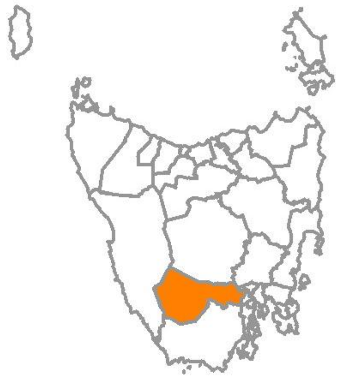
Local climate profile
Derwent Valley Municipality



Past and current climate:

- The Derwent Valley municipality is an inland region stretching from the mountainous and wet western area around Lake Pedder to the drier southeast region near Hobart. As such, it has a large gradient of prevailing temperature and rainfall local climates. The inland and higher altitude areas experiences cold temperatures and frosts.
- The municipality has a large east-west gradient of rainfall. The western end of the municipality around Strathgordon receives over 2500 mm average annual rainfall with a strong seasonal cycle (110 mm in February, 291 mm in August), brought mainly from frontal rain systems coming from the west. The eastern part of the municipality receives 500-700 mm average annual rainfall with no significant seasonal cycle (around 50 mm rainfall each month) from a variety of weather systems.
- The influence of large-scale rainfall drivers on year-to-year rainfall variability also differs across the municipality. The El Niño Southern Oscillation has an influence on the eastern part of the municipality, especially in winter. Rainfall in the west is correlated with drivers that influence the westerly systems that bring rain: the Southern Annular Mode in most seasons and with the incidence of atmospheric blocking in autumn.
- Long-term average temperatures have risen in the decades since the 1950s, at a rate similar to the rest of Tasmania (up to 0.1 °C per decade). Daily minimum temperatures have risen slightly more than daily maximum temperatures.
- There has been a decline in average rainfall and a lack of very wet years in the municipality since the mid 1970s, and this decline has been strongest in autumn. This decline was exacerbated by the 'big dry' drought of 1995-2009. Rainfall since the end of the drought has been about average.

Future scenarios - from the Climate Futures for Tasmania project

Fine-scale model projections of Tasmanian climate were made for two hypothetical but plausible scenarios of human emissions for the 21st Century (taken from the special report on emissions scenarios (SRES) from the Intergovernmental Panel on Climate Change (IPCC)). The scenarios are of ongoing high emissions, A2, and one where emissions plateau and fall, B1. The climate response under the two scenarios is similar through the first half of the century, but the changes under the higher emissions scenario become much stronger than the lower scenario in the later half of the 21st Century.

1. Temperature

- Under the higher emissions scenario (A2), the municipality is projected to experience a rise in average temperatures of 2.6 to 3.3 °C over the entire 21st Century. The rise in daily minimum temperature is expected to be slightly greater than daily maximum temperature, and fairly similar in the different seasons. Under the lower emissions scenario (B1), the projected change over the entire century is 1.3 to 2.0 °C.

Produced by Michael Grose, Antarctic Climate and Ecosystems Cooperative Research Centre,
using material from the technical reports of the Climate Futures for Tasmania project

- A time series of projected mean Tasmanian temperature is shown in Figure 1.
- The projected change in average temperatures is similar to the rest of Tasmania, but less than the global average and significantly less than northern Australia and many regions around the world, especially the large northern hemisphere continents and the Arctic.

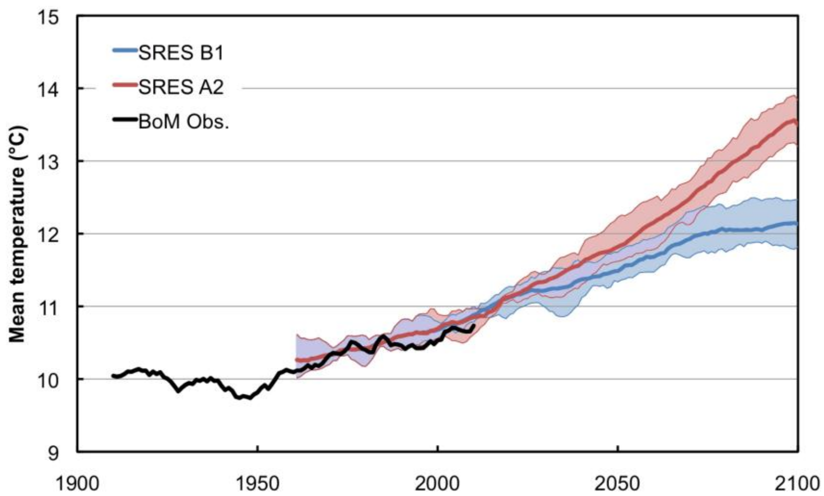


Figure 1. Tasmanian average temperature in observations (black) and model projections for the A2 scenario (red) and the B1 scenario (blue). All series are smoothed (11-year running average), shading shows the range of model projections. Changes under the higher scenario by the very end of the century are discussed in the examples below

- The projected change in average temperature is accompanied by a change in the frequency, intensity and duration of hot and cold extremes of temperature. For the A2 scenario by the end of the century:
  - The number of Summer Days (>25 °C) increases from around 14 to more than 30 days per year at Strathgordon, a similar increase is indicated for New Norfolk.
  - The temperature of very hot days changes more than the change in average temperature (by more than 3 °C in some seasons).
  - The number of frost-risk days reduces considerably from over 15 days per year to less than 3 at Strathgordon.
  - Warm spells (days in a row where temperatures are in the top 5% of baseline levels) that currently last about five days, are projected to last up to five days longer.

2. Rainfall, runoff and rivers

- The projected pattern of change to rainfall and runoff is similar in nature between the two scenarios, but stronger by the end of the century under the A2 scenario. The model projections indicate that the general long-term influence of climate warming by the end of the century is for no change in average annual rainfall in the Derwent Valley municipality as a whole, but increases and decreases at some locations and in some seasons.

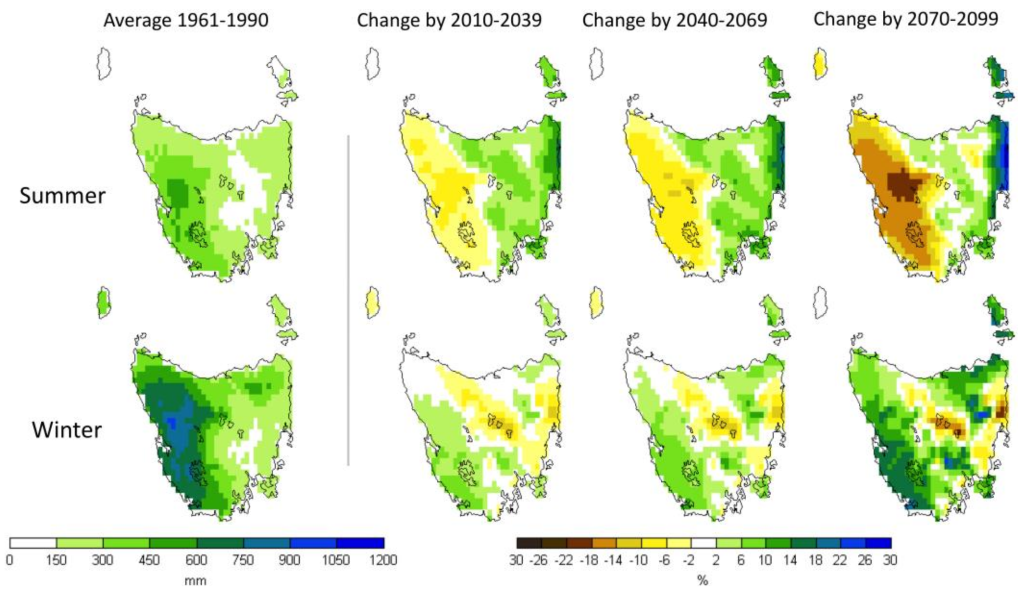


Figure 2. Average rainfall in summer and winter – the left hand side plots show the average rainfall in the baseline period (1961-1990), the plots to the right show the proportional change (%) from that amount in various periods in the 21st century in the average of six climate model projections under the A2 (higher) emissions scenario

- Rainfall is projected to remain within historical ranges on an annual basis, but with a decrease in summer and autumn rainfall and autumn of up to 15% in the western part of the municipality, and increases in winter rainfall of 5 to 15% across the municipality.
- The projected decrease in rainfall in summer and autumn and the increase in winter rain in the west is linked to changes in the westerly circulation that brings frontal rain systems.
- The long-term effect of greenhouse warming is on top of the usual cycles of rainfall, including droughts, termed 'natural variability'. The model projections indicate that the recent dry conditions of the 'big dry' drought is not a new ongoing climate average state. These projections indicate that in the long term, drought frequency and severity may stay similar what was experienced in the twentieth century.
- A major influence of greenhouse warming on rainfall is the tendency for heavier rainfalls interspersed by longer dry periods, and for greater extremes. However, this effect is not as strong in this area as it is in some other places. Under the A2 scenario by the end of the century in the Derwent Valley:
    - The average amount of rain per rain day stays about the same at Strathgordon but increases at New Norfolk.

    - The average number of rain days decreases by more than 3 days per year at Strathgordon and by up to 9 days per year at New Norfolk.
    - Rainfall on the wettest day of the year increases by around 15% across the municipality, and the peak instantaneous rainfall rate is likely to increase by even more (up to 30%).
    - Rainfall brought by rare extreme events increases: a 200-year average recurrence interval (ARI) event at Strathgordon increases by around 35 mm (35 % increase), and by a similar proportion at New Norfolk. More common ARI events (ARI-10, ARI-50) increase by a similar proportion as well.
- Pan evaporation is likely to increase, by up to 19% under the A2 scenario by the end of the century, driven by the increases in temperature but also changes to relative humidity, wind speeds, cloudiness and radiation.
- Changes to rainfall and evaporation lead to changes in water runoff and river flows. This in turn has impacts on the inflows into dams and water storages. Under the A2 scenario by the end of the century:
    - Average runoff decreases in the highest altitude areas in all seasons, by more than 20% in some seasons.
    - Proportional (%) increases in runoff are larger than the equivalent change to rainfall, changes in rainfall of 5-15% lead to changes in runoff of over 25% in some locations in some seasons.
    - Along with average runoff, runoff amounts during low events are also likely to decrease in the western area around Strathgordon. These projections indicate that runoff during high events may stay about the same or increase slightly.
    - Flows in the Derwent River are expected to increase by the end of the century, by an average of around 10%. It is not clear whether flows in the Florentine River may increase or decrease, but are expected to stay within 15% of historical levels.
    - Levels in Australia's largest lake, Lake Pedder/Gordon are managed by Hydro Tasmania, and these projections are being used to help them plan for the future. Inflows to all Hydro storages are projected to decrease on average into the future, but at a slower rate than in the recent past.

3. Agricultural impacts

- The regime of frosts, chilling conditions and the heat energy available to grow crops are projected to change considerably under the high emissions scenario by the end of the century.
- Conditions to grow wine grapes are likely to change markedly, which will affect farming practices. Vineyards around Glenora currently experience less than 800 annual BEGDD (a measure of heating for crop growth and development). Under the A2 scenario, this is likely to change to around 1000 BEGDD in the coming decades, and around 1300 BEGDD in the last decades of the century. These changes would affect the choice of grape variety, bring the ideal harvest date forward in the year and affect the grape quality. As well as temperature, other climate changes are likely to impact upon the wine industry, including heavy rain events.

4. Extreme sea level events

High water events causing coastal inundation comes from a combination of sea level, tide, storm surge and wind waves. Sea level has been rising at a rate of 3.3 ±0.4 mm/year in the recent period, and are expected to continue rising with further climate warming. The upper range of model projections indicates a rise of up to 0.82 m global average sea level by 2100 under a high emissions scenario. The sea level rise varies in different locations, and for Tasmania the sea level rise for this scenario is close to the global average.

In the east and southeast coasts of Tasmania, the very high tide height and the coastal surge contribute a roughly equal amount to high sea level events – the current 100-year storm tide event is around 0.9 to 1.4 m above average sea level. High storm heights in the southeast are generally brought by westerly cold frontal systems with a low-pressure system to the south of Tasmania. Changes to storm surges by the end of the century will not be as large as sea level rise. Accounting for all effects, the current 100-year event in Hobart is projected to be 1.87 m in 2090 under the high emissions scenario. This means that the current 100-year event would be approximately a 50-year event by 2030, and a 2 to 6-year event by 2090 under this scenario. This change in high sea level will affect the estuary of the Derwent up to New Norfolk. Together with high river flows, high sea level events contribute to flooding in this area.

5. River floods – Derwent River

Changes to design flood hydrographs were calculated for the 1:10, 1:50, 1:100 and 1:200 annual exceedance probability events for future periods using the climate model outputs and flood hydraulic models by partners at Entura consulting. Short duration events are projected to become more intense, so catchments with critical durations of less than 72 hours are projected to experience higher flood levels and faster flow responses. However, the Derwent River has a critical duration of more than 72 hours, so is not projected to see any significant increase in peak discharge, or in flood inundation caused by larger rain events for the Derwent River. However, sea level rise is expected to significantly influence inundation events in the estuary of the Derwent up to New Norfolk (see above point).

Appendix – details of climate projections

Greenhouse gas emissions have an influence on the Earth's climate system, along with other human activities such as the emission of ozone-depleting substances, emission of aerosol (particles) and changing the land cover (e.g. deforestation). Sophisticated model simulations can be used to project the likely effect of these influences into the future given our current state of knowledge. It is impossible to predict exactly what future human emissions will be, so models are run under a set of plausible hypothetical emissions scenarios. A model simulation shows the likely effect if we follow that scenario, so it is not a single 'prediction' of the future. The simulation can't include the effect of things that are impossible to predict (such as major volcanic eruptions).

The Climate Futures for Tasmania project produced a set of climate projections at the regional scale for Tasmania. Two emissions scenarios were considered – one of ongoing high emissions (SRES A2), and one where emissions plateau and fall (SRES B1). The climate response under the two scenarios is similar through the first half of the century, but the changes under the higher emissions scenario become much stronger than the lower scenario in the latter half of the 21st Century.

Climate warming causes many complex changes to the earth's climate system. These changes include alterations to ocean currents, average atmospheric circulation and ocean-atmosphere cycles such as the El Niño Southern Oscillation. Projected effects that are relevant to Tasmania include a continued extension of the East Australia Current bringing warmer waters off the east and northeast coast of Tasmania, a pole-ward shift of the subtropical ridge of high pressure and shifts in the mid-latitude westerlies (the 'Roaring 40s'), and a change in remote climate drivers such as atmospheric blocking, the El Niño Southern Oscillation and the Southern Annular Mode. The position of Tasmania adjacent to the Southern Ocean means that the effect of climate warming is not as severe as other more continental regions.

The results presented in this report were made using established methods, including:

- Extreme value distribution fitting in a generalized Pareto distribution to calculate the average recurrence intervals (ARIs).
- Hydrology runoff models developed and calibrated for the Tasmanian Sustainable Yields project to estimate the runoff, river flows and inflows to storages.
- Standard agricultural indices such as the Utah model to calculate chill hours and standard equations and a 10 °C threshold to calculate Growing Degree Days.

All information is drawn from the Climate Futures for Tasmania Technical reports please see these reports for more details, and to cite in other written work.

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Tasmanian Government

LGAT Local Government Association Tasmania

Derwent Valley Council