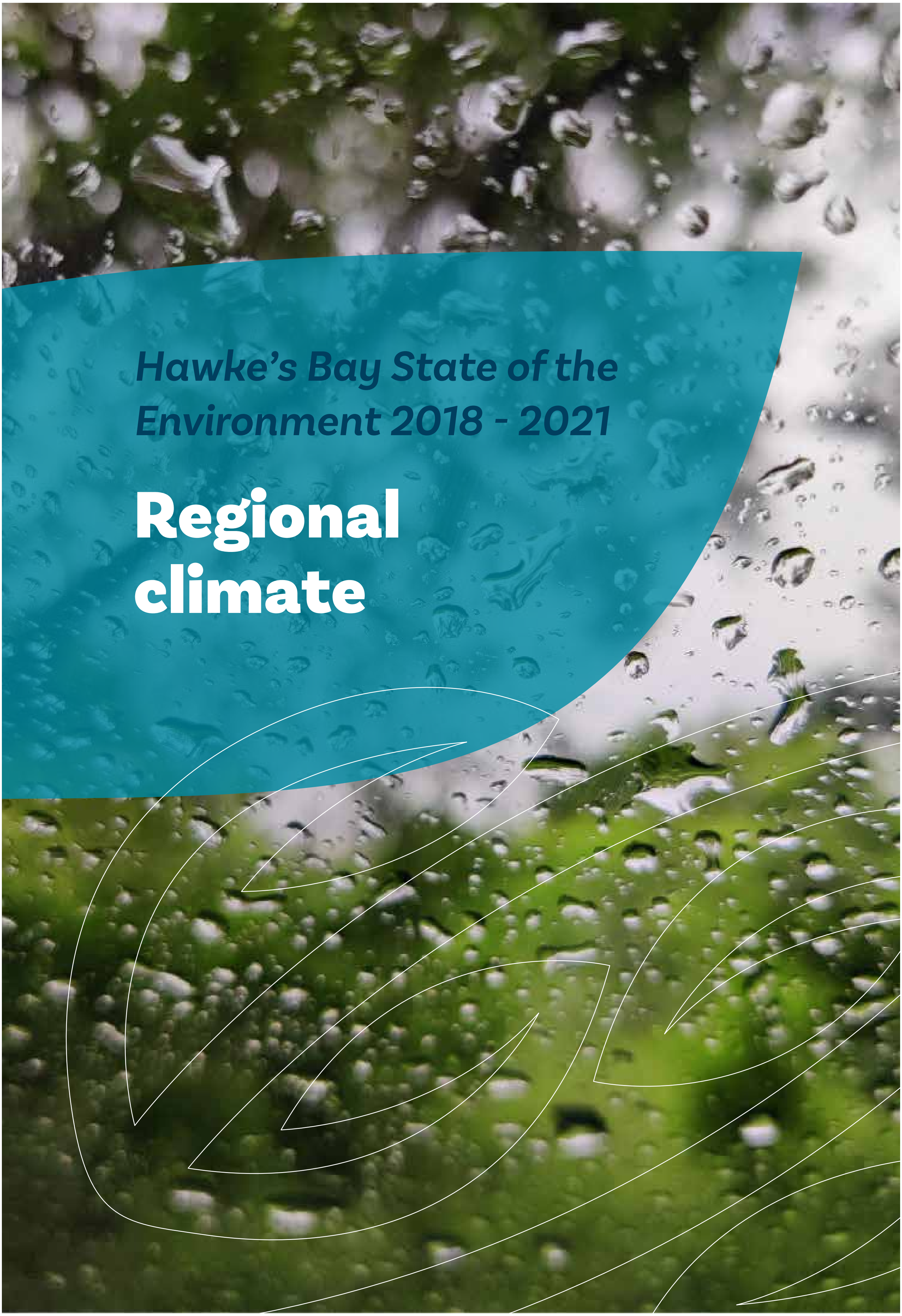

Hawke's Bay State of the Environment 2018 - 2021

Regional climate

4. Regional climate

Hawke's Bay has a warm and dry climate compared to many of New Zealand's regions, but it still has sharp frosts in winter, storms, and – on rare occasions – snow to near sea level. Our environment faces potentially rapid and substantial changes in temperature and rainfall over the next century as a result of climate change. The last three years may be a harbinger of what is to come.

Recent weather

Annual rainfall during the last three years fell within the normal range (within 80-120% of the long-term average), although 2019-20 and 2020-21 were at the lower end of this range. Annual maximum and minimum temperatures, on the other hand, were above average for all three years.

However, the most worrying aspect of the weather in Hawke's Bay during the last three years has been the extreme events, swinging from deluge to drought (Figure 4-1). In spring 2018, the most significant region-wide rainfall event of the three-year period occurred. A complex low-pressure system lying to the east of Hawke's Bay drove rain across the region for five days (Figure 4-2). It amounted to a one-in-100 year rainfall event in northern parts of the region and a one-in-50 year event in the south.

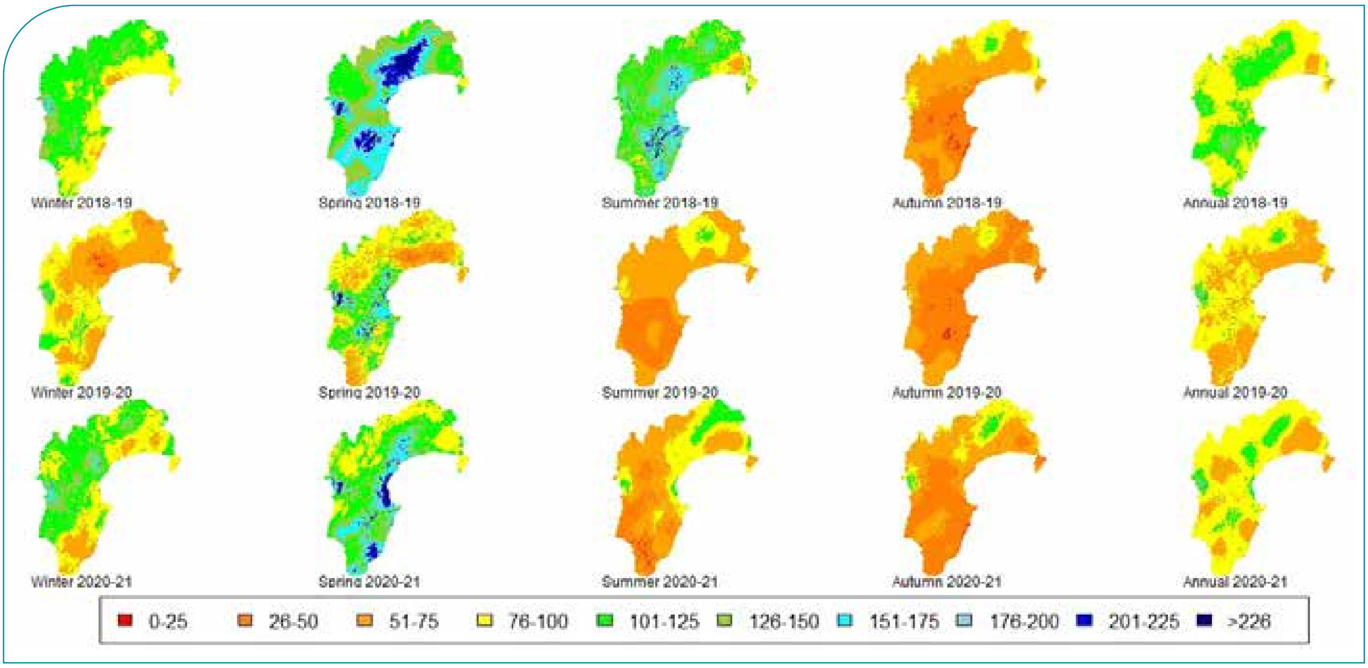

Figure 4-1. Seasonal rainfall totals shown as a percentage of long-term seasonal average rainfall. This highlights the recent pattern of very dry summer and autumn seasons following a wet spring.

These wet conditions continued in the summer of 2018-19, with above average rainfall. This was unexpected given El Niño (present at the time) typically leads to lower rainfall. However, this was followed by a drier than normal autumn and a severe drought in the summer and autumn of 2019-20, although by then the El Niño-Southern Oscillation was neutral.

This drought rivalled the previous significant one in 2012-13, and it was swift to develop on the back of low rainfall and hot temperatures. Daily maximum temperatures in November 2019 and February 2020 were over 2°C hotter than normal (Figure 4-3).

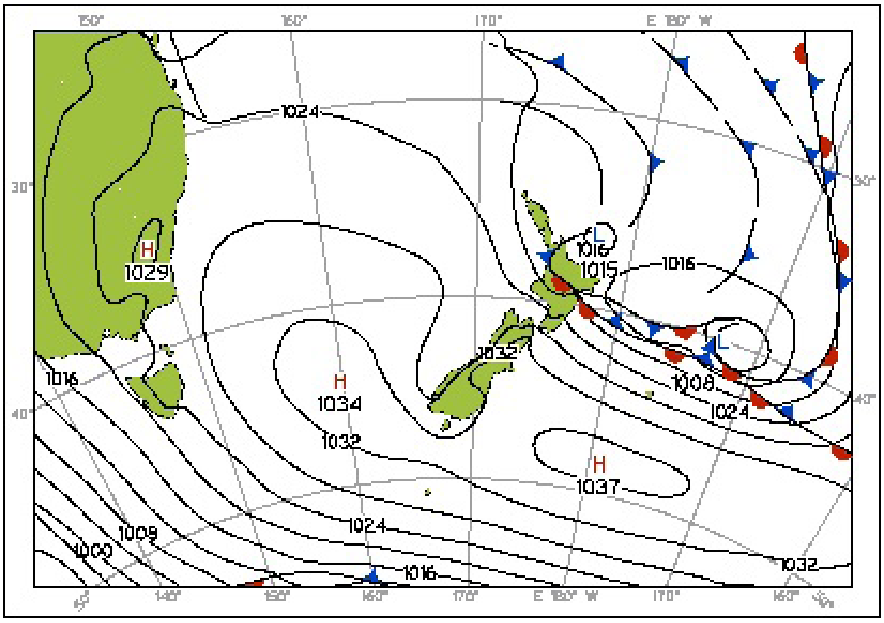

Figure 4-2. The New Zealand Metservice mean sea level pressure map for midday, 5 September 2018.

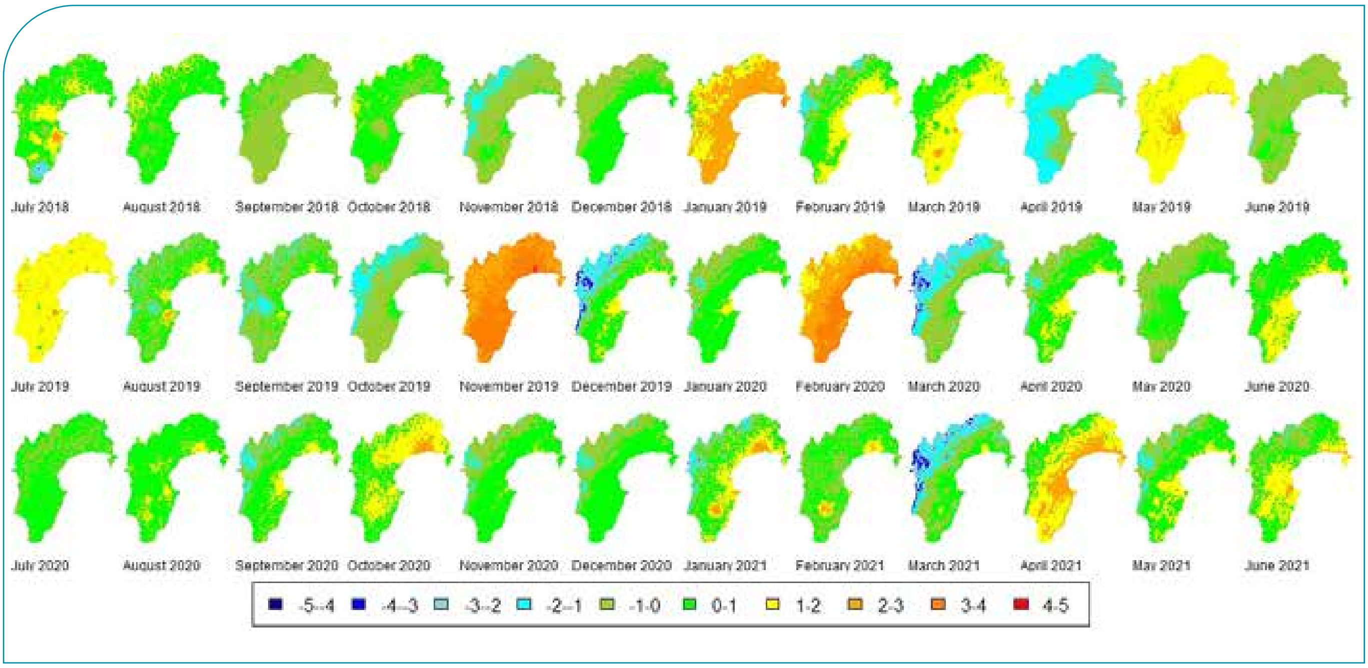

Figure 4-3. Monthly mean maximum temperature differences from the long-term average for the hydrological years 2018-19 to 2020-21, showing the higher-than-average temperatures in November 2019 and February 2020.

Climate change predictions suggest spring will be the season with the greatest decline in rainfall in Hawke's Bay, but so far these predictions haven't been borne out. Spring during all three years from 2018-2021 was wetter than usual in many parts of the region.

In fact, a greater than 100-year flood in Napier occurred in November 2020, caused by a slow-moving band of rain associated with an area of low pressure off the North Island's east coast. The heaviest rainfall was localised in Napier City, where 250mm of rain was recorded within 24 hours, much of it falling within half that time. Hourly totals reached 60mm (Figure 4-4). The intense rainfall caused flooding in low-lying parts of Napier and landslides on Matārauhou/Napier Hill, requiring the evacuation of houses in those areas.

The November storm promoted ill-preparedness for what was to follow – dry conditions for the next six months. Any complacency was compounded by the presence of La Niña conditions, which are not usually associated with low seasonal rainfall. The result was a second consecutive summer of drought. Over the last sixty years, this is the first time that two severe droughts have followed each other (Figure 4-5). Both hit hardest in the region's south.

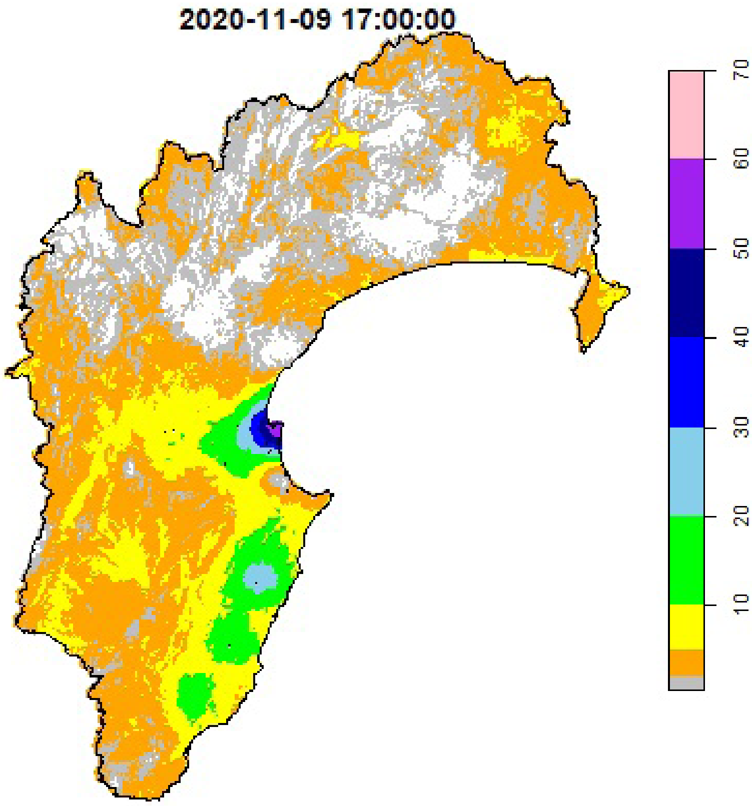

Figure 4-4. Rainfall totals in Hawke's Bay between 4-5pm NZST on the 9th November 2020.

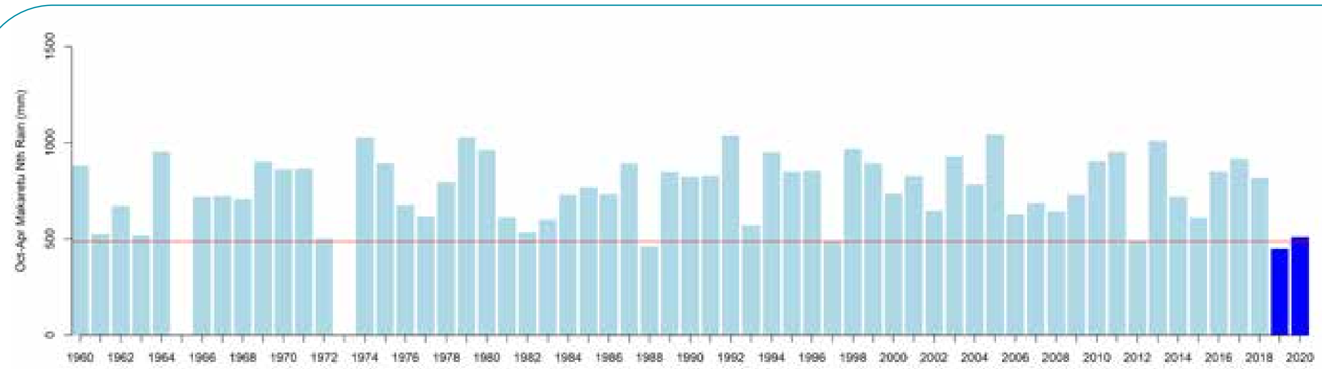

Figure 4-5. October to April rainfall totals since 1960 at Makaretu North rainfall site. The red line indicates the long-term average. The 2019-20 and 2020-21 periods are highlighted in dark blue.

Rainfall

Long-term trends in rainfall are difficult to detect. The region has a collection of rainfall sites that date back to 1988 or earlier (Figure 4-6), and most of these sites do not show a statistically robust trend in monthly rainfall over that time. However, two sites in the Kaweka ranges, Te Koau and Glenwood, are showing signs of a decline in rainfall in summer months. The headwaters of some of our rivers lie in this area, and decreasing rainfall has implications for their summer flows.

Links exist between the region's rainfall and climate modes, such as El Niño-Southern Oscillation (ENSO), the Interdecadal Pacific Oscillation (IPO), the Indian Ocean Dipole (IOD), the Southern Annular Mode (SAM) and South Pacific Subtropical Dipole (SPSD). Their influence is variable across the region and across seasons in both direction (i.e., increasing or decreasing rainfall) and strength.

ENSO, IOD, and SPSD have shown increasing trends since 1988 and IPO a decreasing trend. Summer rainfall in Glenwood and Te Koau has weak negative associations with ENSO, IOD, and SPSD and a weak positive association with IPO. In other words, it is anticipated summer rainfall might decrease given the observed trends in those climate modes.

Other sites do not have similar associations, with many having positive associations with ENSO and SPSD in summer and other seasons and a negative association with IPO. The observed trends in ENSO, SPSD, and IPO could therefore promote an increase in rainfall at those sites over time, but this could be countered by the IOD, which at a lag of three months, appears to have the most significant and common link to all sites. The complex interactions among competing modes might explain why trends in monthly rainfall have been unclear at sites other than Te Koau and Glenwood.

Te Koau and Glenwood are the only rainfall sites used in this report that are nestled high in the region's western ranges. The same trends may extend along the ranges further north, influencing the flows of rivers with headwaters in those areas.

Figure 4-6. Rainfall sites with records dating back to 1988 and sites used for temperature with records dating back to 1997. Waihau Climate provided both temperature and rainfall records.

We also looked at the following trends in rainfall as indications of climate change:

- Annual maximum 1-day precipitation
- Annual maximum 5-day precipitation
- A simple precipitation intensity index (the sum of daily amounts divided by the number of wet days)
- Annual counts of days with rain greater than 10 mm
- Annual counts of days with rain greater than 20 mm
- Annual counts of days with rain greater than 1 mm
- Maximum length of dry spells (consecutive days less than 1 mm)
- Maximum length of wet spells (consecutive days greater than or equal to 1 mm)
- Contribution to total precipitation from very wet days (the 95th percentile rain)
- Contribution to total precipitation from extremely wet days (the 99th percentile rain)
- Annual precipitation on wet days.

These are measures developed by the joint World Meteorological Organisation Commission for Climatology and World Climate Research Programme's Expert Team on Climate Change and Detection, Monitoring and Indices (ETCCDMI) to achieve a globally consistent way of identifying changes in extreme climate. Only one of the measures at two sites showed a significant trend over the more than thirty years of records. Te Koau had a decreasing trend in the annual count of days with rain greater than 1mm. Te Rangi had a positive trend in the same measure. However, the magnitude of change for both was small.

Temperature

Trends in temperature, determined from records extending back to 1997 at HBRC sites (Figure 4-6), show warming mean minimum temperatures rather than a change in maximum temperatures, although both have trended upward over the last 20 years. Sea surface temperature anomalies in Hawke's Bay have warmed over time, and the warmer seas at the coast help moderate overnight falls in temperature.

Like the rainfall measures, a set of ETCCDMI temperature indices for climate change exist too:

- Annual count of days summer days (temperature above 25°C)
- Annual count of frost days (temperature less than 0°C)
- Annual count of tropical nights (daily minimum more than 20°C)
- Growing season length, using a base temperature of 10°C
- Annual maximum value of the daily maximum temperature
- Annual maximum value of the daily minimum temperature
- Annual minimum value of the daily maximum temperature
- Annual maximum value of the daily minimum temperature
- Percentage of days when the minimum temperature is below the 10th percentile
- Percentage of days when the maximum temperature is below the 10th percentile
- Percentage of days when the minimum temperature is above the 90th percentile
- Percentage of days when the maximum temperature is above the 90th percentile
- Warm spell duration index (counts of days with at least six consecutive days above the 90th percentile)
- Cold spell duration index (counts of days with at least six consecutive days below the 10th percentile)
- Daily temperature range.

Strong signals are not evident in these temperature indices so far. Both Gwavas and Ongaonga had fewer frost days and a lower percentage of days when the minimum temperature was in the bottom 10th percentile. Gwavas also had an increase in the number of "summer" or hot days.

Potential evapotranspiration

Measurements of potential evapotranspiration (PET) are important, because even if rainfall does not decrease, increases in PET would mean less rainfall is available to the region as a water resource. HBRC's record of potential evapotranspiration (PET) is short, at most dating back to 2007. PET has been increasing over that time.

Satellite data allows us to extend our estimates back to approximately 2001, and this data also shows an upward trend in PET. Climate change projections suggest that PET will continue to increase through this century.