Local climate profile

Launceston City Municipality

Past and current climate:

- Launceston has a temperate climate with a fairly narrow temperature range (average daily maximum temperature of 24.5 °C in February, 12.5 °C in July).
- Average annual rainfall in the Launceston City is around 680 mm with a small seasonal cycle (minimum of 32 mm in February and a maximum of 87 mm in August). There is higher rainfall to the east of the city itself, with over 1000 mm per year falling near Targa.
- Rainfall in the Launceston area can come from the regular westerly frontal rain systems that cross Tasmania, however the main valley is in a rain shadow of the Great Western Tiers. An important fraction of the rainfall comes from episodic systems from the north and east, including cutoff lows.
- Year-to-year rainfall variability shows some correlation with the El Niño Southern Oscillation in autumn, winter and spring (where El Niño winters are generally drier than average, La Niña winters are generally wetter than average). There is also some correlation with the Indian Ocean Dipole in winter and spring, and with atmospheric blocking in summer.
- Average temperatures have risen in the decades since the 1950s, at a rate similar to the rest of Tasmania (up to 0.15 °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 Launceston City 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 period since the end of the drought has seen average or above average rainfalls.

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 Launceston City 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. A time series of projected mean Tasmanian temperature is shown in Figure 1.

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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.

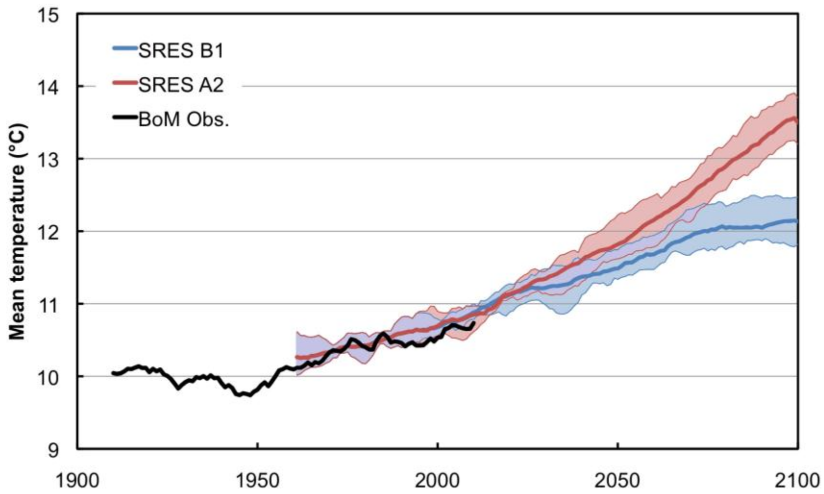

Figure 1. Tasmanian average temperature in observations (black) and model projections for the A2 scenario (red) and the B1 scenario (blue), all series are smoothed (11-year running average), shading shows the range of model projections. Changes under the higher scenario by the very end of the century 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 Launceston airport under the A2 (higher) scenario by the end of the century the projections indicate:
    - The number of Summer Days (>25 °C) increases from up to 30 days per year, to more than 70 days per year, with heat waves (3 days >28 °C) and night time minimum temperatures over 20 °C starting to occur regularly.
    - The temperature of very hot days increases more than the change in average temperature (by 3-4 °C in some locations in some seasons).
    - A reduction in frost-risk days from around 30 per year, to less than 5 per year.
    - Warm spells (days in a row where temperatures are in the top 5% of baseline levels) currently last around 7 days, are projected to last up to 9 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. Due to the strong rain shadow effect from the Great Western Tiers in this region, it was one of the most difficult regions to model, and was subject the largest model biases of any area in Tasmania. Keeping in mind these problems, the model projections indicate that the general long-term influence of climate warming by the end of the century is for an increase in annual average rainfall.

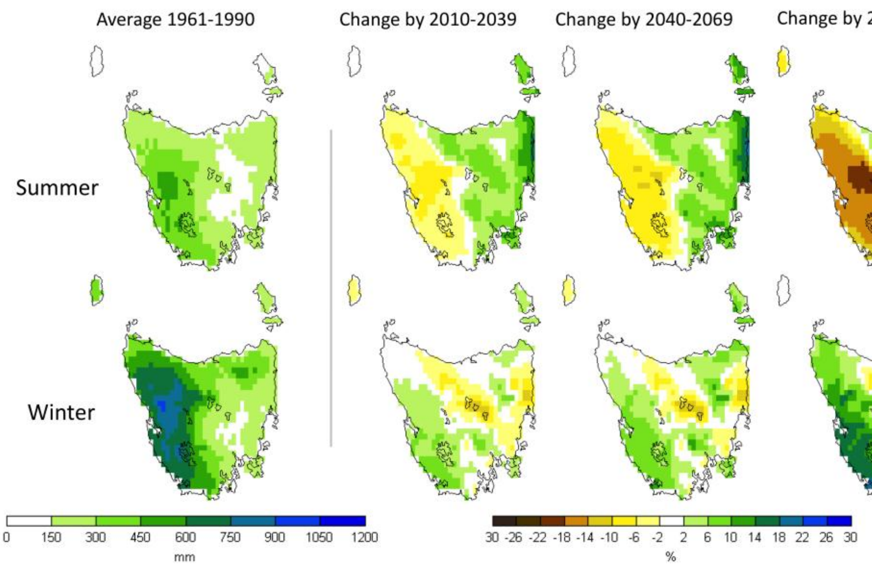

Figure 2. Average rainfall in summer and winter – the left hand side plots show the average rainfall in the baseline period (1961-1990), the plots to the right show the proportional change (%) from that amount in various periods in the 21st century in the average of six climate model projections under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

- There is a projected increase in annual average rainfall under the A2 scenario by the end of the century (model mean is for 0 to 10%). As mentioned above, this area had the largest biases in the models, however most models agreed with this sign of change. The tendency under the B1 scenario is for little change in annual rainfall.
- The model mean shows that rainfall is projected to slightly increase in all seasons, with the strongest increase in winter (see Fig 2 for summer and winter).
- 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 actually reduce slightly due to the increase in average rainfall.
- The projected increase in rainfall is driven by changes to the average circulation of the region, including the average strength of the westerlies, as well as the incidence of the main rain-bearing weather systems from the east and north, including a change in atmospheric blocking and cutoff lows.

- 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 varies in different areas. For the Launceston City municipality under the A2 (higher) scenario by the end of the century there is projected to be:
  - Around 6 fewer days with at least 1 mm rain per year on average, but significantly more rain per rain day (a 15% increase or more).
  - Up to 3 more very wet days each year (where rainfall exceeds the baseline 95th percentile), and 2 more days per year that exceed 20 mm.
  - An increase in the maximum instantaneous rainfall rate of over 30% in some seasons, and an increase of 8 mm of rainfall on the average wettest day of the year (a 25% increase).
  - An increase in the rainfall brought by rare extreme events: a 200-year average recurrence interval (ARI) event for daily rainfall at is projected to increase by more than 30 mm (a 35% increase). Other ARI events (ARI-10, ARI-50) are projected to 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 in all seasons.
  - Proportional (%) increases in average runoff are larger than the change to rainfall, with increases of over 20% possible in some seasons.
  - Runoff amounts during high events are projected to increase, including those events that may lead to erosion and localized flooding. Daily runoff amounts during low flows are projected to stay much the same or increase slightly.
  - Projected increases in rainfall in the catchments upstream of Launceston lead to increased average flows in the major rivers toward the end of the century under the higher emissions scenario. Flows in the Tamar River are projected to increase by 5% by mid century and by 19% at the end of the century, and there are smaller increase in the North Esk River (7% by end of century), with changes to the seasonality of flows.

3. 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 is expected to continue rising with further climate warming. The last IPCC assessment report gave a central estimate of a rise of 0.82 m global average sea level by 2100 under a high emissions scenario. The sea level rise varies in different locations, and for the coasts of Tasmania the sea level rise for this scenario is close to the global average.

On the north coast of Tasmania, the very high coastal surges contribute more to coastal inundation events than the relatively modest very high tide height – the current 100-year storm tide event is around 1.9 to 2.0 m above average sea level. 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 George Town will be exceeded every 10 to 30 years by 2030, and more frequently than once every 4 years in 2090 under the high emissions scenario. These events will also have an influence up the Tamar Estuary to Launceston City.

4. River floods – Tamar 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 high rainfall and runoff events are projected to become more intense, so catchments with a critical duration of less than 72 hours will experience high flood levels and faster response times. The peak discharge of the Tamar River is projected to increase significantly through the 21st Century under the higher emissions scenario. Additionally, sea level rise is projected to significantly increase coastal inundation events in the estuary of the Tamar (see above point). Please see the full Entura report and accompanying maps for more details.

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

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