



Module 2 The impacts of climate change

INTRODUCTION

The impacts of climate change are already being felt. The emission of greenhouse gases by human activities is resulting in increased surface temperatures that are causing multiple and complex changes to the climate at both a global and regional scale.

When we think about climate change there are two important points to remember. Firstly, climate change affects both natural and human systems. The impacts that are felt will not only depend on how large

and rapid the change may be, but also on how vulnerable or adaptable the system is.

Secondly, predictions of warming are based on climate models, which can vary significantly. Global precipitation (rainfall and snow) for example, is expected to increase by between 1 and 9 per cent by 2100. Such differences make it more difficult to predict how serious and/or long lasting possible impacts may be, and how large an area will be affected.

TEMPERATURE

In 2007 the Intergovernmental Panel on Climate Change (IPCC), described in **Module 4**, released its latest report on climate change. It found that:

- in the last 100 years the earth has warmed by 0.74°C;
- eleven of the last twelve years (1995-2006) rank among the twelve warmest years since 1850; and
- there is a risk that by the end of the 21st Century temperatures could rise by between 1.1 and 6.4°C.

Climate models tend to show that the greatest warming will occur over inland areas of continents and in the northern hemisphere (because of the greater proportion of land mass). By contrast, less warming will occur over oceans and coastal zones. The least warming will occur over the Southern Ocean because of its large capacity to transport surface heat into deeper waters.

It is also expected that warmer conditions will occur along the coast of South America, so that El Nino conditions (which is associated with drought in Australia) may become more common. Because the Earth's climate system is so complex, warming could continue for centuries, even after greenhouse gas concentrations are stabilised.

Find out about **El Nino**.

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Increased global temperatures are already associated with a reduction in polar ice, melting of glaciers and thawing of permanently frozen ground in high latitudes (such as the Russian tundra).

At a regional or local scale, it is uncertain as to how much climate change will affect snowfall and the altitude of snowlines, which could likely affect winter sports like skiing.

Australian data indicates that the length of the snow season and the volume of snow is decreasing over time. On the other hand, warmer air can hold more moisture, so it is possible that in humid areas (such as the South Island of New Zealand), warming could be associated with increased snowfall.

Substances called **gas hydrates** (icelike solids in which gas molecules are trapped) are locked up in water within frozen ground. It is estimated that gas hydrates contain twice the total volume of carbon in existing coal, oil and gas deposits on Earth. Thawing of frozen ground due to global warming may destabilise these substances, which would release large volumes of methane back into the atmosphere, further enhancing the greenhouse effect.

RISING SEA LEVELS

The increase in ocean temperatures will not only melt polar ice and glaciers, it will also make the volume of water in oceans expand. Both of these processes contribute to rising sea levels. As waters rise, there is a greater risk of the edges of ice shelves and coastal glaciers collapsing into the sea, thereby causing further sea level rise.

Due to historically favourable climatic conditions, coastal zones throughout the world are densely populated. In Australia, 84 per cent of the population lives on the coast. Rising sea levels will place some of these people at risk, due not only to waterlogging and submergence of land, but also to damage by wave action and storm surges.

The environments most vulnerable to sea level rise are low-lying oceanic islands, particularly island atolls, and river deltas, such as the Ganges delta in Bangladesh. In these localities, rising sea levels are already causing groundwater levels to rise, and submergence during high tides are becoming more frequent. Concerns are now emerging that many island atolls will become uninhabitable, forcing migration of human populations and extinctions of island fauna and flora.



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EXTREME EVENTS

Changes in global temperatures will also lead to more frequent extreme climate events. It is anticipated that the number of very hot days will increase with fewer colder and frosty days. In addition, intense summer heat could result in more violent storms and tropical cyclones as the oceans warm and more energy is stored in our warming atmosphere. This could cause greater flooding, mud/land slides, and damage to buildings, roads and bridges.

By contrast, in the mid latitudes, particularly in inland regions, more frequent and prolonged drought could be associated with reduced water supply, lost productivity and possibly famine. In addition, drier conditions will cause more frequent and higher intensity bushfires.

A Case Study: Bushfires

Each December, as Australians begin their summer holidays, their television screens invariably begin to show pictures of bushfires threatening lives and property. In January and February, it is not uncommon to hear reports of fire fighters attempting to control many fires as resources criss-cross the country to assist those most in need.

The most recent and devastating of these episodes was the 2002-03 fire season. Over three million hectares of bushland and vegetation were destroyed across the country. In Canberra, the worst affected city, four people died, 501 houses were lost and over 160,000 hectares were burnt.

Recent projections indicate that climate change could raise the risk of fire in Australia. According to the CSIRO, climate change will increase the frequency of very high and extreme fire danger days by 4-25 per cent by 2020 and 15-70 per cent by 2050 across south-east Australia.



WATER QUANTITY & QUALITY

In Australia, the increased incidence of drought and reduced runoff will affect water supply to farmers, irrigators and cities. In a drying environment, water use by crops will increase, creating a greater demand for irrigation water. However, there will be less runoff filling storage dams so it will become increasingly difficult to meet those demands.

Under these conditions, water will become an increasingly precious resource. Water of high quality will be particularly valuable, since a decrease in the amount of water flowing through rivers and streams will affect the water quality. For example, the salt content (salinity) could increase.



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ECOSYSTEMS & BIODIVERSITY

Ecosystems throughout the world are already experiencing unprecedented pressures from human activities that make them increasingly vulnerable and less capable of adapting to ongoing changes, including climate change. In the next hundred years ecosystems will be exposed to the highest CO₂ concentrations for 650,000 years, and the highest global temperatures in 740,000 years. These conditions will reduce biodiversity (the number of plant and animal species present), and the function of most ecosystems.

An **ecosystem** is a complex community of animals, plants and micro-organisms which interact with the non-living environment (such as soil, rock and water). Ecosystems are essential to human wellbeing and to overall environmental health.

About 20-30 per cent of plant and animal species would be at risk of extinction if global temperatures rise 2-3°C above pre-industrial levels. In marine environments, sea water will be warmer and carry more dissolved CO₂ (making it more acidic) and hence more difficult for some species to live.

HUMAN HEALTH & WELLBEING

Human health, safety and living standards will be increasingly affected by climate change. There are likely to be more instances of heat-wave induced illness and death such as the 2003 summer heatwave in Europe that killed an estimated 35,000 people. Conversely, in the Northern Hemisphere there may be fewer deaths related to cold weather. Loss of life, injury and loss of infrastructure from natural disasters such as fire, flood, drought, landslides and storms could increase as well.

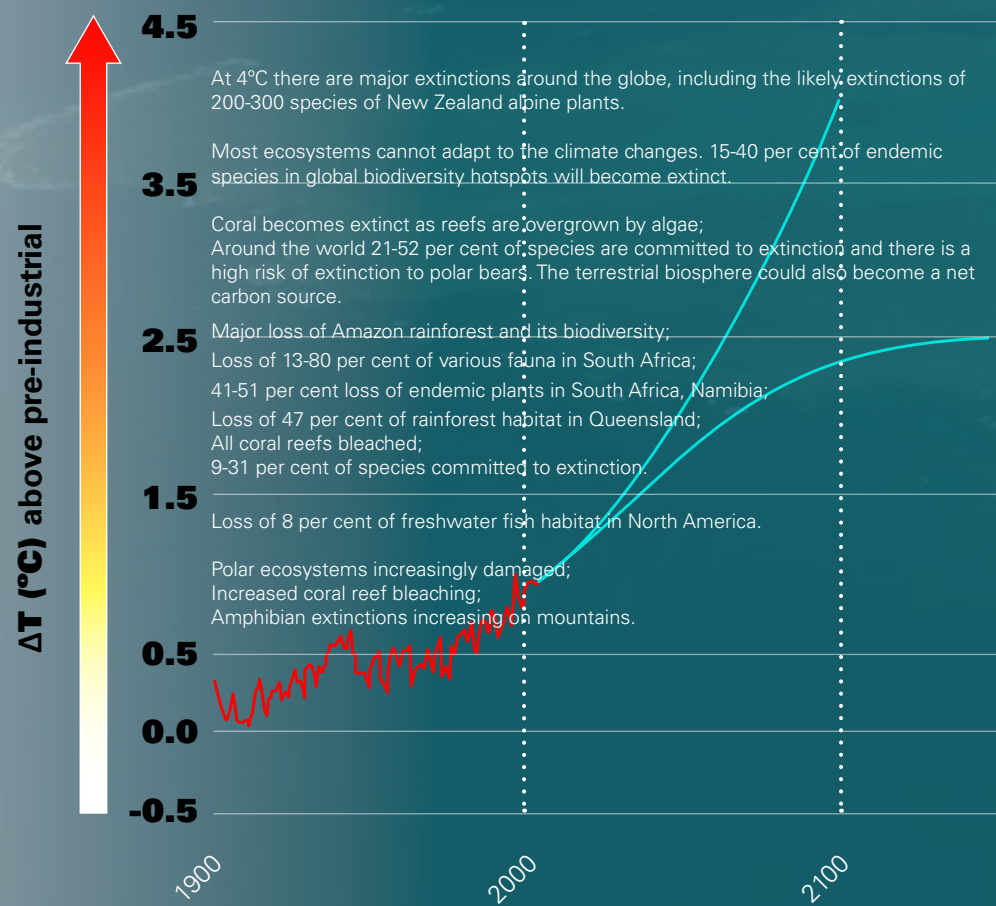
Secondly, sea level rise will be associated with increased risks of inundation, storm surges and the failure of sanitation systems. This can lead to loss of productive land, and associated food shortages, an increase in disease, and loss of fish nurseries (also an important food source).

Indirect, longer term impacts include a change in the incidence and distribution of infectious diseases, especially those that are transmitted through animals and insects that carry human disease. These include malaria, dengue fever and rabies. Where drier conditions develop, a higher incidence of respiratory disease associated with pollen and dust can be anticipated.

A word of caution relating to human health issues: while these impacts have been identified, there is little hard evidence to date of the effects of observed climate change on health.

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Figure 1 Impacts of climate change on ecosystems



As **Figure 1** shows, the projected impacts of climate change are many, and could be expressed either as rapid shifts or slow, progressive changes. Some of the changes may be manageable, particularly if greenhouse gas emissions stabilise, but others will be irreversible.

The **Great Barrier Reef** is a world heritage site located off the coast of Queensland. Home to a network of some 2,900 reefs, thousands of species and seagrass meadows, it is now under threat from climate change. For example, higher temperatures, and the number of extremely hot days (above 35°C) create the risk of coral bleaching leading to coral death. In addition, more severe tropical storms could physically damage sections of the reef. Any destruction of the reef is also likely to affect the thousands of people employed in tourism in and around the reef.





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STUDENT ACTIVITIES

Comprehension Questions

- Write in your own words how the impacts of climate change are likely to affect different parts of the world.
- What are the major risks from climate change for people living in low lying coastal areas?
- Evaluate one climate-related risk faced by Australia. For example, the risk of bushfires, droughts or storm surges. Identify what effect potential climate changes could have on this risk.

Analysis Questions

- How can human activities affect ecosystems? Explain your answer with reference to an ecosystem that is under threat from climate change.
- Consider an ecosystem in your own area. Describe the ecosystem in detail. What are the potential impacts on this ecosystem that might result if temperatures increased and rainfall decreased?

Exercises

Complete the table below to indicate the types of extreme events that may take place in response to climate change, and the impacts these events may have on plants, animals and humans.

Type of extreme event	Impacts on animals, plants and/or humans	
Increasing temperatures		
Increasing precipitation		
Decreasing precipitation		
Rising sea level		