Local climate profile

Central Coast Municipality

Past and current climate:

- The Central Coast municipality has a temperate climate with moderate temperature range at the coast (average daily maximum temperature is around 21 °C in February, and 12.7 °C in July). There is a climate gradient moving inland and up the slope to where there is a greater temperature range and cooler winters (daily maximum temperature of around 20 °C in February and 8 °C in July).
- There is also a gradient in average annual rainfall from around 1000 mm per year at the coast to over 1700 mm per year up the slope, but all locations have a distinct seasonal cycle. For example, Ulverstone receives 964 mm per year (43 mm in January, 123 in July), and Loongana receives 1730 mm per year (71 mm in February and 235 mm in July).
- Rainfall in the Central Coast area can come from the regular westerly frontal rain systems that cross Tasmania, however an important fraction of the rainfall comes from episodic systems from the north and east, including cutoff lows.
- Year-to-year rainfall variability is partly correlated 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.
- 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 Central Coast 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 generally 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.

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

1. Temperature

- Under the higher emissions scenario (A2), the Central Coast 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.
- 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.

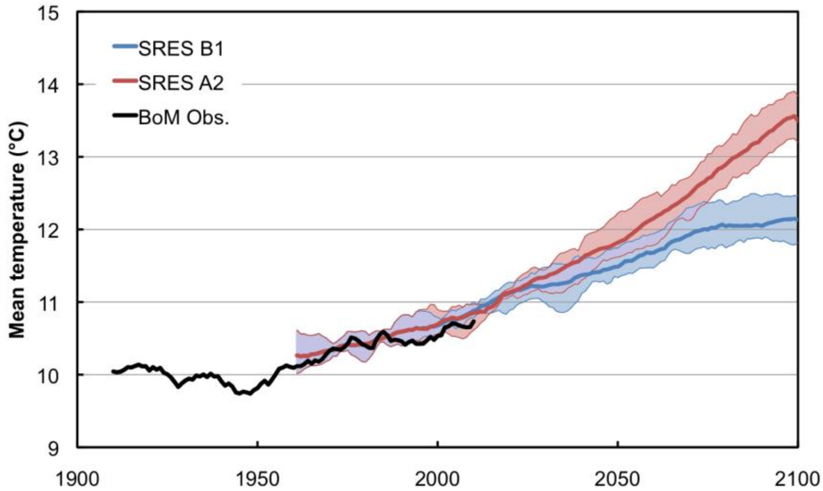

Figure 1. Tasmanian average temperature in observations (black) and model projections for the A2 scenario (red) and the B1 scenario (blue), all series are smoothed (11-year running average), shading shows the range of model projections. Changes under the higher scenario by the very end of the century 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 Ulverstone under the A2 (higher) scenario by the end of the century the projections indicate:
  - The number of Summer Days (>25 °C) increases from around 10 days per year, to more than 35 days per year, with night time minimum temperatures over 20 °C occurring a few times every year.
  - 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 at the coast from up around 6 per year to around 1 per year, and in the inland area from up to 50 days per year to less than 25 days 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 14 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 little change to annual average rainfall at the coast, but slightly decreased rainfall inland.

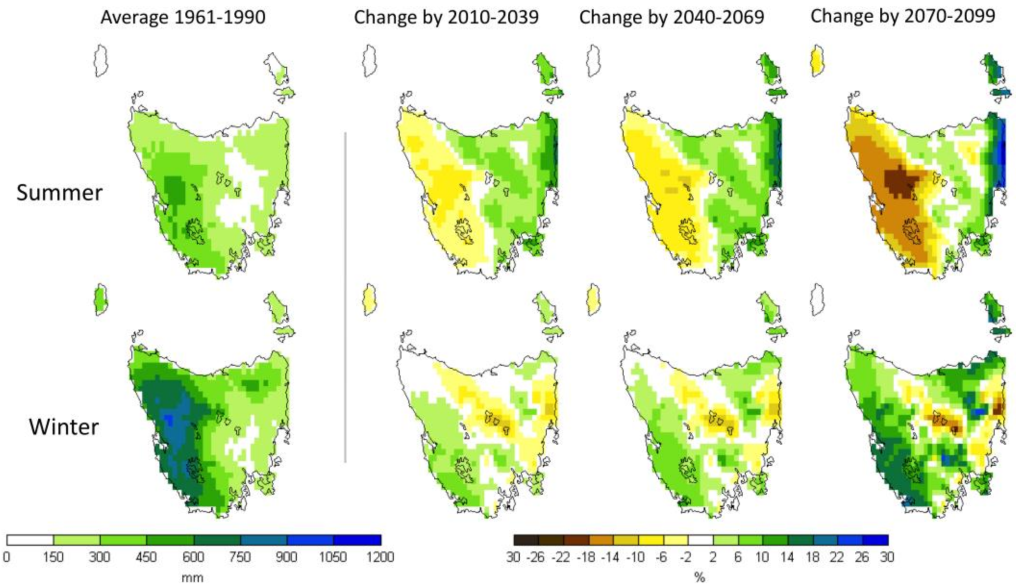

Figure 2. Average rainfall in summer and winter – the left hand side plots show the average rainfall in the baseline period (1961-1990), the plots to the right show the proportional change (%) from that amount in various periods in the 21st century in the average of six climate model projections under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

- The central estimate of the projections indicates little change to the annual average rainfall under the A2 scenario or B1 scenario by the end of the century (model mean is for less than 5% change). There is a range between the different models used, but they all show little change (+/- 10%).
- The projections indicate the central coast area is near the border between different seasonal rainfall changes. In summer and autumn the Central Coast sits between an area of decreasing rainfall in the west and increasing rainfall near the coast and to the east. In winter and spring, Central Coast sits near the border between decreasing rainfall in the highlands and increasing rainfall generally at the coast. For this reason, either increases or decreases could occur in each season, but these changes are likely to be smaller than some other regions (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 stay similar what was experienced in the twentieth century.

- 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 Central Coast municipality under the A2 (higher) scenario by the end of the century there is projected to be:
    - Up to 9 fewer days with >1 mm rain per year on average, but significantly more rain per rain day (a 15% increase or more).
    - Around 2 more very wet days each year (where rainfall exceeds the baseline 95th percentile), and the possibility of 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 wettest day of the year (a 20% increase).
    - Rainfall brought by rare extreme events increases: a 200-year average recurrence interval (ARI) event for daily rainfall at is projected to increase by more than 30 mm (a 35% increase). More common 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:
    - Due to the small projected changes to rainfall and the position of the municipality near a boundary between increasing and decreasing rainfall in most seasons, there is no clear and significant projected decrease or increase in average runoff in any season at the coast. Runoff is projected to decrease in the inland, higher altitude area of the municipality.
    - Similarly, there is no clear and significant change in runoff amounts during high events or low events for most of the municipality.
    - Decreased rainfall in the inland areas is projected to lead to slightly reduced average flows in the Forth River (central estimate is -7%) and the Leven-Gawler River system (-7%), but the smaller rivers are projected to show little change in flows, including Claytons Rivulet (0%).

3. Agricultural impacts

- As the climate warms, there is a tendency for biological niches to move upward in elevation. This means that there would be increased opportunities for agriculture and increased land-use pressure in the areas that are currently limited by temperature up the slope from the coast.
- There is a projected increase in Growing Degree Days (GDD, a measure of the heat to grow and ripen crops). This will affect where crops are grown, reduce the time to harvest of many crops, and affect many aspects of crop management. At Kindred, the annual count of GDD is projected to increase from less than 1000 to around 1750 by the end of the century under the higher emissions scenario. Higher altitude sites are projected to experience an even larger increase.

This means that the temperature environment at 300 m in the baseline period will be present at above 700 m at the end of the century under the higher emissions scenario.

- Pasture growth for dairying is projected to increase through the century as the temperature limitation decreases.
- Frost risk days are projected to become much less frequent with a warming climate. Damaging spring frosts may still occur rarely.
- Chilling affects the growth and flowering of berries, fruits and nuts. Accumulated chill hours decrease given the warming under the two future climate scenarios.
- For more information on agricultural impacts, including a detailed case study of changes along the altitudinal gradient from the coast up the slope, see Holz et al. (2011).

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 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 tide heihgts contribute more to coastal inundation events than the relatively modest storm surge heights – 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 Burnie 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, and a similar change can be expected in the Central Coast (e.g. at Ulverstone and Penguin).

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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