NIWA
Taihoro Nukurangi

Number 37 15 July 2002

The Climate Update

New Zealand climate in June 2002

Rainfall and air temperature

Hot, cold, wet, dry – June had it all

It was the third warmest June since records began in the 1850s. New Zealand's national average temperature for the month was 9.8 °C, which was 1.5 °C above normal. Hamilton was 3.5 °C above normal, its warmest June since 1907. Napier had maximum temperatures over 20 °C on six days, five more than average.

Although parts of the southwest and south of the South Island recorded near normal temperatures, Tara Hills broke the record for the coldest New Zealand June air temperature at –19.1 °C. Fairlie equalled its coldest June temperature since 1925 at –14 °C.

Floods and snow

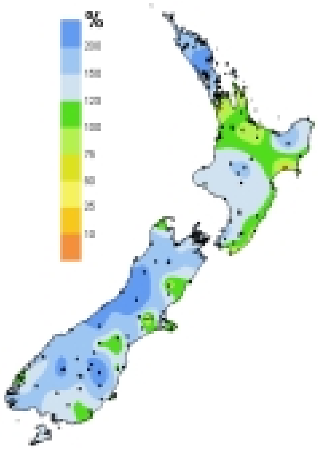
Heavy rain on the west coast of the South Island flooded Granity twice, and very wet conditions also affected Wellington and Coromandel. Rainfall in Central Otago was three times normal with Queenstown recording its fourth wettest June since 1872. Snow closed State Highway 1 south of Dunsandel for the first time in 26 years.

Rainfall in parts of South Auckland, Waikato, and Hawke's Bay was near average or below.

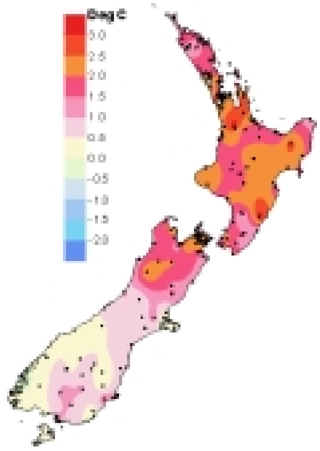
Sunny in the southeast

Coastal Southland and Otago had above average sunshine hours. It was cloudier than usual in central, western, and northern North Island regions.

Rainfall



Mean air temperature



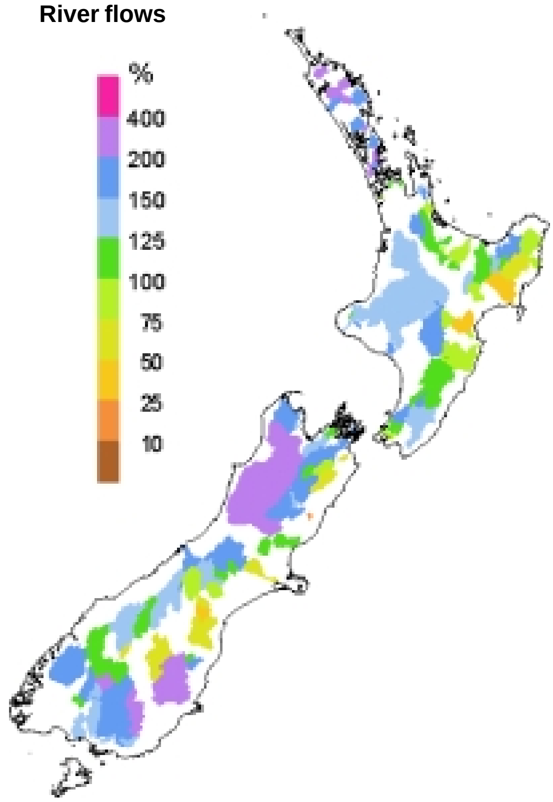
ABOVE: Percentage of average rainfall (left) and difference from the average air temperature in degrees Celsius (right). Dots indicate recording sites.

River and streamflows

June streamflows mostly high

June flows were above normal for most of the country, below normal around Gisborne and Hawkes Bay, and normal in Canterbury and much of Marlborough.

River flows



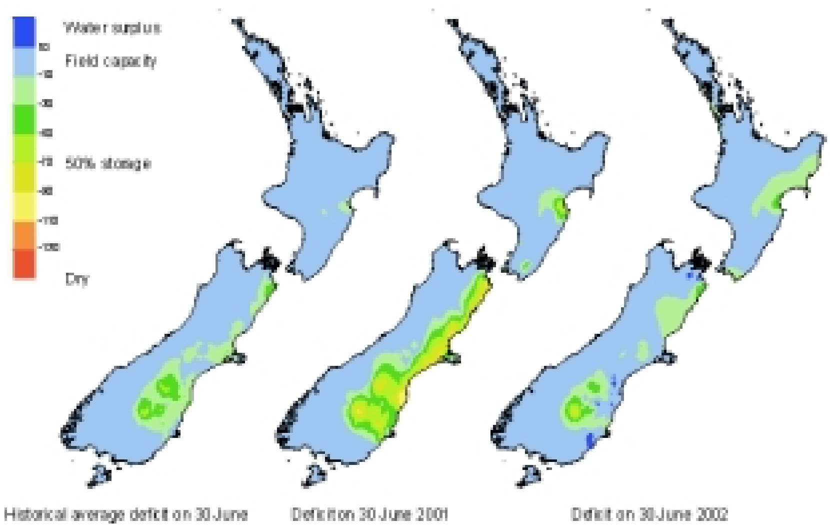
ABOVE: Percentage of average June streamflows for rivers monitored in national and regional networks. The contributing catchment area above each monitoring location is shaded. NIWA field teams, regional and district councils, and hydro-power companies are thanked for providing this information.

Soil moisture

Above average rainfalls during June reduced or eliminated remaining root zone soil moisture deficits in most parts of the country. Soils in a few areas of Gisborne, Hawke's Bay, coastal Marlborough, and inland Otago were at less than field capacity at the end of the month. Apart from Gisborne, moisture levels at these locations were generally in line with normal conditions for this time of year.

Moisture levels along the east coast of the South Island were generally higher than at the end of June last year.

Soil moisture deficit



ABOVE: Soil moisture deficit in the pasture root zone at the end of June (right) compared with the deficit at the same time last year (centre) and the long-term end of June average (left). The water balance is for an average soil type where the available water capacity is taken to be 150 mm.

Checkpoint

April to June 2002

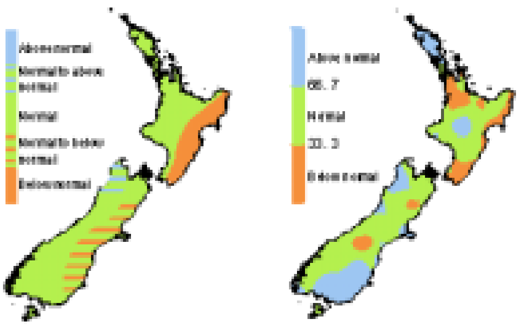
Rainfall was expected to be near normal in most regions and below normal in the east. The outcome was as expected in the North Island and most of the South Island. Parts of Southland and Otago received 125 –175% of normal.

Air temperatures were normal or above normal in all regions as predicted.

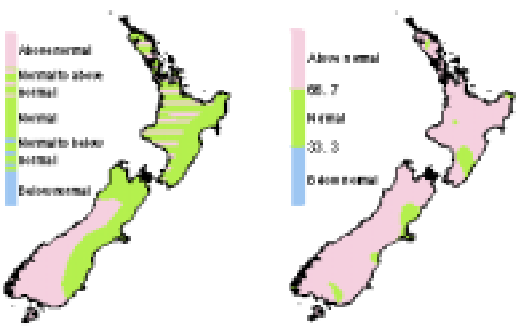
Normal **river flows** were expected for most regions of the country, except in the east. Much of the Waikato, Bay of Plenty, the southwest of the North Island, Canterbury, and the West Coast had normal flows. Flows were below normal in the east of the North Island, Marlborough, and inland Otago, and above normal in Northland, Nelson-Buller, and coastal Otago-Southland.

Outlook — What we said | **Outcome** — What actually happened

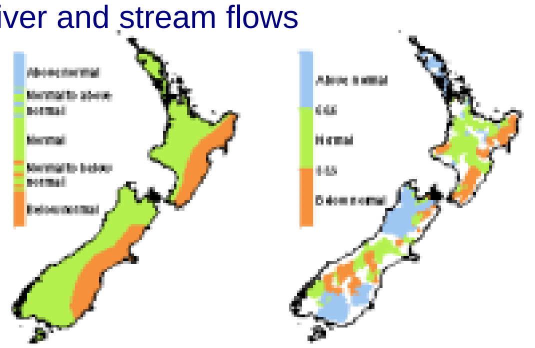
Rainfall



Mean air temperature



River and stream flows



The three outcome maps (right column) give the tercile rankings of the rainfall totals, mean temperatures, and river flows that eventuated for April to June 2002. Terciles were obtained by dividing ranked April to June data from the past 30 years into three groups of equal frequency (lower, middle, and upper one-third values) and assigning the data for the present year to the appropriate group.

As an approximate guide, middle tercile rainfalls (33.3 to 66.7%) often range from 80 to 115% of the historical average. Middle tercile air temperatures typically occur in the range of the average plus or minus 0.5 °C.

Note that in the maps above, the upper, middle, and lower tercile ranges are described by the terms *Above normal*, *Normal*, and *Below normal,* respectively.

Outlook

July to September 2002

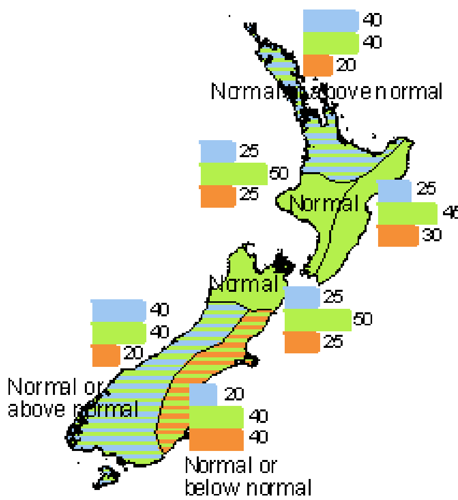
The evidence for a developing El Niño event, which is expected to influence New Zealand climate over spring and summer 2002–03, continues to strengthen, though the magnitude of the coming event remains uncertain.

El Niño is typically associated with below average temperatures in many places. However, the outlook for July to September 2002 is for normal or above normal temperatures in all regions because of the influence of local sea temperatures and a warm Indian Ocean. Short-term cold outbreaks typical of winter are still likely, even though average temperatures are expected to remain relatively high.

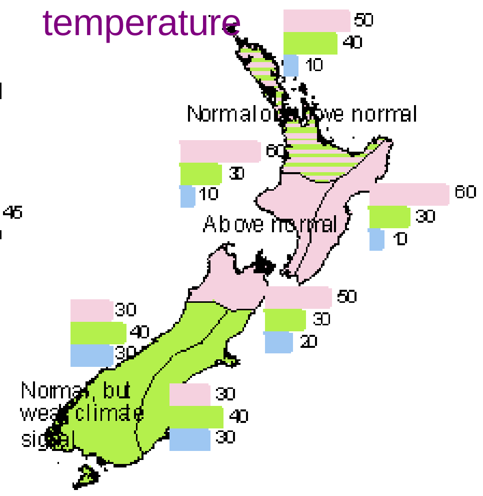
Rainfall is expected to be near normal in many regions, but may be above normal in the north of the North Island and the west of the South Island, and below normal in eastern South Island regions.

Normal soil moisture levels and river flows are predicted for all regions of the country, except for the north of the North Island and the west of the South Island where above normal to normal soil moisture levels and river flows are likely.

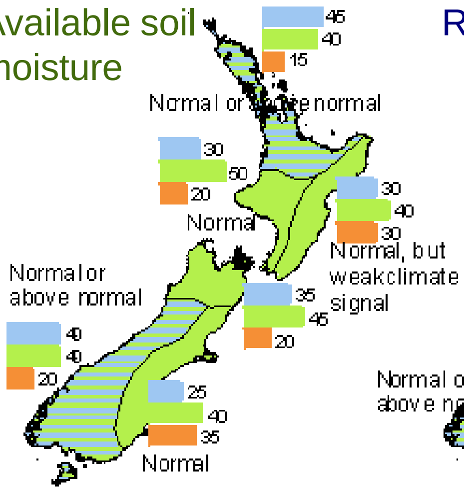
Rainfall



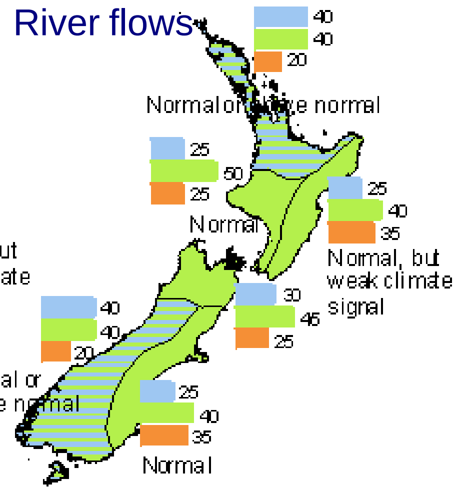
Mean air temperature



Available soil moisture



River flows



KEY to maps (Example interpretation)

A. Climate models give no strong signals about how the climate will evolve, so we assume that there is an equal chance (33%) of the climate occurring in the range of the upper, middle, or lower third (tercile) of all previously observed conditions.

B. There is a relatively strong indication by the models (60% chance of occurrence) that conditions will be below normal, but, given the variable nature of climate, the chance of normal or above-normal conditions is also shown (30% and 10% respectively).

	No strong climate signal (A)	Strong expectation of below normal (B)
Above normal	33	10
Normal	33	30
Below normal	33	60

Backgrounder

Winter smog – meteorological and topographical factors

In common with many cities world wide, and with some other New Zealand locations, Christchurch is subject to both meteorological and topographical influences that slow down and at times prevent the removal of air pollutants from the urban area.

Inversion layer

A meteorological phenomena that affects Christchurch often during the cooler months is the *inversion layer,* a primary reason why polluted air is so often trapped over the city.

Christchurch suffers from more frequent winter night-time *temperature inversions* than many other places in New Zealand. Temperature inversions occur when there is little or no wind, and the sky is clear. Under these conditions, in the evening and during the night, heat from the ground is radiated into the atmosphere, and the air adjacent to the ground cools relative to the layer of air above. In this way the normal lowering of temperature with increasing height is temporarily reversed.

When this happens, the cool air near the ground, particularly in low lying areas, is trapped and is described as being strongly stable. This means pollutants suspended in the air at these times diffuse only very slowly, while larger particles are deposited on the ground and other surfaces.

A strong inversion can occur even when winds are moving above the stable surface layer. In this condition, the upper air layer is said to be *decoupled* or separated in such a way as to have little influence on the inversion layer.

Christchurch has two features that can reinforce the temperature inversion. Firstly, the topography of the area results in cold air draining off the Southern Alps and Banks Peninsula which adds to the pool of cold air over the city. Secondly, one of the favourable features of Christchurch, its low density of buildings compared to many cities, contributes to the problem. There is less heat stored in the urban area during the day, and therefore a more rapid cooling at night which accelerates the formation of the inversion layer.

Mixed layer

During the period after sunrise, the surface of the ground is heated by the sun, creating near the ground a warm air layer which gradually increases in height. The buoyancy of this warm air causes it to mix vertically with the air above. Initially, this mixed layer creates a problem of *fumigation*, whereby air still trapped by the inversion layer can be mixed downwards, thus spreading pollutants that may have been hovering at chimney level down to the ground, creating very unpleasant conditions for a time.

Finally, as the heating of the sun continues, the mixed layer becomes deep enough to break down the inversion, and the pollutants disperse by *convection* (predominantly upward motion of the air) and as a result of horizontal air flow (often referred to as *advection*). Pollutant concentrations are generally lower during the late morning and early afternoon, when convective influences are strongest, and when there are fewer particles being introduced to the air from sources such as heating appliances.

Just before sunset, the heating of the ground surface stops, and the temperature inversion starts to re-establish near the ground. This cuts off the mixed layer from its source of heat, and it collapses. The process of pollutant concentration build up begins again.

Unstable weather conditions

The conditions described above occur only under clear skies and light winds. Cloud cover and windy conditions generally reduce the daily temperature range and increase turbulence. It is then more likely that the atmosphere near the ground at night will be less stable and provide more effective pollutant dispersion through mixing.

The Climate Update

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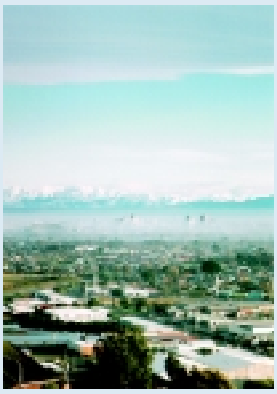
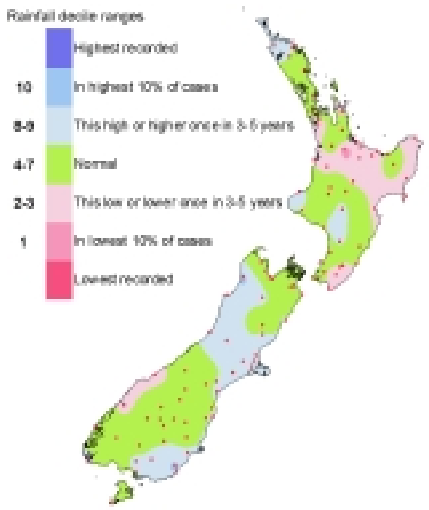


Cover picture:
An inversion layer traps smog over Christchurch. The view of the Southern Alps from above the inversion layer is unaffected. The clear area in the foreground may be due to the drainage of cold, clear air from Banks Peninsula.

Photograph: Alistair McKerchar

2002 rainfall to date

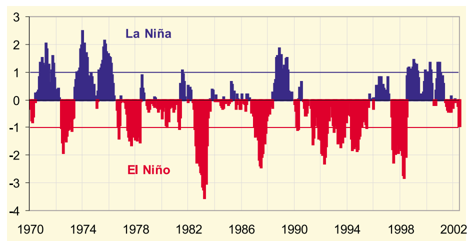
Rainfall so far this year has been lower than average across some central and eastern parts of the North Island. Much of the South Island has received normal or above normal rainfall. Parts of the north and west of the North Island have also been wetter than average.



ABOVE: Total rainfalls for 1 January to 30 June 2002, shown according to decile rankings of all rainfalls for this period from 1972. Dots indicate observation sites used in the analysis.

Update on the SOI

The mean Southern Oscillation Index (SOI) for June was –0.8, with the three month average now at –0.9. El Niño is expected to develop by spring, but the magnitude of the event is still uncertain. The latest World Meteorological Organization press release on El Niño (22 June) can be viewed on their web site www.wmo.ch



ABOVE: The Southern Oscillation Index (SOI), a measure of changes in the atmospheric pressures across the Pacific, smoothed over three months. La Niña or El Niño typically have an observable effect on the New Zealand climate when there is a large departure of the SOI from zero.

Online climate graphics

Climate maps and line plots of climate site observations are updated each week on the `Climate Now` website. See www.niwa.co.nz/ncc/climatenow