Aotearoa New Zealand National Monthly Fire Danger Outlook (2024/2025 season)

Issue: December 2024

Current fire danger situation

An increase in dry spells during December saw a significant change in fire dangers in some areas. Indices have been steadily moving into moderate and high, with western areas still remaining at lower levels. Periods of high temperatures and strong westerly winds elevated scrub and forest fire dangers to extreme in eastern areas, but recent rain has brought the indices down to low again; although these are expected to increase again.

While ENSO neutral conditions currently continue, there is about a 50% chance of La Niña developing during January-March.

Current fuel and soil moisture status

As of 16 December (see Figure 5, left), soil moisture levels were below normal across much of the North Island and the northern and eastern South Island. Near normal soil moisture was observed around Auckland, western coastal Waikato, parts of the Kāpiti and Manawatū areas, as well as the western and lower South Island. A small area of above normal soil moisture was observed in western coastal Waikato, and in Fiordland and southern Southland.

Values of the Duff Moisture Code (DMC), Drought Code (DC) and Buildup Index (BUI) are generally moderate, indicating that increased amounts of medium and heavy fuels are available to burn, and fires will be moderately difficult to extinguish. These values increased earlier than the past few years, with some places drier than normal for this time of year, as indicated by values of the BUI prior to the latest rainfall (Fig. 1, left). The BUI saw a rapid climb in eastern parts of the country, with the Central Otago, Nelson and Northland areas also seeing increases. However, values have decreased significantly following the recent rain (Fig. 1, right), but will increase again rapidly with periods of warm, dry weather.

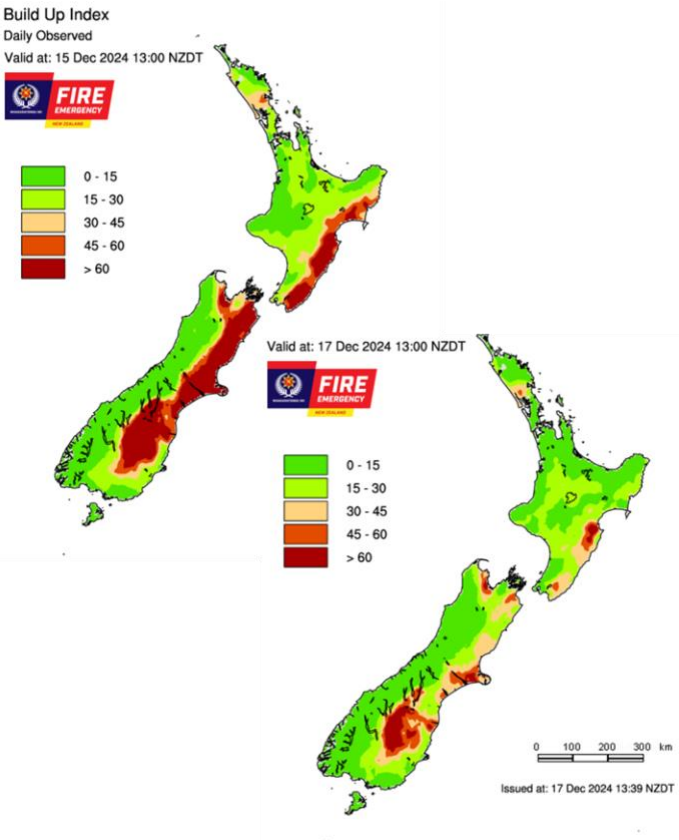


Figure 1: Maps of the Buildup Index (BUI) indicating total fuel availability from prior to (Dec. 15, left) and after (Dec. 17, right) the recent rain.

Periods of warmer weather between rain events have also brought rapid drying of fine fuels, as represented by increasingly more elevated values of the Fine Fuel Moisture Code (FFMC) (Fig. 2). The FFMC is a key indicator of ease of ignition and a significant factor influencing fire spread rates, along with wind. Dry and sunny weather over the past month has seen rapid drying of fine fuels, curing of grasses in many areas and, along with the periods of strong winds, elevated Initial Spread Index (ISI) values in eastern parts of both islands.

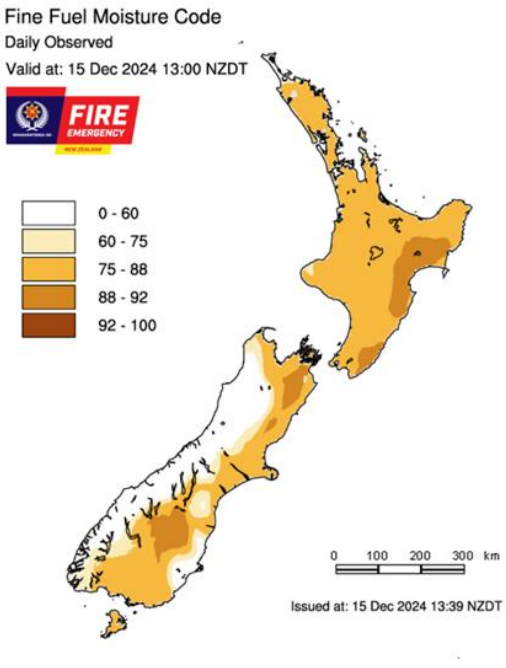


Figure 2: Map of the Fine Fuel Moisture Code (FFMC) as at Dec. 15, with elevated values across the country indicating dryness of fine fuels and relative ease of ignition.

Forecast climate and weather

Variable conditions are expected for the rest of December, characterised by alternating easterly and westerly airflows. Easterly winds will bring cooler temperatures and wetter conditions to eastern areas initially. However, a transition to westerly winds is likely towards the end of the month. During this time, there is a heightened risk of elevated fire weather conditions (spike days), as heat from Australia combines with low soil moisture levels and strong winds, particularly across eastern areas.

During January, a slow-moving pulse of the Madden-Julian Oscillation (MJO) may channel tropical moisture toward New Zealand, increasing the likelihood of significant rainfall events. However, there remains a possibility that these rainmakers either miss New Zealand or have only minor impacts, resulting in drier-than-normal and warmer-than-average conditions. This would worsen ongoing dryness and meteorological drought in affected regions. An easterly wind anomaly is most likely, reflecting the influence of a weak La Niña.

The January to March period is expected to see a continued prevalence of northeasterly and easterly winds, with La Niña's influence strengthening. Wetter-than-normal conditions are favored for the upper North Island and eastern areas of both islands, while the lower South Island is likely to experience drier-than-normal conditions. Temperatures across the country are forecast to be above average, accompanied by lighter-than-usual winds.

For more information, see page 9.

The La Niña climate pattern

ENSO-neutral conditions will likely for the rest of December, but there is about a 50% chance that La Niña will develop during January-March.

No two La Niña events are the same, and each event can produce different effects on weather conditions and therefore fire dangers across New Zealand depending on its timing, strength, and duration. In general, however, La Niña events are historically associated with higher-than-normal pressures east of New Zealand, resulting in more northeasterly winds than normal. This leads to wetter than normal conditions being favoured for northern and eastern areas, while drier than normal conditions tend to prevail in the south and west.

The El Niño-Southern Oscillation (ENSO), which includes El Niño and La Niña phases, is often highlighted in seasonal forecasts, as it the most important source of intraseasonal variability. While ENSO provides predictability over longer timescales, it doesn't fully explain all climate variability. Increasing global Sea Surface Temperatures (SSTs) due to climate change in recent years have also altered traditional impacts of ENSO phases and its associated weather patterns. It is therefore essential to continue monitoring the fire season through the Fire Weather System, with an understanding that even under normal or near-normal conditions, there will be periods of elevated fire danger.

What to watch for

Holdover fires

Land management fires that have been left to burn out during December can result in fires that will hold heat and smoulder for extended periods when DMC and DC values are moderate. In coming days or weeks, as the fuels dry and become available to burn, these fires can become more active and potentially escape, particularly during warmer and windy periods.

Complacency

Recent rainfalls can provide a perception that the current conditions are not favourable for fires to escape. This perception can lead to some complacency amongst the public, landowners and firefighters. Once the weather conditions improve, we can expect the indices to return to elevated levels relatively quickly. Warm temperatures, strong winds and availability of fine flashy fuels still provide conditions suitable for fires to start, spread rapidly and burn with moderate to high intensities, which can result in burning of large areas.

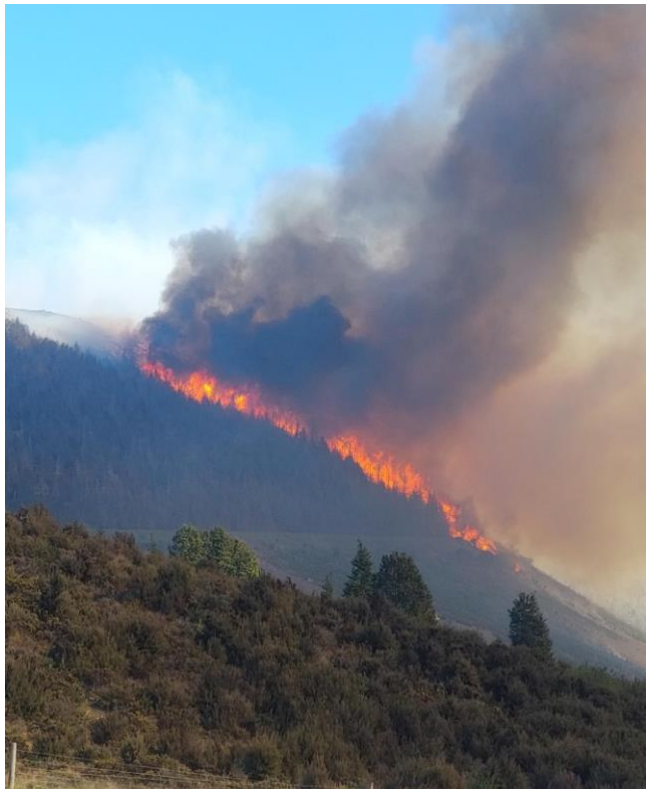
Photos from the Bridge Hill Fire of 5th December, near Arthurs Pass Canterbury, which burned in desiccated wilding pines and beech forest (left photo supplied by DOC, right photo FENZ).

Responsiveness of light flashy, medium and heavy fuels

Light flashy fuels present in scrub, logging slash and young plantations (often mixed with scrub or grass fuels) that are exposed to sunlight and wind are elevated and so more responsive to atmospheric conditions. These fuels will become readily available to burn quickly following rain due to their elevated nature. This is observable with the changing FFMC but, depending on rain amounts, ground moisture may also initially reduce fire intensity.

However, in forest fuel types with a closed canopy, the combined effects of canopy sheltering and moisture being drawn down into drier soil layers or taken up by trees means rainfall may not have a significant effect on the moisture content of surface fuels on the ground. Medium and heavy fuels can therefore remain dry, or effects of rain only be short-lived. We therefore need to watch out for fires in these fuel types, and especially during sunny, windy periods in early summer.

Like scrub fuels, some hedges can be readily available to burn as they are also elevated with fine needles, and can hold dead fuel throughout their structure. Sheltered medium and heavier fuels protected within the hedge can also dry out so that if they burn, they burn with high intensity. Managing burn piles near hedges requires extra vigilance.



Wind driven fires

The current seasonal forecast indicates winds over summer will have more of a northeasterly influence. Up until now, we have seen a season characterized by windy northwest conditions. We can continue to expect strong winds, usually associated with passing weather systems, which can lead to wind-driven fires. Recent examples include the Bridge Hill fire near Arthurs Pass, and the West Melton, Kirwee and Burnham fires in Canterbury.

Humidity

Relative humidity (RH) factors significantly in the potential for fires starting and growing. RH is itself a good indicator of the dryness of fine dead fuels, so the lower the humidity, the drier these fine fuels, and the easier fires can ignite and spread.

The flow of air over mountainous terrain can result in warmer and drier air on the lee side of the terrain, due to the foehn effect. Under westerly winds, this is more common in eastern areas such as Canterbury and Hawkes Bay. However, under La Niña conditions when northeasterly flows are more common, this can mean the opposite occurs, with warm dry conditions and lower RH on the western side. A change from the usual westerly to northeasterly winds therefore poses a significant risk to communities that are not used to dry conditions; for example, on the western side of both islands, which could see significant drying in all fuel types.

Grass curing

There has been rapid curing of grasses in parts of the country, and seasonal die-off is well underway with seedheads drying – the first indication of curing. Recent rainfall and cooler conditions will prolong curing, although grass that is already cured will still be available to burn. Following the recent rainfall, we can expect some greening up of areas as the warmer weather returns.

Fire normally starts in the fine fuels, but with an increase in the amount of dead fuel present, this means that everyday activities can cause fires. Managing grass fuels before they cure in the summer months is the key to slowing fire growth.

Aspect

North-facing slopes are good indicators of early drying. These slopes face the sun longer and in native vegetation the fuel is often different (different vegetation type, shorter, less vigorous growth) than the southern aspect. This contrasts with south-facing slopes where the radiation hits the landscape at an angle meaning it is more spread out. North-facing slopes are warmer and dry out quicker, making them more conducive to fire. Greater caution is needed when managing fire risk on northern aspects due to greater fire potential.

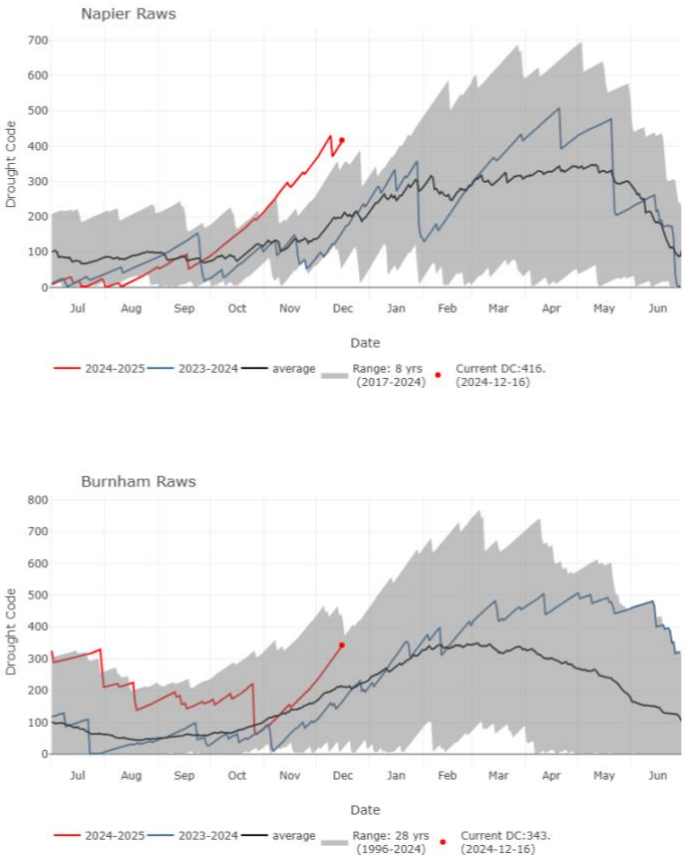


Figure 3: Examples of current trends (red line) in fire dangers using the Drought Code (DC), for Napier Rural Automatic Weather Station (RAWS) in Hawkes Bay (top) and Burnham RAWS in Canterbury (bottom). Both stations showed elevated values prior to the recent rain, well above normal (black line) as well as the same time last year (blue line), highlighting the underlying dry conditions in soil organic layers and large woody fuels. Although decreased by recent rains, these DC values (along with other codes and indices such as the DMC and BUI) will quickly rise again with warm dry weather.

Areas to watch:

Areas to monitor for fire potential include the currently dry regions in Hawke's Bay, coastal Canterbury and Central Otago. Warm, dry conditions in these areas could result in fire dangers quickly recovering to their above normal mid-December pre-rainfall levels and increasing further. However, if recent changeable weather patterns continue, or if there is an onset of more easterly flows with La Niña bringing increased rainfall and humidity, fire dangers could decline to normal or below normal levels.

In the longer term, the onset of La Niña is expected to bring moister flows to eastern and northern parts of both islands. This may lead to below normal fire potential, particularly for the east and north of the North Island around East Cape, the Coromandel, and Northland, where conditions are predicted to be slightly below normal (Fig. 4). Fire potential in other eastern areas of the North Island such as Hawkes Bay and Wairarapa is not expected to decrease as much due to the current elevated fire dangers offsetting the moisture brought by La Niña.

For the South Island, the onset of La Niña with its increased northeasterly flows is predicted to result in slightly above normal fire potential for inland Otago and Southland, although this may be partly offset by the current moisture anomaly. Warmer, drier conditions are also expected for the far south with La Niña, but are predicted to produce normal fire dangers due to the wetter than normal conditions experienced in these areas in recent months.

Areas around Nelson have missed much of the recent rains and are beginning to dry, however are expected to only reach normal fire potential; whereas fire dangers in Marlborough have dropped recently and are expected to remain below normal to normal. Along the east coast of the South Island, fire potential is expected to be around normal, with the currently elevated fire dangers around Christchurch and North Canterbury offsetting the expected effects of cooler, moister onshore flows. However, depending on the timing and strength of the La Niña event, fire potential might end up below normal, especially along the eastern coastal strip, or possibly even dry out again and increase if La Niña does not eventuate and dry periods continue.

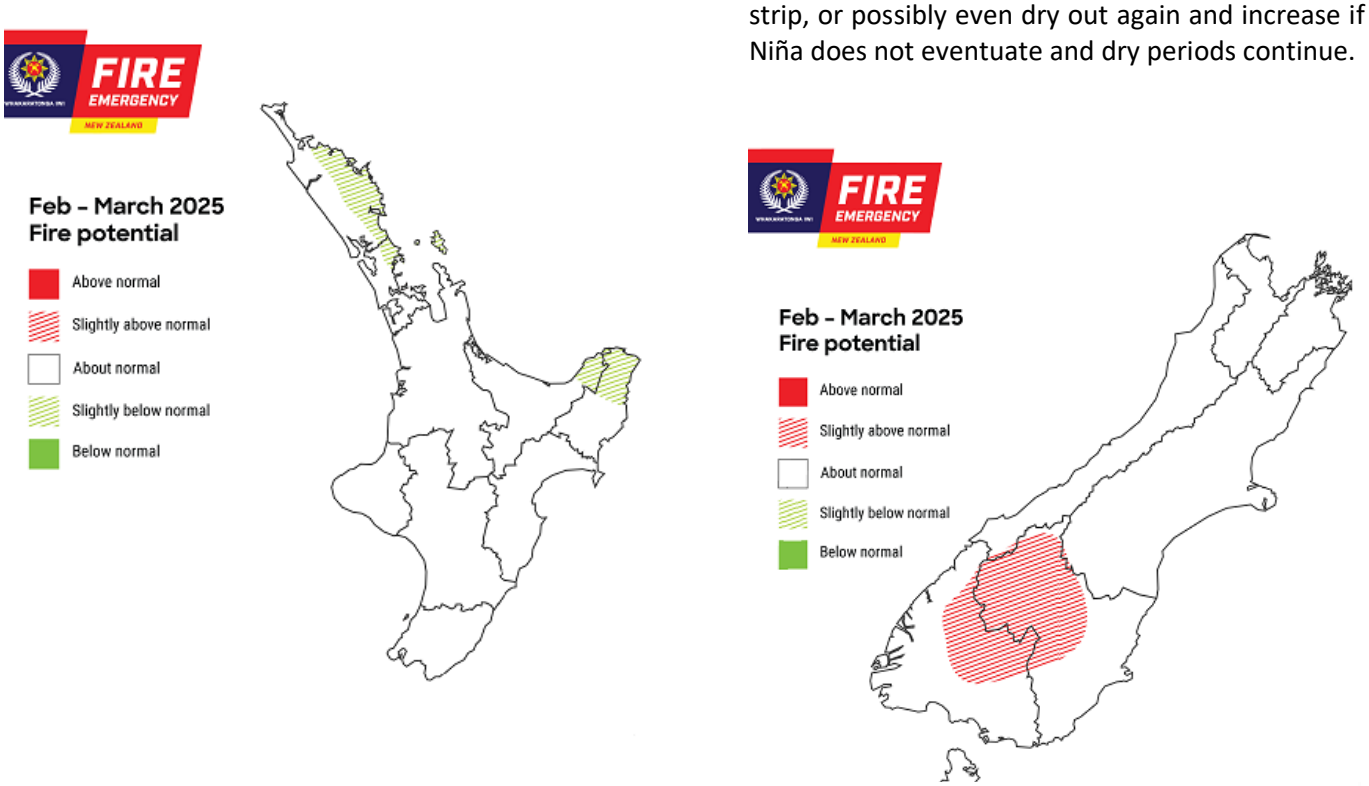


Figure 4. Fire potential over the next three months for the North and South Islands based on an assessment of the effects of climate predictions for the Jan-Mar period. However, this outlook is at odds with the current situation which may offset the impact of the seasonal prediction. Areas identified as above or below normal may change in future outlooks as certainty around seasonal climate drivers increases as the fire season develops.

Current climate

In November, temperatures were above average (0.51°C to 1.20°C above average) or well above average (>1.20°C above average) for most of the country. Temperatures were near average (±0.50°C of average) in parts of Southland, inland Otago, the West Coast, and northeastern Northland. So far in December, temperatures have been well above average across both the North and the South Islands (Figure 5, right).

November rainfall was below normal (50-79% of normal) or well below normal (<50% of normal) for much of the country. Rainfall was above normal (120-149% of normal) or well above normal (>149% of normal) for parts of the West Coast.

So far in December, rainfall has been below or well below normal for much of the country. Small parts of Auckland, as well as West Coast and Fiordland have observed above normal rainfall, with near normal rainfall observed in small parts of western Taranaki and coastal Waikato, and Rakiura/Stewart Island (Figure 5, middle).

As of 16 December (see Figure 5, left), soil moisture levels were below normal across much of the North Island and the northern and eastern South Island. Near normal soil moisture was observed around Auckland, western coastal Waikato, parts of the Kāpiti and Manawatū areas, as well as the western and lower South Island. A small area of above normal soil moisture was observed in western coastal Waikato, and in Fiordland and southern Southland.

Climate drivers

Sea surface temperatures (SSTs) remained in the neutral range in the central equatorial Pacific (Niño 3.4 Index) ending 16 December (-0.27˚C), falling sharply over the last few weeks. As of 16 December, the 30-day relative Niño 3.4 Index[1] (RONI) was -0.75˚C, reflective of the central equatorial Pacific being significantly cooler than the average of the global tropics.

The Southern Oscillation Index (SOI) was on the La Niña side of neutral during November (+0.4) and September-November (+0.3), but daily values show a recent trend towards more positive values.

While recent signals in both the ocean and the atmosphere point to the Pacific transitioning to more distinct La Niña-like conditions over the course of December and into January, there is still large uncertainty as to whether official La Nina thresholds will be exceeded over the coming season; guidance from the international forecast models that NIWA monitors indicates about equal chances for La Niña (50%) and neutral (49%) categories over the forecast period. A “La Niña Watch” remains in effect.

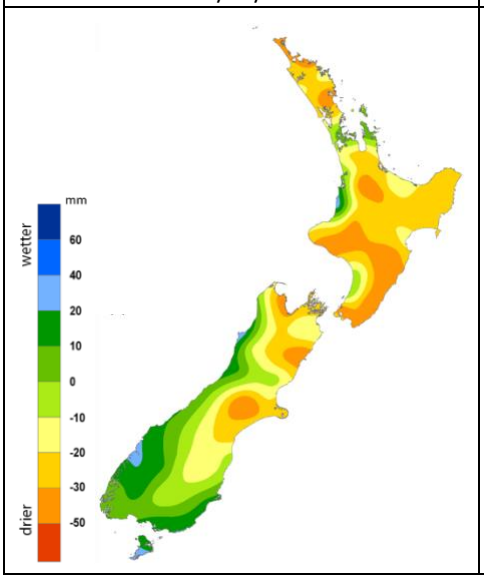
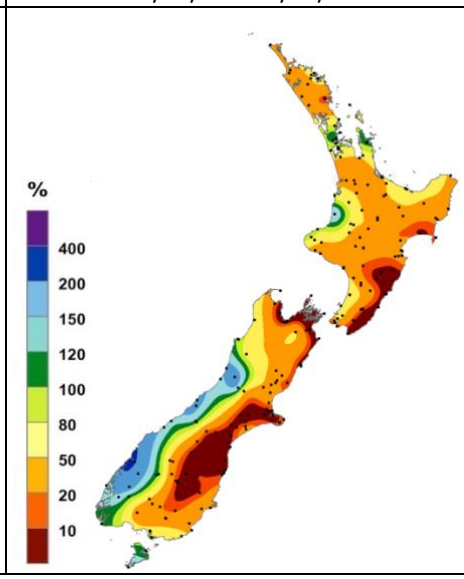
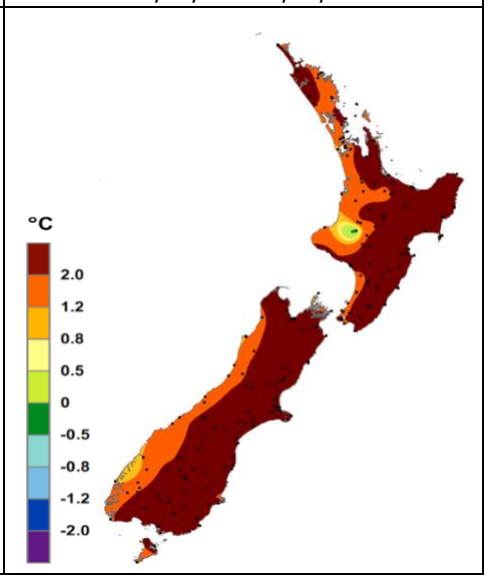
The Indian Ocean Dipole (IOD) index became more strongly negative in November, and the latest (23 November) 30-day anomaly is -1.38. A negative IOD is typically associated with developing La Niña events and the eastern Indian Ocean is accordingly warmer than average.

During November, convective forcing associated with the MJO reached the eastern Indian Ocean (phase 3) where it was associated with increased convection in the last few days of November. In December, another pulse originated in the Indian Ocean and is currently over the Maritime Continent (phase 5). This pulse will gradually move eastwards into the Western Pacific during the latter half of December and into January.

New Zealand’s coastal water temperatures have continued to warm in December. Marine heatwave conditions are occurring near the east, southeast and north of the North Island, and east of the South Island. Model guidance suggests the potential for intensifying marine heatwave conditions over the next few months.

[1] The Relative Oceanic Niño 3.4 Index (RONI) is a modern way of measuring oceanic El Niño and La Niña that is complementary to oceanic traditional indices. While traditional oceanic indices like the Niño 3.4 Index monitor SSTs in one region, the RONI compares the average SST in the central equatorial Pacific with the average SST across the global tropics. Since tropical rainfall patterns respond to relative changes in ocean temperatures, this new relative index can help forecasters better determine if the equatorial Pacific is warmer or cooler than the rest of the global tropics, which has become more challenging to discern as seas warm because of climate change.

Figure 5: Maps showing the current soil moisture anomaly, as well as rainfall and temperature differences from normal since the start of the month.

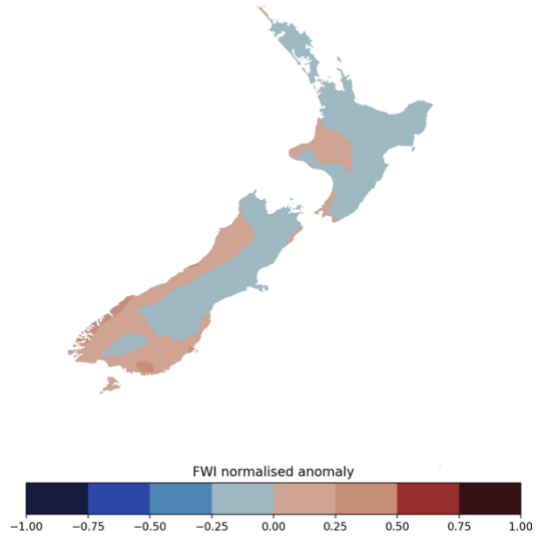
Soil moisture anomaly: 16/12/24	Rainfall anomaly: 01/12/24 – 16/12/24	Temperature anomaly: 01/12/24 – 16/12/24
		

Fire season analogues

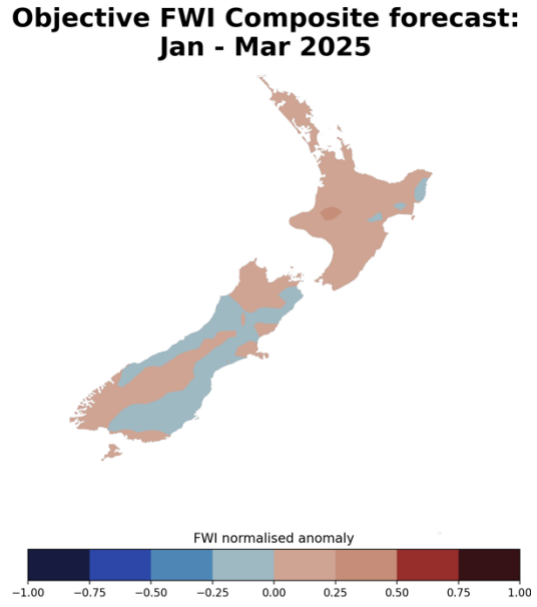
To help understand what fire weather conditions may be like this summer, we can look at analogues. Analogues are historical years with similar climatic conditions to the current year.

This season's analogue years feature historical years that had La Niña patterns in the ocean (Figure 6). 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. These analogues have less similarity than normal to the selected years owing to weak La Niña conditions. The strongest analogues are the fire seasons of 2022-2023 and 2020-2021.

Northeasterly quarter winds will become more likely in the coming months, and this is likely to cause a drying trend in the west of both islands, potentially increasing the fire weather threats there. Conversely, the east of both islands may be exposed to more rainfall, onshore winds, higher humidity, and a decrease in the fire weather potential. The upper North Island may also be more exposed to northerly rainmakers as the three-month period progresses.



Forecaster-selected analogue season - Jan to Mar
2023
2022
2021
2011
2008
2006
1996
1989



Data-driven analogue season - Jan to Mar
2020
2015
2014
2012
2008
2007
2000
1997

Figure 6: 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: January 2025

January's air flows are expected to tend more northeasterly to easterly at times as high pressure becomes favoured near and east of New Zealand. This will bring an increased chance for drier than normal conditions to the west of both islands, although the West Coast may still see moisture-bearing fronts at times. Meanwhile, the east and north of the North Island have an increased chance for wetter than normal conditions. Wind speeds are expected to be below average across most of the country except for far northern areas, while above average temperatures are favoured (Figure 7).

Climate outlook: January – March 2025

A northeast to east air flow anomaly will be favoured during the season. Temperatures for the next three months are expected to be above average overall (Figure 8). Owing to the likelihood for weak but potentially short-lived La Niña-like conditions throughout the season, rainfall is generally favoured to be above normal in the upper North Island and east of both islands, with drier than normal conditions possible in the lower South Island. Slightly above normal relative humidity is expected in most regions. Wind speeds are expected to be lower than normal.

The tropical cyclone season for the Southwest Pacific runs through April 2025. NIWA has assessed that the risk for an ex-tropical cyclone to come within 550 km of New Zealand is normal to elevated for this season.

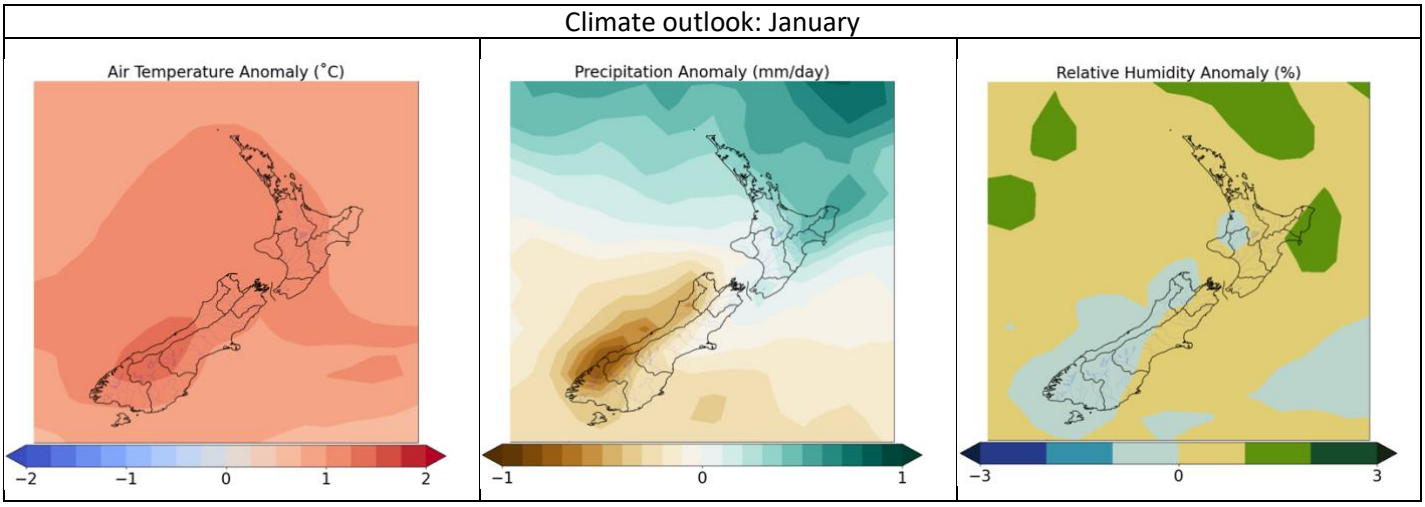


Figure 7: Climate outlook for January showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

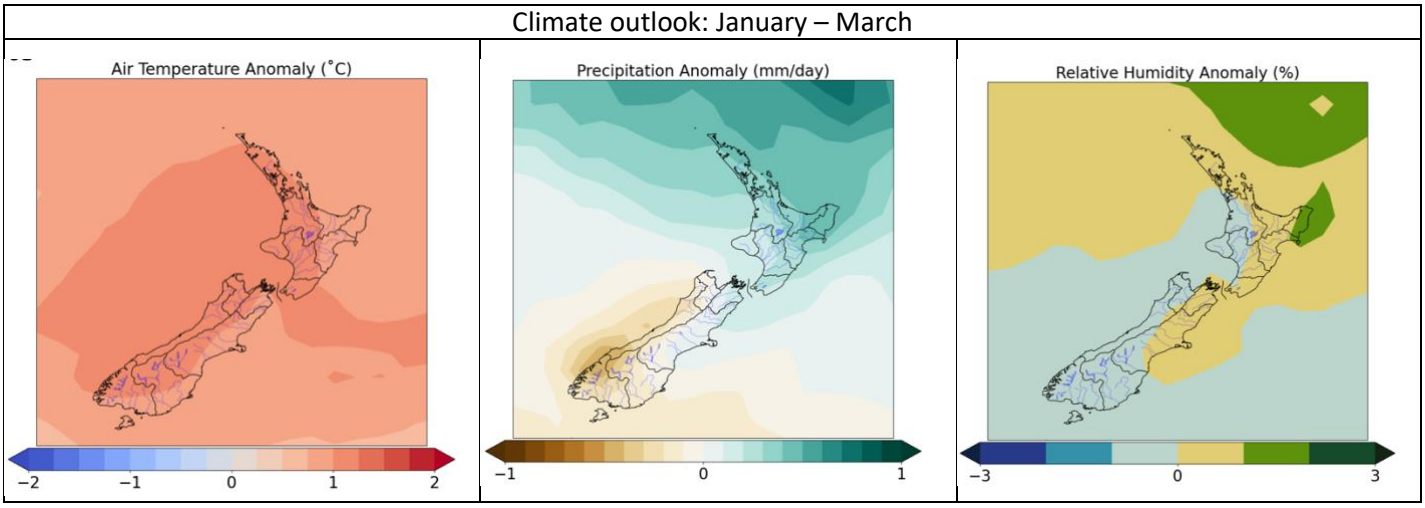


Figure 8: Climate outlook for January-March showing forecast temperature (left), rainfall (middle) and relative humidity (right) anomalies.

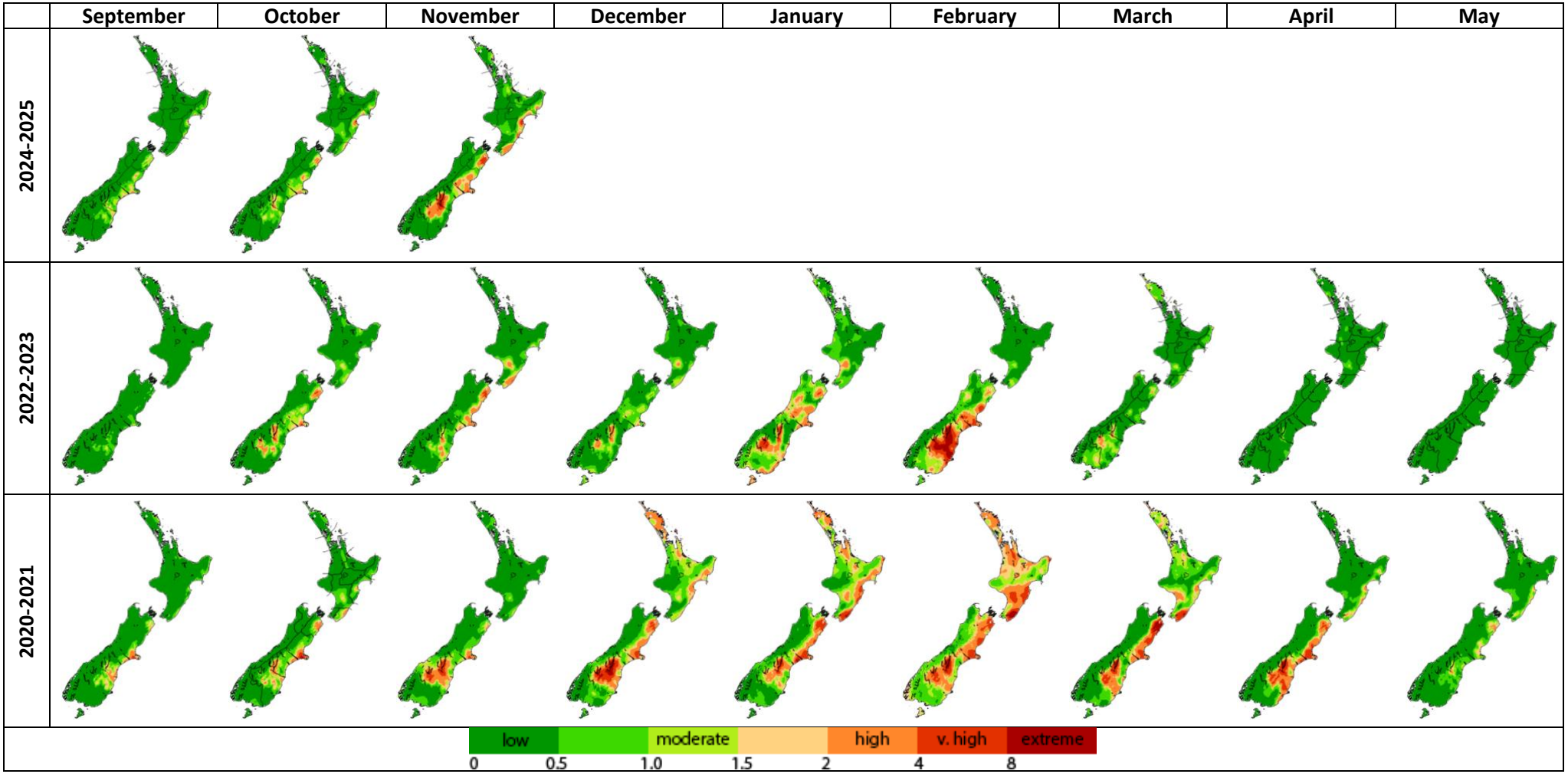


Figure 9: Monthly average severity rating for the current year 2024/2025 and the comparative years of 2022/2023 and 2020/2021. These are analogue years for the current season and give us an insight into what the upcoming season may be like.

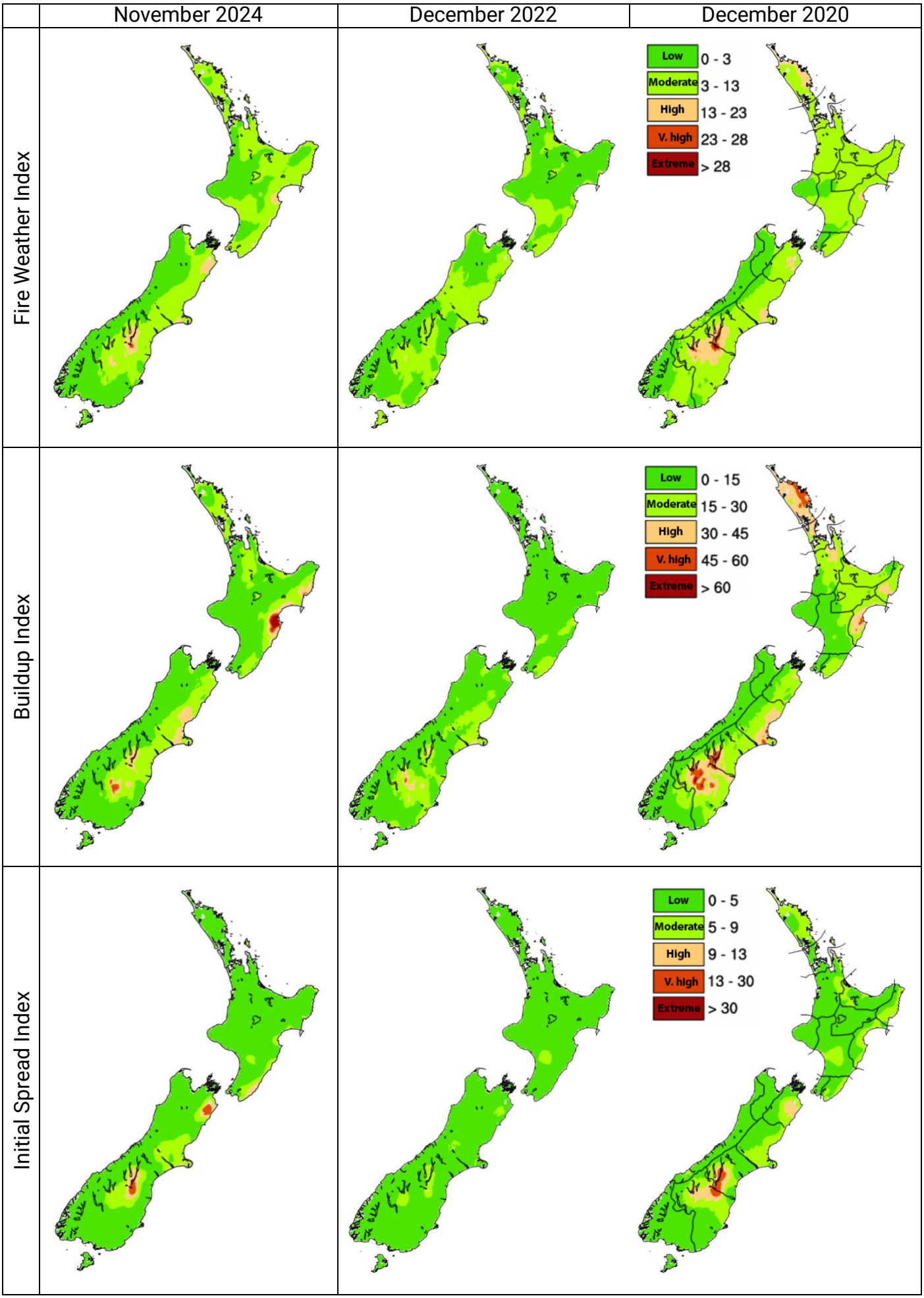


Figure 10: The most recent observed month (left column) and analogue months for November (middle and right columns); monthly average for the Fire Weather Index (top), Buildup Index (middle) and Initial Spread Index (bottom).

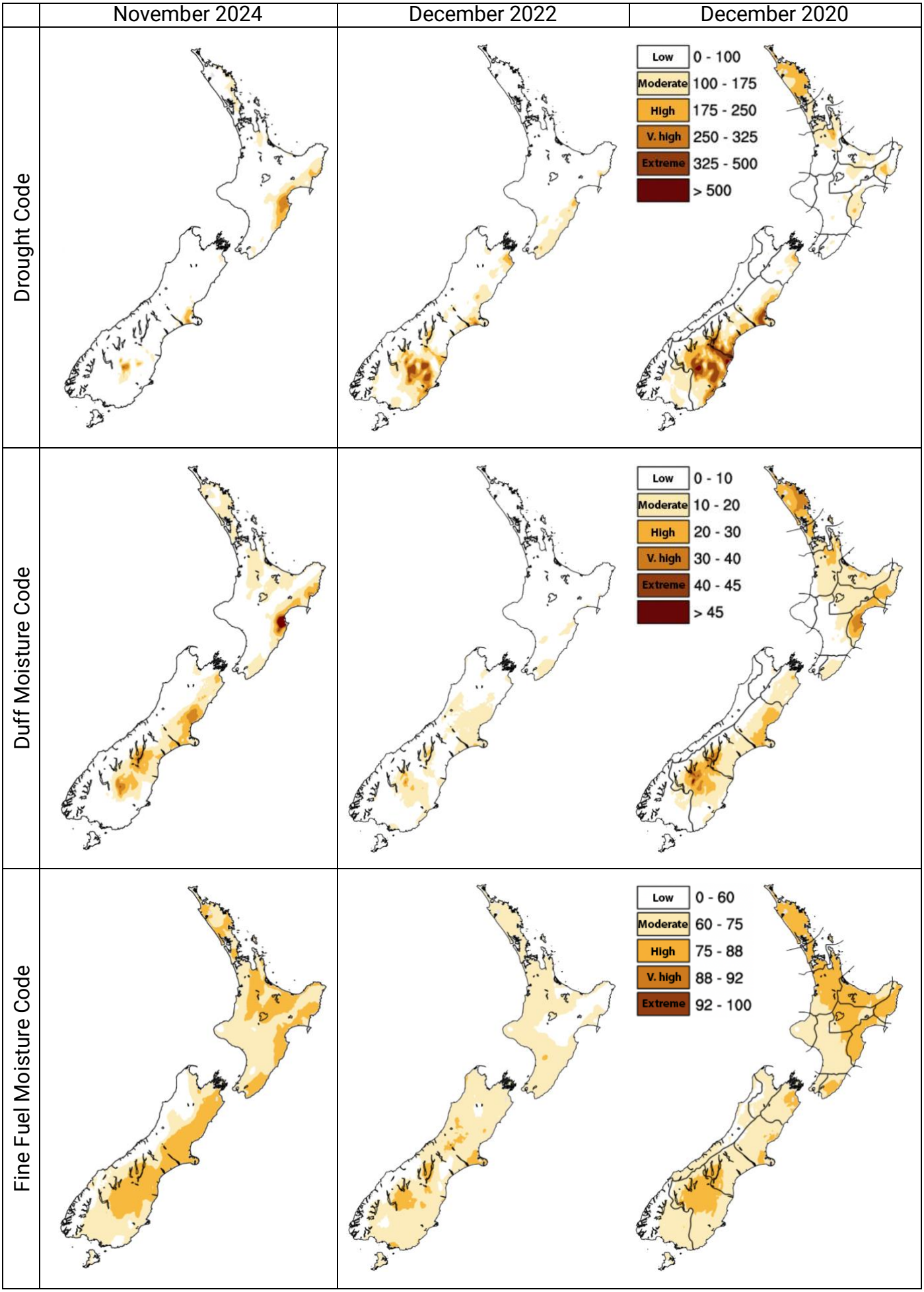


Figure 11: The most recent observed month (left column) and analogue months for November (middle and right columns); monthly average for the Drought Code (top), Duff Moisture Code (middle) and Fine Fuel Moisture Code (bottom).

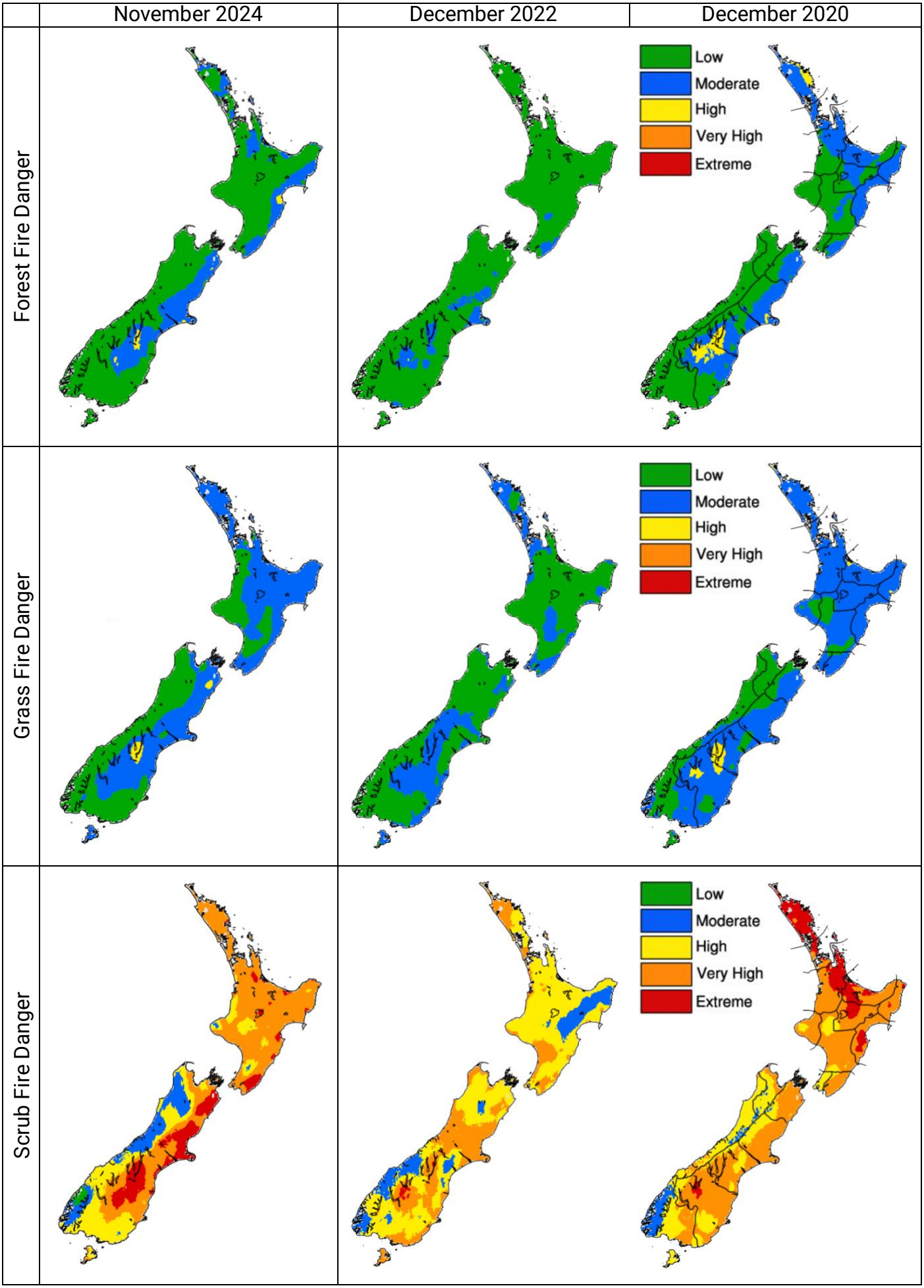


Figure 12: The most recent observed month (left column) and analogue months for November (middle and right columns); monthly average for the Forest Fire Danger (top), Grass Fire Danger (middle) and Scrub Fire Danger (bottom).

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