



New Zealand **FOOD SAFETY SCIENCE & RESEARCH CENTRE**

On-farm impact of climate
change (on food safety)

United Fresh: NZFSSRC Food Safety
Workshop

12 March 2020

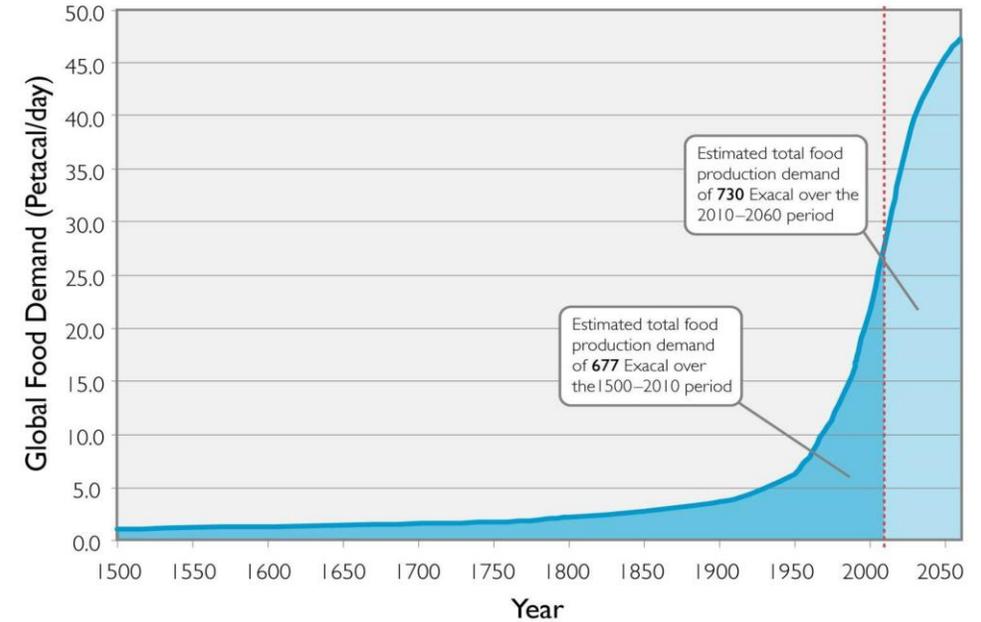
Nigel French



Food safety and security in 21st Century

Era of:

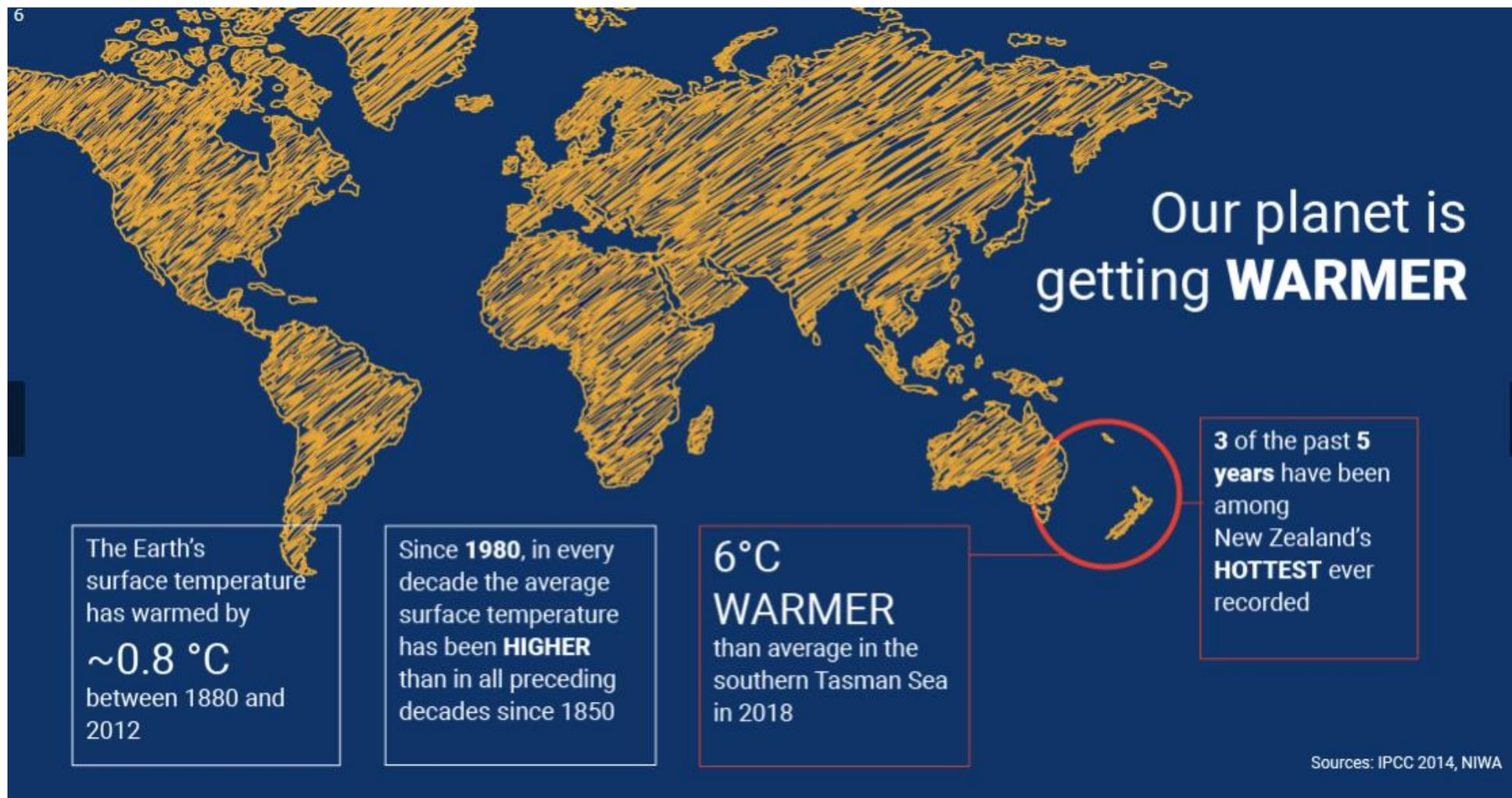
- Novel foods
- Novel processing
- Raw food
- Global pathogen traceability
- Adulteration and bioterrorism
- Product tracing and provenance
- Population growth, increased food demand and reduced agricultural land availability
- Climate change



Source: Brian Keating, CSIRO



Climate change and global warming



Climate change and global warming

HUMAN activities are largely responsible for this warming

Globally:

Climate change is caused by **INCREASED** concentrations of **GREENHOUSE GASES** in the planet's atmosphere

The amount of carbon dioxide, methane and many other greenhouse gases is **INCREASING** due to human activities, and they are now at their highest level in at least **800,000** years

52% INCREASE in Carbon Dioxide CO₂ between 1990-2016 mostly from fossil fuel burning



Methane CH₄ atmospheric concentrations **RISING FASTER** now than any time in the past 2 decades



In New Zealand:

19.6% INCREASE in gross emissions since 1990



A new pattern of more extreme weather across the globe

Increases in extreme heat and intense precipitation



Hurricanes and other storms are likely to become stronger

Floods and droughts will become more common

In New Zealand:



~5% increase in extreme rainfall
10%+ for intense thunderstorms



0.7-1.0°C
increase
by 2040



\$800M
storm costs
in past 5 years

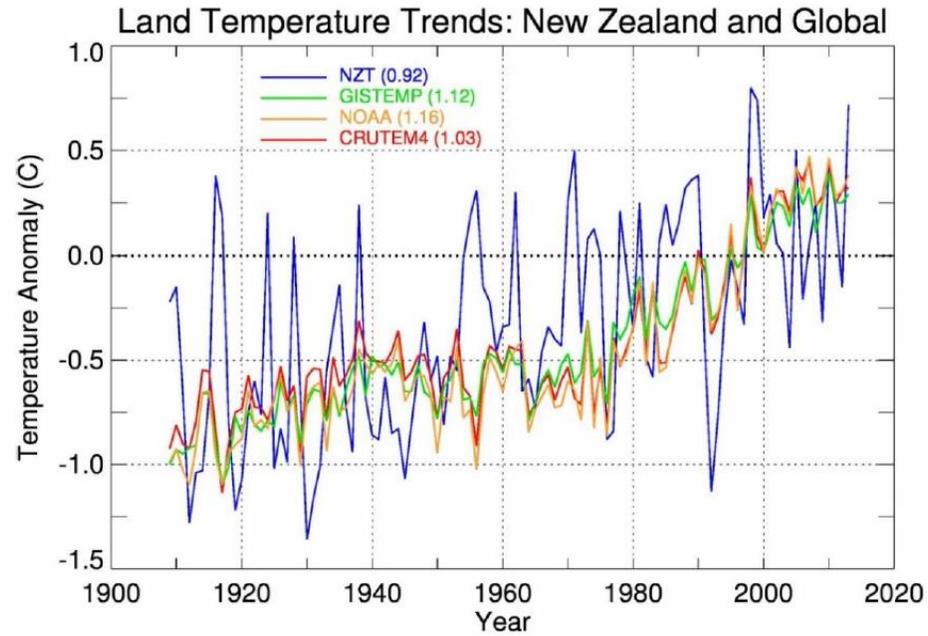
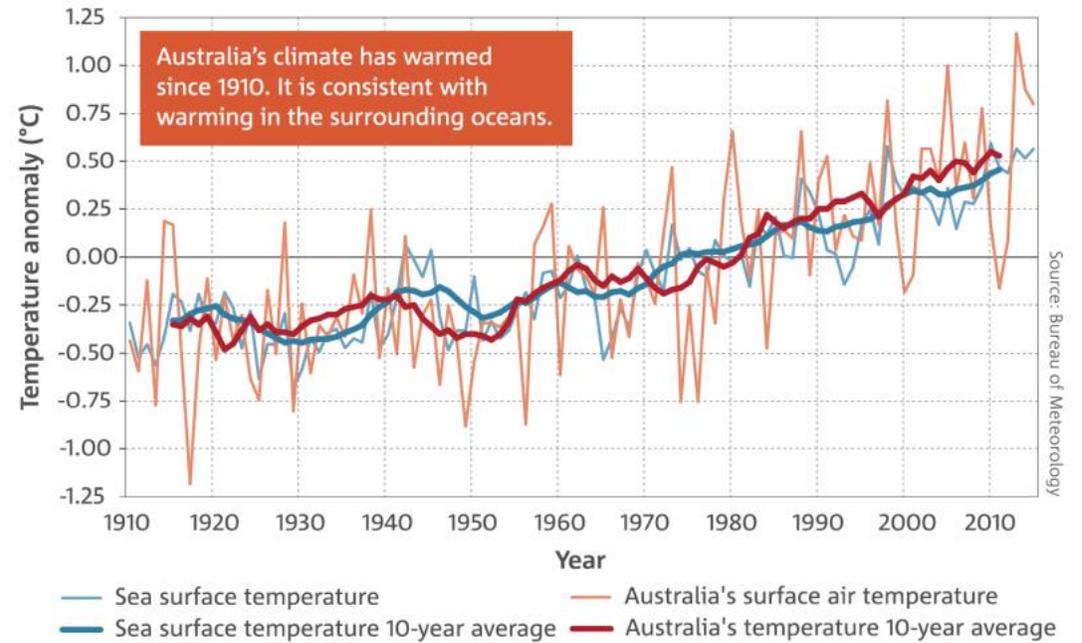


Figure 1: Comparison of New Zealand and global annual surface air temperature anomalies (in °C) over land, relative to a 1981–2010 baseline

Source Ministry for the Environment, 2018

Top ten UK's hottest years all since 2002

Source: <https://www.metoffice.gov.uk/>



Source: <https://www.climatechangeinaustralia.gov.au>

Met Office

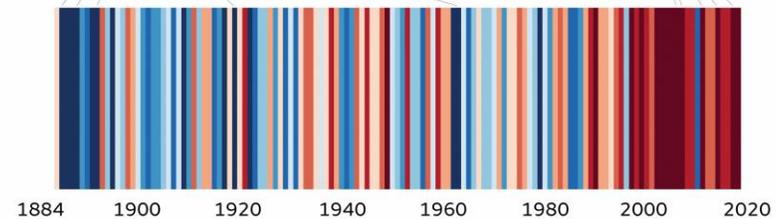
UK annual temperature

5 coolest years

1892, 1888, 1885, 1963, 1919

5 warmest years

2014, 2006, 2011, 2007, 2017



Climate predictions: CO₂ concentration scenarios

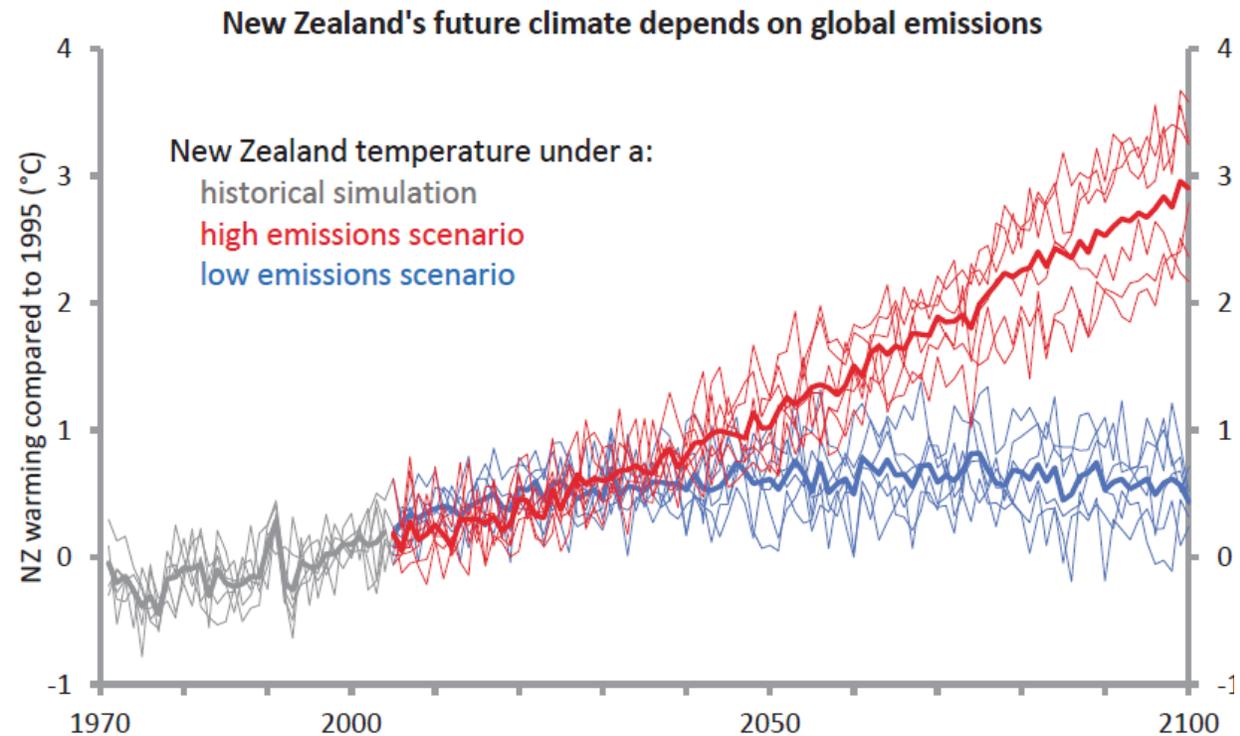
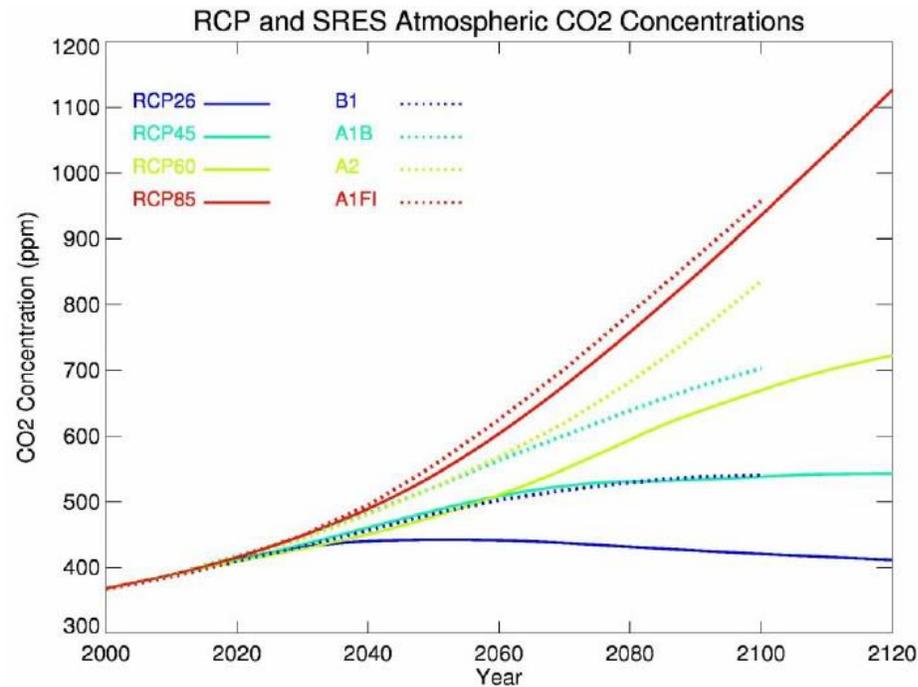


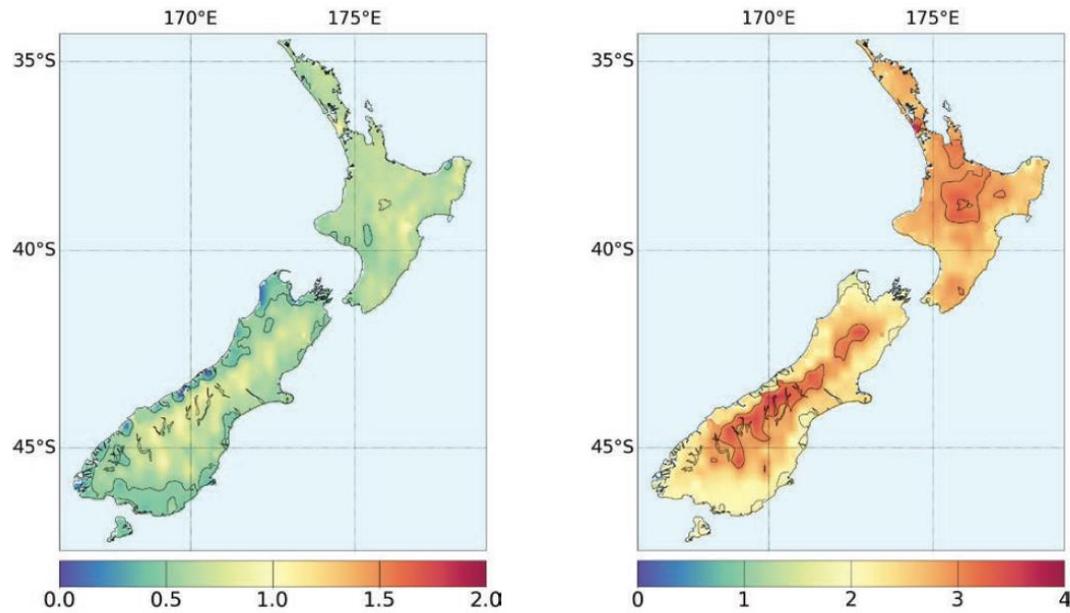
Figure 2: Atmospheric carbon dioxide concentrations for the IPCC Fourth Assessment (dotted lines, SRES concentrations) and for the IPCC Fifth Assessment (solid lines, RCP concentrations)

RCP=representative concentration pathways (mitigation, stabilisation and worst-case)

Source: Ministry for the Environment: Climate change projections snapshot

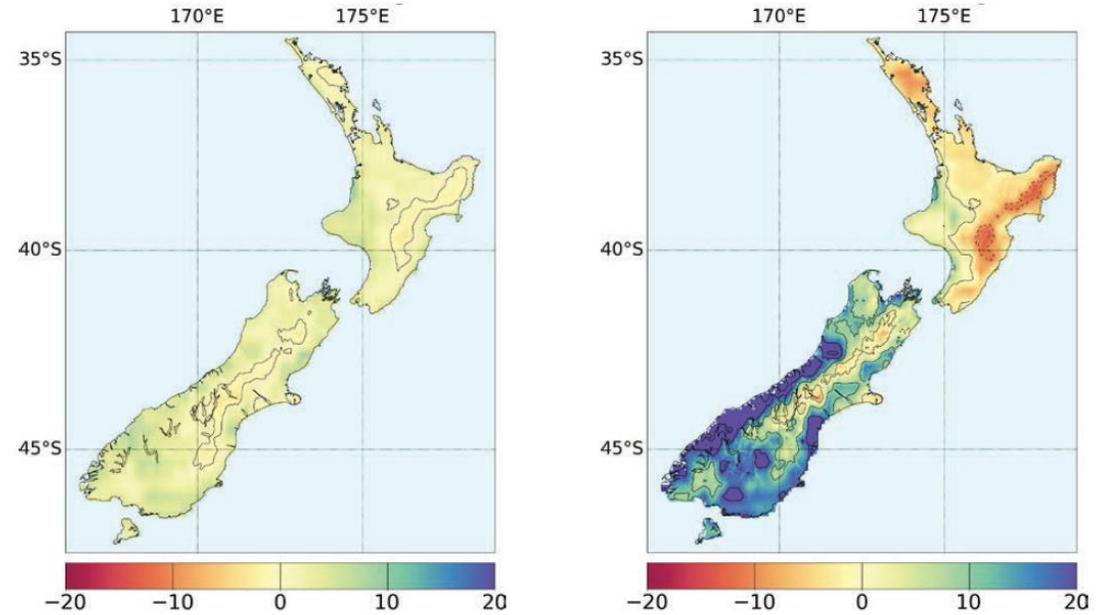
Climate change in New Zealand

Average change in temperature (°C) by 2090 under RCP2.6 (left) and RCP8.5 (right)



Temperature

Annual average change in rainfall (%) by 2090 under RCP2.6 (left) and RCP8.5 (right)



Rainfall

Climate change impacts on New Zealand



Temperature
 Temperature is expected to increase throughout the country. This will mean:

- Decreased frequency and severity of frosts
- More days above 25°C
- Longer growing seasons
- Increased rural fire risk
- Increased demand for water
- Increased occurrence of food and water-borne diseases

Towns and cities

- Increased stormwater flooding
- Warmer winters > decrease in cold-related illnesses
- Warmer summers > increased heat stress
- Decreased electricity use in winter (less heating)
- Increased electricity use in summer (more air-conditioning)

Key



- Drier**
- Decreased annual rainfall
 - Decreased run-off to rivers
 - Increased evaporation
 - Increased frequency and severity of drought
 - Increased irrigation demand



- Wetter**
- Increased precipitation
 - Increased intensity in weather events
 - Increased flooding, particularly in already flood-prone areas
 - Increased slips
 - Increased soil erosion



- Coastal**
- Sea level rise
 - Increased storm surge
 - Coastal inundation
 - Increased coastal erosion



- Ex-tropical cyclones***
- Increased intensity > increased wind, waves, storm surge and rainfall
- * Tropical cyclones, in travelling to NZ change their character, becoming slightly less intense but causing damage over a much wider area



- Wind**
- Increased westerly winds in winter and spring (especially in the South), more north-easterlies in summer and autumn (especially in the North)



- Snowlines and glaciers**
- Changes in length and area of glaciers
 - Rise in snowline
 - Reduction in snow days
 - Decrease in seasonal snow duration and depth



- Natural areas**
- Species distribution changes
 - Changes to/loss of habitat
 - Increased pressure from pests, animals and plants

Regional variation

Increase in extreme weather events e.g.

- Increase in storm water, flooding
- Increase in hot/dry spells, droughts

Temperature is expected to increase throughout the country

- Increase in hot days (maximum temperature of 25°C or higher)
- Decrease in severity of frosts
- Increased winter rainfall coupled with milder winter temperatures

Likely impacts of climate change (relevant to horticulture)

Higher temperatures

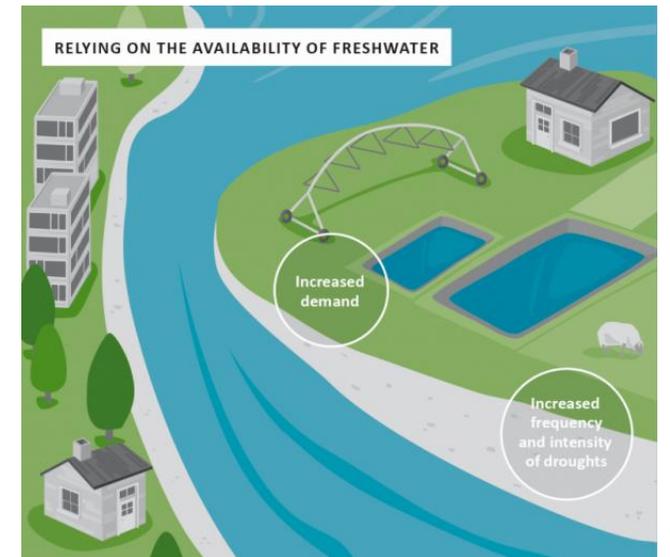
- Summer drought
- Warmer winters with fewer frosts

Flooding

- More frequent intense winter rainfalls: rivers flooding, flash flooding.

Water resources

- Water demand increase during hot, dry summers.
- Longer, drier, hotter summers: reduce soil moisture and groundwater supplies.
- Drought intensity increase over time
- Lower river flows raise water temperatures and reduce water quality



Source Royal Society of New Zealand

Likely impacts of climate change (relevant to horticulture)

Sea-level rise

- Erosion, coastal flooding and saltwater intrusion

Agriculture/horticulture

- Productivity expected to increase in some areas.
- Increased risk of drought and spreading of pests and diseases.
- Costs associated with changing land-use activities to suit a new climate.

Business and finance

- Fruit and vegetable growers find it more expensive to insure against weather related damage (eg, from hail).
- Risk management of potential climate change impacts may provide opportunities for businesses.

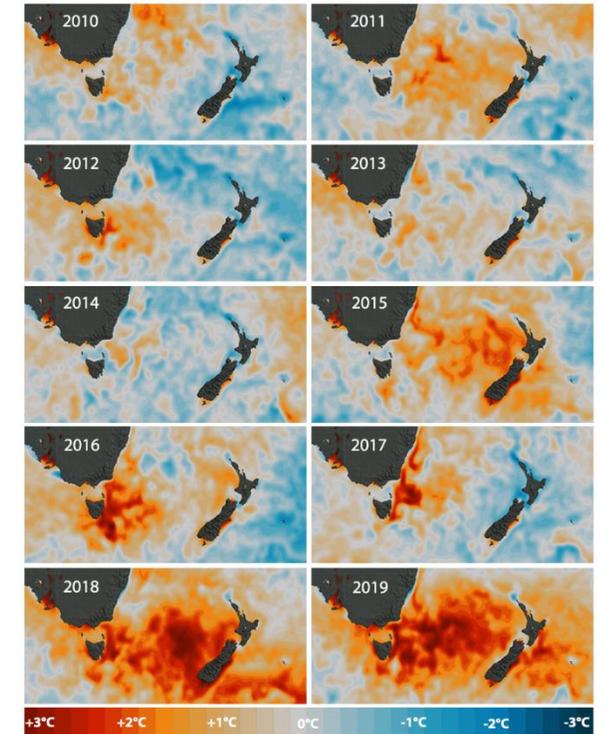
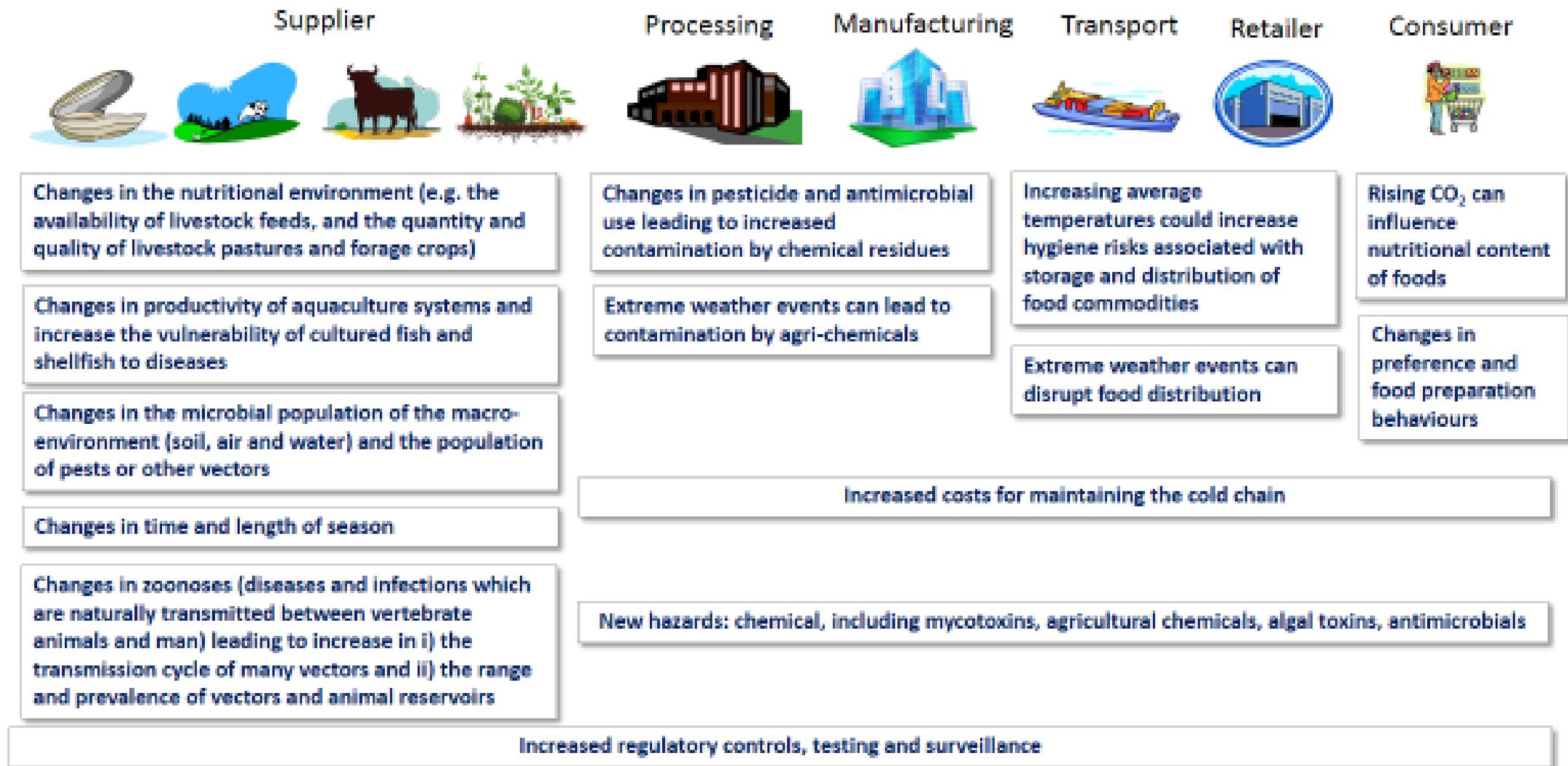


Figure 1. Potential Interactions of rising CO₂ and Climate Change on Food Quality and Safety Systems along the Supply Chain



Impacts of climate change on horticultural food safety (SLMACC study)

Impact

- Increased flooding – increase spread of pathogens from animal faecal matter to plant systems.
- Increased temperature and moisture increase growth of pathogens
- Increase in heavy rainfall - increase flooding contaminating land with fertilizer and chemical residues from neighbouring land used for livestock.

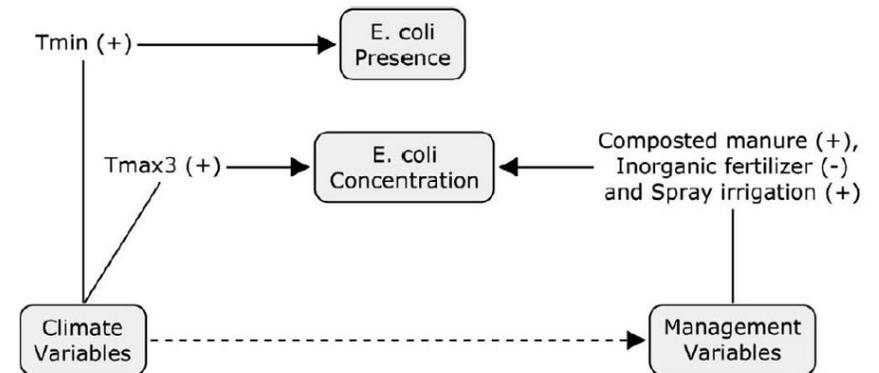
Mitigation

- Strengthening food safety management programmes. Integrated management of water sources, soil, wildlife intrusion and manure application.
- Strengthening of on-farm and food safety management programmes. Allocation of horticulture land to dedicated areas.
- Movement of some plants further south, especially those requiring winter chilling.



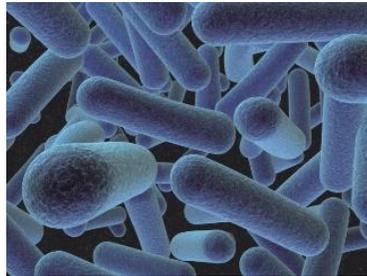
Biomass in millions of tonnes in NZ

From: Liu et al 2016. *Journal of Food Protection*, 79. 17
 Impacts of climate and management on contamination of leafy greens with *E. coli*



Fresh produce – increasingly common cause of foodborne outbreaks

- Increase in consumption
 - Fresh-cut, minimally processed, convenience, ‘healthy fast-food’
- Irrigation waters and fertilisers of animal origin important sources of pathogens, including protozoa and viruses



FOODBORNE PATHOGENS AND DISEASE
 Volume 12, Number 1, 2015
 © Mary Ann Liebert, Inc.
 DOI: 10.1089/fpd.2014.1821

Reported Foodborne Outbreaks Due to Fresh Produce in the United States and European Union: Trends and Causes

Raquel M. Callejón,¹ M. Isabel Rodríguez-Naranjo,¹ Cristina Ubeda,^{1,2} Ruth Hornedo-Ortega,¹ M. Carmen García-Parrilla,¹ and Ana M. Troncoso¹

TABLE 2. SUMMARY OF OUTBREAKS ASSOCIATED WITH FRESH VEGETABLES AND FRUITS IN UNITED STATES, 2004–2012 (CENTER FOR DISEASE CONTROL AND PREVENTION’S OUTBREAKNET FOODBORNE OUTBREAK ONLINE DATABASE. [HTTP://WWWN.CDC.GOV/FOODBORNEOUTBREAKS/](http://wwwn.cdc.gov/foodborneoutbreaks/))

Type of pathogen	Food vehicle									Total outbreaks
	Vegetables				Sprouts	Fruits				
	Salad	Leafy	Tomato	Other		Berries	Melon	Juices	Other	
Norovirus	97	62	5	9	0	5	9	3	33	223
<i>Salmonella</i> spp.	8	8	17	3	14	2	14	0	5	71
<i>Escherichia coli</i>	10	22	0	0	4	2	0	6	2	46
<i>Campylobacter</i> spp.	4	2	1	0	0	0	1	0	1	9
<i>Shigella</i> spp.	1	2	0	0	0	0	0	0	0	3
<i>Clostridium</i> spp.	0	0	0	0	0	0	0	0	0	0
<i>Staphylococcus</i> spp.	2	0	0	0	0	0	0	0	0	2
<i>Yersinia</i> spp.	0	0	0	0	0	0	0	0	0	0
<i>Bacillus</i> spp.	1	0	0	0	0	0	0	0	1	2
<i>Giardia</i> spp.	0	1	0	1	0	0	0	0	0	2
<i>Cyclospora</i> spp.	1	1	0	1	0	3	0	0	2	8
<i>Cryptosporidium</i> spp.	0	0	0	0	0	0	0	3	0	3
Other foodborne viruses (hepatitis A virus)	0	1	1	1	0	0	0	0	2	5
Other microorganism (<i>Listeria monocytogenes</i>)	0	0	0	0	2	0	1	0	0	3

Review

Fresh Produce: A Growing Cause of Outbreaks of Foodborne Illness in the United States, 1973 through 1997

SUMATHI SIVAPALASINGAM,^{1,2*} CINDY R. FRIEDMAN,¹ LINDA COHEN,¹ AND ROBERT V. TAUXE¹

Climate mapping and projections: Australia

VIEW MAIN NAVIGATION

CLIMATE CHANGE IN AUSTRALIA
PROJECTIONS FOR AUSTRALIA'S NRM REGIONS

About Future climate Explore data Climate Futures Tool Climate analogues Coastal & marine Sign-In/Register

Home » **Climate projections**

CLIMATE PROJECTIONS

Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken.

Climate projections are spatially focussed around natural resource management regions (or clusters) for which information, data and reports are available. Use the [Data Exploration](#) tools found on this site to see what climate models are projecting about future climate change for Australia.

Also available is a range of model outputs (to registered users) including climate model data formulated for use in further studies or applications ([Application-ready data](#)).

Page updated: 28th June 2019



CLIMATE ANALOGUES

The Climate Analogues tool is used to explore what the future climate would be like in a location of your choice. Future climate is described as the current climate of another town or city that is in another location (within Australia).

[Climate Analogues](#)

COASTAL AND MARINE

Coasts and marine ecosystems are important for Australia. Seven of the eight analysis clusters have coastlines. This section allows users to read about and explore projections for the coastal and marine environments including sea level rise, sea surface temperatures, aragonite saturation and ocean chemistry.

[Marine Explorer](#)

CLIMATE FUTURES TOOL

A multi-purpose tool to support advanced users of climate projections data to obtain appropriate climate model data for detailed impact assessments.

[Climate Futures](#)

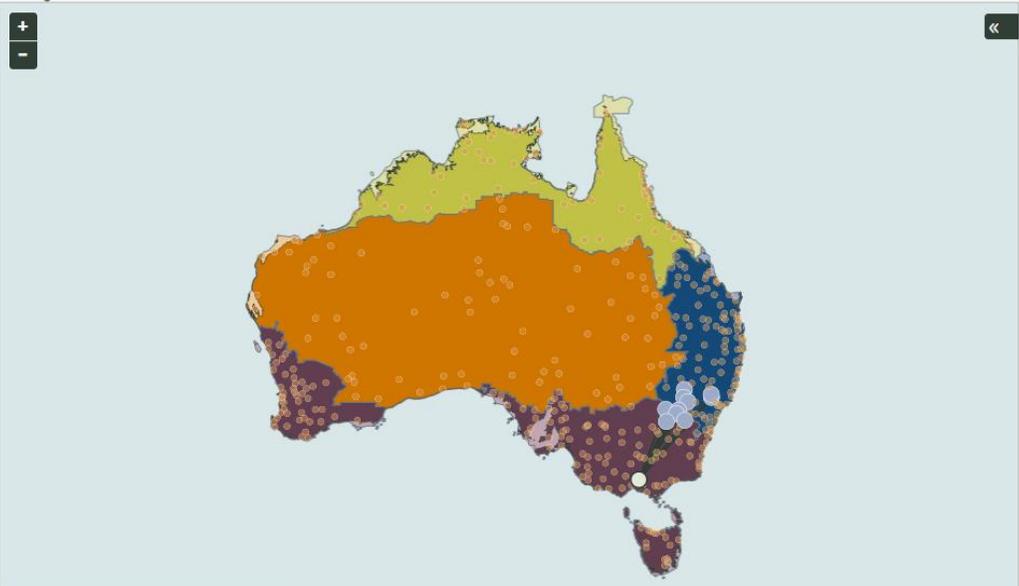
CLIMATE THRESHOLDS

The number of days above or below particular thresholds of temperature or rainfall is a useful way to describe extremes of climate. Use this tool to generate maps and tables of past and future threshold exceedances.

[Thresholds](#)

CLIMATE ANALOGUES

BASIC



Melbourne

Preset Scenarios

EMISSIONS SCENARIO: **RCP 8.5**

TIME PERIOD: **2090**

DESCRIPTION: **Maximum Consensus**

Configure Data

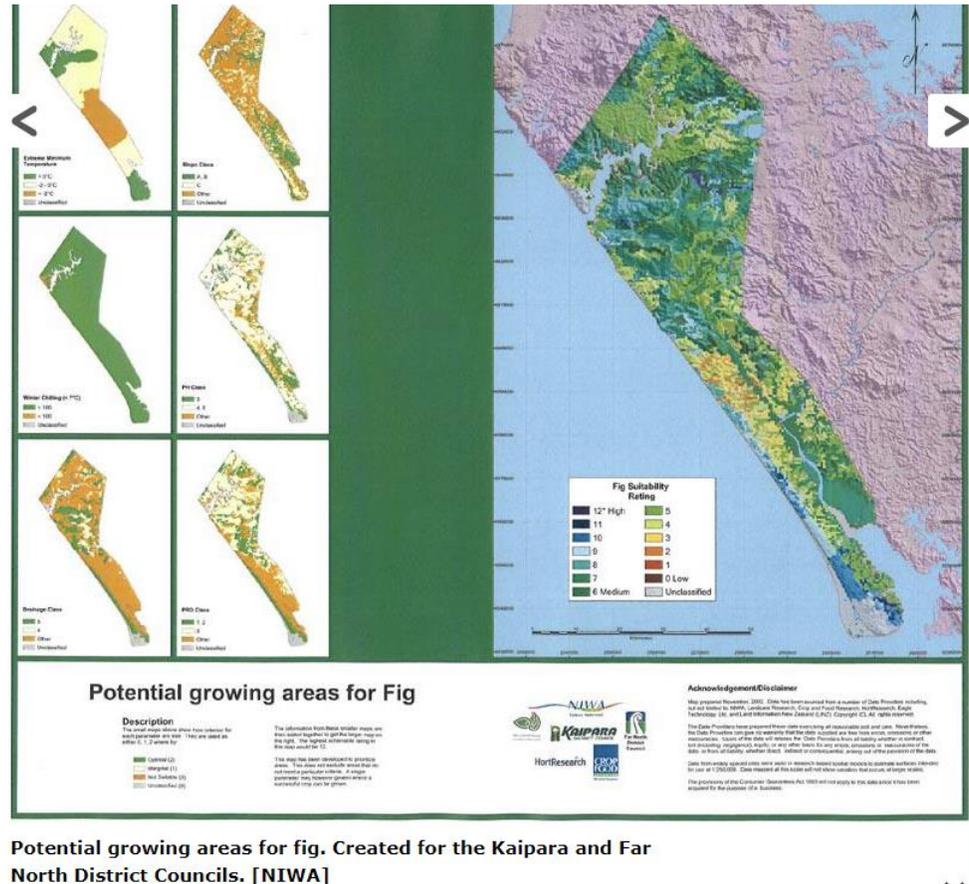
TEMPERATURE CHANGE: 3.8 °C

RAINFALL CHANGE: -10 %

ANALOGUE TOWNS

Muswellbrook, Scone, Gilgandra, Condobolin, Dubbo, Wellington, Parkes, Forbes, West Wyalong, Cowra,

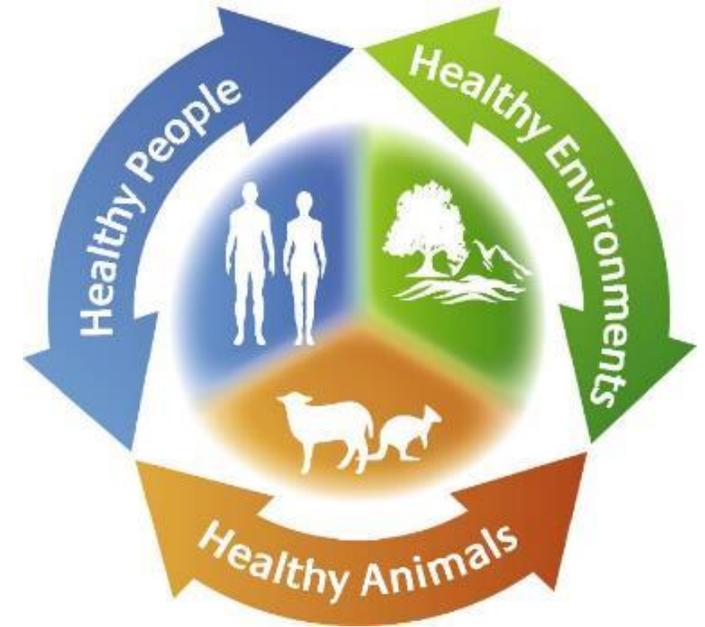
Land use mapping and projections: New Zealand



<https://www.niwa.co.nz/climate/our-services/climate-mapping>

Conclusions

- Impacts of climate change already being felt.
- Will be compounded by population growth and reduced land available for agriculture
- Need to understand likely future scenarios for your region...
...and plan to adapt
- May be that horticulture no longer viable in some areas
 - Need for change in land use?
 - Use of regional climate projections
- Reduce likelihood of contamination from livestock (and wildlife)?
 - Reduce impact of flooding
 - Source of water for irrigation and spraying
 - Testing of water, equipment and product (risk based)
- Embrace new technologies
 - Data science, AI, predictive modelling... risk prediction
 - Microbial source tracking
- Need to take a One Health, Ecosystem Health approach





New Zealand FOOD SAFETY SCIENCE & RESEARCH CENTRE



INDUSTRY PARTNERS:



GOVERNMENT FUNDERS:



**MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT**
HĪKINA WHAKATUTUKI

Ministry for Primary Industries
Manatū Ahu Matua



RESEARCH PARTNERS:

