



## CLIMATE CHANGE: A GUIDE FOR LAND MANAGERS 1

# The theory, the history, the science

This fact sheet is the first in a series of five from the resource pack: **CLIMATE CHANGE: A GUIDE FOR LAND MANAGERS**

Other fact sheets in this series are:

No 2. New Zealand's variable climate

No 3. Climate change scenarios and uncertainty

No 4. Future New Zealand: Possible effects on our climate

No 5. Future New Zealand: Possible impacts of climate change

Other material contained in this resource pack includes climate change projections at a regional level.

To view other material in this resource pack visit [www.maf.govt.nz/climatechange](http://www.maf.govt.nz/climatechange) or phone **0800 CLIMATE** to request a hard copy.

## WHAT IS THE IPCC

### THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

A scientific intergovernmental body set up in 1988 by the World Meteorological Organization and by the United Nations Environment Programme. In 2007, it was awarded the Nobel Peace Prize for "efforts to build up and disseminate greater knowledge about man-made climate change and to lay the foundations for the measures that are needed to counteract such change".

It provides information on climate change through reports based on the continually growing body of scientific evidence. The comprehensiveness of the content is achieved through the contributions of thousands of experts across all relevant disciplines and in all regions of the world including New Zealand.

## WHAT IS CLIMATE CHANGE?

Climate change is defined by the Intergovernmental Panel on Climate Change<sup>1</sup> (IPCC, 2007) as follows:

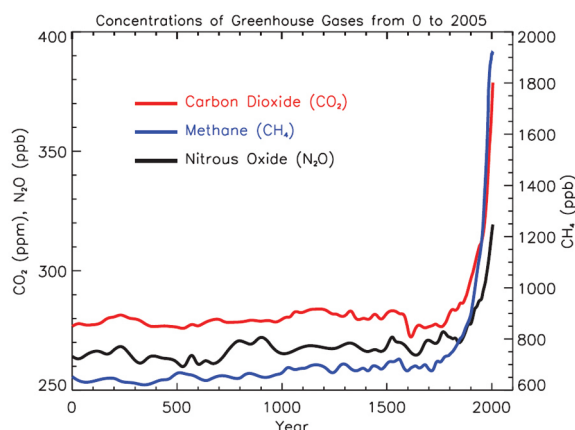
*"Climate change refers to a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use."*

Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as:

*"a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".*

The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

**FIGURE 1: ATMOSPHERIC CONCENTRATIONS OF GREENHOUSE GASES OVER THE LAST 2000 YEARS**



Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the GHG per million/billion air molecules, in an atmospheric sample.

Source: IPCC 2007.

<sup>1</sup> Contribution of Working Group I to the Fourth Assessment Report of the IPCC 2007 Climate Change 2007: The Physical Science Basis; Annex 1; pp 943.

## IS CLIMATE CHANGE NEW?

No. The climate has changed constantly over millennia due to natural processes, evident through the cooling and warming experienced with ice ages and interglacial periods. The relatively stable climate of the past 10 000 years or so has allowed human civilisation to flourish through settled communities and the development of agricultural production.

Two well documented changes since the end of the last major ice age are the Mediaeval Warm Period (10th to 14th century AD) and Little Ice Age (16th to 19th century AD). The relatively small climate changes that occurred during these periods had significant effects on agricultural production and human health.

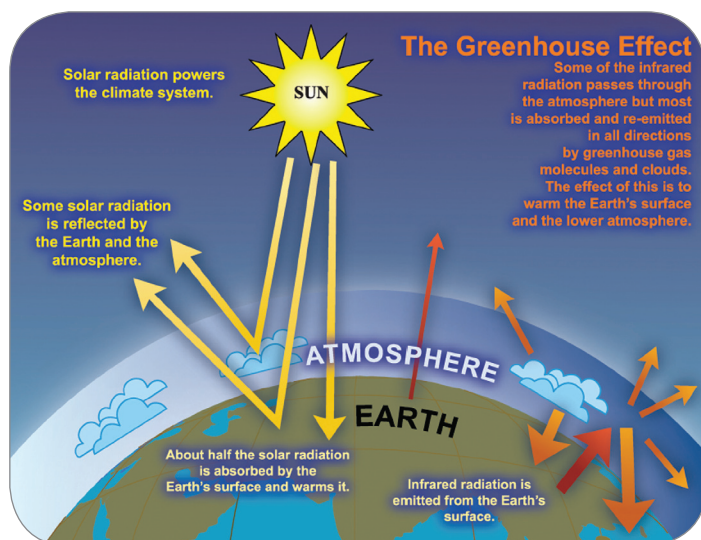
## THE RESULT OF HUMAN INFLUENCE

As time goes by, the evidence is mounting that human activity is changing the global climate.

Figure 1 shows how the volume of atmospheric greenhouse gases (GHGs) increased significantly from around 1750, coinciding with the onset of the Industrial Revolution, rapid economic and population growth, and widespread deforestation.

The IPCC consider it “very likely” that these GHG increases have caused the warming of the Earth’s atmosphere over the last century.

FIGURE 2: THE GREENHOUSE EFFECT



## THE DEVELOPMENT OF CLIMATE CHANGE SCIENCE

The scientific theory that humans could change global climate had its beginnings in the 19th century. Climate change theory has developed considerably since the 1970s.

Unlike many scientific theories that are tested under controlled conditions in the laboratory, climate change theory is being played out beyond our control in the Earth’s biosphere.

Over the past century, the average temperature on Earth increased by more than half a degree Celsius with the 1980s, and 1990s being the warmest decades on record.

New Zealand climate, like the global climate, has warmed over the past century, and this trend is expected to continue for at least the next century.

## CLIMATE CHANGE SCIENCE IN PRACTICE

Scientists in New Zealand and around the world are monitoring, measuring, modelling and analysing all manner of atmospheric and environmental changes.

These changes include:

- increases in atmospheric carbon dioxide and other greenhouse gases;
- increases in temperature and frequency of temperature extremes such as heat waves;
- melting of snow and mountain glaciers;
- ice melt from Greenland and Antarctica;
- rising sea levels;
- increased intensity and duration of droughts;
- changes in rainfall patterns;
- effects on Arctic and Antarctic ecosystems;
- warming of lakes and rivers;
- earlier timing of spring events such as flowering and bird migration;
- longer growing seasons in some regions and shorter, more drought affected, growing seasons in others.

Other scientists are focused on how we respond to climate change. This activity has increased significantly over the last decade as the evidence has grown of climate change and its effects, and of the human influence on climate.

## FOR MORE INFORMATION

- For more information on the Royal Society, the national academy of science of the UK and the Commonwealth, visit [www.royalsociety.org](http://www.royalsociety.org)
- For general information on climate change for land-based sectors visit the Ministry of Agriculture and Forestry website [www.maf.govt.nz/climatechange](http://www.maf.govt.nz/climatechange)
- For more information on climate change in New Zealand visit [www.climatechange.govt.nz](http://www.climatechange.govt.nz) or the Ministry for the Environment’s website [www.mfe.govt.nz/issues/climate](http://www.mfe.govt.nz/issues/climate)
- For a popular guide to the IPCC reports, visit the website of the United Nations Environment Programme [www.grida.no/publications/climate-in-peril](http://www.grida.no/publications/climate-in-peril)



How farmers respond to climate change was the focus of a recent SFF project in the Bay of Plenty.

## HOW CAN WE RESPOND TO CLIMATE CHANGE?

There are two main responses: mitigation and adaptation.

Mitigation relates to actions to reduce or offset emissions of GHGs. Effective mitigation will require international co-operation and action. While some action is being taken, emissions of GHGs are continuing at a level that will lead to significant climate change.

Adaptation involves actions to deal with the effects of climate change. The extent to which we need to adapt will depend on international actions to reduce emissions, and on the rate and extent of climate change that we experience.

## IS THERE STILL DEBATE OVER CLIMATE CHANGE?

Given the complexity that is climate change, it is inevitable that there remains debate. However, the scientific consensus is that it is now unequivocal that warming of the climate system is happening. The evidence continues to grow that human activity is contributing significantly to this warming.

## WHAT DO YOU BELIEVE?

Regardless of what the science says, for many people “seeing is believing”. Increasing numbers of farmers, foresters and growers are experiencing changes in weather patterns. They are reading and responding to the climate signals, as they are to economic, market and consumer signals. Pragmatic farmers and growers tend to see mitigation and adaptation responses as ways of making their businesses more resilient and sustainable.

*“Science moves forward by challenge and debate and this will continue. However, none of the current criticisms of climate science, nor the alternative explanations of global warming, are well enough founded to make not taking any action the wise choice.” The Royal Society, the national academy of science of the UK and the Commonwealth*

## Key points

- 1** Global variations in temperature are strongly linked to variations in the amount of greenhouse gases in the atmosphere, principally carbon dioxide.
- 2** Levels of GHGs in the atmosphere have increased significantly as a result of human activities and will continue to increase in the absence of measures to reduce emissions.
- 3** Natural factors, such as volcanic activity and changes in solar radiation, cannot by themselves account for the changes in climate that are now happening.
- 4** Globally and on average, temperatures are steadily rising.
- 5** There is increasing evidence of climate change effects on natural systems.
- 6** The climate system is complex and uncertainties remain regarding future climate changes, especially the magnitude of global warming and sea level rise, and regional differences.
- 7** The effects of climate change will continue beyond the 21st century.



## A TIMELINE OF climate change science

1824

French physicist Joseph Fourier recognised the importance of the atmosphere's role in trapping heat and influencing the temperature of the earth. He uses the analogy of a greenhouse.

1896

Swedish chemist Svante Arrhenius makes the first climate prediction: halving CO<sub>2</sub> could lead to an Ice Age, doubling CO<sub>2</sub> could lead to an increase in global temperature of 5°C.

1938

Engineer Guy Stewart Callendar first suggested that fossil fuel burning was responsible for the observed warming of the world's climate.

1979

The first World Climate Conference voices concern that "continued expansion of man's activities on earth may cause significant extended regional and even global changes in climate."

1988

The Intergovernmental Panel on Climate Change (IPCC) is set up by the UN to provide policy makers with a source of information on climate change.

1990

The first IPCC assessment states that scientists are certain that emissions from human activities are substantially increasing atmospheric concentrations of GHGs resulting, on average, in an additional warming of the Earth's surface.

1995

The second IPCC assessment states that the balance of evidence suggests a discernible human influence on global climate.

2001

The third IPCC assessment states that there is new and stronger evidence that most of the warming observed over the past 50 years is attributable to human activities.

2007

The fourth IPCC assessment states that warming of the climate system is unequivocal and most of the recent warming is very likely to be a result of human activity.

Source:

The United Kingdom Met Office  
[www.metoffice.gov.uk/climatechange/guide/timeline/](http://www.metoffice.gov.uk/climatechange/guide/timeline/)

## KEY REFERENCES

IPCC (2007) Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon, S; Qin, D; Manning, M; Chen, Z; Marquis, M; Averyt, KB; Tignor, M and Miller, HL (eds), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available from [www.ipcc.ch](http://www.ipcc.ch)

IPCC (2007) Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Parry, MKL; Canziani, OF; Palutikof, JP; van der Linden, PJ; and Hanson, CE (eds), Cambridge University Press, Cambridge, UK, 7-22. Available from [www.ipcc.ch](http://www.ipcc.ch)



**THIS IS ONE IN A SERIES OF CASE STUDIES CALLED  
CLIMATE CHANGE: A GUIDE FOR LAND MANAGERS THAT CAN BE  
FOUND AT [WWW.MAF.GOV.TZ/CLIMATE CHANGE](http://WWW.MAF.GOV.TZ/CLIMATE CHANGE)**

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