Local climate profile
Tasman Municipality

Past and current climate:

- The Tasman peninsula has a temperate, maritime climate with smaller daily and annual temperature ranges than continental regions.
- The municipality receives an average of around 900 mm of rainfall a year with a weak seasonal cycle (minimum in February, maximum in June). Rainfall can come from westerly cold fronts, but a large proportion of the rainfall comes from easterly and northeasterly systems such as cutoff lows.
- Year-to-year rainfall variability in this municipality shows some correlation with the El Niño Southern Oscillation in winter and spring (where La Niña winters are generally wetter than average, El Niño years are generally drier than average), and some correlation to atmospheric blocking in spring and summer (blocking affects the incidence of easterly systems).
- 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. The recent two years have seen average or slightly below average conditions.

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 change over the entire century is projected to be 1.3 to 2.0 °C. A time series of projected mean Tasmanian mean temperature is shown in Fig 1.

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

- 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.

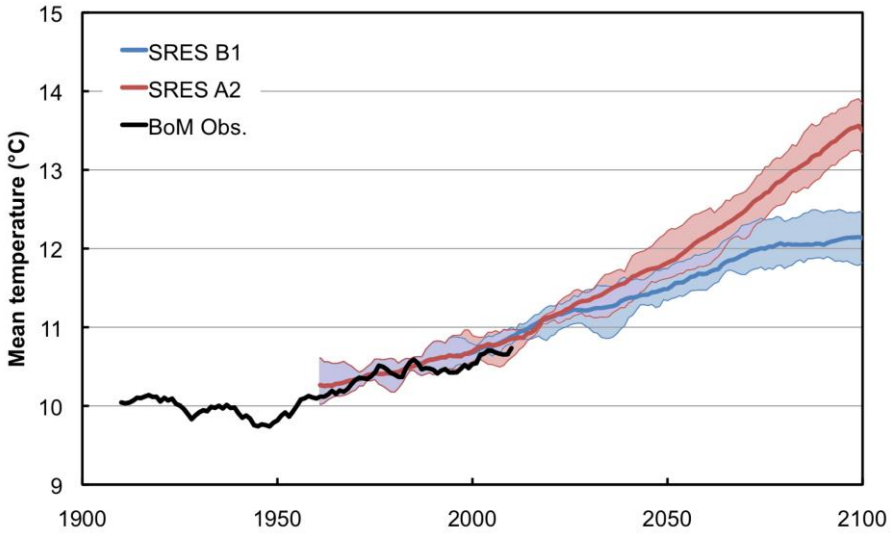

Figure 1. Tasmanian average temperature in observations (black) and model projections for the A2 scenario (red) and the B1 scenario (blue), all series are smoothed (11-year running average), shading shows the range of model projections. Changes under the higher scenario by the very end of the century 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 Tasman Peninsula under the A2 (higher) scenario by the end of the century the projections indicate:
    - The number of Summer Days (>25 °C) almost doubles from 10-20 days, to around 35 days.
    - An increase in the temperature of very hot days by more than the increase in average temperature in winter and spring (hot days may be >3.5 °C hotter than baseline conditions).
    - Frost-risk days become rare.
    - An increase in the length of warm spells (days in a row where temperatures are in the top 5% of baseline levels) from 4-5 days, to 7-11 days. Heat waves may occur (>3 days exceeding 28 °C).
    - The temperature of cold nights also rises by more than the average (>3 °C), and the region may even experience some tropical nights (>20 °C min. temperature).
- Sea temperatures directly offshore of the Tasman Peninsula are projected to keep rising as the East Australia Current continues to strengthen and move further south. This effect is strongest in autumn and winter, and the change is more than the global average temperature change (>3.5 °C).

2. Rainfall, runoff and rivers

- The climate response 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 general long-term influence of climate warming by the end of the century is for increased annual rainfall in the Tasman municipality.

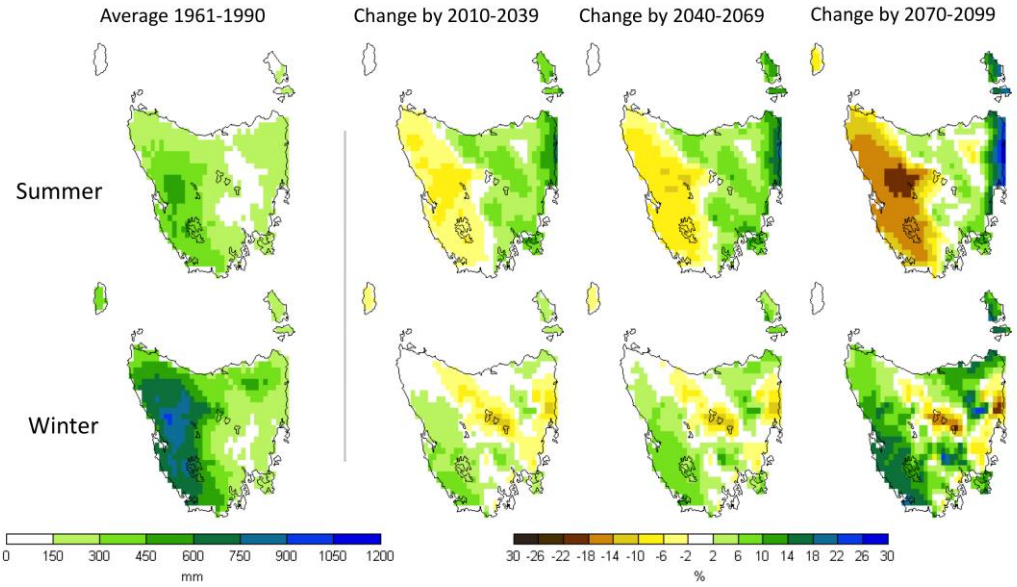

Figure 2. Average rainfall in summer and winter – the left hand side plots show the average rainfall in the baseline period (1961-1990), the plots to the right show the proportional change (%) from that amount in various periods in the 21st century in the average of six climate model projections under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

- By the end of the century, rainfall is projected to increase in all seasons (by 0-18%).
- The projected increase in annual rainfall is primarily driven by increasing sea temperatures offshore, changes to atmospheric circulation and the incidence of the synoptic systems that bring rainfall.
- 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 on the Tasman Peninsula may actually decrease due to the higher average rainfall.
- A major influence of greenhouse warming on rainfall is the tendency for heavier rainfalls interspersed by longer dry periods, and for greater extremes. For the Tasman peninsula under the A2 scenario by the end of the century there is projected to be:
    - Up to 7 less rain days per year, and an increase in the average rainfall per rain day of up to 1.3 mm/day.
    - Up to 5 more very wet days per year (rain days exceeding current 95th percentile), and 2 more days each year where rainfall exceeds 10 mm.

  - An average of 20 mm more rainfall on the wettest day of the year (30% increase), a similar increase for the wettest 5-day run of wet days.
  - An increase in the rainfall brought by rare extreme events: a 200-year average recurrence interval (ARI) event increases by up to 70%. More common ARI events (ARI-10, ARI-50) increase by a similar proportion.

- Pan evaporation is projected 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 is projected to increase steadily in all seasons through the latter half of the century.
  - Proportional (%) increases in runoff are larger than the change to rainfall, so average runoff changes may be over 60% in some areas in some seasons.
  - High daily runoff amounts are projected to increase, including those that may lead to erosion or flooding, low daily runoff amounts are projected to stay much the same.

3. Agricultural impacts

- Temperature, frost risk, rainfall and drought conditions all have a strong effect on agricultural growing conditions. In addition, chilling for berry crops is projected to decrease to low levels (<1300 chill hours) by the end of the century, and total GDD (a measure of the heat to grow crops) increases by over 700 GDD (an increase of >80%).

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. Similar changes can be expected for the coastal regions in the Tasman municipality.

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.

Reference list

Bennett JC, Ling FLN, Graham B, Grose MR, Corney SP, White CJ, Holz GK, Post DA, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: water and catchments technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania

Corney SP, Katzfey JJ, McGregor JL, Grose MR, Bennett JC, White CJ, Holz GK, Gaynor SM & Bindoff NL 2011, Climate Futures for Tasmania: climate modeling technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania

Entura Consulting, 2010, Climate Futures for Tasmania Flood inundation mapping, Entura Consulting Technical report, 23 Dec 2010

Grose MR, Barnes-Keoghan I, Corney SP, White CJ, Holz GK, Bennett JC, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: general climate impacts technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania

Holz GK, Grose MR, Bennett JC, Corney SP, White CJ, Phelan D, Potter K, Kriticos D, Rawnsley R, Parsons D, Lisson S, Gaynor SM & Bindoff NL 2010, Climate Futures for Tasmania: impacts on agriculture technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania

McInnes KL, O'Grady JG, Hemer M, Macadam I, Abbs DJ, White CJ, Bennett JC, Corney SP, Holz GK, Grose MR, Gaynor SM & Bindoff NL In Press, Climate Futures for Tasmania: extreme tide and sea level events technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania

White CJ, Sanabria LA, Grose MR, Corney SP, Bennett JC, Holz GK, McInnes KL, Cechet RP, Gaynor SM & Bindoff NL 2011, Climate Futures for Tasmania: extreme events technical report, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania