
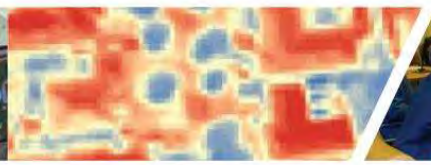


Your Council and Climate Change

UNDERSTANDING THE RISKS AND LEARNING TO ADAPT

Climate Change - Science and impacts

Training for Victorian councillors, supported by DELWP and developed in partnership with

RMIT UNIVERSITY Centre for Urban Research

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VICTORIA State Government

Key messages we will cover in this topic

The enhanced greenhouse effect

- Greenhouse gas emissions, mainly caused by burning fossil fuels, are causing climate change
- In Victoria coal and gas fired electricity is the largest source of these emissions

The climate is already changing

- The temperature has already risen globally and in Victoria
- We must act now to reduce emissions

The climate is expected to continue to change with more severe impacts

- Higher temperatures, urban heat island effect, increased fire danger
- Reduced overall rainfall, declining snowfalls. Increased rainfall intensity may increase the risk of flash flooding, and sea level rise may increase the risk of coastal inundation

Climate change is likely to impact us all in some way

- But some groups in your community will be particularly vulnerable to those impacts

In this first section, you'll learn about the science of climate change and what we expect in the future.

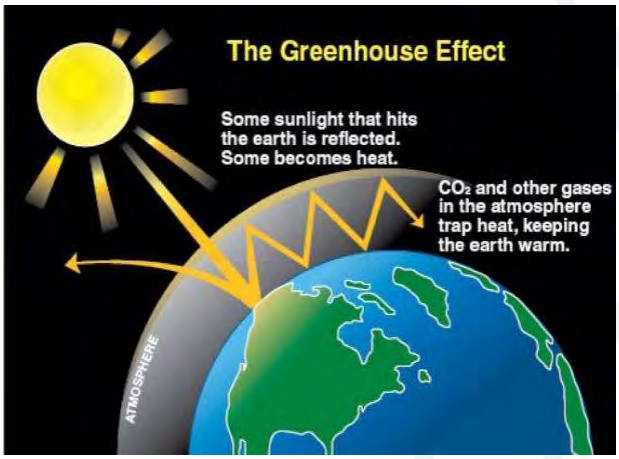
We will also identify the impacts of climate change on different communities in Victoria.

The enhanced greenhouse gas effect

The greenhouse effect is necessary for life on Earth

Increasing greenhouse gases from human activity are trapping more heat, causing temperatures to rise

The main greenhouse gas is carbon dioxide



The climate is changing because of the enhanced greenhouse effect.

Energy from the sun arrives in our atmosphere. Some of it is reflected back out to space, and the rest is absorbed by the land and the oceans, heating the Earth. Heat radiates from the Earth towards space, but some of it is trapped within our atmosphere by greenhouse gases.

While this process is necessary for life on Earth, increasing concentrations of greenhouse gases from human activity are trapping more and more heat from the sun in the atmosphere, causing the Earth's temperature to rise – this is the enhanced greenhouse effect.

The main greenhouse gas is carbon dioxide.

This greater concentration has mainly been caused by burning fossil fuels.

Fossil fuels and greenhouse gas emissions

CO_2 is produced when we burn fossil fuels

We burn fossil fuels for

- Electricity
- Heating
- Cooking
- Transport fuel

Carbon dioxide (CO_2) is produced when we burn fossil fuels.

Fossil fuels contain lots of carbon – they are "fossilised" carbon-based life forms.

When we burn a fossil fuel, the carbon combines with oxygen in the air to make carbon dioxide.

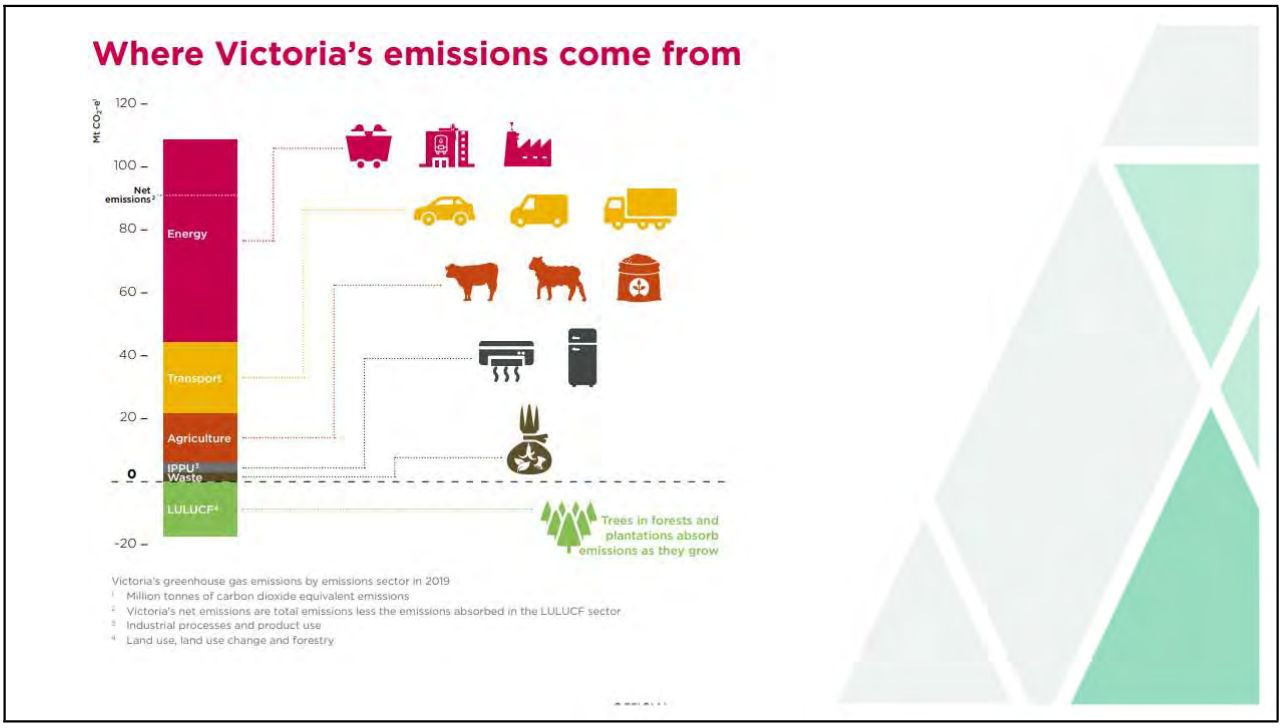
Since the beginning of the industrial revolution, about 260 years ago, people have been using new manufacturing processes which require more energy use.

We have been releasing massive quantities of carbon from its long-term storage in fossil fuels. This is not part of the Earth's natural carbon cycle.

We burn fossil fuels like coal and gas to create electricity. We use gas to heat our homes and cook, and petrol and diesel to fuel our transport.

There are other greenhouse gases such as methane. Methane, though occurring in much smaller amounts than CO_2, still plays a key role in climate change as it is much better at trapping heat in the atmosphere. Methane is produced by fossil fuel burning but is also produced from agriculture and decaying organic waste. Agriculture produced 13.5% of Victoria's emissions in 2017, mainly from methane.

Note: In Victoria, forests and natural systems absorbed around 19% of Victoria's emissions in 2019 (https://www.climatechange.vic.gov.au/victorias-greenhouse-gas-emissions) .

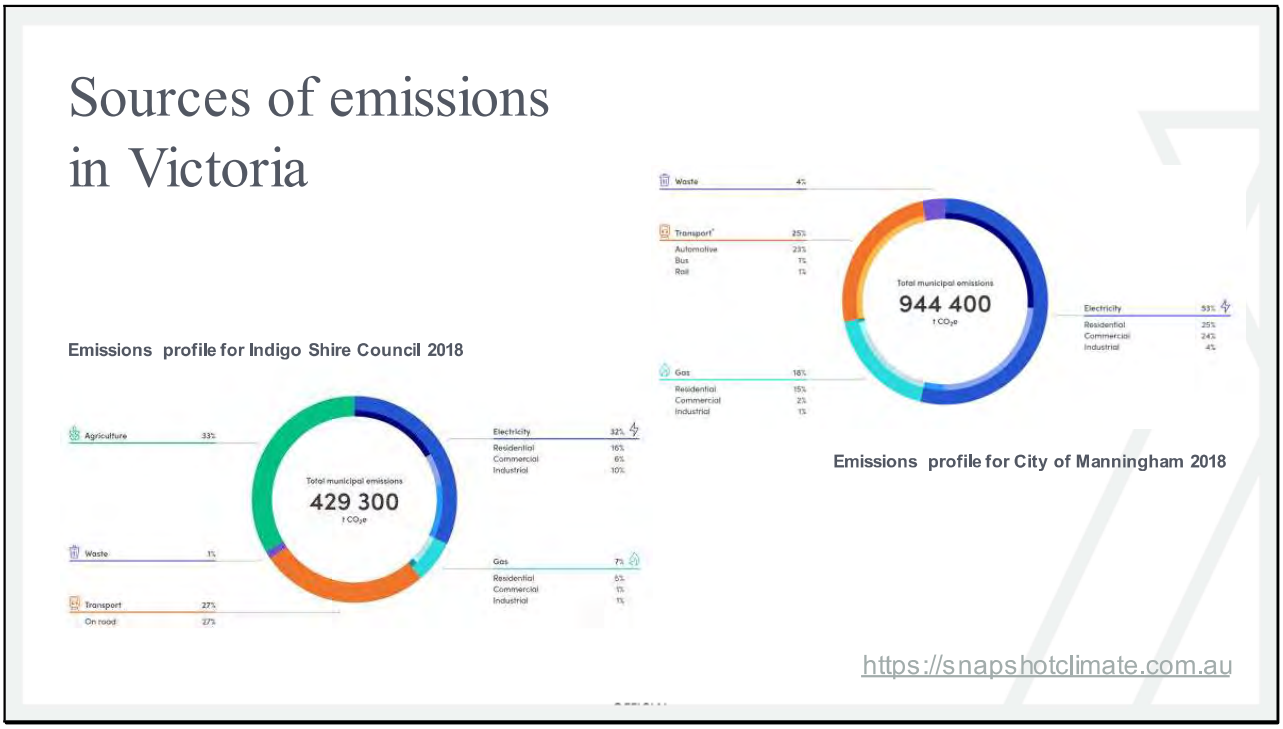


Victoria's net emissions were 91 million tonnes CO2-e in 2019.

Victoria's greenhouse gas emissions are generated by various activities across our economy. Although the energy sector is the largest source of emissions, opportunities exist to reduce emissions across other sectors too. We can also take carbon dioxide out of the atmosphere in the land use, land use change and forestry sector.

Whilst energy is the biggest emissions source in Victoria, transport is the fastest growing source of emissions.

Victoria's Climate Change Strategy (page 10, https://www.climatechange.vic.gov.au/victorias-climate-change-strategy/Victoria-Climate-Change-Strategy.pdf)



Here in Victoria, electricity use is the largest single source of emissions.

This can differ at a municipal level.

The example from the City of Manningham on the right shows that 42% of emissions are from electricity use. This is closely followed by transport emissions at 35% and then gas use at 20%.

This profile will differ depending on the municipality.

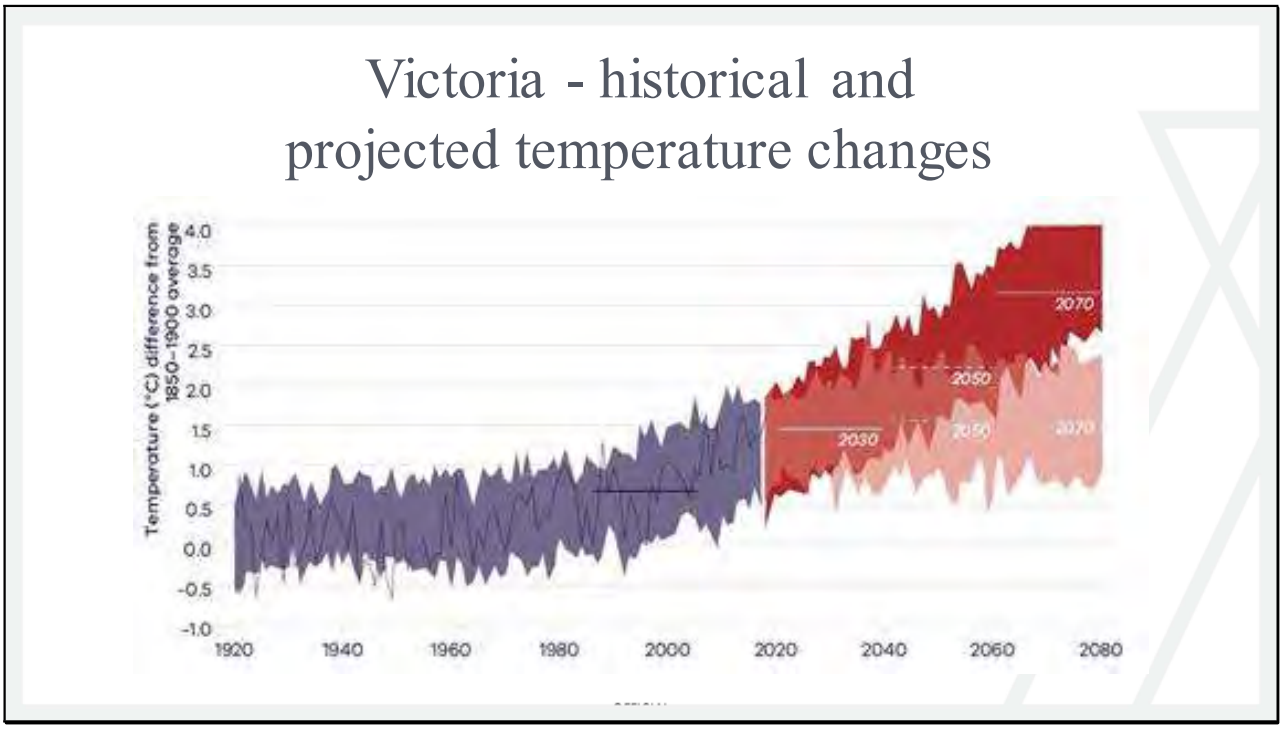
For example,

- If there is a lot of commercial and industrial activity in shire or city, the use of gas and electricity in these sectors might be higher than the residential proportion
- Transport emissions may be higher in areas with less public transport
- If an area has a landfill site, the emissions from waste will be much higher
- Regional areas will include a proportion of emissions due to agriculture

The example from Indigo Shire on the left shows this last point – the highest emissions are actually from agriculture, very closely followed by electricity.

All councils across Victoria can access their own emissions data for free through the Snapshot project that uses an internationally consistent methodology for calculating

these emissions. This tool estimates emissions at the local government authority scale using commonwealth emissions inventory data divided by population and potentially inventories also developed by councils themselves – *it is important to note this tool produces an estimate only*.



Using climate models, we can project future temperature changes being caused by the enhanced greenhouse effect.

This graph shows – in the purple shaded area – what modelling indicated the global temperature in Victoria to be over the 1920 – 2019 time period. The line through the middle is the actual observed temperature. This shows that our modelling is pretty good.

It also shows different scenarios depending on whether we continue to produce greenhouse gas emissions at a high or low level. The different shades of red represent different possible pathways with temperature ranges linked to those levels of emissions.

The dark red represents what may be the worst-case scenario in Victoria – a high emissions scenario with global temperatures rising by up to 2.4 degrees C by 2050 and up to 4 degrees Celsius by 2070.

If we do nothing to reduce emissions, we may follow this pathway.

If we reduce our emissions to keep the temperature rise lower – as per the light red area on the graph, we will still see some changes as the emissions we emitted in the past have "locked in" this degree of change. This is because emissions stay in the

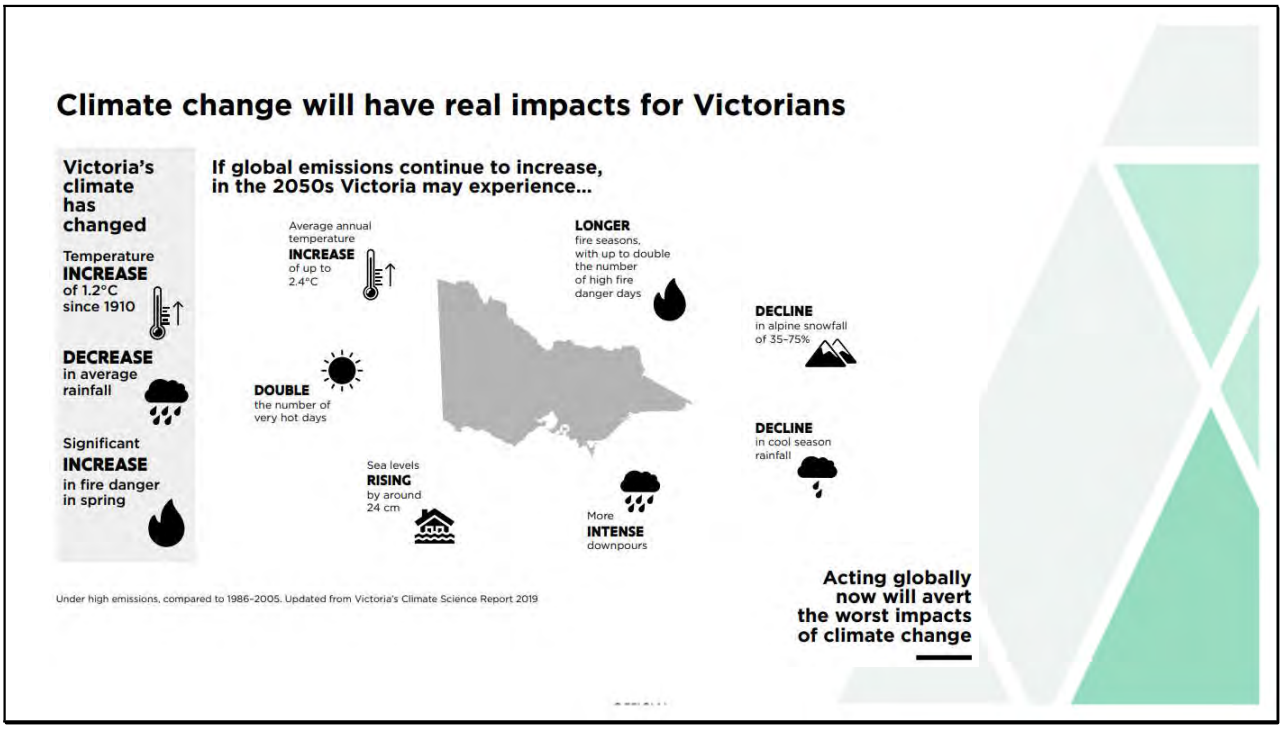
atmosphere.

Whichever pathway we take, we are tracking towards at least a 1.5 degree C rise by the 2030s here in Victoria.

Within each pathway, we need to consider regional contexts and policy impacts, and to plan in a way that considers multiple possible futures.

The science is clear.

We must also adapt to the changes which have already occurred in order to avoid harm.



Here in Victoria, we are already experiencing the impact of changing climate.

We have experienced a temperature increase of just over 1.2 degree Celsius since 1910. This is already having impacts

What does this temperature rise mean for us here in Victoria if we keep on a high emissions trajectory?

By **2050s** – less than 30 years from now - under high emissions (RCP8.5) the number of very hot days (over 35 or 40 degrees) may double. There will be higher temperatures for longer.

There will be a decline in cool season rainfall (April to October).

When it does rain, we will see more intense downpours, increasing the risk of flash flooding.

The fire season will be longer with up to double the current number of high fire danger days.

Sea levels will rise by about 24 centimetres, on average.

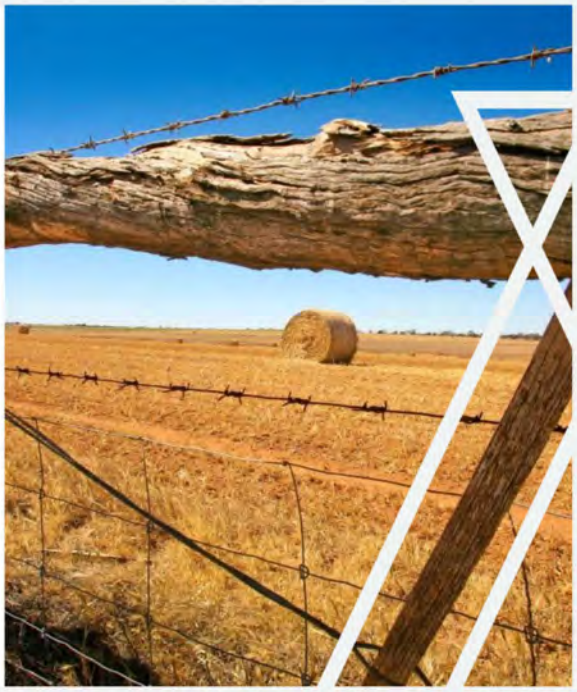
Alpine snowfall will decline by up to 75 per cent.

Diagram from *Victoria's Climate Change Strategy* accessed May 2021 at https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0025/522169/Victoria-Climate-Change-Strategy-Accessible.pdf

Higher temperatures

Under high emissions, Victoria can expect:

- Double very hot days by 2050s, e.g. around 16 days above 35°C in Melbourne and 4 heatwaves per year.



By the 2050s, if the current rate of global warming continues, Victorian towns and cities could experience around double the number of very hot days each year compared to a 1986-2005 average, very hot days being those that have a maximum temperature greater than 35°C, 38°C or 40°C depending on what the average temperatures usually are in your area of Victoria.

By the 2090s, average annual temperatures could be between 2.8 and 4.3 degrees warmer.

We will also see increases in extreme temperatures.

Extreme heat costs the Victorian economy on average $87 million a year (DELWP 2019). It has serious implications for health and wellbeing.

Rural areas are more economically vulnerable to heatwaves, with almost half of total economic impacts incurred by the agriculture sector.
(DELWP (2019), *The economic impact of heatwaves,* Victorian Government.)

In northeastern Victoria, hot days can damage fruit and a lack of cool days at certain times can impact fruit quality and yield. The summer temperatures in this region is expected to extend from a 3-month period to over 4 and half months by 2050. (North East Catchment Management Authority Regional Climate Explorer Tool, data for

Wangaratta, extracted 23.12.20, available at: https://necma.spatialvision.com.au/climateexplorer/)

More than 7 million dollars is already lost from the Mallee Gross Regional Product each year due to heatwave. The expected annual cost to Victoria of heatwaves event is $179 million. (DELWP (2019), *The economic impact of heatwaves,* Victorian Government.)

More people died from the heatwave preceding the Black Saturday weekend, than of the fires. (Australian Bureau of Statistics. (2015, November). *Feature Article: The Exceptional Heatwave of January-February 2009 in South-Eastern Australia* (No. 1301.0). https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1301.0Chapter1042009%E2%80%9310)

Urban heat island effect

Thermal mapping, Wyndham City Council

You may have heard of the "urban heat island effect."

Built up areas like cities can get hotter and stay hotter than surrounding areas.

This is due to a number of factors:

- Firstly, cities have a high percentage of solid surfaces such as asphalt and concrete – these absorb, trap and re-radiate heat. They also prevent rainwater soaking into the soil.
- Secondly, cities have limited vegetation. Plants would have provided shading and cooling through evaporation from leaves
- Denser urban environments trap heat
- Construction materials – such as terracotta tiles, bricks, bitumen and concrete – absorb, trap and re-radiate heat
- Heat is producted by human activities – such as cars and air conditioners
- Lastly, air pollution creates a local 'greenhouse' effect, trapping heat.

This urban heat can have detrimental impacts on health and air quality.[1]

Recent research into urban heat across Greater Melbourne showed that the metro councils had an average summer Urban Heat Island reading of more than 7°C hotter than non-urban areas. The only exceptions were Mornington Peninsula, Yarra Ranges and Nillumbik.[2]

On the slide, you can see thermal image mapping from Wyndham. This shows the cooling effect of the street trees (in blue) against the heat of buildings (in red).

Moreland City Council has produced an Urban Heat Island effect action plan.[3] Vulnerabilities they will focus on include:

- Hotspots – locations with surface temperatures of 52 degrees or above on extreme heat days
- Social vulnerability – young children aged 0-4, older people living alone, socio-economically disadvantaged groups, those who aren't fluent in English and those living in social housing
- Areas of high human activity such as commercial and retail areas, neighbourhood activity centres, bike paths, schools, kindergartens and childcare facilities
- Future zoning and population growth changes.

References

1. Moreland City Council (2016) *Moreland Urban Heat Island Effect Action Plan,* accessed 14.12.20, available at: https://www.moreland.vic.gov.au/globalassets/areas/esd/esd-uhie-urban-heat-island-effect---action-plan---final-draft-for-council-june-2016.pdf
2. Sun C, Hurley J, Amati M, Arundel J, Saunders A, Boruff B, Caccetta P (2019) *Urban Vegetation, Urban Heat Islands and Heat Vulnerability Assessment in Melbourne, 2018*. Clean Air and Urban Landscapes Hub, Melbourne, Australia
3. Moreland City Council (2016) *Moreland Urban Heat Island Effect Action Plan,* accessed 14.12.20, available at: https://www.moreland.vic.gov.au/globalassets/areas/esd/esd-uhie-urban-heat-island-effect---action-plan---final-draft-for-council-june-2016.pdf

Changes in rainfall

Under a high emissions scenario, Victorian can expect:

- Drier in all seasons except summer
- Increase in rainfall intensity > potential increase in flash flooding

Victoria is likely to continue to get drier in the long term in all seasons except summer.

This is due to changes in global wind and ocean movements.

Declining rainfall will have a higher impact certain industries such as dairy farmers, who are reliant on irrigation.

While overall rainfall will decline, when it does rain there is an increased risk of more intense rainfall and flash flooding.

We are already experiencing extreme rainstorms causing severe local impacts.

In February 2020, extreme precipitation across Melbourne, the La Trobe Valley and East Gippsland resulted in 388 calls to the State Emergency Service in just six hours - for flooding, building damage and fallen trees.

The warmer the atmosphere, the more water vapour it can hold, and basic physics enables scientists to estimate that the intensity of extreme rainfall may increase by about 7% for each degree of warming.

Changes in atmospheric dynamics are also likely to cause heavier rainfall events when the conditions are right (Wasko et al., 2016). For example, extreme rainfall events have been

associated with the combination of thunderstorms with other weather systems over Victoria (Dowdy and Catto, 2017). Together with a warmer atmosphere, this means that an increase of 14% has been observed in the most extreme short-duration rainfall extremes in Victoria (Guerreiro et al., 2018). From page 26 Victoria's Climate Science Report 2019 (DELWP 2019).

The future will see increasing risks to safe reliable water supplies due to a decline in cool season rainfall when water storage receives most inflows.

Increased fire danger

Under a high emissions scenario Victoria can expect:

- Extended fire season
- Up to double the number of high fire danger days by the 2050s

The number of very high fire danger days in spring has already increased.

Victoria is likely to have a longer fire season and the number of very high fire danger days is likely to increase. Heat and drought exacerbate bushfires.

By the 2050s under a high emissions scenario, there will be a 60 per cent increase in the number of high fire danger days in Bendigo, Ballarat and Shepparton compared to 1986–2005.

In the 2019/20 bushfire season alone:

- 65,000 people were displaced from their homes between July 2019 and February 2020.
- 3,100 homes were destroyed. This could mean longer-term displacement for over 8,000 people.
- People who had to leave their homes have faced impacts to their livelihoods, education, security, health and mental wellbeing.
- Nearly three billion animals – mammals, reptiles, birds, and frogs – were killed or displaced. (Commonwealth of Australia (2020) *Royal Commission into National Natural Disaster Arrangements: Report.)*

The indirect effects of bushfires are felt by those not in bushfire areas. Canberra experienced the worst air quality of any major city in the world in January 2020, and other Australian capital cities experienced poor air quality from bushfire smoke kilometres away.

Bushfires can also impact water quality.

Former fire fighter and emergency leaders from around the country have been warning that the worsening bushfire conditions have been aggravated by climate change.

Sea level rise

Under a high emissions scenario Victorian can expect:

- Sea levels to continue to rise by up to half a metre by the 2070s, with new research suggesting even greater changes beyond 2100.
- More than 75 per cent of coastal reserve land will see a 20 cm rise in sea level

Rising sea levels result in an increased risk of coastal erosion and inundation – threatening coastal ecosystems, local landscapes and crucial infrastructure.

Sea levels will rise in Victoria and extreme sea levels from storm surge events will also impact the coast (DELWP 2019 – Victoria's Climate Science Report 2019).

Sea level rise not only results in changes in mean sea level but can also change the frequency and intensity of extreme sea level events, such as storm tides that occur when high tides combine with strong winds and low-pressure systems. Even a 50 cm increase in mean sea level would contribute to a significant increase the hazards of extreme sea levels, such as coastal erosion and flooding.

For example, a 1-in-100-year storm tide height in Geelong is likely to rise from 110 cm to 220 cm by the end of the century for a high emissions scenario (McInnes et al., 2013).

Coupled with erosion and population growth, we will see increasing pressure on our coasts. This is known as 'coastal squeeze'.
(Association of Bayside Municipalities (ABM) (2017) *Bay Blueprint 2070*, ABM).

Almost all coastal reserves with high biodiversity values and those with high recreation and tourism values are predicted to be impacted.

Of the coastal reserves with community facilities such as club houses, surf lifesaving facilities and tourist sites, 88 per cent may be impacted by 2040. (Victorian Environmental Assessment Council (2020), *Assessment of Victoria's Coastal Reserves: Final Report,* Victorian Environmental Assessment Council, Melbourne.)

Declining snowfall

Victorian alpine areas are projected to continue to experience declining snowfall – between 35 and 75% by the 2050s under a high emissions scenario

Declining snowfall will have implications for alpine biodiversity and animals already under threat – this includes the Mountain Pygmy Possum, Baw Baw Frogs and the Powerful Owl.

Less snow will impacts on the tourism industry. Visitor numbers may decline.

(Slide reference: Harris, R. M. B., Remenyi, T. & Bindoff, N. L. 2016. The Potential Impacts of Climate Change on Victorian Alpine Resorts. A Report to the Alpine Resorts Co-ordinating Council. Hobart, Australia: Antarctic Climate and Ecosystems Cooperative Research Centre.)

Vulnerability to impacts

- Natural environment
- Built environment and infrastructure
- People
  - Older and younger people
  - Culturally and linguistically diverse communities
  - New arrivals
  - People with mental and physical health issues
  - Housing insecurity
- Industry
  - Small and medium-sized enterprises
  - Agriculture
  - Outdoor workers

Everyone is impacted by climate-related hazards, but some groups are more vulnerable to the effects of **extreme** heat than others. This includes babies, very young children and older people. (DHHS (2019) *Heat health plan for Victoria: Protecting health and reducing harm from extreme heat,* Victorian Government, Melbourne)

Community members who speak a language other than English might not be able to access emergency communications and receive risk warnings during extreme events. Refugees may be more likely to be in poor quality housing and/or have low socioeconomic status. These factors contribute to vulnerability to climate change.

Certain physical health conditions make people more vulnerable to **extreme** heat. Climatic events can also be difficult for those with mental health issues who may be vulnerable to rapid, unplanned changes such as emergency events.

People in insecure housing and those sleeping rough or in temporary shelters are more vulnerable in emergency situations. They also may not be factored into emergency plans and communications. (Sevoyan, Arusyak & Hugo, Graeme & Feist, & Tan, George & McDougall, & Spoehr,. (2013). *Impact of Climate Change on Disadvantaged Groups: Issues and Interventions.* NCCARF)

Workers across many sectors may be affected. Small and medium enterprises are

likely to be disproportionately impacted by climate change. (DELWP (2016), *Victoria's Climate Change Adaptation Plan 2017-2020,* Victorian Government, Melbourne.)

With few staff and smaller margins, they may be less able to deal with significant losses caused by extreme events and emergencies.

The health and safety of people working outdoors during **extreme** heat and other extreme weather events is a consideration.

Climate change will also place pressure on the agricultural sector, which is particularly vulnerable to extreme weather events.
(DELWP (2019), *The economic impact of heatwaves,* Victorian Government.)

Our built environment – our buildings, roads and infrastructure is affected by climate hazards. Electricity infrastructure can be damaged by extreme events, resulting in electricity supply being cut off. Concrete erosion is exacerbated by extreme heat.
(IPWEA (2018), Climate Change Impacts on the Useful Life of Infrastructure, Practice Note 12.1, IPWEA.)

How we respond

Mitigating climate change

To avoid the worst effects of climate change, the international Paris Agreement aims to limit the rise in global average temperature to between 1.5 and 2 degrees Celsius.

To help achieve this goal, Victoria – along with many governments around the world – is committed to net-zero emissions by 2050.[2]

We need to urgently cut emissions – also known as **mitigating climate change** - and support our communities to do so too.

Adapting to climate change

Emissions to date mean some effects of climate change are 'locked in'.

Therefore, we also need to plan, prepare for and respond to the impacts of climate change. This is known as **adapting to climate change.**[1]

1. Victoria's Climate Science Report 2019 https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0029/442964/Victorias-Climate-Science-Report-2019.pdf
2. Victoria's Climate Change Strategy 2021 https://www.climatechange.vic.gov.au/victorias-climate-change-strategy/Victoria-Climate-Change-Strategy.pdf

Key messages

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