Assessing future Hayward kiwifruit viability using a simple temperature index approach

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Background & Research Question

- A critical temperature-related time of the year for kiwifruit production is the three-month period May to July.
- The ‘coldness’ of this period has a very strong influence on both the quantity and quality of kiwifruit flowers, as well as the timing of flowering.
- This in turn has a direct influence on the number of buds, the timing of bud-break, and hence the number and quality of fruit produced by the vine.
- Sufficient 'winter chilling' is therefore vital for kiwifruit production viability.
- As air temperatures increase due to global warming the risk of insufficient winter chilling will also increase – how will this impact kiwifruit viability in the Bay of Plenty and elsewhere in New Zealand?

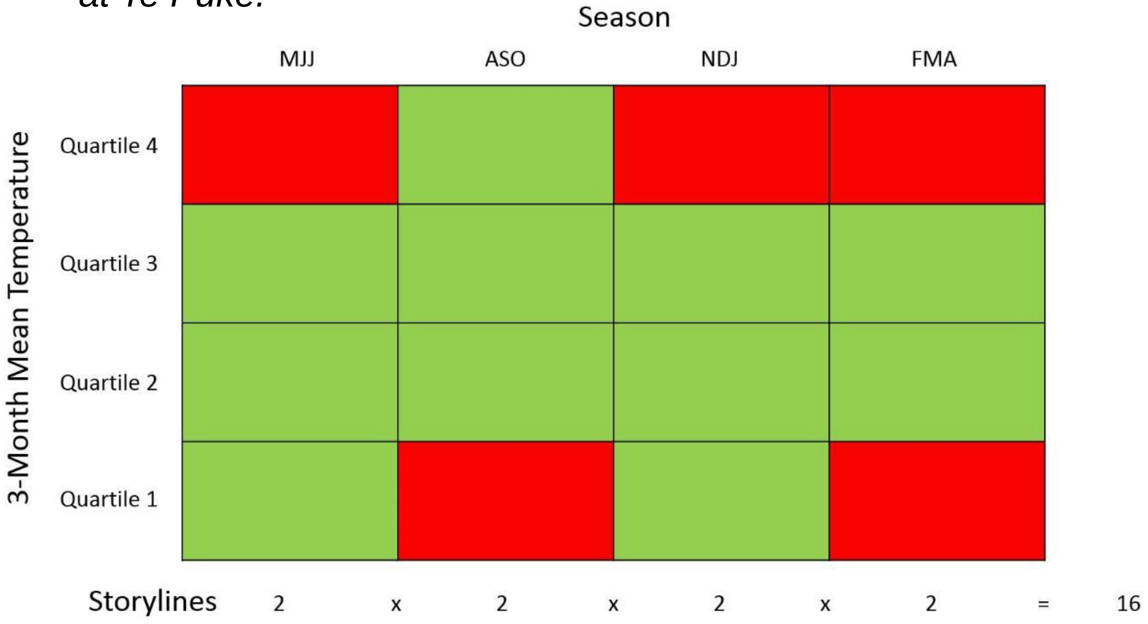
Methodology

Stage 1 – Seasonal ‘production risk’ temperature thresholds

A simple temperature index approach is used to identify threshold ‘production risk’ temperatures at Te Puke in four phenologically-important seasons, based on the historic period 1971-2000. The seasons are:

- May-July (important for winter chilling and bud/flower numbers);
- August-October (important for flowering and primary growth);
- November-January (important for canopy secondary growth and fruit development); and
- February-April (important for fruit maturation and harvest).

High (red) and low (green) Hayward kiwifruit production risk thresholds, based on quartiles of 3-month mean temperature at Te Puke.

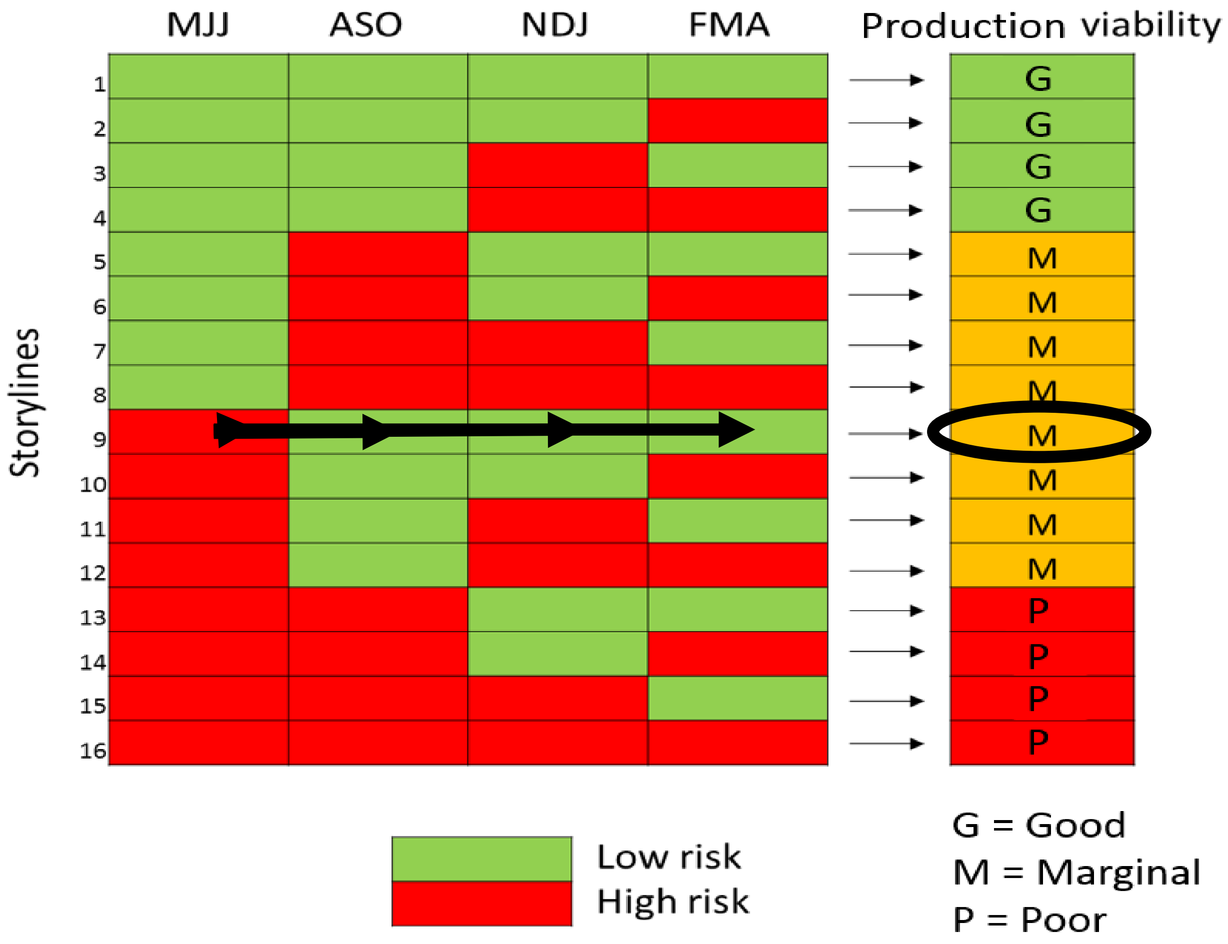


16 unique growing year (May-Apr) temperature “storylines”, which are each linked to Hayward kiwifruit production risk.

Methodology

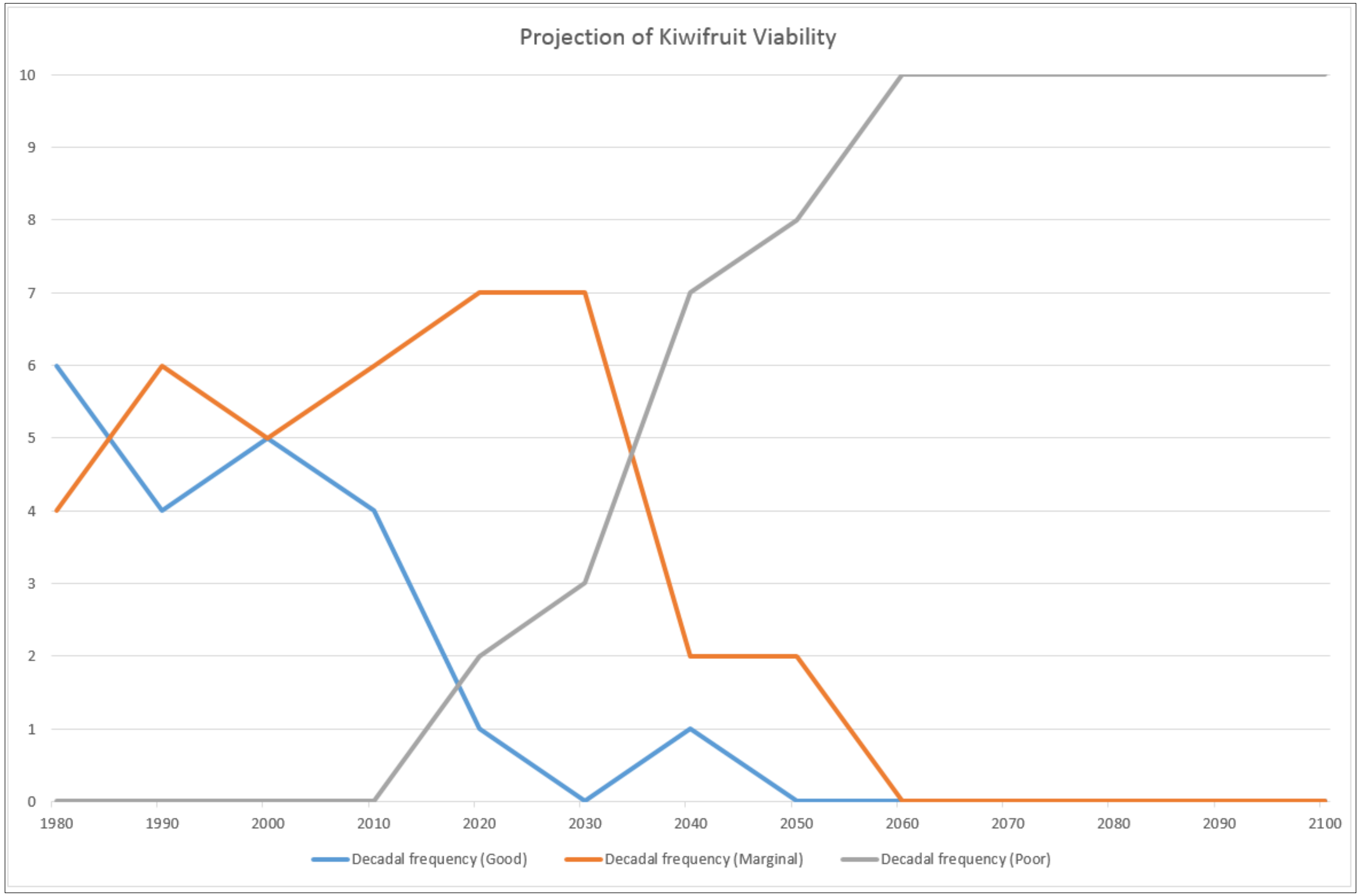
For example, a temperature storyline for a particular growing year might be as follows:

- May-July (MJJ) average temperature greater than the upper quartile threshold (high risk)
- August-October (ASO) average temperature in third quartile (low risk)
- November-January (NDJ) average temperature in the second quartile (low risk)
- February-April (FMA) average temperature in the second quartile (low risk)



This example storyline results in a 'marginal' Hayward kiwifruit production viability scenario.

Results: Te Puke viability

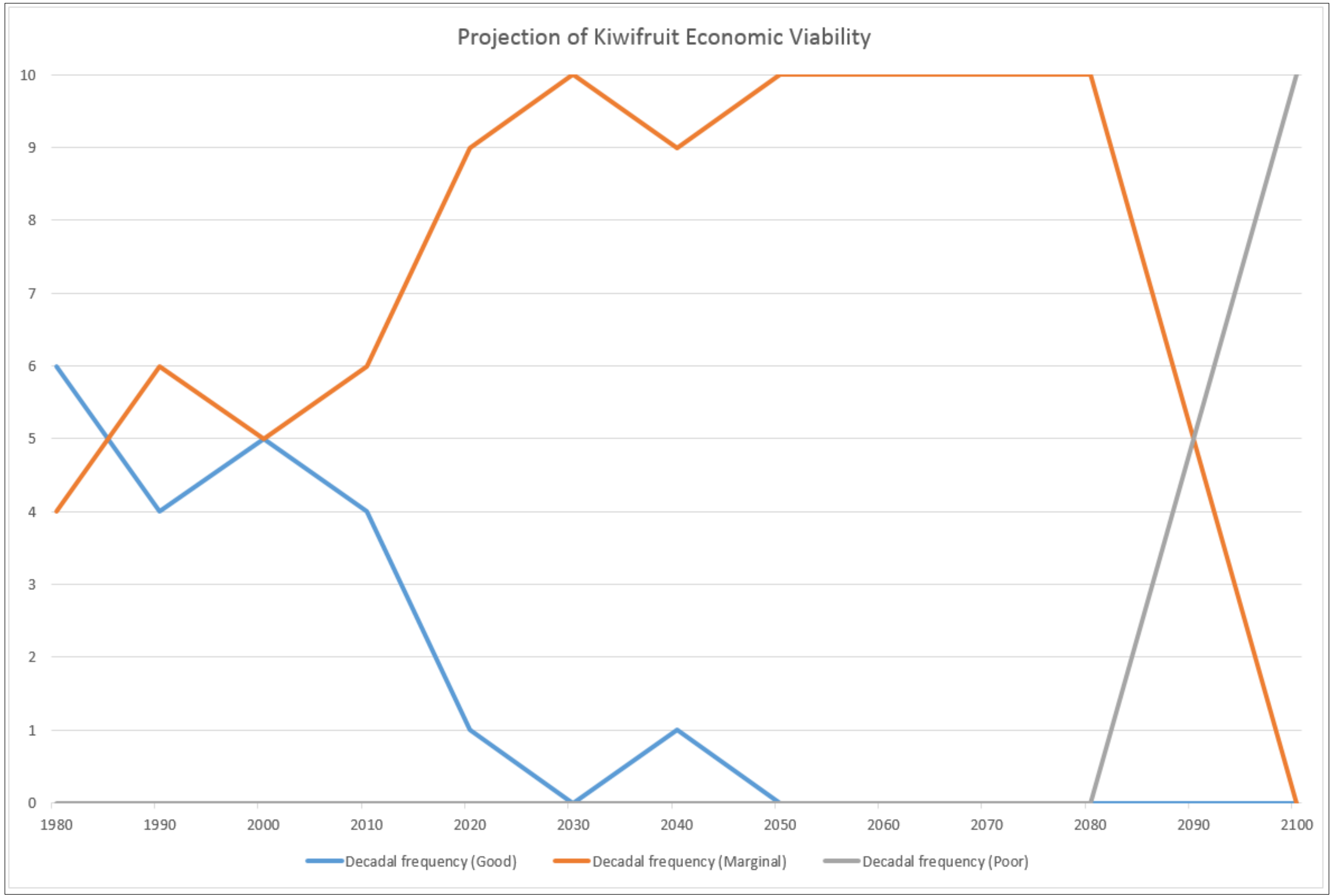


The number of years per decade with 'good', 'marginal' and 'poor' production viability for Hayward kiwifruit, based on HadGEM2-ES / RCM RCP8.5 simulated data for Te Puke. The year on the X-axis is the last year of the decade (i.e. 1980 = 1971-1980).

Results: Te Puke viability

Application of the chemical hydrogen cyanimide, H_2NC can reduce the impact of insufficient winter chilling.

Effectively, spraying hydrogen cyanimide on the vines gives an average of about 2°C of winter chilling benefit.

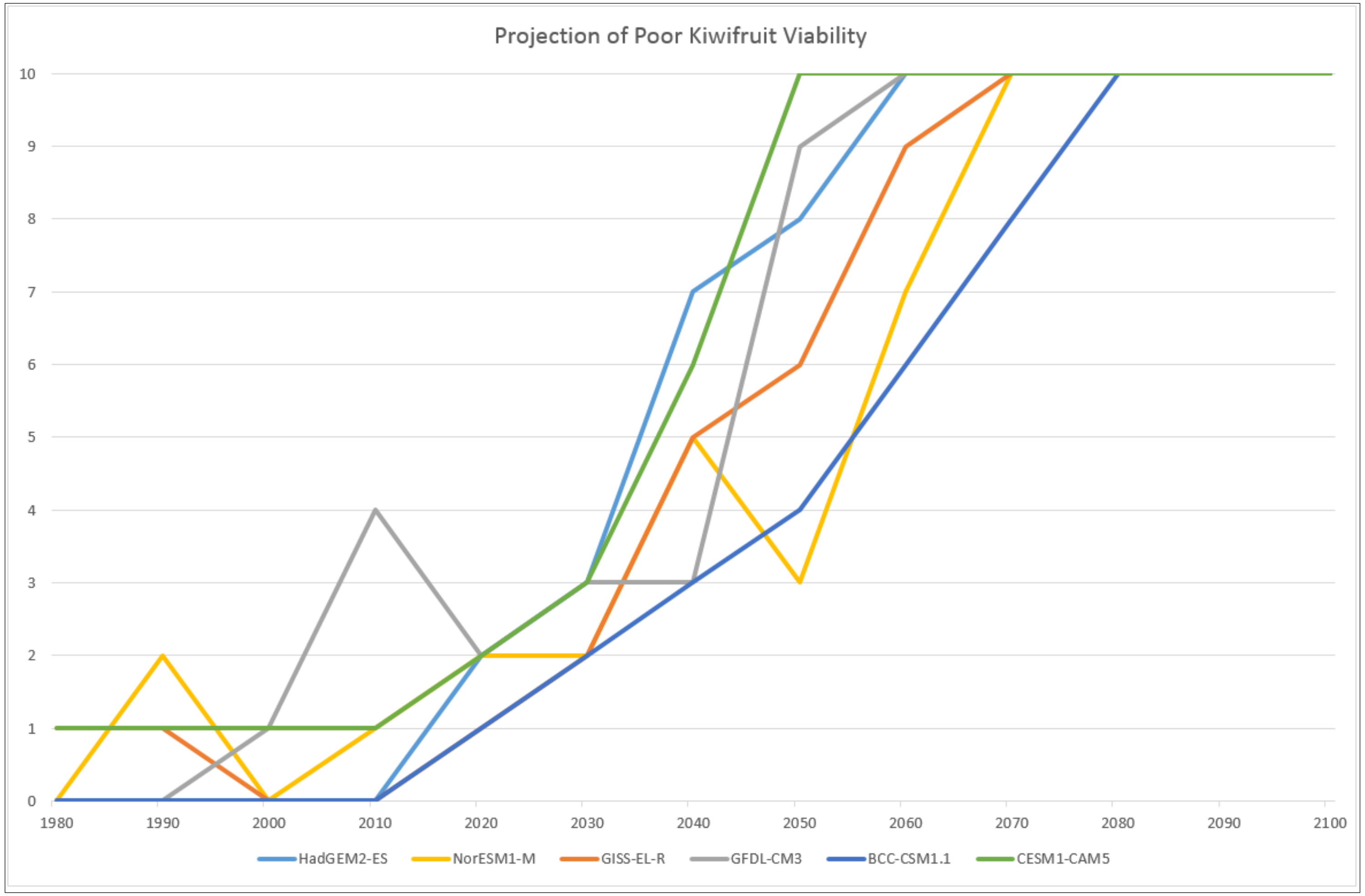


As for the previous Figure, but including the effect of applying hydrogen cyanamide.

But will use of this chemical be allowed in the future?

Results: Te Puke viability

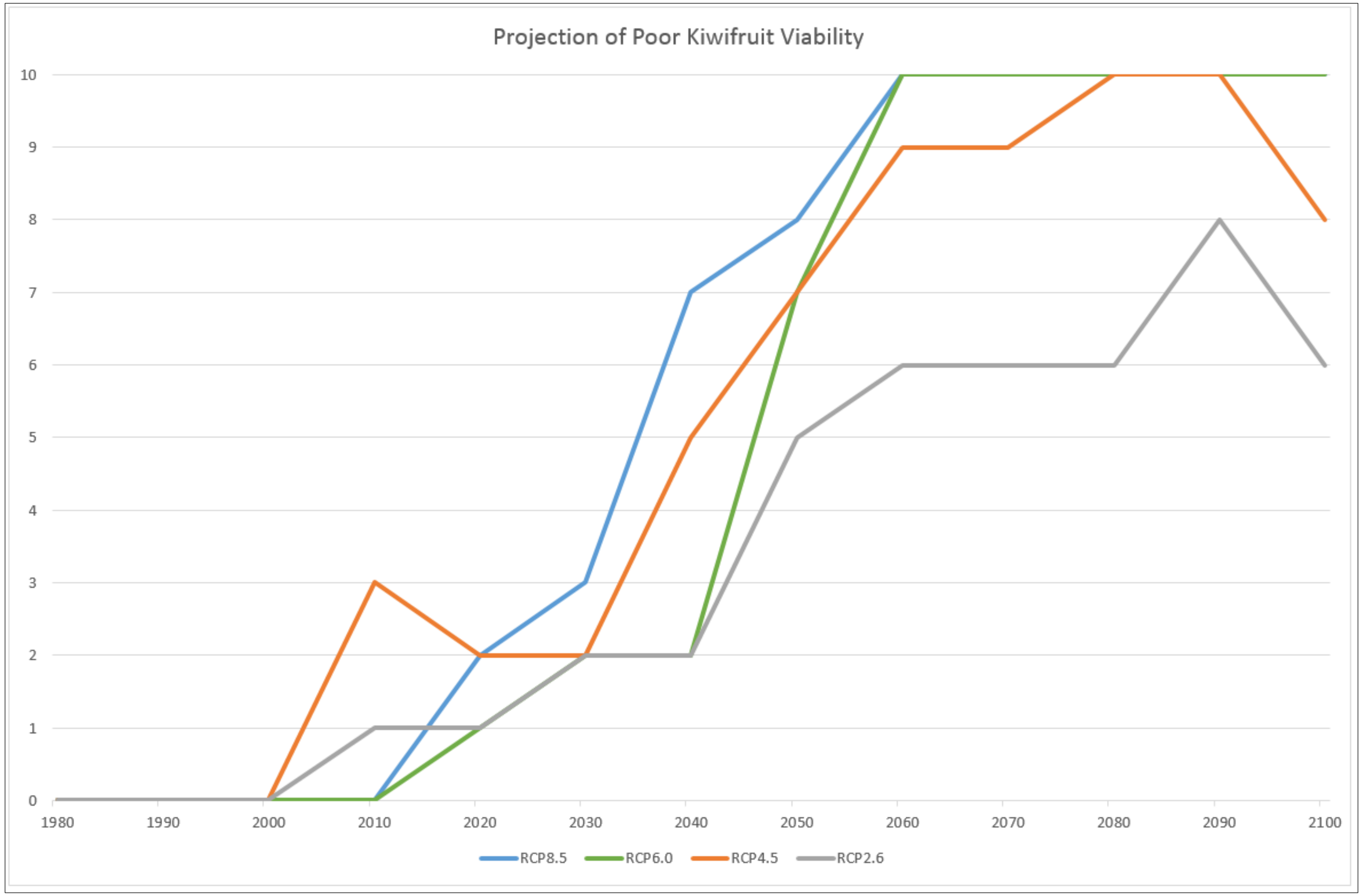
It's useful to compare results from multiple climate models



The number of years per decade with 'poor' production viability for Hayward kiwifruit for all six GCMs, based on RCM RCP8.5 simulated data for Te Puke and no application of hydrogen cyanimide.

Results: Te Puke viability

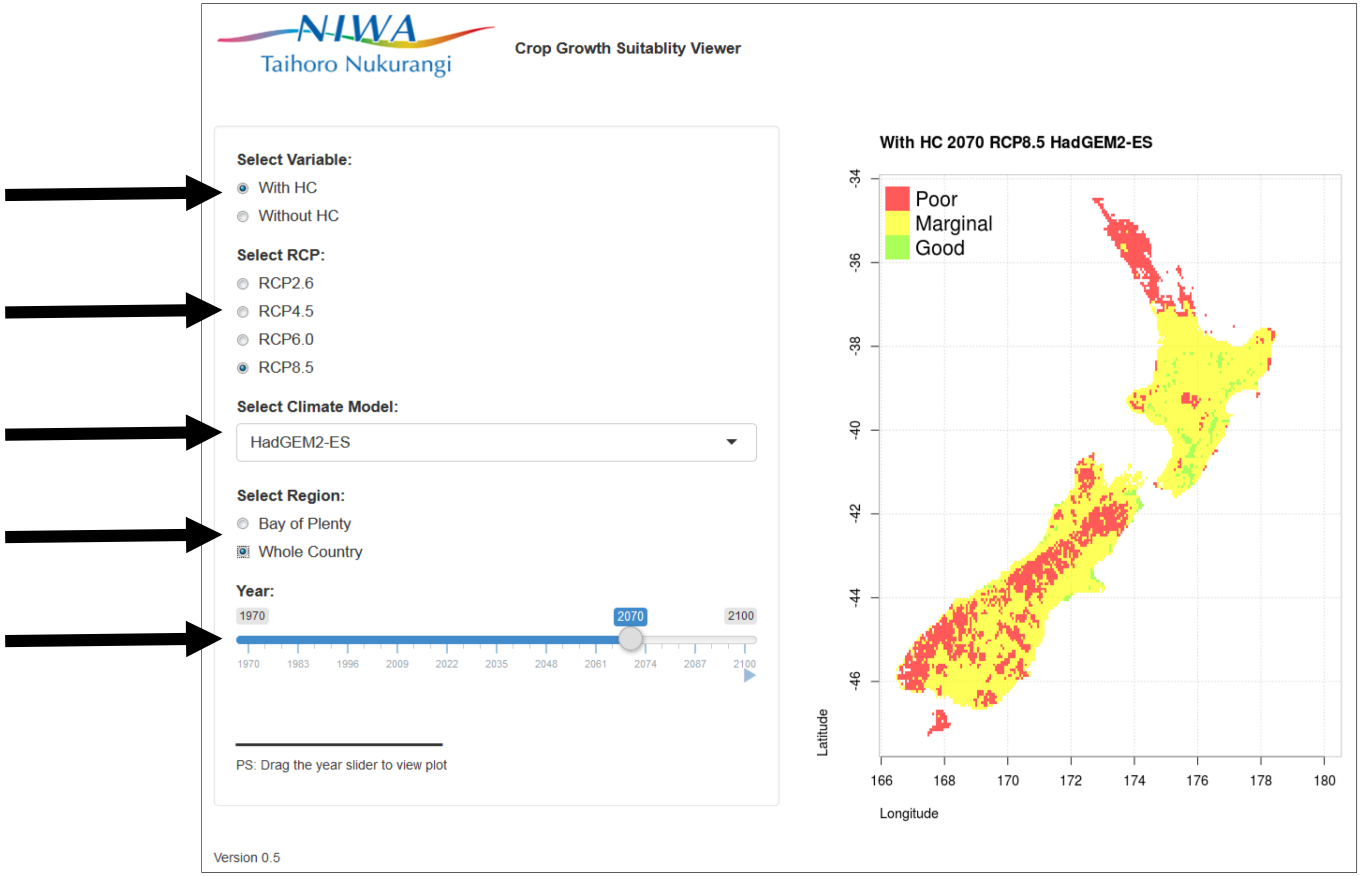
And to compare different RCPs (greenhouse gas concentrations)



As for the previous Figure, but showing all four RCPs for the HadGEM2-ES model.

Results: Year-by-year simulations

https://well-shny-vp.shinyapps.io/CCII/



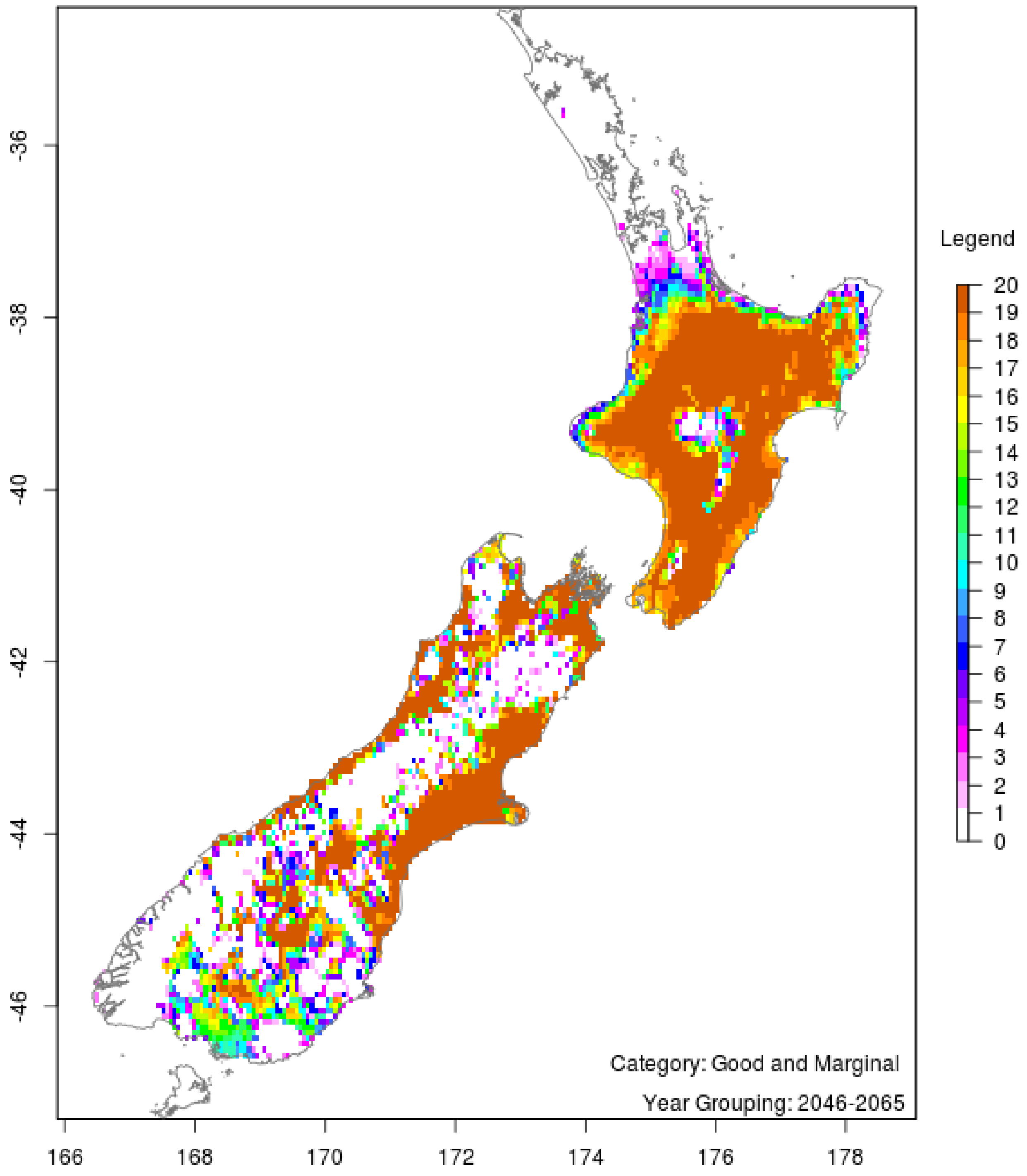
The user can select:

- with or without hydrogen cyanimide
- a particular RCP
- a particular climate model
- and either the Bay of Plenty region or the whole country.

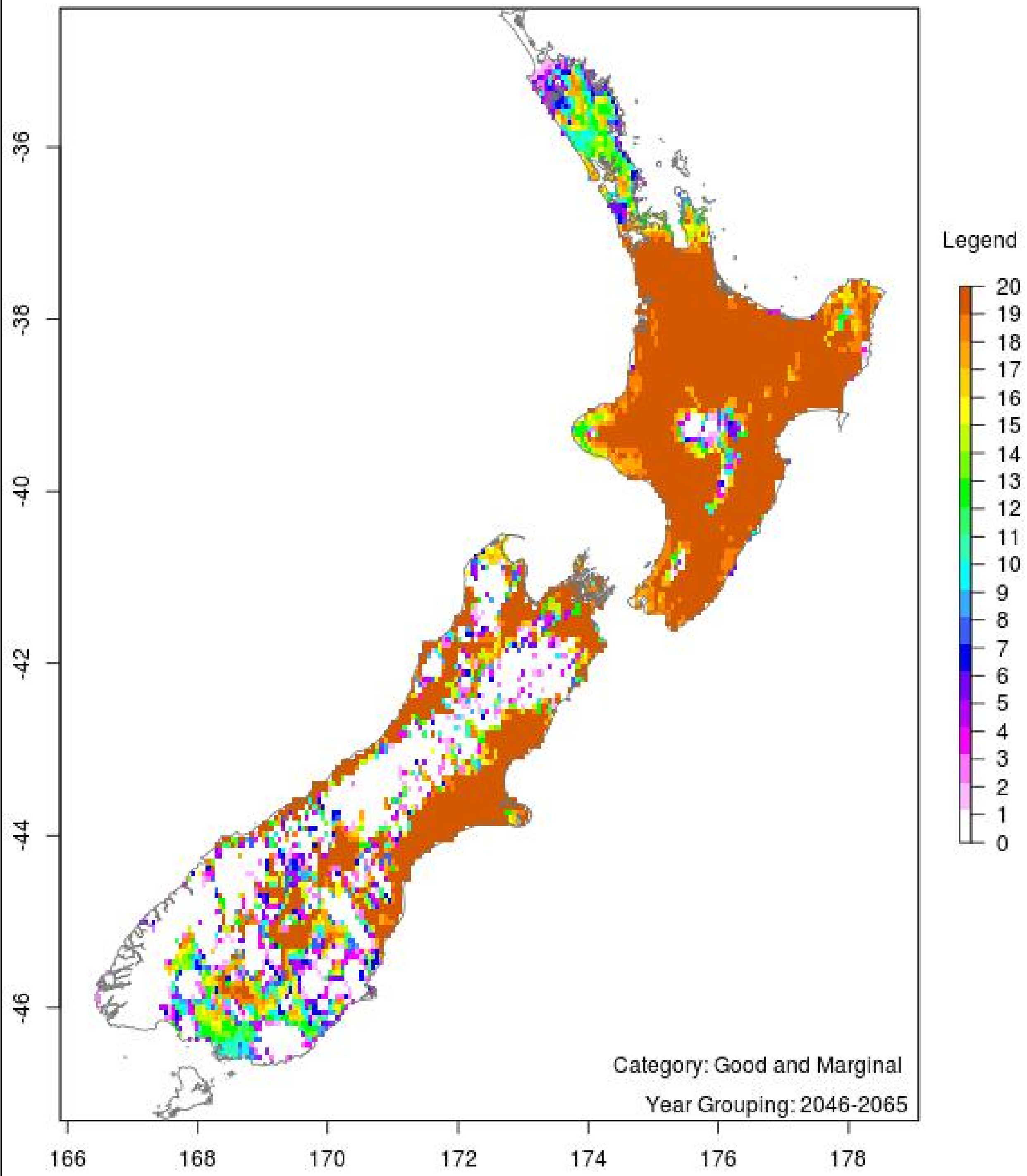
The slider can then be dragged to a specific simulation year, or the 'play' button can be pressed to start a map animation sequence (and 'paused' to stop it).

A year-by-year Hayward kiwifruit production viability for 1971-2100 map application.

Results: National 20-year time slices



The number of ‘good or marginal’ Hayward kiwifruit viability years for the period 2046-2065, based on the average of all six GCMs and RCP8.5 (without HC).



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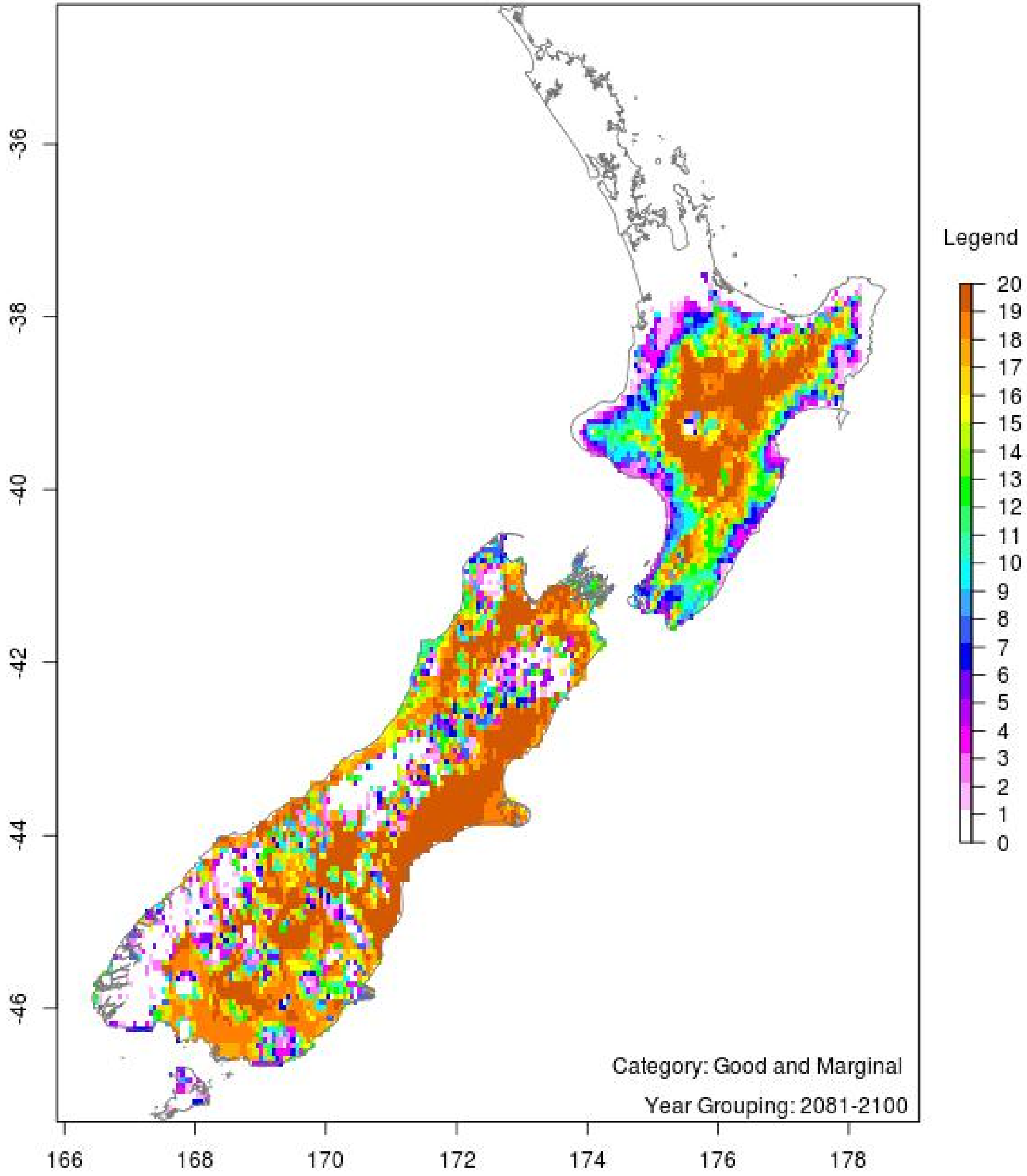

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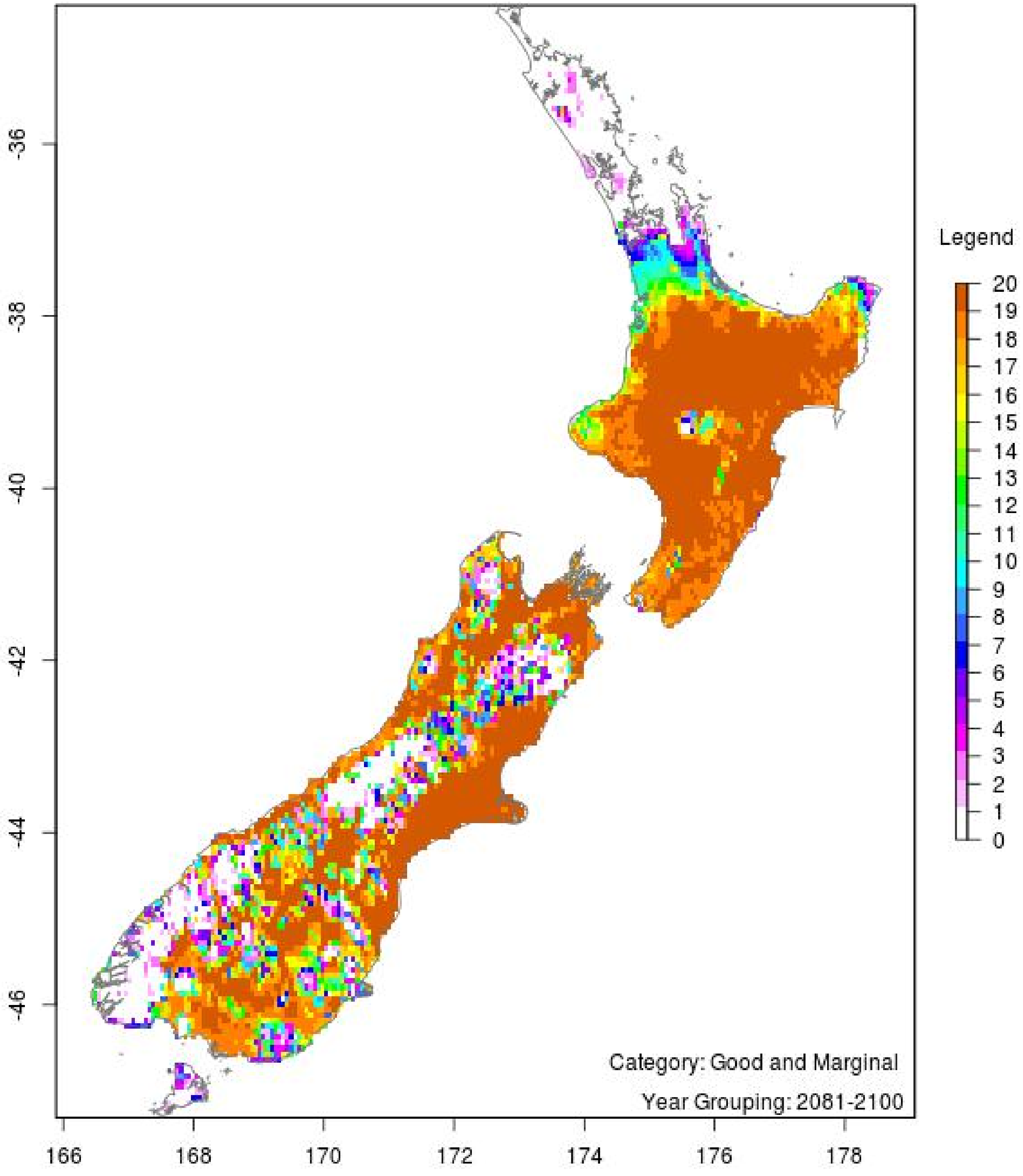

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Conclusions

Disclaimer:

- The relative simplicity of the model is an advantage in that it is easy to understand and interpret. It can also easily be used with simulated temperature data output from climate models.
- The model simplicity is also a disadvantage in that many of the factors that determine kiwifruit viability, such as soil fertility and drainage, slope, solar radiation, wind, and humidity, are not considered.
- Furthermore, factors such as proximity to ports and other infrastructure, access to a labour force, economics, trade, etc. are also not considered.

Conclusions

- The results of this study clearly show that Hayward kiwifruit viability in Te Puke and nearby environs is very likely to become ‘marginal’ by the middle of the century and generally non-viable by its end, as temperatures continue to increase.

- Application of hydrogen cyanimide in winter greatly enhances the long-term viability, but there is a risk that the chemical may be banned from use.

- If this happens soon, then there is an urgent need to look into the viability of Hayward kiwifruit production in other areas of the country.

Conclusions

- Based on the model used here, areas further inland in the Bay of Plenty show potential for becoming more viable in the future, as do other currently cooler parts of the country including Canterbury and Central Otago (which look viable even without the application of hydrogen cyanimide).

- Of course, detailed site-specific viability investigations, taking all production factors into account, would be required to assess the true potential for these other locations.

- Nevertheless, it seems clear that through good planning, the New Zealand kiwifruit industry is very likely to remain viable for many decades to come.

Thanks very much

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