?

ADD YOUR OWN EXAMPLES:

In relation to either of the climate change scenarios

What affects the ability to prevent, manage or adapt to the water supply impact or health impact?

ASSUMPTIONS AND PERCEPTIONS

“They seem to think if it rains the ‘drought’ is over, but often its not”

“people know climate change is happening now, but think government or council will solve the problem”

“How do you get the desire to move into action?”

“There are people who don’t accept that climate change is happening – its not big enough to see”

“climate change was raised – people are aware of it, know it may have some impact, but there are always some sceptics”

“I have not seen a consistent trend in climate change – it swings from drier to wetter”

“Climate change is a pattern within a pattern”.

- How do different people view climate change? Are there sceptics? How might different opinions about climate change impact on ability to prevent/manage/adapt?
- Are there any assumptions held that might impact on ability to prevent/manage/adapt? E.g., that roads will be open to allow access to tankered water, that you will be at home or at work when the event happens.

ADD YOUR OWN EXAMPLES:

INFORMATION AVAILABILITY AND ACCESSIBILITY

“Civil Defence don’t see land use consent applications unless publicly notified so . . .”

“climate change is confusing”

“When you explain to people the costs and processes for water restrictions then they do understand – they need that information”

“There is not much information – I don’t know the predictions for climate change”

“It is the councils role to provide information”

- What kind of information is available to help prevent/manage/adapt?
- For what purposes do different groups of people need information? E.g., land-use planning, operating a drinking-water supply
- What kind of information do different groups of people need? E.g., to be practical, there needs to be a balance between information being simple enough to understand and yet sufficiently detailed to inform decisions and actions.
- How is information shared or made available?

ADD YOUR OWN EXAMPLES:

Worksheet 7 *continued*

In relation to either of the climate change scenarios

What affects the ability to prevent, manage or adapt to the water supply impact or health impact?

REGIONAL DEVELOPMENT AND LAND USE

“There is a need for farmers to have a reliable supply of water”

“If dairy payout is high, farmers will stock more densely – farmers take it for granted that water is there”

“Dairying is high water demand”

“in drought, the rural system comes under pressure –[need water for] stock, drinking water, and environmental values”

“the meat-works uses a third of the town’s water supply”

“we are taking into consideration . . . the potential for both industrial and residential growth”

“The ‘dream’ for [this town] is to have population growth of 30% over the next ten years – this will impact on abstraction limits”.

- How might regional development initiatives impact on the ability to prevent/manage/adapt? E.g., deteriorating water quality from industrial discharge.
- How might national or regional economic, environmental, social or cultural priorities influence the ability to prevent/manage/adapt? E.g., in a drought situation, how might priorities for water allocation be decided?

ADD YOUR OWN EXAMPLES:

POLITICAL CONTEXT

“Water is the highest priority in the next ten years for [our region]”

“water is TOP priority”.

- What is the current political focus on climate change? How might this influence your ability to prevent/manage/adapt? E.g., is there any funding available to help? Is there guidance or information available from central government?
- What priority is given to water or public health issues in your region/locality? How will this influence decisions and actions?

ADD YOUR OWN EXAMPLES:

