South Island Monthly Fire Danger Outlook (2022/2023 season)

Issue: March 2023

Current fire danger situation

February's various indices mostly show high to extreme values across southern Canterbury and Otago, with generally much lower values in the upper and western South Island. See Figures 9-12 for more detail.

Current fuel and soil moisture status

As of 15 March (Figure 4, left), soil moisture levels are below normal across Nelson, Tasman, and Buller District, along with the lower South Island. Soil moisture levels are generally near normal to above normal elsewhere. The New Zealand Drought Index is currently showing dry to extremely dry conditions in the upper West Coast, Otago, Southland, and Stewart Island (Figure 1).

Conditions across the South Island remain variable in terms of fuel dryness, with large parts of Southland, Otago, South Canterbury and the Buller area of the West Coast still experiencing elevated Drought Code (DC) values, despite recent rains. Those recent rains have had the effect of significantly increasing the fuel moisture content (or wetting) of the medium-sized woody fuels and loosely compacted organic layers. This has led to a reduction in the Duff Moisture Code (DMC) across most of the South Island, which in turn has reduced the Build Up Index (BUI). Further forecast rain over the coming week could continue to ease the risk for deep-seated burning.

At the fine fuel end of the fuel complex, grass curing remains elevated in large parts of the eastern South Island, especially in Southland, Otago, South Canterbury and Marlborough. Large volumes of dead material in the grass sward remain highly receptive to any drying conditions, making them easy to ignite and potentially presenting some challenges for fire suppression, particularly under windy conditions.

Elevated Fine Fuel Moisture Code (FFMC) values combined with wind could result in high Initial Spread Index (ISI) values, and also contribute to scrub fuels igniting easily and spreading rapidly.

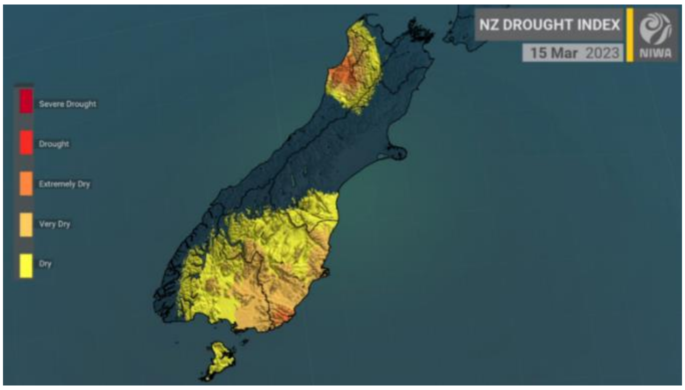


Figure 1: The New Zealand Drought Index (NZDI)[1] as of 15 March 2023, showing dry to extremely dry conditions in parts of the upper West Coast, lower South Island, and Stewart Island.

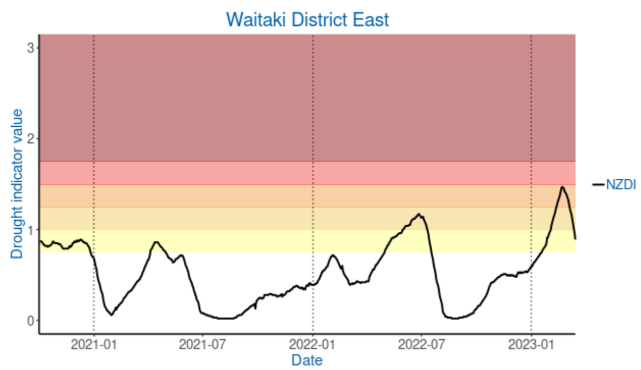


Figure 2: New Zealand Drought Index for Waitaki District East, showing the relative drying experienced during the 2022/23 summer season compared to the previous two years. Similar elevated patterns are being shown across parts of Southland, Otago and Buller.

[1] *NZDI is a climate data-based indicator of drought based on four commonly-used climatological drought indicators, these being the Standardised Precipitation Index, the Soil Moisture Deficit, the Soil Moisture Deficit Anomaly, and the Potential Evapotranspiration Deficit.*

Forecast climate and weather

The remainder of March looks to have variable air flows, with more westerlies than have been seen in recent months. For April as a whole, the transition away from La Niña is expected to be associated with variable air flows, temperatures and rainfall patterns. However, there is the possibility for La Niña-like easterlies and tropical or sub-tropical moisture to return for a time during the first half of April, although with low confidence.

April-June may exhibit a trend toward somewhat drier conditions, consistent with the easing of La Niña. Variable air flows are expected, but there may still be a preference for easterly-quarter winds at times.

For more information, see pages 3 and 4.

What to watch for

- Persistent drier fuels along the east and northwest of the South Island mean that the potential remains for fires to occur in these areas. Fires may involve all fuels, although will initially be driven by elevated grass curing or scrub, with the potential to spread to heavier fuels. This will gradually ease as the days continue to shorten heading into the late autumn/early winter months.
- Westerly wind conditions in the remainder of March bring the added potential for fast moving fires, especially where grass curing values are high (meaning the proportion of dead material in the grass sward is high compared to live material) or where scrub fuels are prevalent. This is also a consideration for active fire permits, with the potential for reignition of old fires under strong wind conditions.
- As Easter approaches, it could reasonably be anticipated that holiday-home owners will be looking to put in a last effort around their properties to tidy up ahead of the winter months. As part of this there may be an increase in people wanting to burn vegetation waste over the long holiday weekend, with little regard to prevailing conditions in favour of just getting the job done. Where restrictions and prohibitions remain in place, controls can be placed on this activity through fire permits and appropriate conditions.
- A general drying trend from April, associated with easing of the La Niña conditions which dominated over the summer, could be compounded by winter frost curing (the drying out of dead fine fuels by freezing). This could lead to the continuing potential for burning during the latter part of autumn into early winter, although this is likely to be limited to fine fuels and scrub.
- With shortening day lengths, the onset of heavy dews and typically good overnight temperature and humidity recovery, the chance of there being a significant fire which challenges initial attack capability in the South Island over the coming months is steadily reducing. The likelihood will continue to lessen as we progress towards the colder winter months.

The South Island is typically experiencing normal to above normal fire potential for the time of year, except for coastal Canterbury and Marlborough which are experiencing below normal conditions. Figure 3 shows current fire potential based on the prevailing conditions. While large areas of Otago and South Canterbury are shown as having slightly above normal fire potential, the reality is that it is still less than typical for this time of year, but due to the prevailing elevated fuel dryness compared to neighbouring areas it was felt prudent to highlight this.

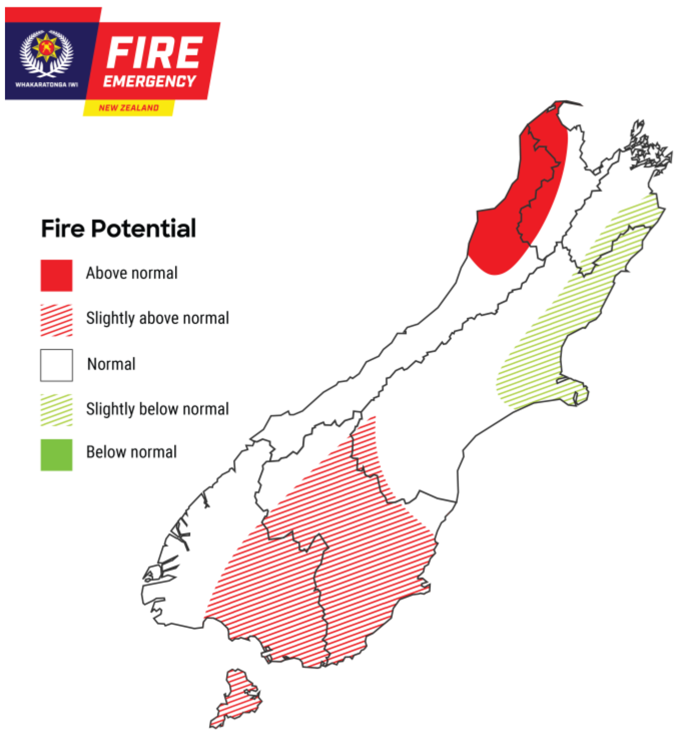


Figure 3: Relative fire potential across the South Island based on prevailing weather and fuel conditions.

Current climate

February temperatures were above average (0.51-1.20°C above average) or well above average (>1.20°C above average) across a majority of the South Island. For the Mackenzie Basin and North Canterbury, temperatures were generally near average (±0.50°C of average). So far in March, temperatures have been above average to well above average across the entire South Island and Stewart Island (Figure 4, right).

February rainfall was above normal (120-149% of normal) or well above normal (>149% of normal) across eastern Marlborough, northern and middle Canterbury, parts of the central and lower West Coast, and inland Otago. Rainfall was below normal (50-79% of normal) along parts of the northern West Coast, inland Canterbury, and coastal Otago, with an area of well below normal rainfall (<50% of normal) in Fiordland. So far in March, rainfall has been above normal in many areas, but slightly below normal in the upper South Island and parts of Otago, Southland, and Stewart Island (Figure 4, middle).

Soil moisture levels are below normal across Nelson, Tasman, and Buller District, along with the lower South Island. Soil moisture levels are generally near normal to above normal elsewhere. The New Zealand Drought Index is currently showing dry to extremely dry conditions in the upper West Coast, Otago, Southland, and Stewart Island (Figures 1 & 4, left).

Climate drivers

The NINO3.4 Index anomaly (in the central equatorial Pacific) through 27 February was -0.46˚C (climatology: 1991-2020), in neutral territory for the first time since July-August 2022. The remnant central Pacific "cool pool" is now flanked by warmer than average seas.

The February monthly Southern Oscillation Index (SOI) was +1.0 and +1.2 from December-February (climatology: 1991-2020), both in the La Niña range.

Trade winds were stronger than normal in the equatorial Pacific. However, significantly reduced trade winds and a possible westerly wind burst are predicted for March. This is linked to a pulse of the Madden-Julian Oscillation (MJO) crossing the Pacific. This radical change in equatorial circulation represents the first real sign that the ocean-atmosphere system has a chance of moving toward El Niño during 2023.

In the subsurface central equatorial Pacific, La Niña's decay continued during February. Sub-surface water temperatures were above average across the entire basin, with waters in the upper 100 m of the eastern equatorial Pacific becoming more anomalously warm as compared to January. Closer to the surface, warmer than average waters spread toward the central Pacific, leading to a contraction of La Niña's remnant cool pool of water.

NIWA's analysis indicates that La Niña will transition to ENSO-neutral during autumn (95% chance), most likely during March. The chance for El Niño conditions then increases to over 60% during winter, continuing through spring. That chance is supported by the trends in sub-surface ocean conditions and trade winds.

During March, Madden-Julian Oscillation (MJO) phase 8 is expected to be associated with below normal air pressure and temperatures and a strong south-to-southwest air flow anomaly around New Zealand. The MJO may move toward phase 1 during mid-to-late March, which is associated with stronger westerly winds during the autumn season. From late March into early April, a convective pulse associated with the MJO may move over the Indian Ocean, Maritime Continent, and West Pacific once more, bringing La Niña-like patterns and briefly increasing the risk for tropical cyclones in the Southwest Pacific.

During February, marine heatwave conditions persisted in the South Island coastal waters. February SSTs were the warmest on record in the west and east of the South Island and second warmest on record in the north of the South Island.

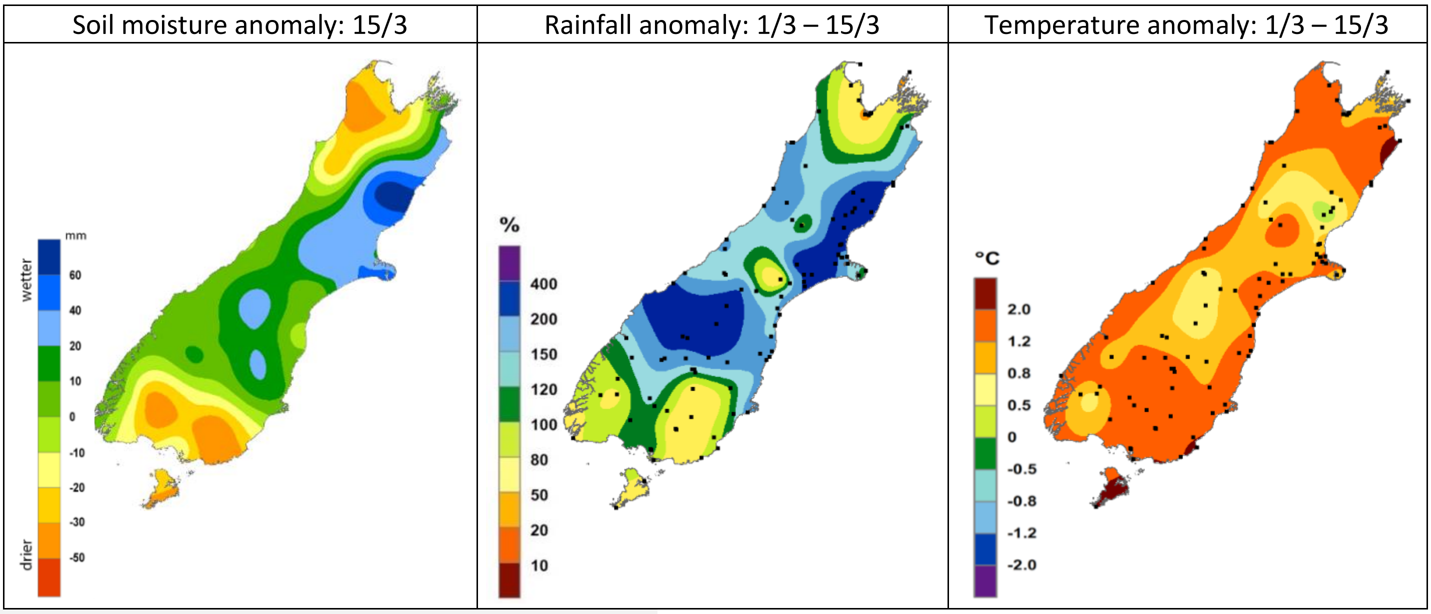


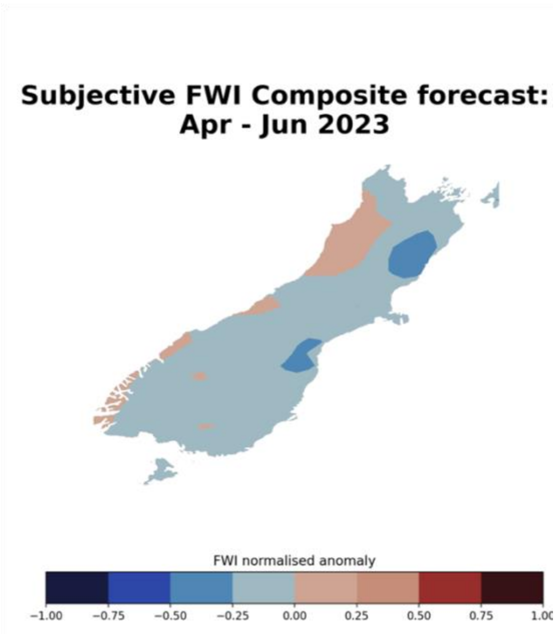
Figure 4: Maps showing the current soil moisture anomaly, as well as temperature and rainfall differences from normal since the start of the month.

Fire season analogues

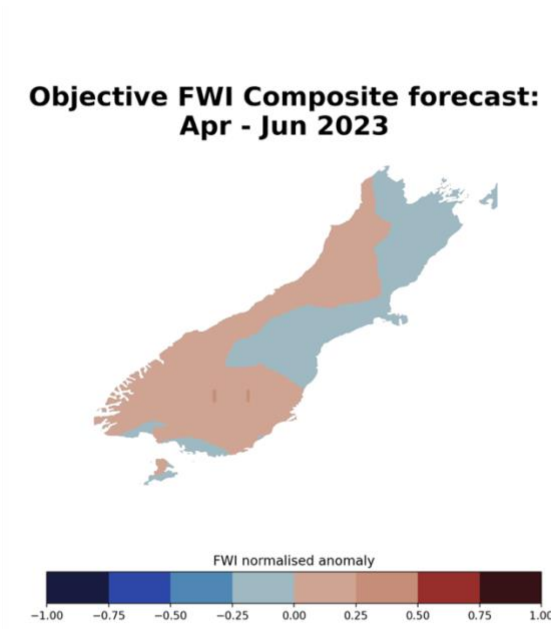
To help understand what fire weather conditions may be like this summer, we can look at analogues. Analogues are historical years with similar climatic conditions to the current year.

This season's analogue years features historical years that had La Niña transitioning to ENSO-neutral conditions, with the possibility of El Niño conditions developing by the middle of the year (Figure 5). The subjective analogue seasons are selected with expert interpretation from NIWA. The objective analogue seasons are automatically selected via a computer analysis. Where the two methods agree, confidence tends to be higher.

The current signal favours the expert-selected years for April-June. Most areas are expected to have lower fire danger than normal as mixed air flows bring the potential for periodic rainfall to most of the island. However, fire danger could be elevated at least early in the season in the northwest and lower South Island due to recent underlying dryness.



Forecaster-selected analogue season – Apr to Jun
1997
2006
2003
1993
1986
1982
2020
2018



Machine-selected analogue season - Apr to Jun
2004
2001
2011
2000
1981
2013
1990
1999

Figure 5: Analogue fire seasons as selected with expert interpretation from NIWA (top) and automated computer analysis (bottom). The Fire Weather Index (FWI) is a combination of the Initial Spread Index and Buildup Index, and is a numerical rating of the potential frontal fire intensity. In effect, it indicates fire intensity by combining the rate of fire spread with the amount of fuel being consumed. Here, the Fire Weather Index anomaly is calculated by averaging historical analogue years together and comparing to the average FWI between 1991-2020 for the relevant season.

Climate outlook: April 2023

April's air flows are expected to be variable, but still tending easterly at times. Rainfall patterns may also be variable, allowing for more precipitation in western and southern regions that were very dry during the summer. Wind speeds are expected to be below normal during April. Above average temperatures are favoured overall, but periodic cold snaps may occur. Relative humidity is generally expected to be near normal or below normal (Figure 6).

Climate outlook: April – June 2023

Guidance suggests that April-June may trend a bit drier than normal due to the easing of La Niña into ENSO-neutral conditions, with mixed air flows likely. Temperatures overall look to be warmer than average, but notable cold snaps may occur when air flows become southerly at times (Figure 7). Generally near normal to below normal relative humidity is expected. Wind speeds continue to look lower than normal across the South Island.

The tropical cyclone season for the Southern Hemisphere runs through April.

Climate outlook: April

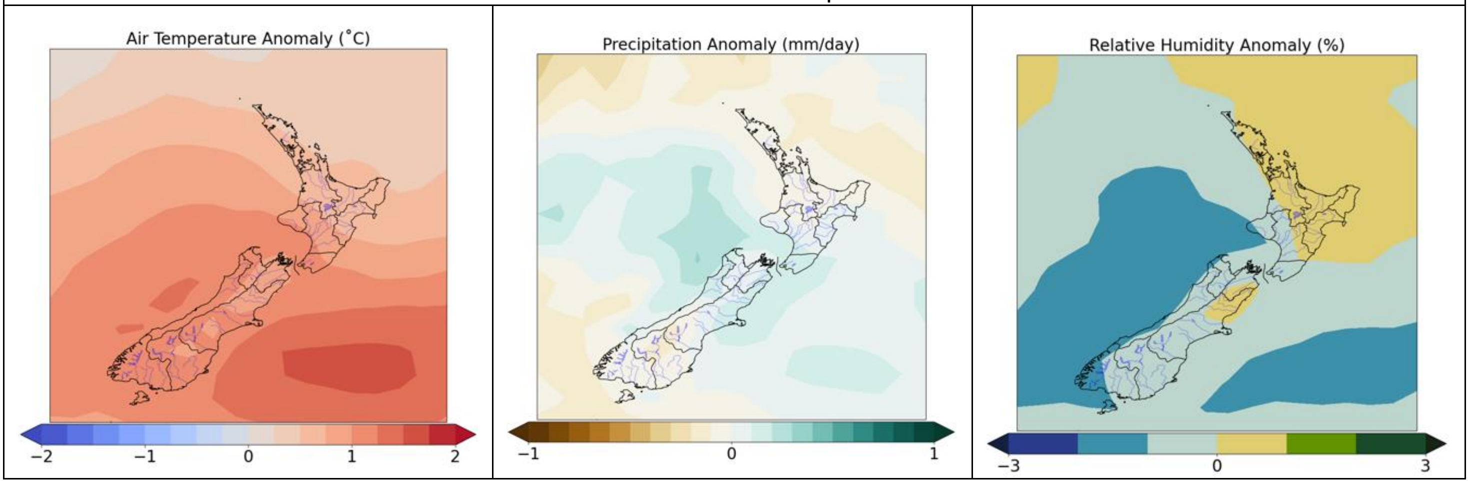


Figure 6: Climate outlook for April showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

Climate outlook: April – June

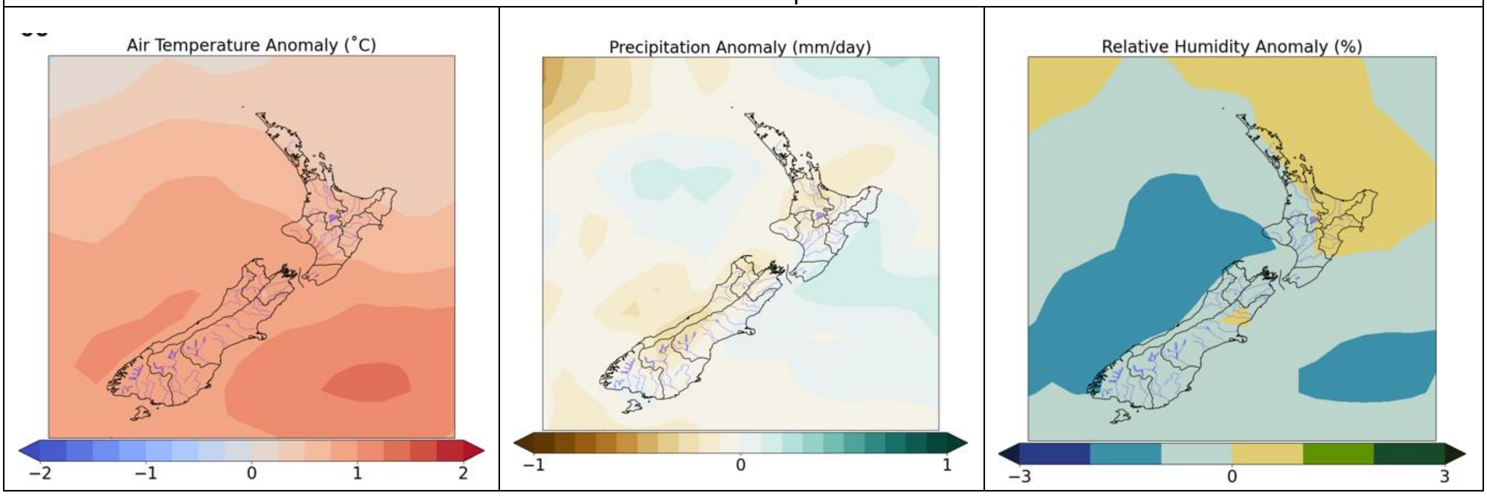


Figure 7: Climate outlook for April-June showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

Expected impact on fuels and fire danger

With Drought Code (DC) values remaining elevated in eastern and north western areas, the potential for fires to become deep-seated remains. However, recent rains have helped to reduce the availability of the medium-sized woody fuels and loosely-compacted organic subsurface layers represented by the Duff Moisture Code (DMC). This has effectively resulted in a reduction in the Build Up Index across all areas over the last few weeks. Autumn rains should see a further reduction in the underlying fuel dryness, especially in those areas that were typically very dry over the summer.

With the onset of autumn conditions, daily increases in the DC and DMC will at best be 7 points and 4 points respectively, further reducing as the days get shorter and cooler as we transition to winter. These in turn influence the Build Up Index (BUI), which is an indicator of the total available fuel for combustion. BUI values below 30 indicate that fires are unlikely to pose any difficulties for control, while values between 31-45 indicate that suppression will be difficult. There are relatively few sites that are currently exhibiting BUI values greater than 45 across the South Island, and these conditions are likely to continue easing with rain events.

Those areas with elevated grass curing (high proportions of dead material) will remain susceptible to ignition and therefore fire spread until such time as green-up occurs. This is slowly starting to happen in some areas, but in other areas grasses remain 100% cured, such as around Lake Pukaki in Mid-South Canterbury (see Figure 8). Any ignition in highly cured grasses could result in spreading fires, which could be challenging for suppression under dry windy conditions.

Scrub fuels remain a high risk at any time of the year, with the elevated nature of the fine fuels making them highly receptive to even subtle changes in the drying trend of the weather. They only need windspeeds of 20 km/h with Fine Fuel Moisture Code (FFMC) values of 60 to exhibit very high to extreme fire behaviour, which will challenge and exceed initial response capabilities.

As we transition towards the colder months, thunderstorm risk can increase due to the presence of relatively warmer temperatures at ground level compared to colder air aloft. While they only represent a very small proportion of total incidents in Aotearoa (typically recognised to be less that 2% of all ignitions), lightning has the potential to ignite fires. Where these occur in receptive fuels, they can have spectacular results. An example of this is the Hinewai Fire on Banks Peninsula in winter 2011, which consumed about 300 ha of gorse before effectively being stopped by a change in fuel type and overnight snow. However, most thunderstorms will be associated with rain, and as such things are typically too wet for fire to spread following lightning.

Figure 8: Photo taken from the Pukaki Aero RAWS (Harvest) in Mid-South Canterbury showing highly cured grass fuels

Spontaneous combustion[2]

Accumulations of vegetation debris generate heat as they start to decompose in the presence of low levels of oxygen. This occurs as microbes within the debris turn sugars into water and carbon dioxide, with heat being generated in the process. As the biological activity associated with decomposition increases within the accumulated material, the heat produced can quickly raise the internal temperature to ignition point and over time can result in spontaneous combustion.

Spontaneous combustion fires can occur within large compost or woodchip/sawdust piles, forestry skid sites, or where hay is baled when the plant material is either too green or has excess moisture (as a result of rain, dew etc).

Depending on the size of the accumulation of material, spontaneous combustion fires can be extremely difficult to extinguish, taking considerable time and the use of heavy machinery. Where these fires occur in remote locations, the potential for the fires to become large and potentially spread to surrounding vegetation is elevated even further due to delays in both detection and response, such as with remote forestry skid-sites.

[2] Report-182-Factors-contributing-to-spontaneous-combustion-of-slash-at-skid-sites.pdf (fireandemergency.nz)

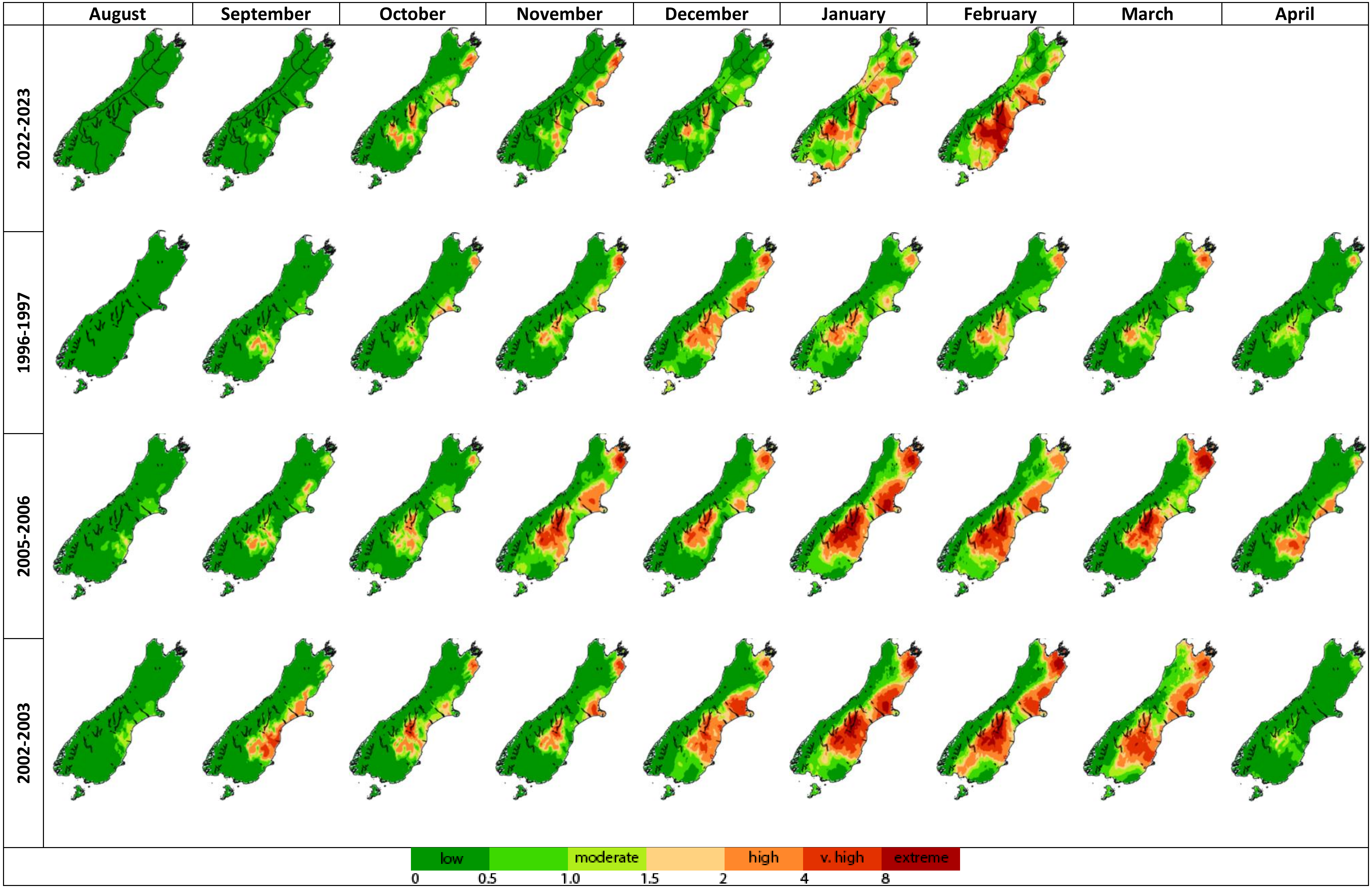


Figure 9: Monthly average severity rating for 2022-2023 up to and including January and the comparative years of 1996/1997, 2005/2006, and 2002/2003. These are analogue years for the current season and give us an insight into what the upcoming season may be like.

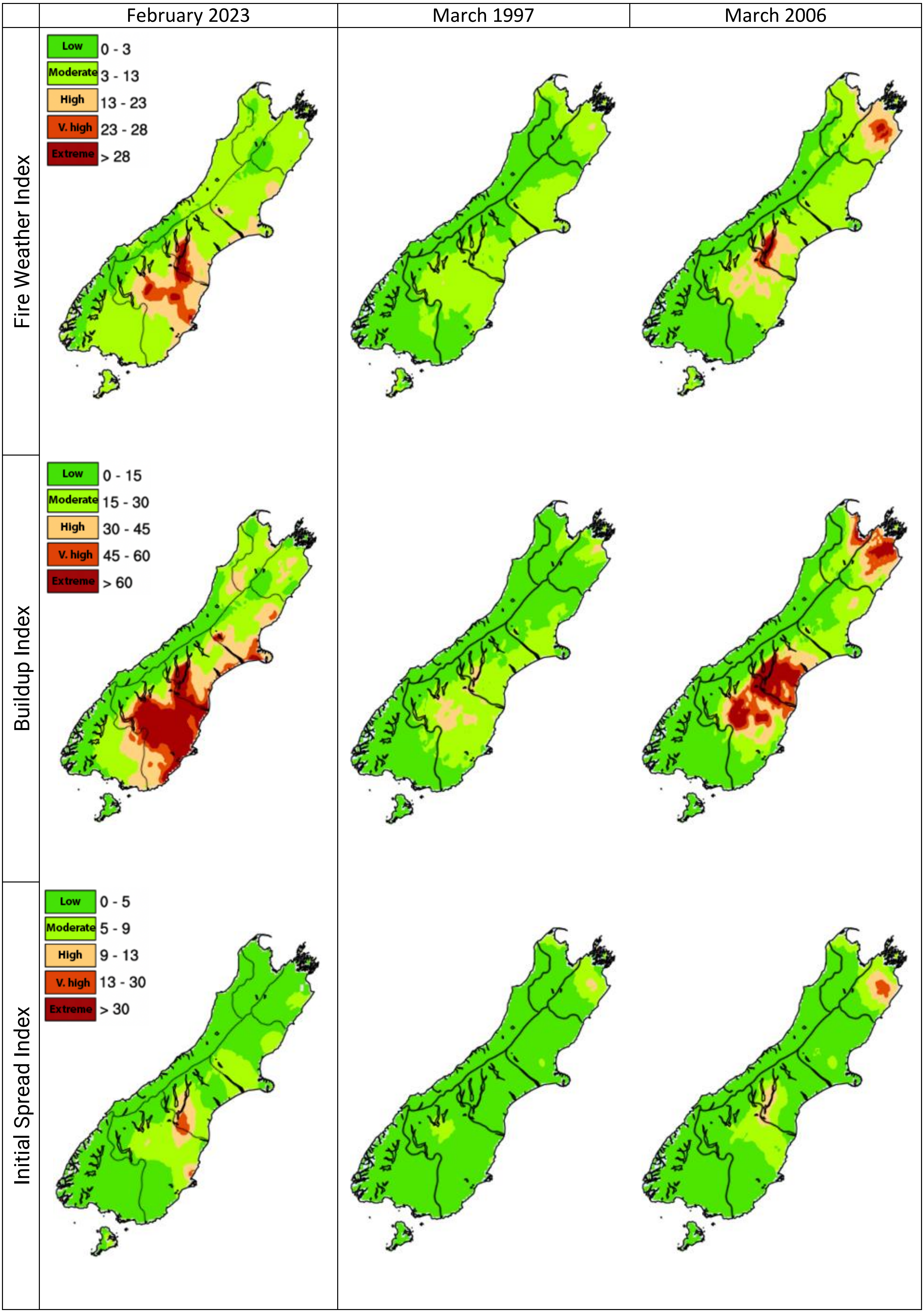


Figure 10: The most recent observed month (left column) and analogue months for March (middle and right columns); monthly average for the Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (bottom).

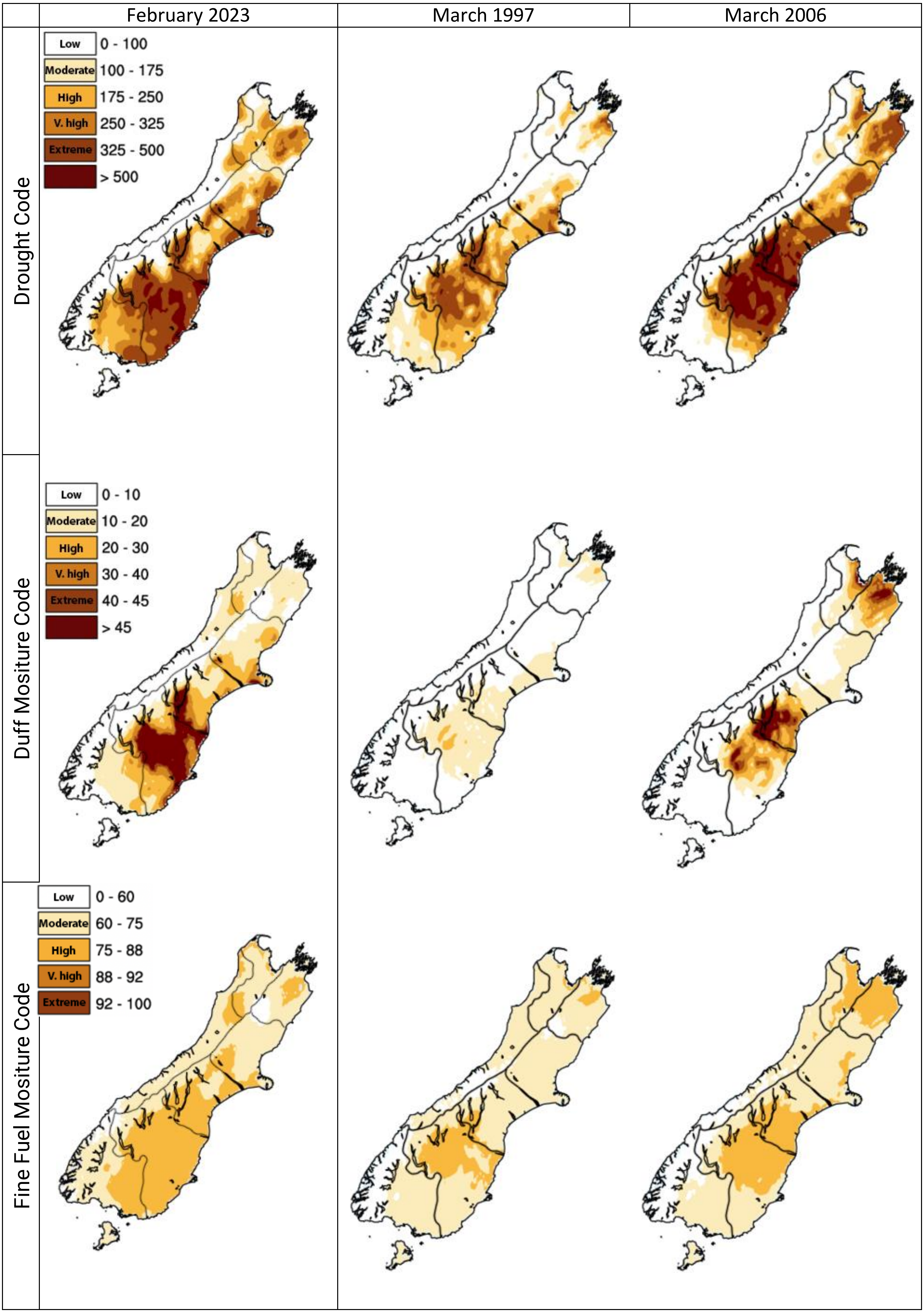


Figure 11: The most recent observed month (left column) and analogue months for March (middle and right columns); monthly average for the Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (bottom).

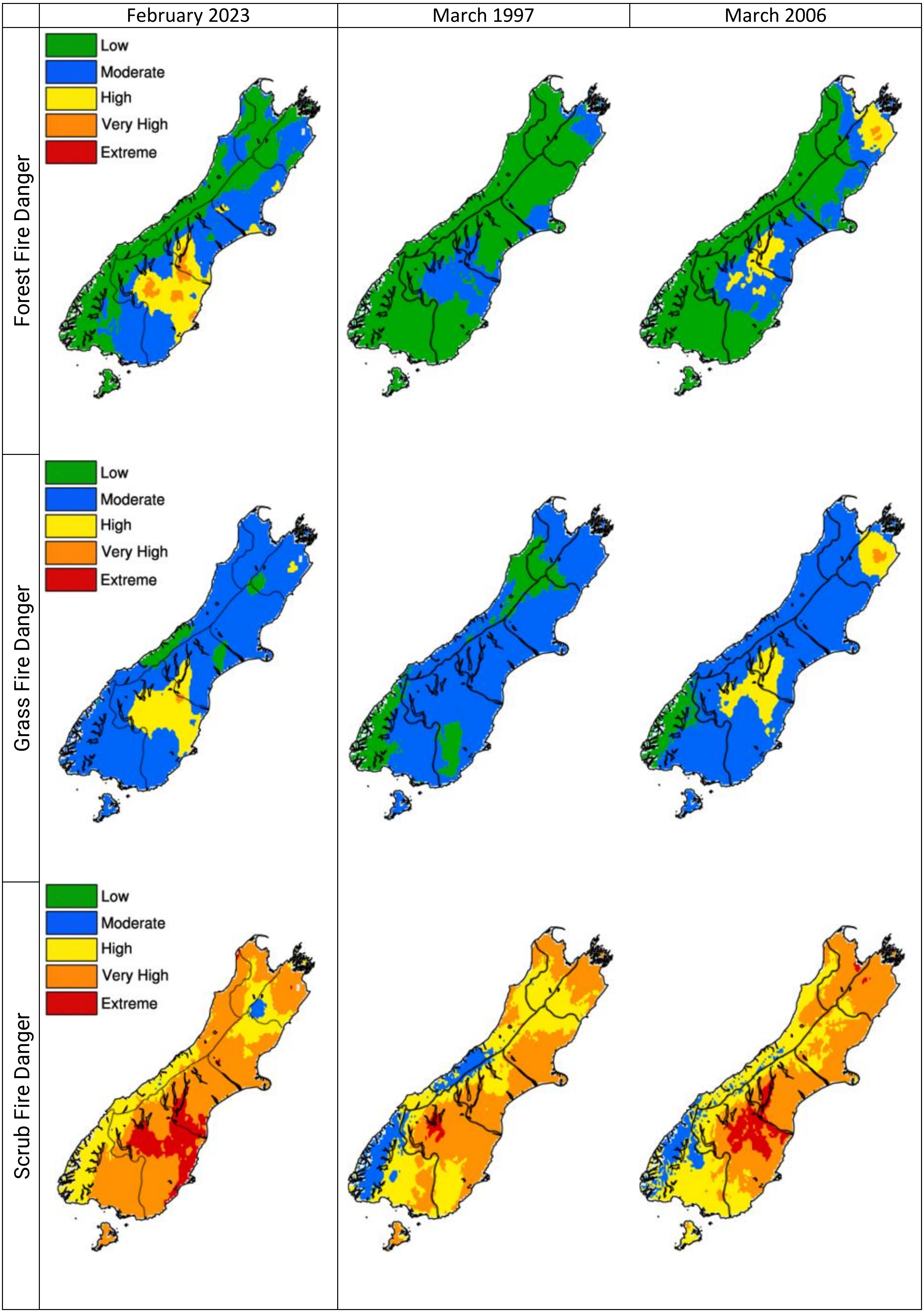


Figure 12: The most recent observed month (left column) and analogue months for March (middle and right columns); monthly average for the Forest Fire Danger (top), Grass Fire Danger (middle) and Scrub Fire Danger (bottom).

Background information on fire weather indices and codes

Fine Fuel Moisture Code: An indicator of the relevant ease of ignition and flammability of fine fuels.

0-74	Difficult
75-84	Moderately easy
85-88	Easy
89-91	Very Easy
92+	Extreme Easy

Initial Spread Index: Combines the effect of wind speed and the FFMC, providing a numerical rating of potential fire spread rate.

0-3	Slow rate of spread
4-7	Moderate fast
8-12	Fast
13-15	Very fast
16+	Extremely fast

Duff Moisture Code: A rating of the average moisture content of loosely compacted organic soil layers (duff/humus) of moderate depth, and medium-sized woody material.

0-10	Little mop-up needs
11-20	Moderate
21-30	Difficult
31-40	Difficult & extended
41+	Extreme & extensive

Fire Weather Index: Combines the ISI and BUI to indicate the potential head fire intensity of a spreading fire (on level terrain).

0-5	Low fire intensity
6-12	Moderate
13-20	High
21-29	Very high
30+	Extreme

Drought Code: A rating of the average moisture content of deep, compact, organic soil layers, and a useful indicator of seasonal drought effects on forest fuels and amount of smouldering in deep duff layers and large logs.

0-100	Little mop-up needs
101-175	Moderate
176-250	Difficult
251-300	Difficult & extended
301+	Extreme & extensive

Daily Severity Rating: A numerical rating of the daily fire weather severity at a particular station, based on the FWI. It indicates the increasing amount of work and difficulty of controlling a fire as fire intensity increases. The DSR can be averaged over any period to provide monthly or seasonal severity ratings.

Buildup Index: Combines the DMC and DC, and represents the total amount of fuel available for combustion.

0-15	Easy control
16-30	Not difficult
31-45	Difficult
46-59	Very difficult
60+	Extremely difficult

Monthly Severity Rating: is the average of the DSR values over the month. DSR and MSR captures the effects of both wind and fuel dryness on potential fire intensity, and therefore control difficulty and the amount of work required to suppress a fire. It allows for comparison of the severity of fire weather from one year to another.

0-1	Low fire behaviour potential
1-3	Moderate fire potential
3-7	High to very high fire potential
7+	Extreme fire behaviour potential

This document was prepared by NIWA in collaboration with Fire and Emergency NZ