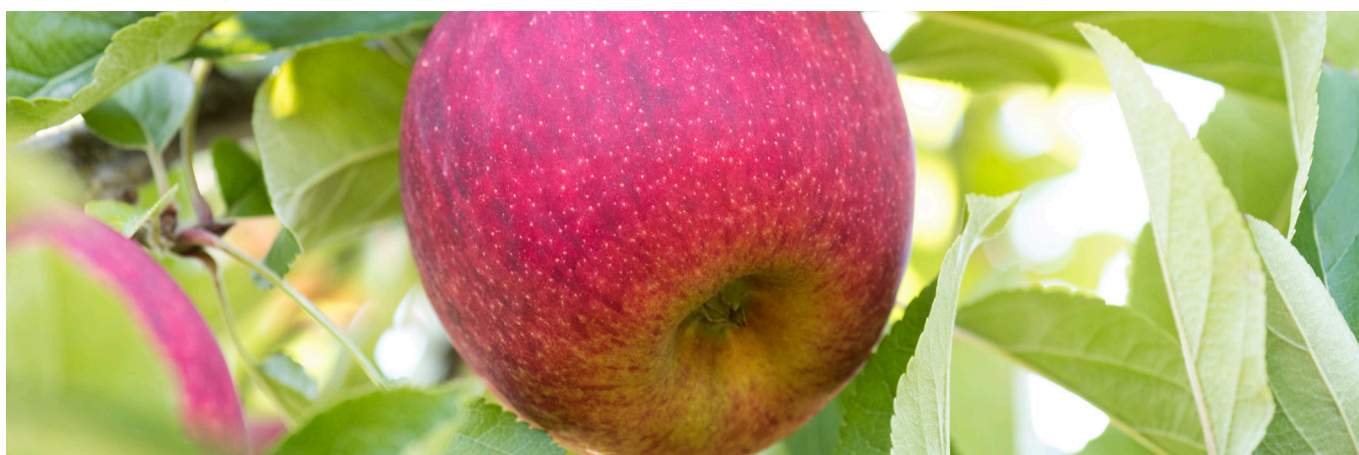**FACT SHEET**

Climate change impacts on apple

Climate change will affect where crops can be grown in the future.

We developed models to map how suitable areas around the country currently are, on a scale of 0 to 1. These combined several identified criteria based on their relative importance. We used simulated climate data as model inputs to forecast how suitability will change in the future, for two Representative Concentration Pathways (RCPs) which are scenarios for greenhouse gas (GHG) concentrations in the atmosphere:

1. RCP 2.6 (A low GHG concentration pathway consistent with significant emissions reductions)

2. RCP 8.5 (A high GHG concentration pathway consistent with unabated emissions).

Criteria considered	Importance	
Climate related		
Frost risk	High	●
Winter chill	Moderate	●
Growing degree days	Moderate	●
Fruit size	Moderate	●
Sunburn	Low	●
Soil or land related		
Drainage	High	●
Potential rooting depth	Moderate	●
Land use capability class (LUC)	Moderate	●
Slope of land	Low	●

Please note irrigation is assumed to be available if needed and rainfall is not evaluated.
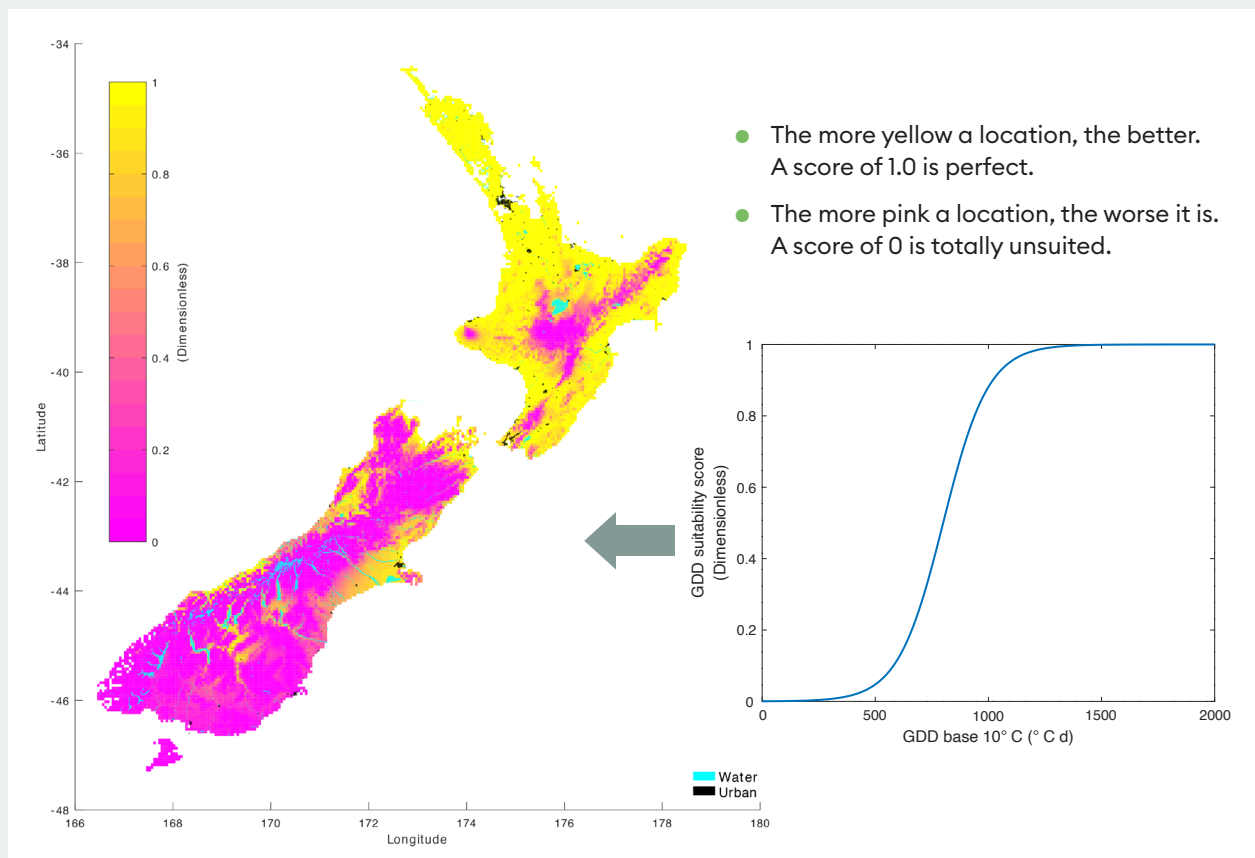
Criteria suitability scores

For each criterion we calculated a sliding-scale suitability score.

- Criteria were based on literature and expert knowledge.

- Scores were mapped and checked by experts for accuracy.

- Suitability scores calculated for each location across the country.

- Uses GIS databases with climate and land information.

Overall suitability scores

- Scores for criteria were combined, weighted by importance.

- Weighting was decided by experts.

- Allows locations to be ranked on relative merit.

Example: Growing degree days (GDD) suitability score for apple

- The more yellow a location, the better. A score of 1.0 is perfect.

- The more pink a location, the worse it is. A score of 0 is totally unsuited.

Low scores indicate mitigation may be needed, e.g.

- Frost protection if frost suitability is low

- Drainage improvement if drainage suitability is low

- Low-chill cultivars in warmer climates.

Overall suitability map from calibrated apple rules
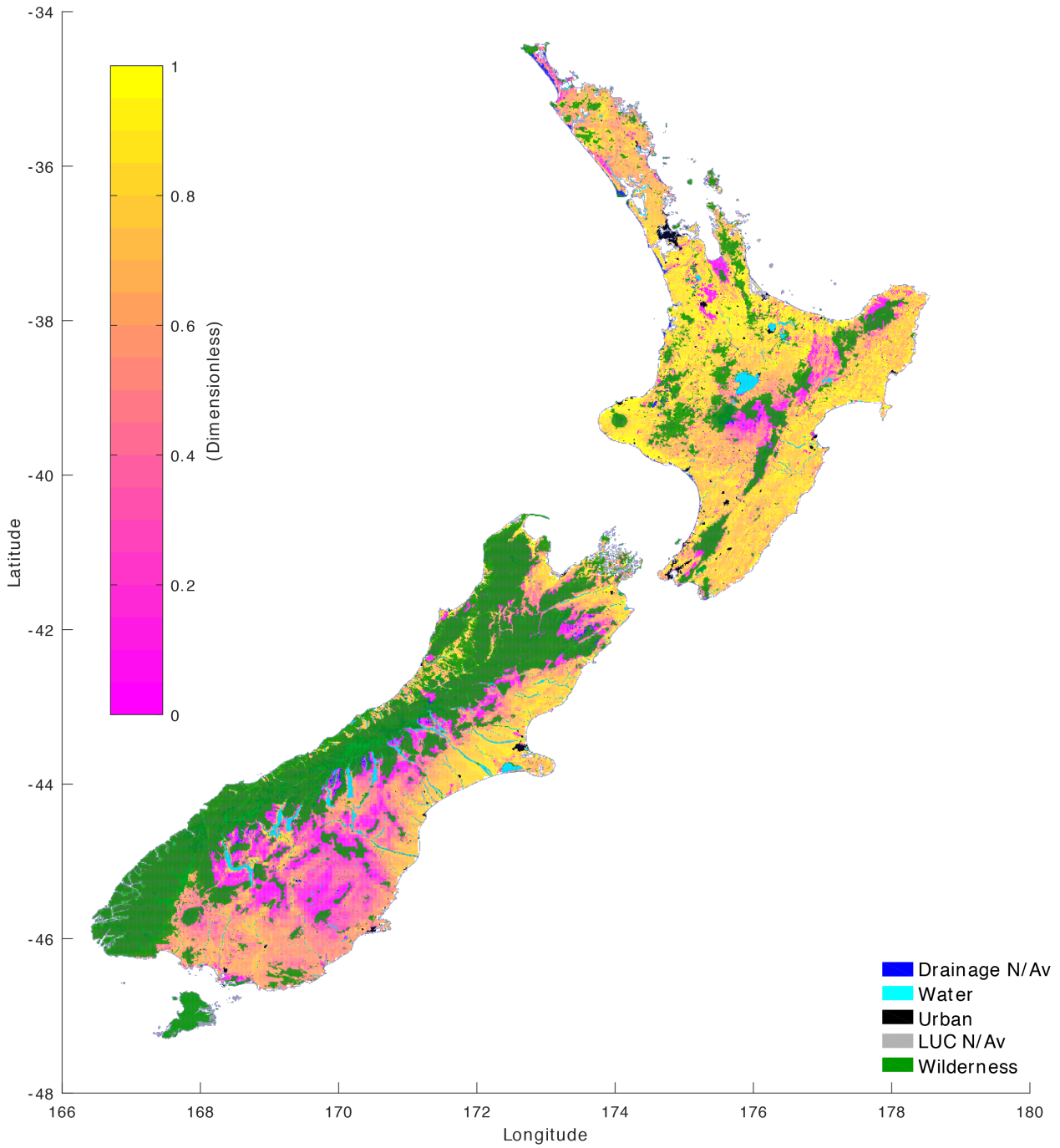
Our modelled suitability score is in agreement with current apple-growing regions around the country, most notably Hawke's Bay, Nelson and Central Otago.

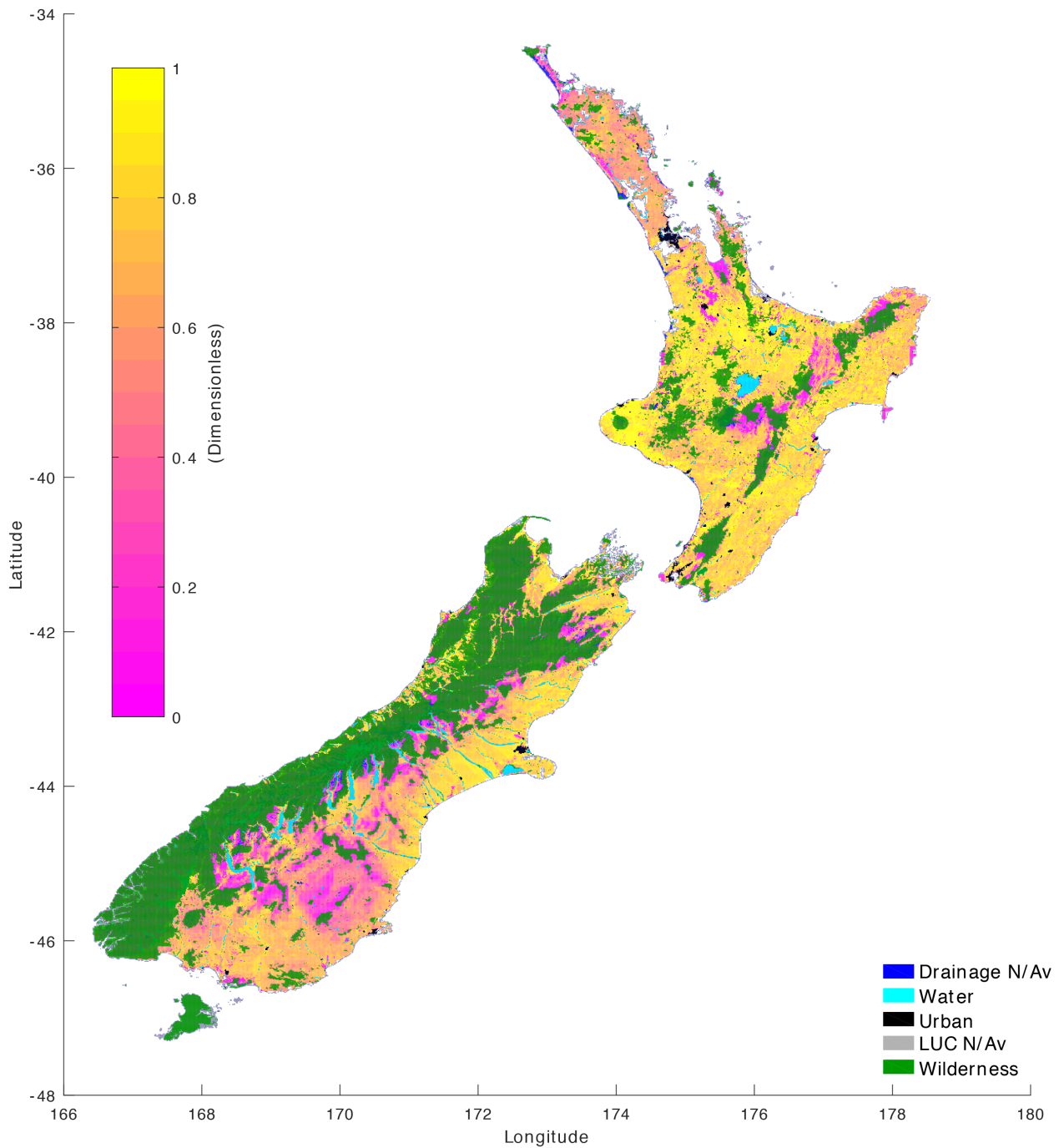## Mid-century forecast for apple under the low GHG concentration pathway (RCP 2.6)
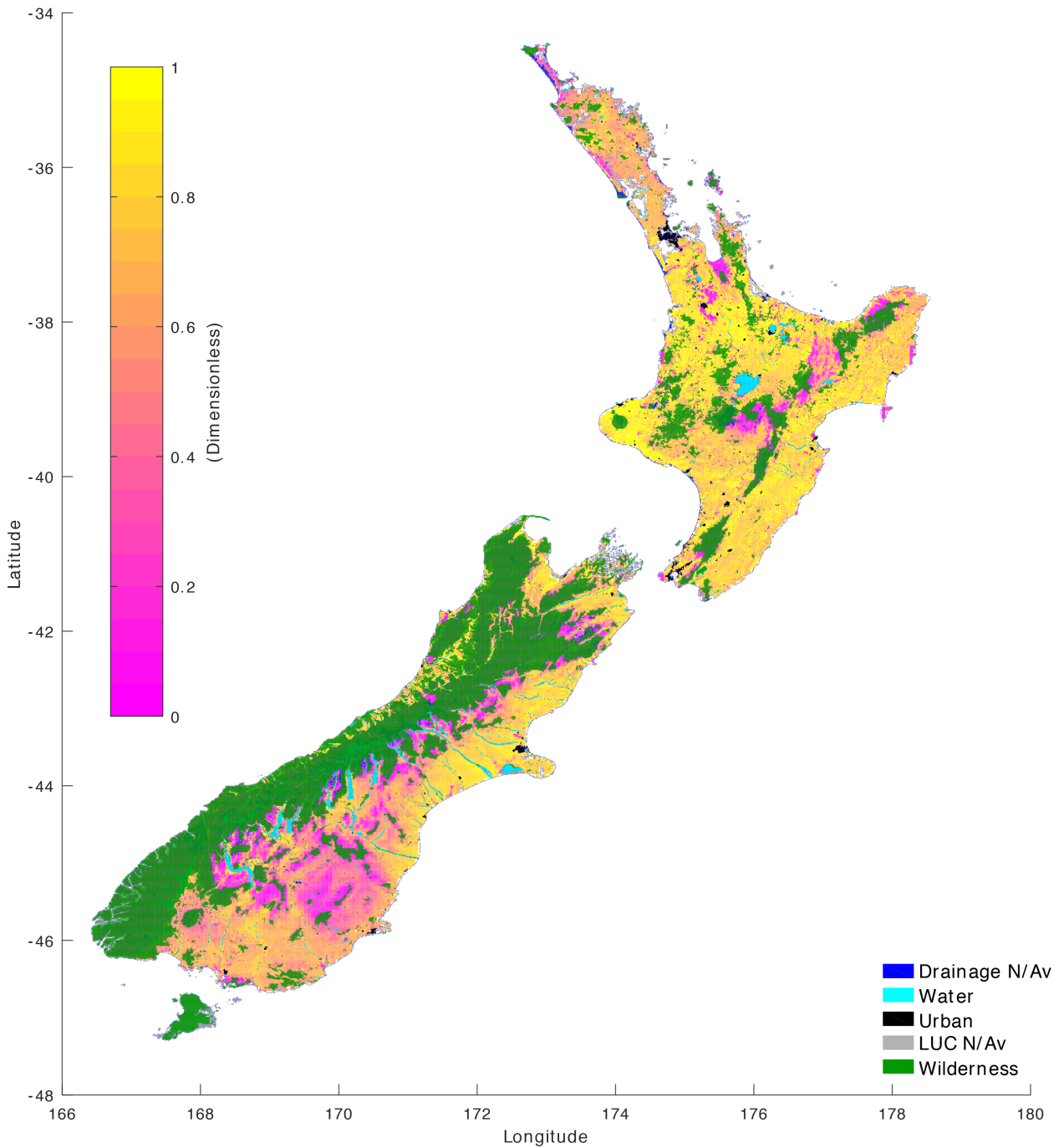
Land area (km²) of suitability ranges under the low GHG concentration pathway (RCP 2.6)

Suitability range	Historic (1972–2004)	Mid-century		Late-century	
0.6–0.7	31,700	35,500	(32,600–36,600)	36,100	(32,800–36,800)
0.7–0.8	32,200	33,200	(29,400–36,000)	32,700	(29,400–35,900)
0.8–0.9	31,900	36,500	(34,700–37,200)	37,300	(35,500–38,000)
0.9–1.0	20,500	21,700	(15,200–31,200)	21,100	(14,400–30,700)

Ranges in brackets indicate prediction uncertainty

Mid-century forecast for apple under the high GHG concentration pathway (RCP 8.5)

Land area (km²) of suitability ranges under the high GHG concentration pathway (RCP 8.5)

Suitability range	Historic (1972–2004)	Mid-century		Late-century	
0.6–0.7	31,700	35,400	(32,600–35,800)	33,200	(32,100–34,600)
0.7–0.8	32,200	33,100	(30,600–35,500)	34,900	(32,700–35,800)
0.8–0.9	31,900	40,100	(37,600–41,400)	46,100	(39,700–51,800)
0.9–1.0	20,500	20,800	(15,800–28,200)	10,300	(5,950–16,400)

Ranges in brackets indicate prediction uncertainty

Summary: Climate change effects on apple

Differences between climate change pathways are more pronounced by late-century (maps not shown) than by mid-century.

Under the low GHG concentration pathway (RCP 2.6)

- Small decreases in suitability are expected in much of the upper and eastern North Island.
- Small increases in suitability are expected for most of the rest of the country.
- Most changes in suitability occur by mid-century.

Under the high GHG concentration pathway (RCP 8.5)

- By mid-century, the pattern of change is similar to but more pronounced than in the late-century under low GHG concentration pathway.
- By the end of the century the situation becomes more extreme, with sometimes large reductions in suitability occurring in many upper, eastern and coastal parts of the North Island (maps not shown).
- The central North Island, Taranaki and the South Island would see (sometimes large) improvements in suitability (maps not shown).

Analysis of land-use impacts under changed suitability

- Under the low GHG pathway:
  - The apple footprint is forecast to decline in Hawke's Bay, Gisborne and the Waikato.
  - Other apple regions such as Central Otago and Nelson would become more favourable, and areas of the Taranaki will possibly open up.

- Under the high GHG concentration pathway:
  - The apple footprint will reduce in the main centre of Hawke's Bay, and in Waikato and Gisborne.
  - Some new opportunities for orchard establishment could occur in Southland.

Main climate factors affecting changes

- In areas such as Hawke's Bay decreased chill would reduce suitability, with increased sunburn also contributing.
- Mitigation strategies, such as breeding low-chill cultivars and strategies to mitigate sunburn, could assist with ongoing successful apple production in these areas.

ⓘ For more information

This is one in a series of fact sheets about climate change impacts on the spatial footprint of horticultural crops that can be found at plantandfood.co.nz.

Prepared by The New Zealand Institute for Plant and Food Research Limited.

J009496

Acknowledgements