Extreme rainfall and drought

This report presents indicators of drought, annual rainfall and days where extreme amounts of rainfall occurred in Aotearoa New Zealand. It comments on the current overlap in where these days occur and the geographical distribution of populations more vulnerable to extreme weather.

Key facts

- Many areas of the eastern and northern North Island received 50% or more excess rainfall over their normal levels in 2023.
- New Zealand experienced an average of 19.9 days with extreme rainfall in 2023. Such days were most common in northern and eastern areas of the North Island, which received as many as 39 of them in 2023.
- Though data for Soil Moisture Deficit is mostly limited to the North Island, the few areas of the South Island with valid data had far more dry days than anywhere else.
- Higher concentrations of vulnerable populations live in areas prone to extreme rain, particularly Māori, young children and people living in higher levels of deprivation.

Climate change will increase extremes of drought and rainfall

Detecting changes in rainfall patterns in New Zealand is difficult due to the high variability in rainfall from year to year and from region to region. The variability is caused by changing weather patterns and natural climate variations such as El Niño (Ministry for the Environment and Stats NZ 2020). In 2023, the effects of Cyclone Gabrielle pushed the amounts of rainfall received in some parts of the country far above their normal levels, while other areas were unaffected.

Climate change is projected to cause both the annual amount of rainfall and the number of days with extreme rainfall to increase in the west and south of both islands, areas which have not historically been affected by extreme weather. An ‘extreme rainfall day’ is one where the amount of rainfall is greater than the 95th percentile during the Climate Normal Period (1991–2020).

The number of dry days (those in Soil Moisture Deficit) is projected to increase in the North Island and inland areas of the South Island (Ministry for the Environment 2018). A day in Soil Moisture Deficit (a ‘dry day’) is one where the moisture content of soil is less than half the soil’s capacity to hold water.

+20% **Extreme rainfall days**	**Extreme rainfall days are expected to increase by more than 20% in the south and west of the South Island by 2090** (Ministry for the Environment 2018).
+5% **Dry days**	**Dry days are expected to increase by about 5% by 2090 across New Zealand (up to 10 more days per year)** (Ministry for the Environment 2018).

Extreme rainfall and drought can have several effects on health

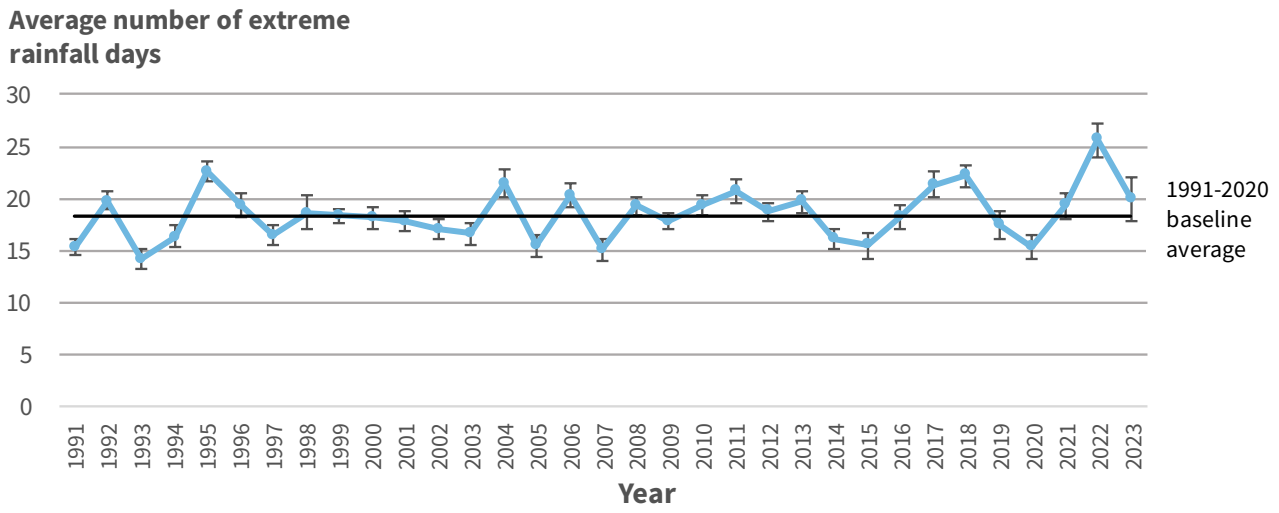
Variations in rainfall patterns can affect health in several ways:

- Drinking water: Prolonged drought can reduce the quality and the amount of drinking water available. Flooding caused by extreme rain can also affect the quality of drinking water. New Zealand's populations that rely on rainwater tanks for their drinking water supply can be particularly affected by periods of drought (McMichael, 2013). See the 'Drinking water' domain for more information.
- Gastrointestinal infections: Heavy rainfall washes disease-causing pathogens into waterways, where they can contaminate drinking water sources. Studies show a positive association between heavy rainfall and campylobacteriosis outbreaks, such as in Havelock North in 2016 (Gilpin et al 2020).
- Leptospirosis: Floods displace rodents from their usual habitats, which may then congregate around houses where food is easily available. Rats are known to carry a variant of the leptospirosis bacteria, which may survive in flood water or soil for several days before infecting a human host (Vallee et al 2023). See the 'Climate sensitive diseases' domain for more information.
- Food: Drought can reduce crop production, meaning less (and possibly more expensive) food is available. Food from freshwater sources will also be diminished. Extreme rainfall can also damage crops or prevent harvests (McMichael, 2013).
- Mental health: Drought can strongly affect mental health, particularly for those in rural areas who rely on rain for their livelihoods. Similarly, extreme rainfall can lead to flooding or landslides, damaging infrastructure and property - and placing severe mental stress on those affected (McMichael, 2013).

Extreme rainfall is variable, but its effects are highly localised

During the Climate Normal Period (1991–2020), which sets a baseline for climate variables like temperature and rainfall, the annual average number of extreme rainfall days per year was 18.2 (about 5% of days in a year). In 2023, the average was 19.9 (Figure 1). In the last ten years of data, the number of annual extreme rainfall days has been more variable than normal, with both the all-time record high (25.6 days in 2022) and third-fewest on record (15.1 in 2020) occurring within two years of each other.

Figure 1: Average number of days with extreme rainfall, 1991–2023



Note: 95% confidence intervals have been presented as vertical bars. The baseline refers to the most recent Climate Normal Period, 1991–2020

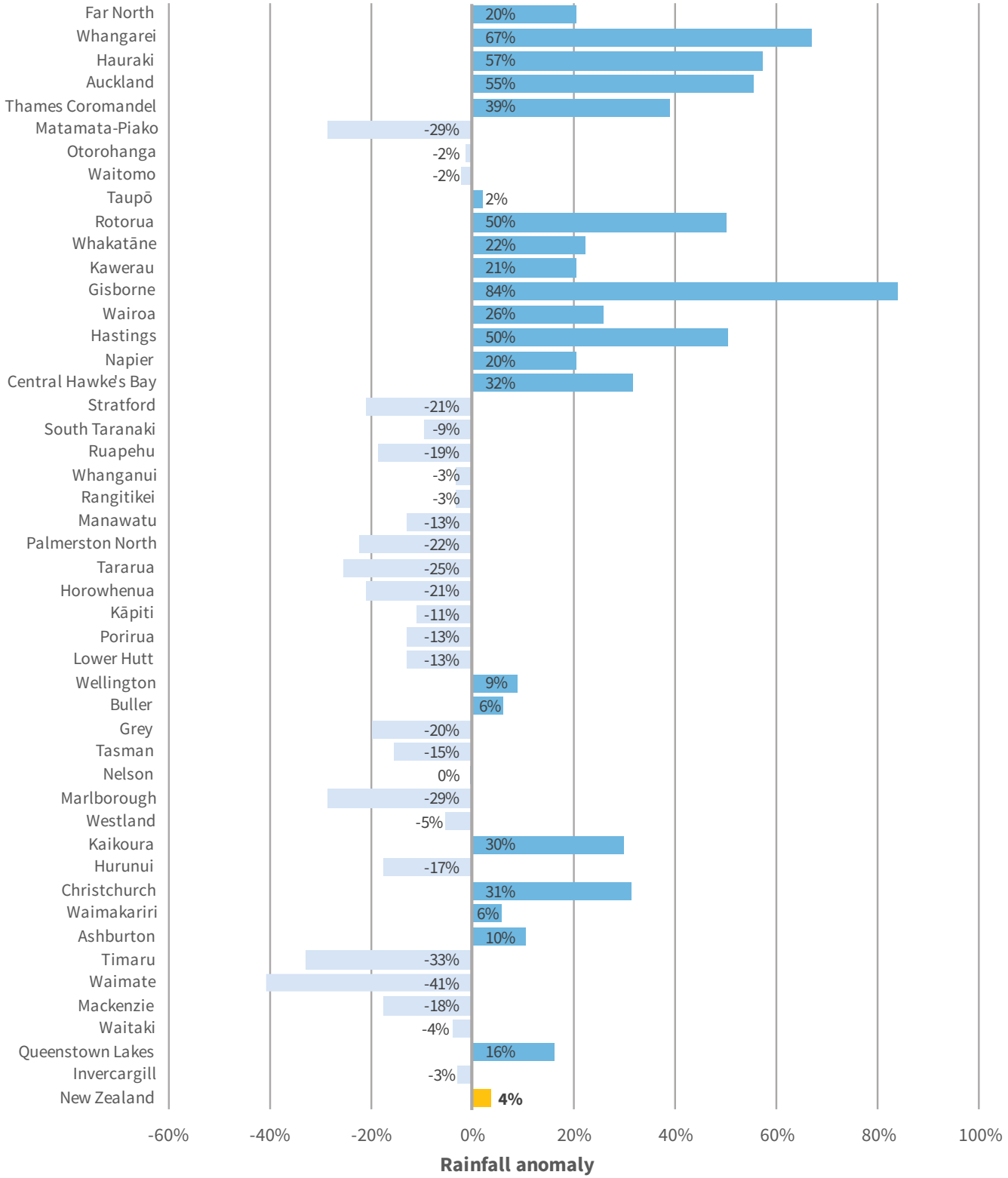
(NIWA 2024). Thirty years of data were averaged to act as a benchmark against which current or recent observations can be compared. The New Zealand average is calculated based on the data taken from each climate station with valid data for a given year.
Source: National Climate Database (CliFlo), NIWA

Figure 2 shows the ‘rainfall anomaly’ for every Territorial Authority (TA) with valid data (see ‘data for this indicator’) for 2023. ‘Rainfall anomaly’ compares the quantity of rainfall each TA received in 2023 to the region’s annual average during the Climate Normal Period. A positive value indicates rainfall in quantities above the norm, and a negative value indicates less.

Due largely to Cyclone Gabrielle and the extreme weather that led to the Auckland floods, much of the North Island received unusually high quantities of rainfall in 2023. Several TAs received 50% or more rainfall above their typical amount, and Gisborne received as much as 84% more rain than normal over the course of the year. A few districts also received noticeably lower amounts of rain, with some receiving 30% less than normal rainfall or below in 2023.

Therefore, while parts of the country were undeniably far wetter than usual, regional differences in weather mean that New Zealand as a whole only received 4% more rain than normal. This demonstrates that regional-level data must be considered when analysing climate patterns, as national-level data may obscure localised and often more telling information.

Figure 2: Quantity of rainfall compared to the Climate Normal Period (1991–2020), by TA, 2023



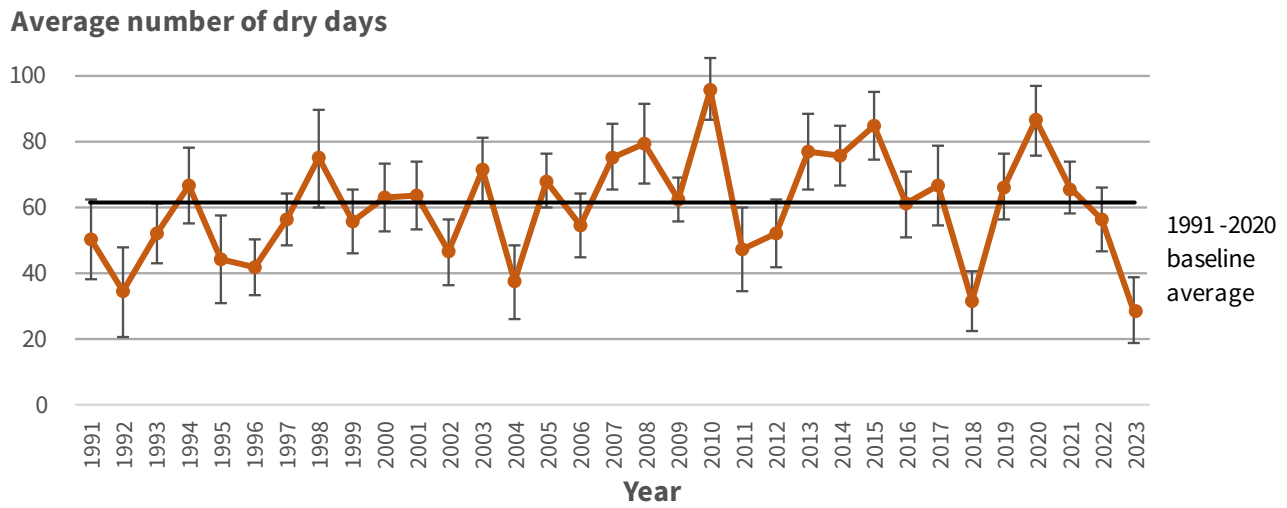
Source: National Climate Database (CliFlo), NIWA

A wetter North Island reduces the average Soil Moisture Deficit

In 2023, the average number of days in Soil Moisture Deficit was well below the 1991–2020 baseline in 2023. However, this average is based on relatively few stations compared to the average for extreme rainfall - and the majority of these are located in the North Island (see the map at Figure 4b).

Since the South Island is typically drier, and much of the North Island received more than the usual amount of rainfall in 2023, this should not be considered a representative national average.

Figure 3: Average number of days with Soil Moisture Deficit, 1991–2023



Source: National Climate Database (CliFlo), NIWA

Extreme rainfall was more common in the North and East

In 2023, New Zealand experienced an average of 19.9 extreme rainfall days, though several TAs, particularly in the North and East of the North Island experienced much more than the average. Note that 'extreme rainfall' refers to rain in quantities above normal levels for a given region. That is, if one region has more extreme rainfall days than another, that does not imply that the first region received more rain, only that it experienced more days of unusually high rainfall.

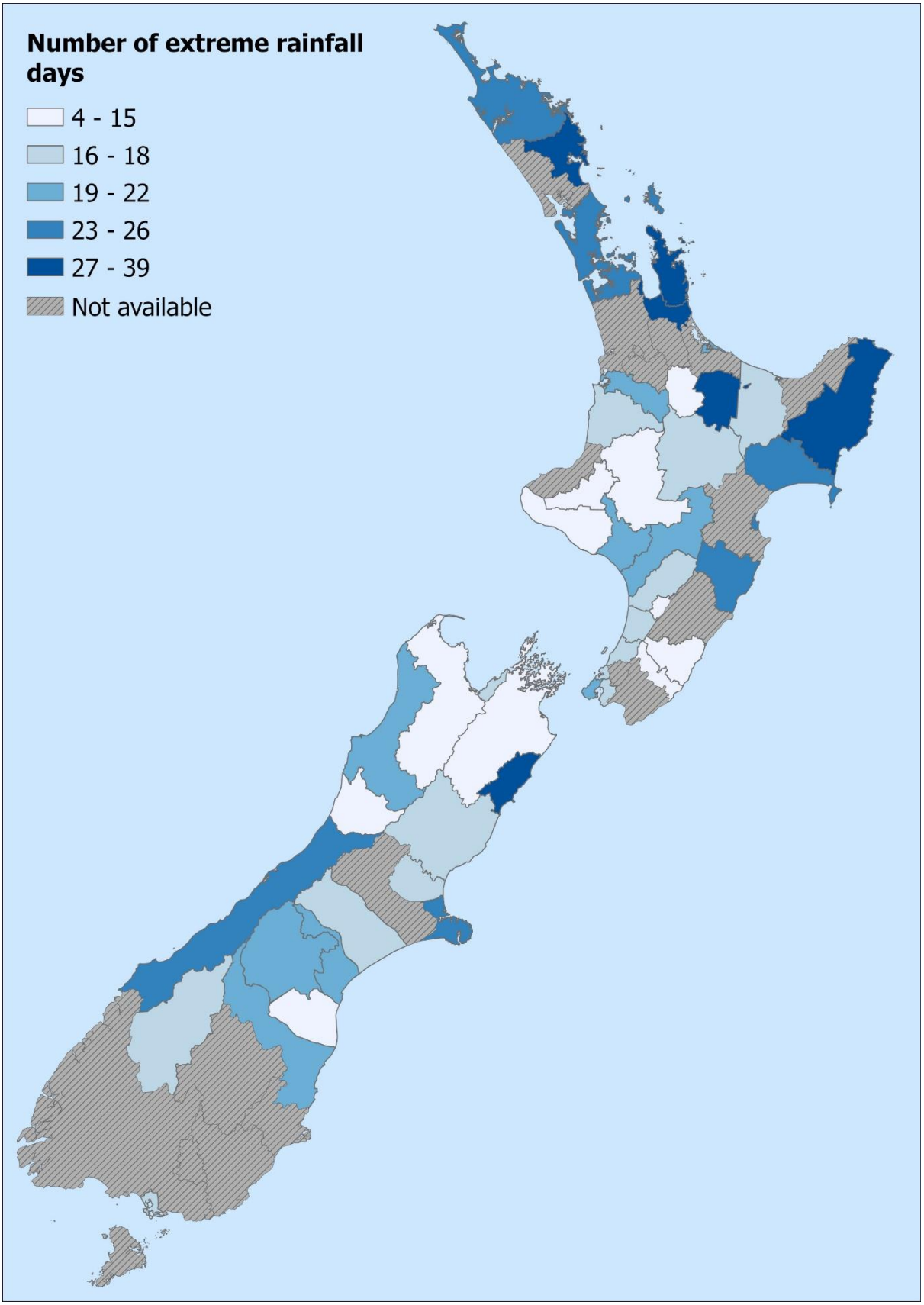
The greatest number of extreme rainfall days occurred in:

- Hauraki and Kawerau (39 days each)
- Kaikoura (32 days)
- Whangarei and Rotorua (31 days each)
- Gisborne (30 days)
- Thames-Coromandel (27 days)
- Far North & Central Hawke's Bay (26 days each)
- Westland (25 days)

It is quite likely that many of the TAs in the North Island that are labelled 'Not available' in Figure 4a would also have experienced an above-average number of extreme rainfall days.

For data quality reasons, we excluded any TAs with data for less than 75% of the year from our analysis, but there is a strong similarity between the path of Cyclone Gabrielle and the TAs that lacked sufficient data in 2023. In previous years, most of these TAs had data for 90% of the year or more, so it may be that the cyclone disrupted data collection at the weather stations used to source the data for this indicator.

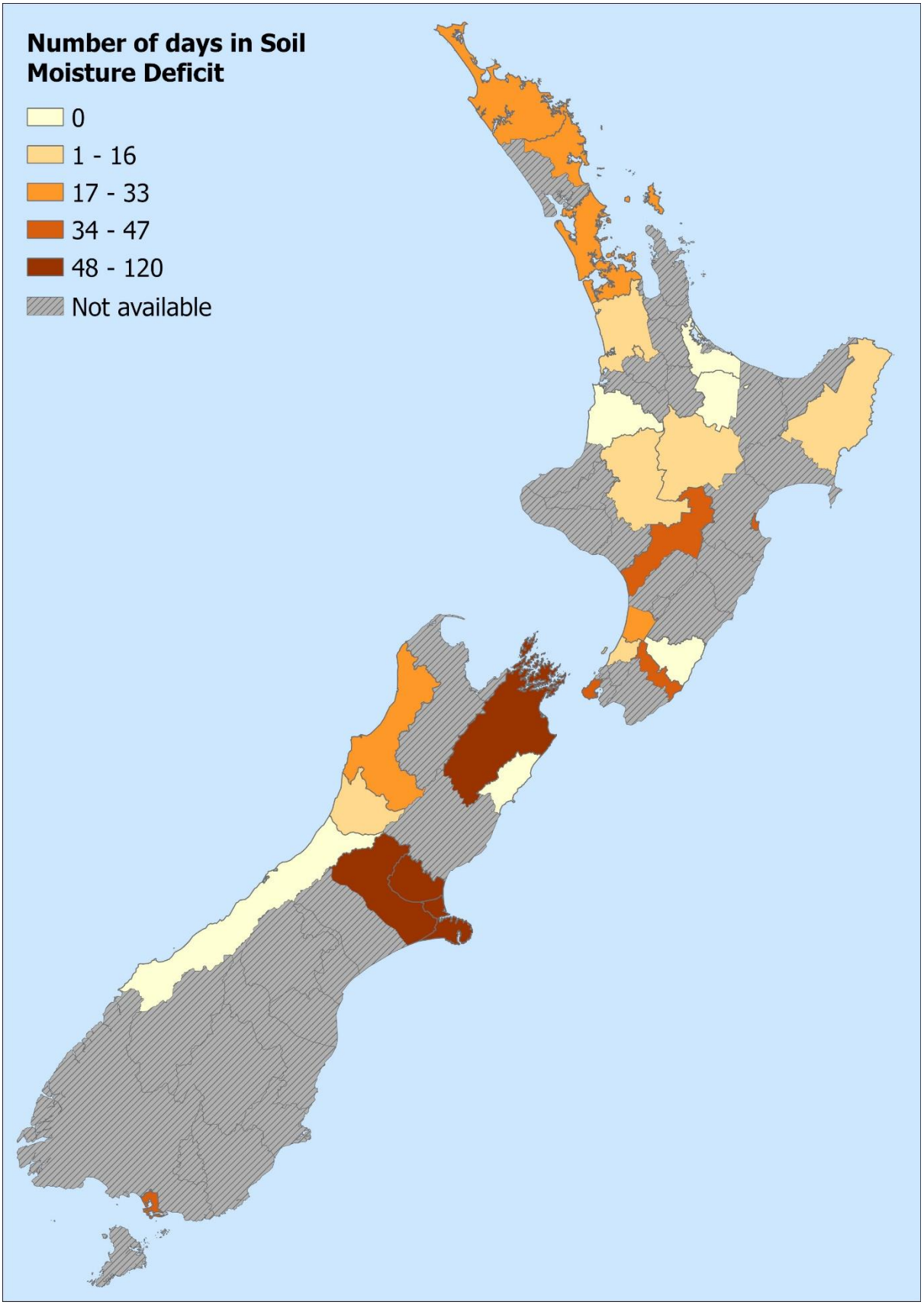
Figure 4a: Number of days with extreme rainfall, 2023



Source: National Climate Database (CliFlo), NIWA

Though data is limited, all the TAs that fell into the upper quintile of days in Soil Moisture Deficit were in the South Island, specifically Marlborough (120 days), Selwyn (91), Christchurch City (78), and Waimakariri (76).

Figure 4b: Number of days with Soil Moisture Deficit, 2023



Source: National Climate Database (CliFlo), NIWA

Rainfall variations and population vulnerability

Populations more vulnerable to rain or drought-related health effects are:

- young children aged 0–4 years - who are more quickly dehydrated from waterborne infection (Gamble et al. 2016, Smith et al. 2014)
- older people aged 85+ years - who are also more quickly dehydrated by waterborne diseases (Smith et al. 2014)
- Māori communities – with high employment rates in climate-sensitive industries like farming and forestry (Te Puni Kōkiri, 2007)
- people employed in primary industries - whose livelihoods may be disrupted by the effects of weather (Royal Society Te Apārangi, 2017)
- rural communities - through loss of income as businesses are disrupted by wet weather, drought or flood damage (Smith et al. 2014)
- those on low incomes - through inability to respond to higher food prices (Smith et al. 2014).

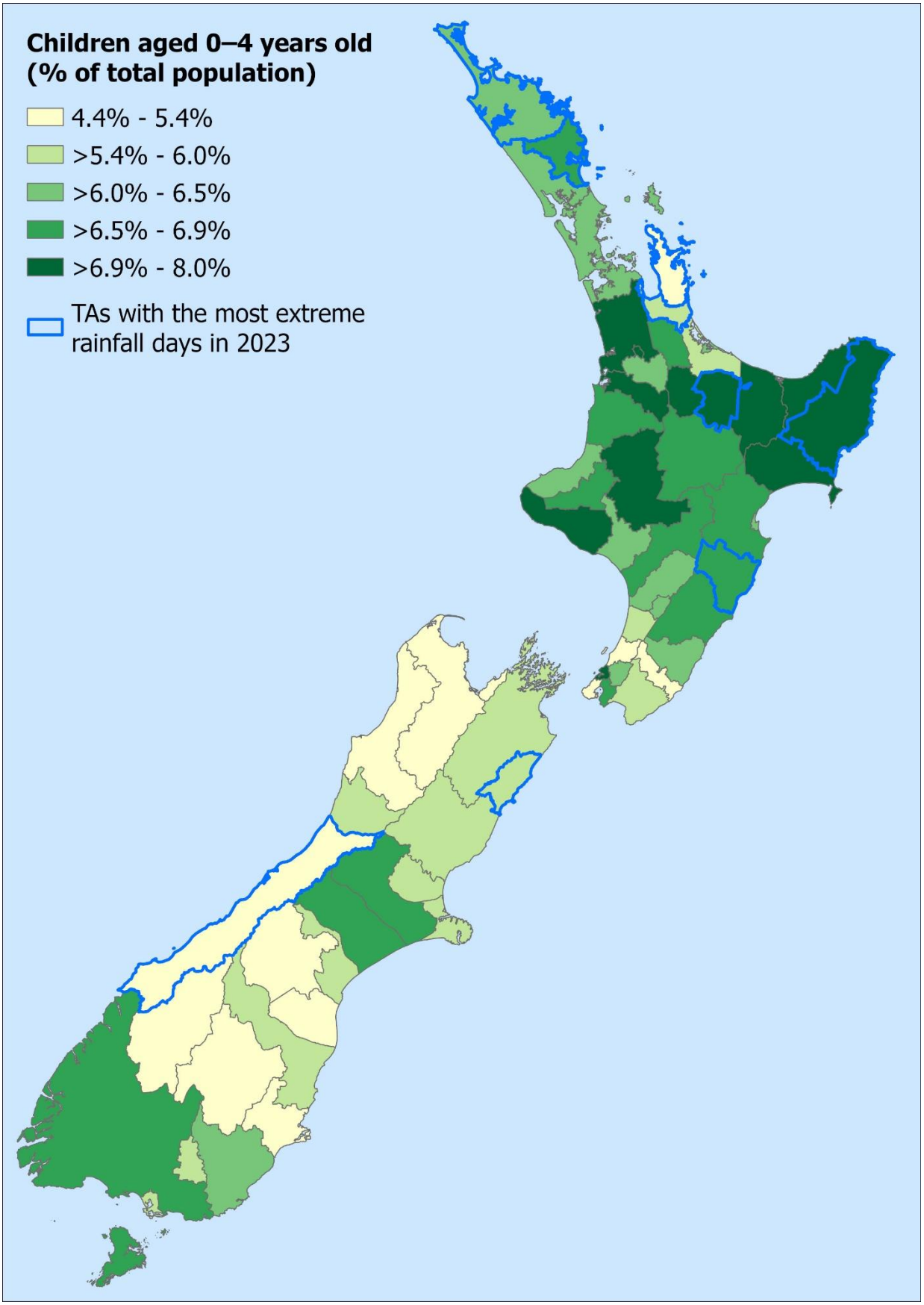
Areas with extreme rainfall, dry days and vulnerable populations

Comparing rainfall, drought and population data shows that the health effects associated with extreme rainfall are most likely to occur in the central and eastern North Island. These areas have higher concentrations of Māori, young children and people living in higher levels of deprivation.

Figures 5a – 5e below show the TAs with the most extreme rainfall days in 2023, in relation to the distribution of these vulnerable populations.

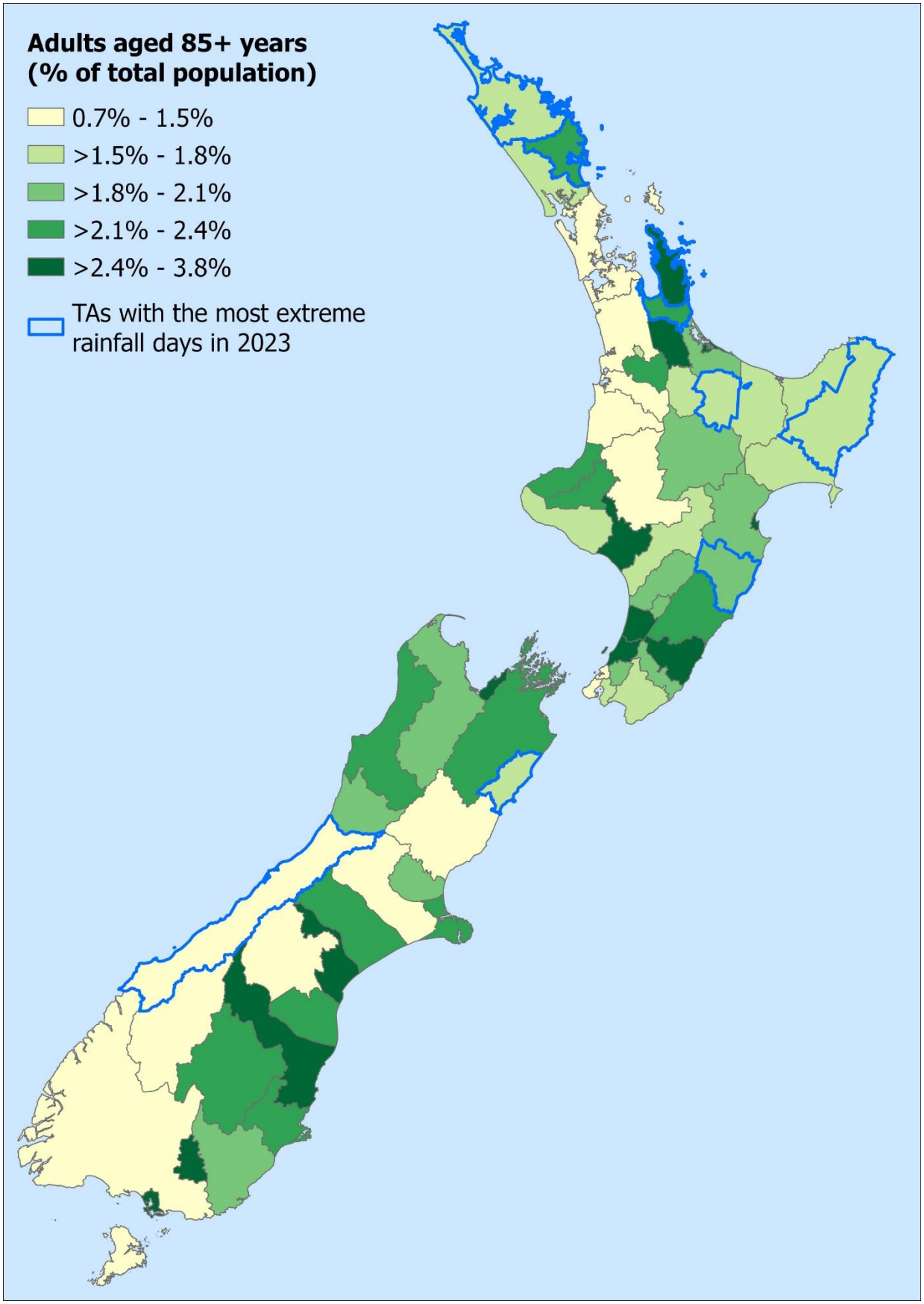
Figure 5d further suggests that increases in Soil Moisture Deficit, particularly in the South Island would have pronounced effects on those employed in primary industries – most likely in the area of the Canterbury Plains where the primary industries are a large employment bloc.

Figure 5a: Children aged 0–4 years old, by TA, 2018 (% of total population)



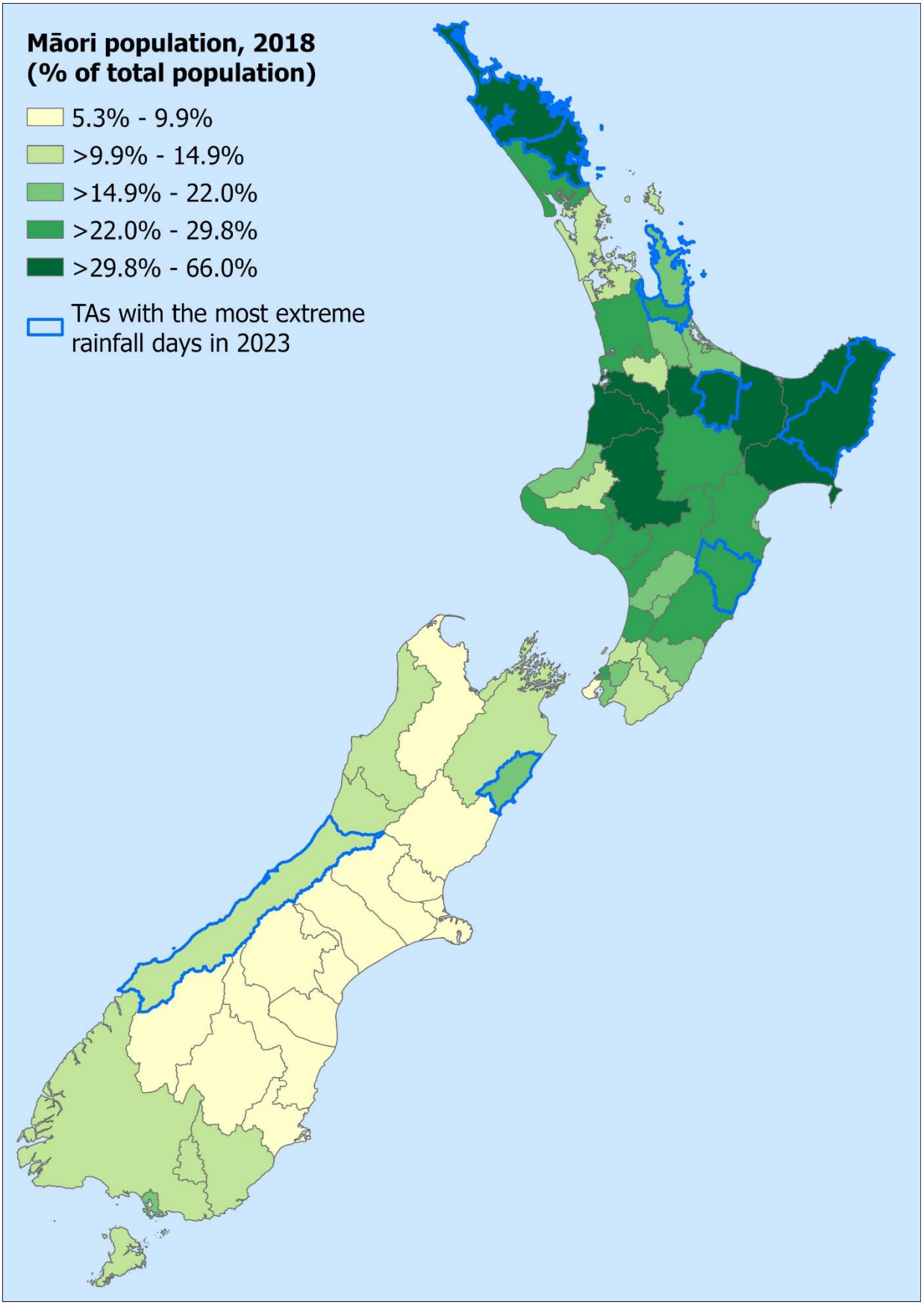
Source: National Climate Database (CliFlo), NIWA

Figure 5b: Older adults aged 85+ years, by TA, 2018 (% of total population)



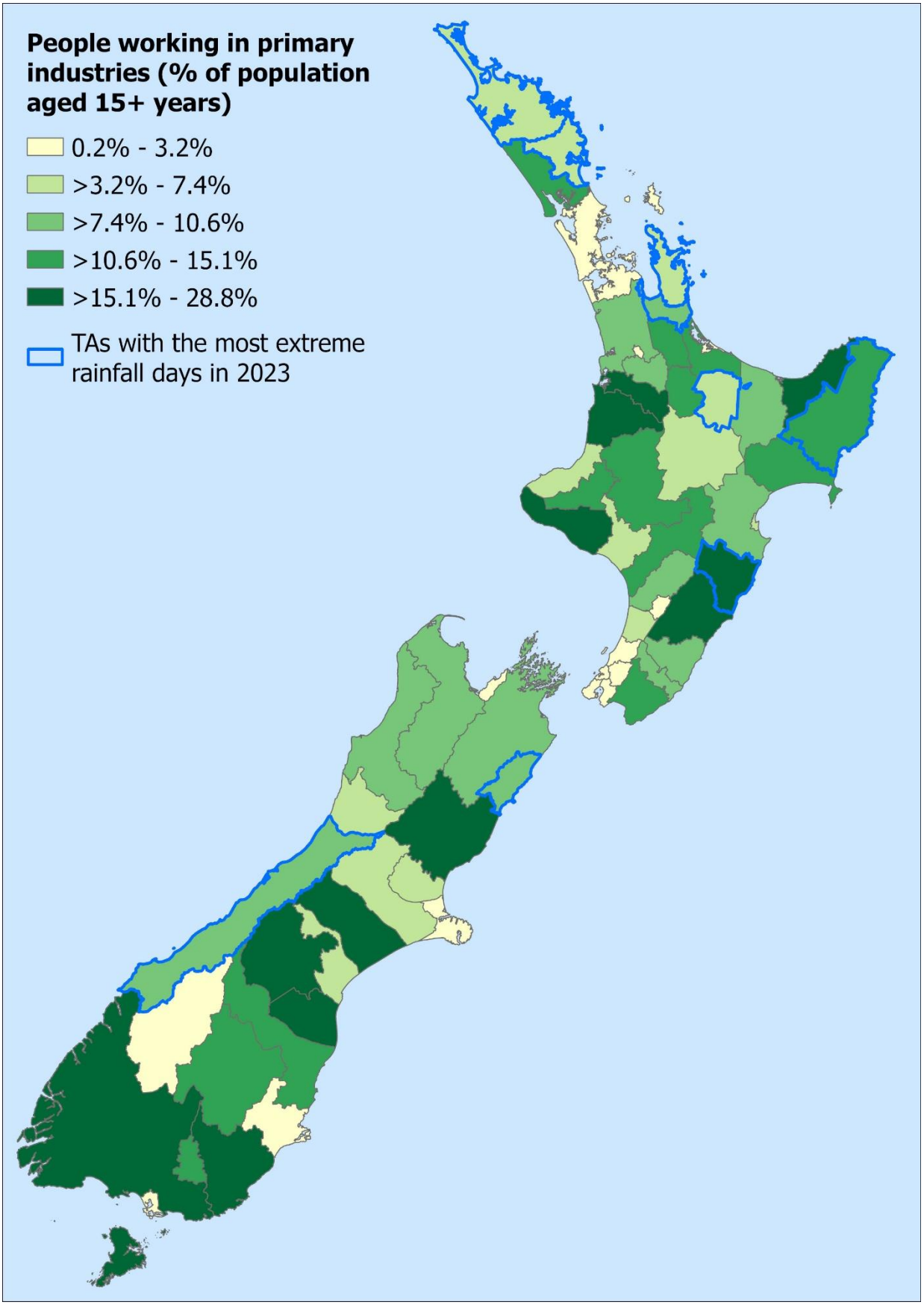
Source: National Climate Database (CliFlo), NIWA

Figure 5c: Māori population, by TA, 2018 (% of total population)



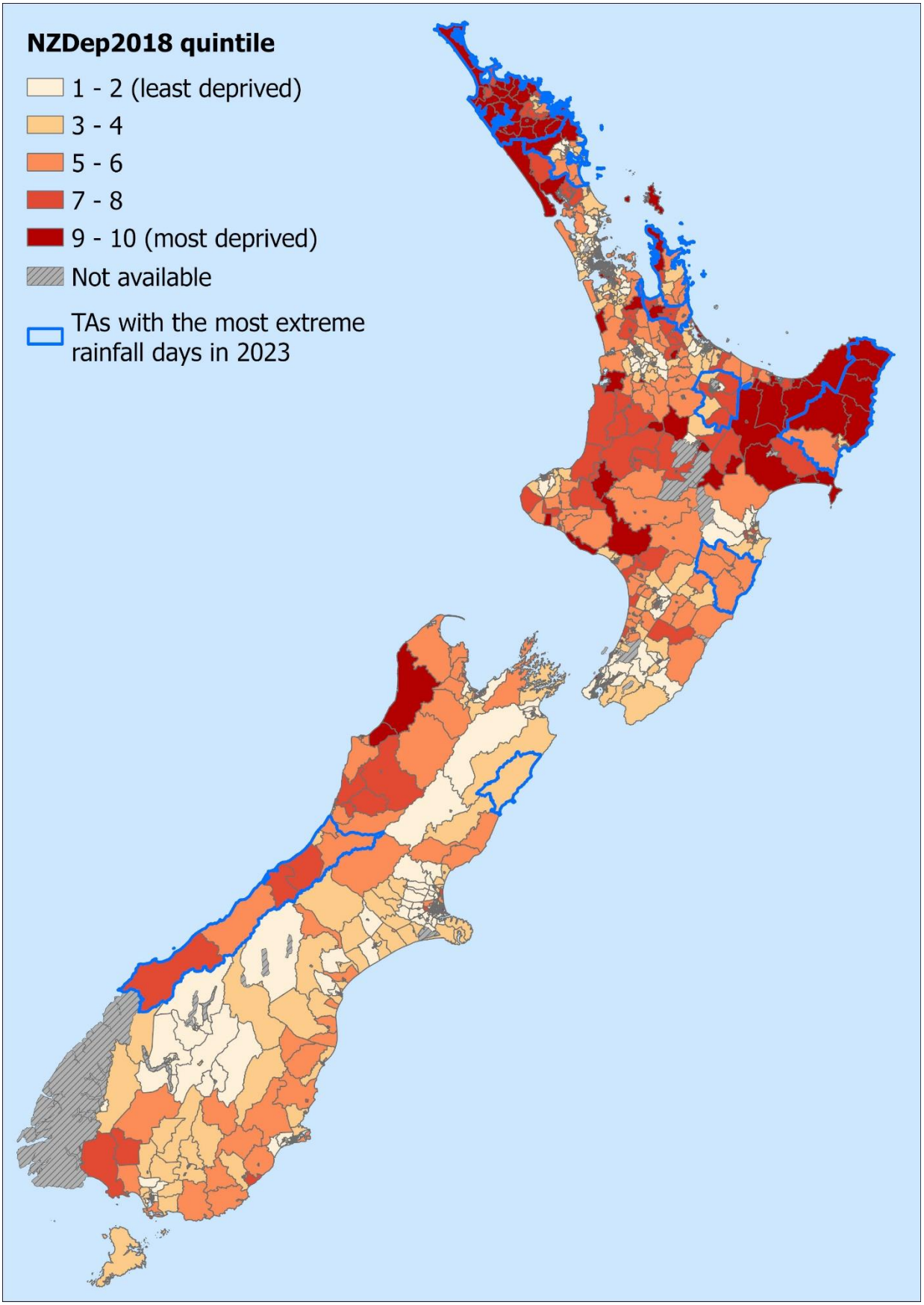
Source: National Climate Database (CliFlo), NIWA

Figure 5d: People working in primary industries, by TA, 2018 (% of population aged 15+ years)



Source: National Climate Database (CliFlo), NIWA

Figure 5e: Socioeconomic deprivation index (NZDep2018 decile), by Statistical Area 2 (SA2)



Source: National Climate Database (CliFlo), NIWA

Data for this indicator

This indicator analyses climate station records of daily rainfall around New Zealand, sourced from the National Climate Database (CliFlo), a web service provided by the National Institute of Water and Atmospheric Research (NIWA). One climate station was selected to represent each Territorial Authority based on its proximity to that TA's population-weighted centroid (2018 Census data).

Number of days with extreme rainfall

The annual amount of rainfall was calculated by TA. Only stations with data for more than 75% of the year were analysed. In previous editions of this report, a 90% cutoff was used; we lowered the cutoff for 2023 to offset disruptions to data collection caused by Cyclone Gabrielle. The 95th percentile of rainfall between 1991–2020 was calculated from historical data for each TA, the number of days above this percentile was counted as extreme rainfall days.

Number of days with Soil Moisture Deficit (SMD)

The number of days with Soil Moisture Deficit was counted for each year by TA. Only years with more than 90% of valid data were counted.

Data for both indicators were compared to the most recent Climate Normal Period, 1991–2020 as defined by NIWA (2024), where the 30-year average acts as a benchmark against which more recent observations can be compared.

For additional information, see the Metadata sheet.

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