



Climate and “terroir” of New Zealand wine regions: a GIS perspective

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Climate and “terroir” of New Zealand wine regions: a GIS perspective

Climate and “terroir” are the two major commonly used set of factors when describing a wine region apart from those relating to “Cultiva” or variety. The latter is given the utmost consideration during site selection and once the vines are planted and established “climate and terroir” become the deterministic factors of grape crop and the consequent wine production annually. In this context, the paper looks at developing a GIS of thematic digital maps along with grape crop/ wine production / wine quality data to analysing the year-to-year variability by looking at the spatial patterns and any correlations between dependent and independent factors, using geospatial tools at different scales, such as New Zealand wine regions and within a vineyard. The dependent factors analysed in this instance are grapes harvested and wine quality both at a regional scale. The independent factors used in the study are temperature, soil, elevation and hill shade. The paper describes the initial results of an integrated data analysis being investigated with the above stated factors using a geographical information system (GIS).

“terroir” and “cultiva”

- A " **terroir** " is a group of vineyards (or even vines) from the **same region**, belonging to a **specific appellation**, and **sharing the same type of soil, weather conditions, grapes and wine making savoir-faire**, which contribute to give its **specific personality** to the wine.

<http://www.terroir-france.com/theclub/meaning.htm>

“Terroir” X “Cultiva”

- Variety
- Clone
- Rootstock
- Soil
- Canopy management
- Terrain
- Pest Pressure
- Disease Pressure
- Climate
 - Rainfall
 - Humidity
 - Sunshine
- Wind speed
- Cluster microclimate
- Seasonal Variation
- Vineyard Practices

Cultivation practices

+ Wine making => **specific personality**

Each choice in the successive steps of the elaboration of wine has repercussions on the taste and the quality of the wine

- **the terroir**
- **The climate (and the date of harvest)**
- **the grape-variety**
- **the type of container used for fermentation**
- **the temperature - the juice of grape is maintained during fermentation**
- **the fermentation period**
- **the type of container used for maturation**

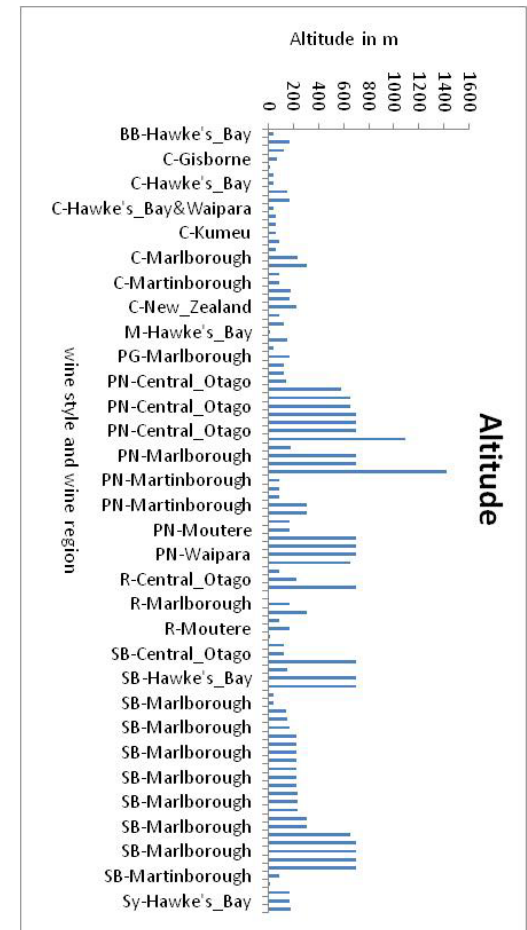
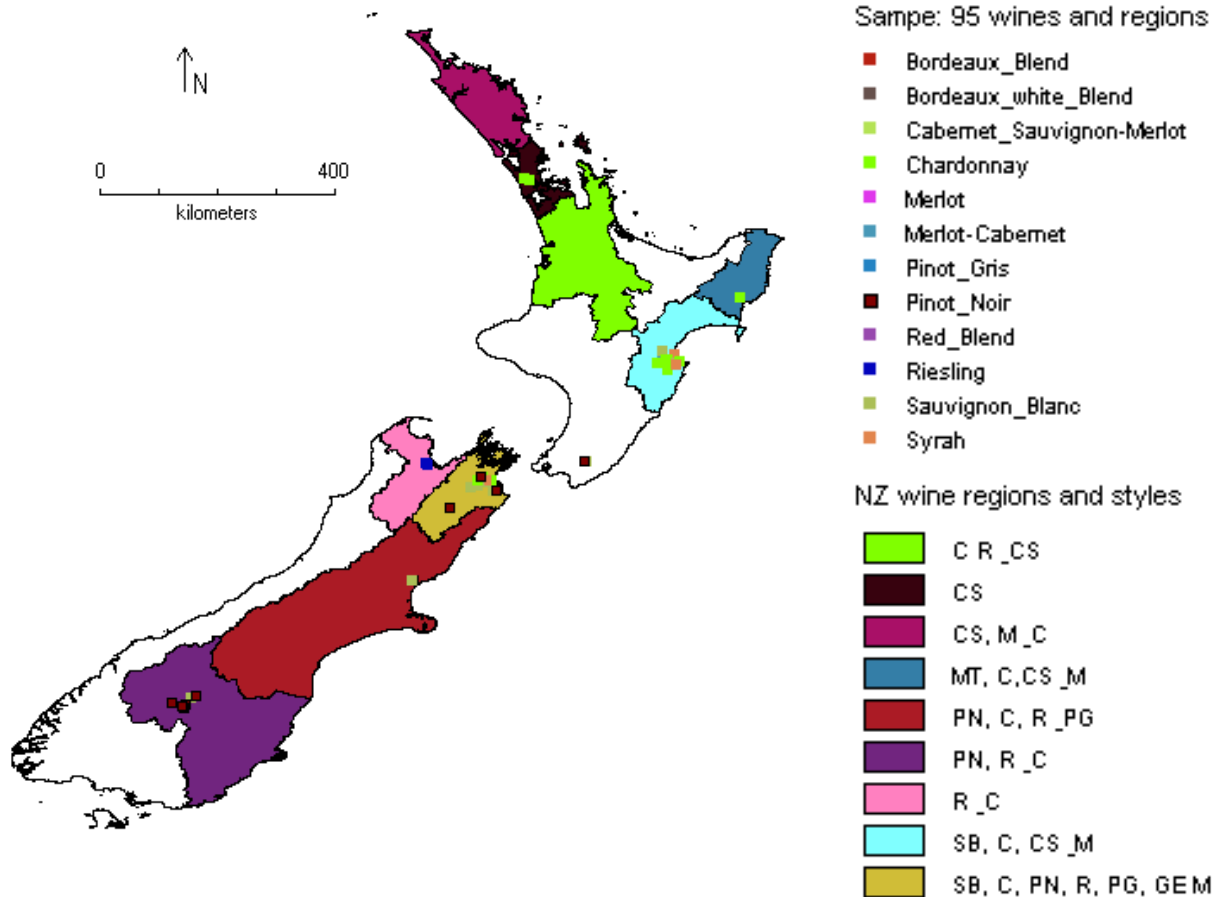
<http://www.terroir-france.com/wine/making.htm>

independent Vs dependent factors

Methods used

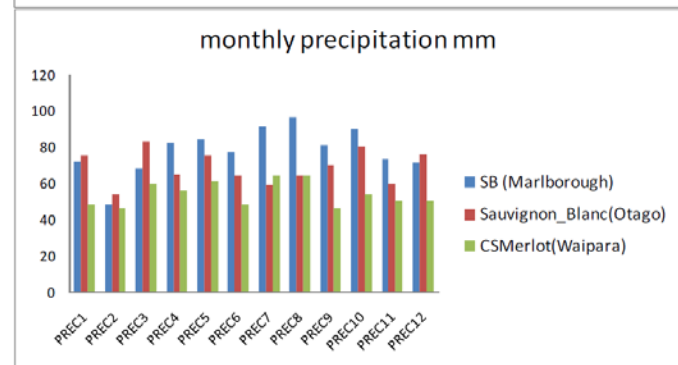
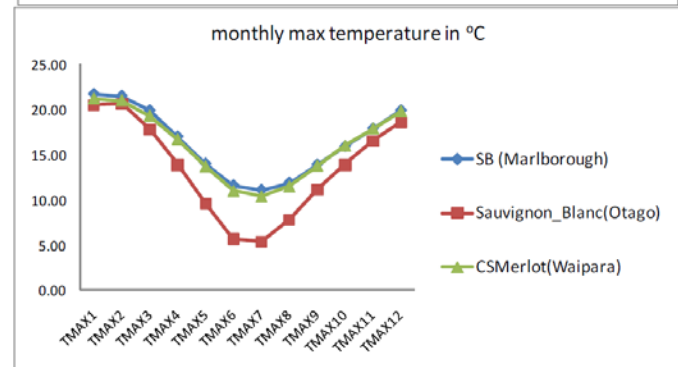
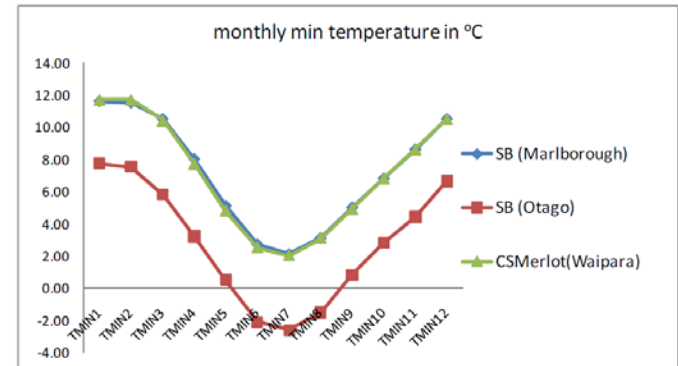
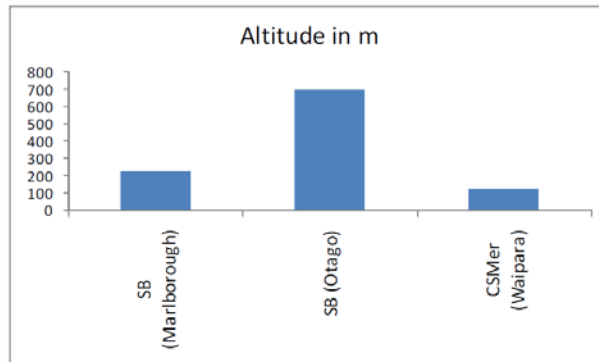
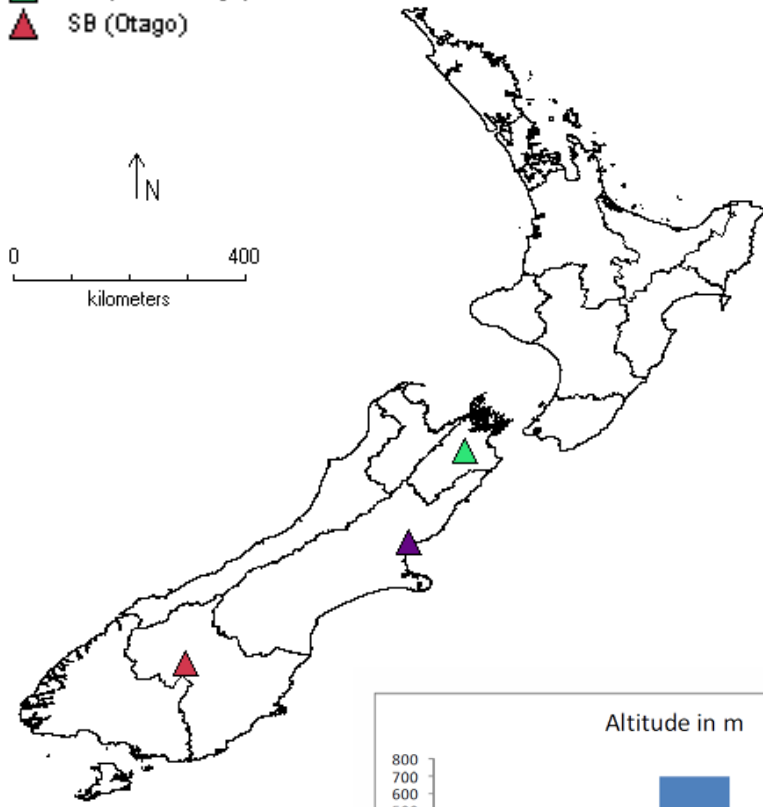
- Point
- Polygon
- Raster

Point based

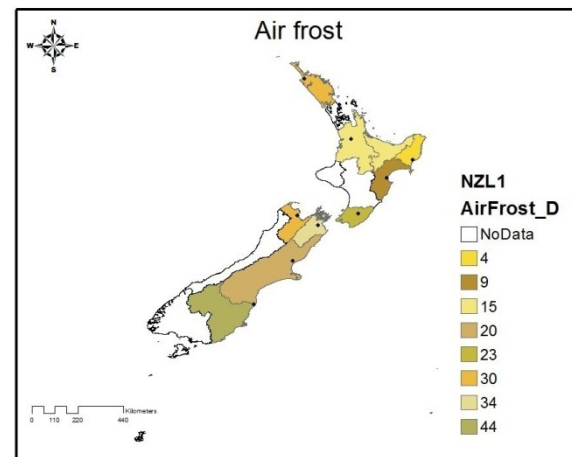
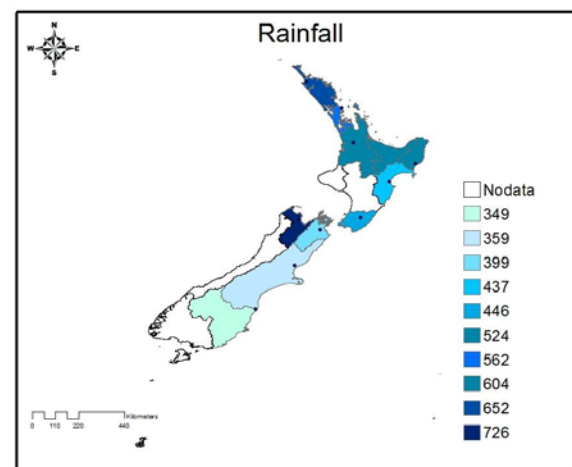
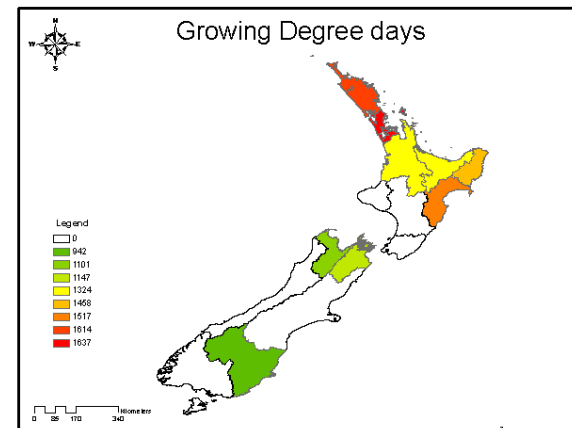
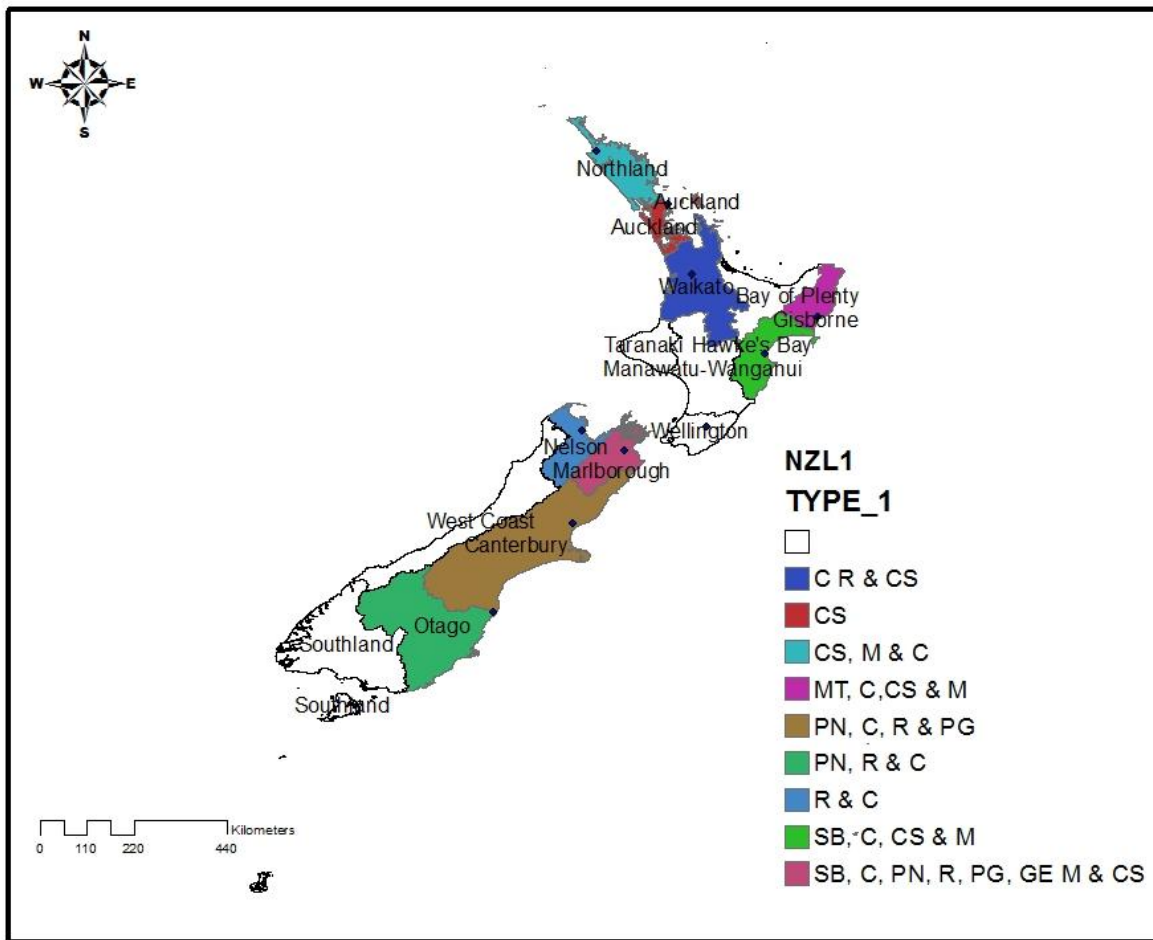


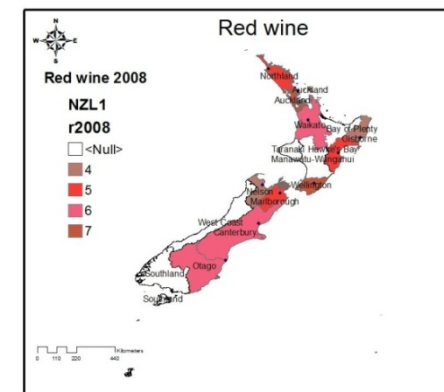
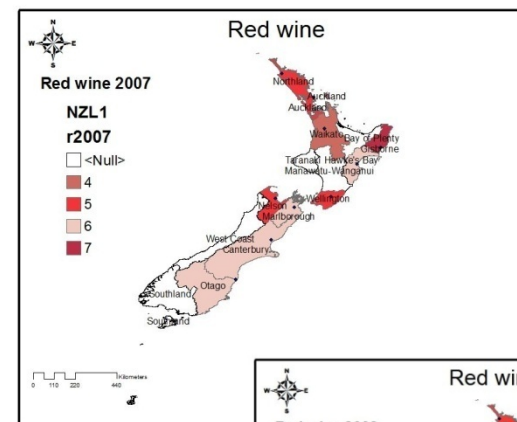
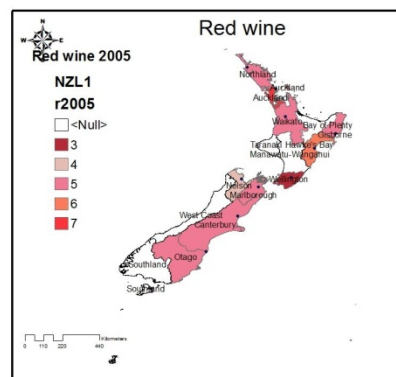
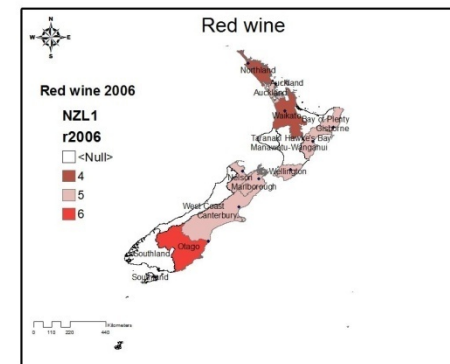
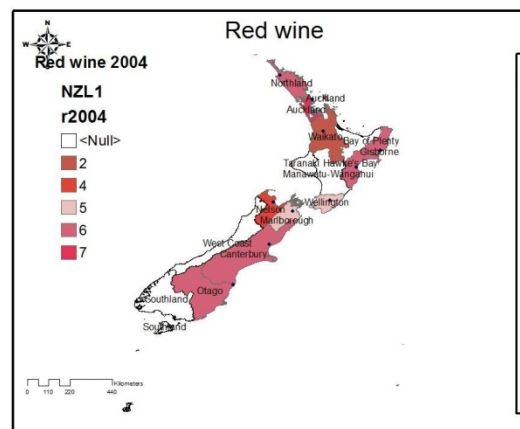
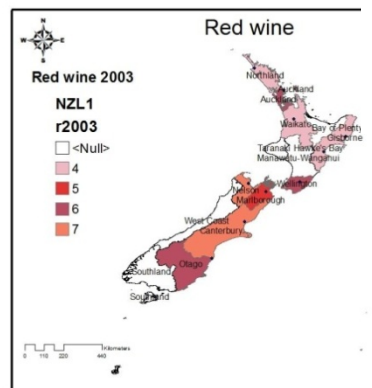
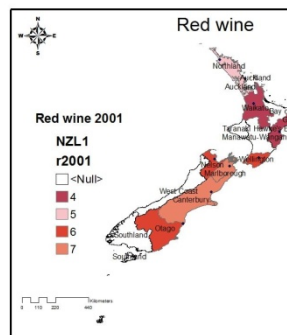
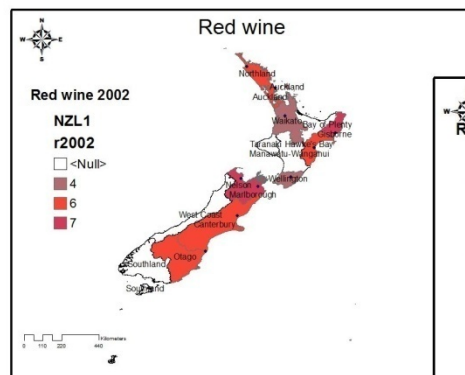
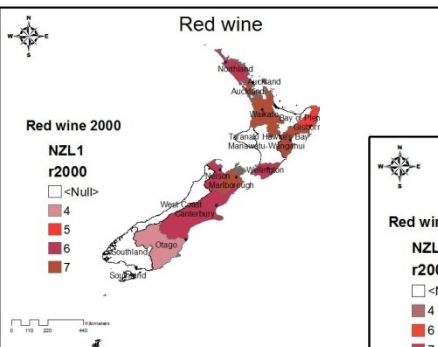
Point based

- ▲ CSMerlot (Waipara)
- ▲ SB (Marlborough)
- ▲ SB (Otago)

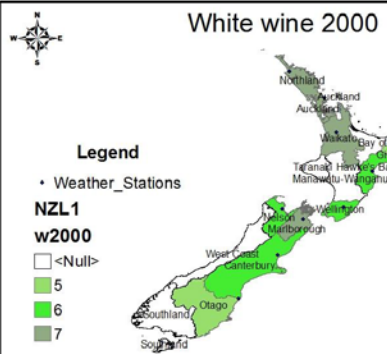


Polygon based @ the regional scale

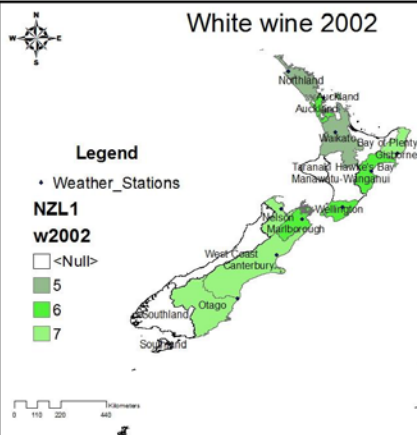




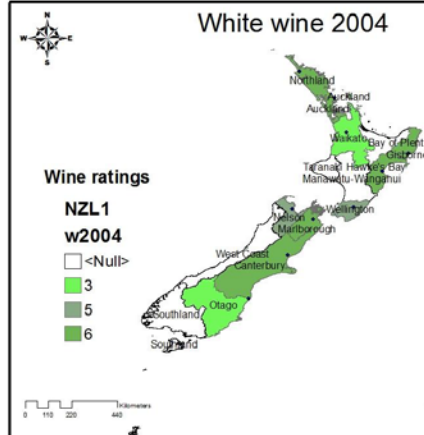
White wine 2000



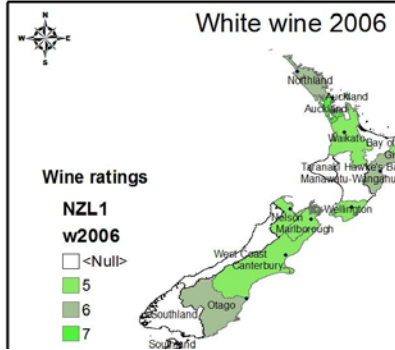
White wine 2002



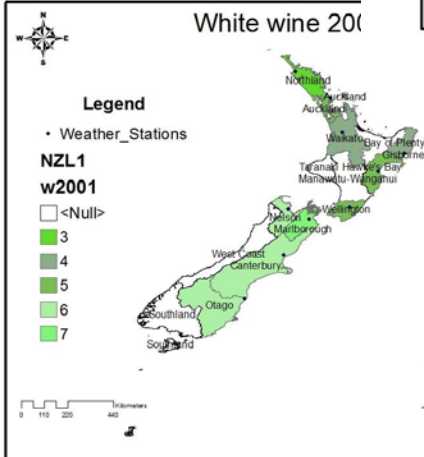
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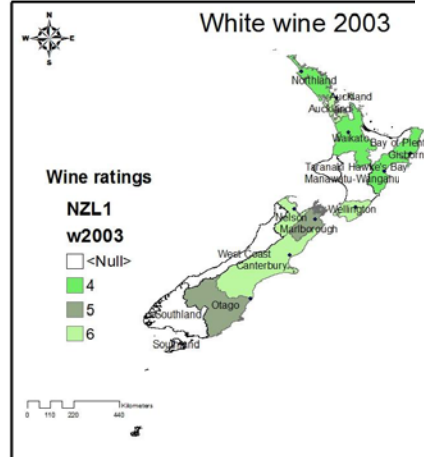
White wine 2006



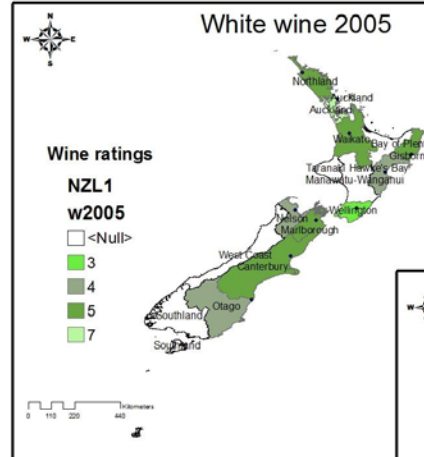
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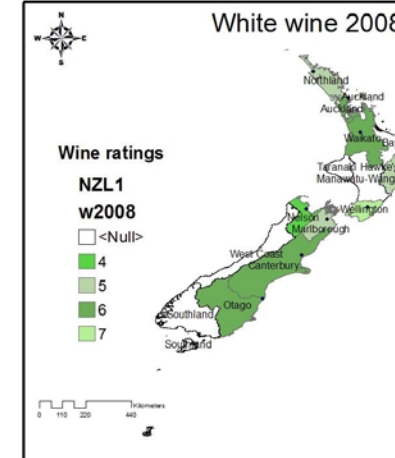
White wine 2003



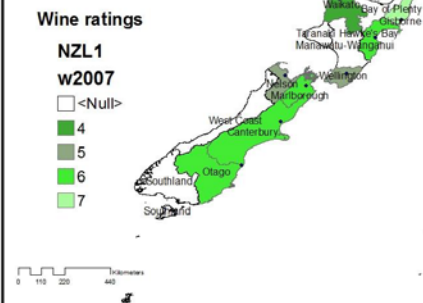
White wine 2005



White wine 2008



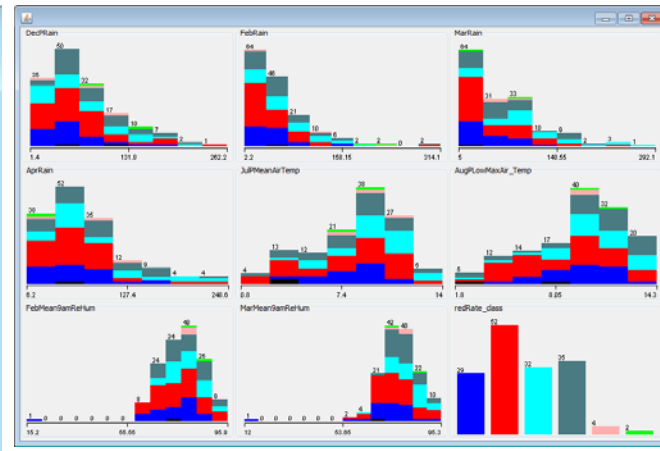
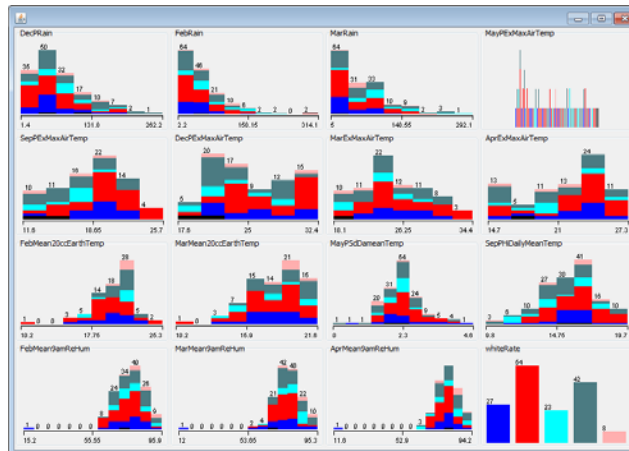
White wine 2007



Polygon based

- Rainfall
- Mean Air Temperature
- Extreme Maximum Air Temperature
- Mean 20cc Earth Temperature
- Mean 20cc Earth Temperature
- Mean Vapour pressure
- Growing degree days (GDD)
- Days of Snow
- Low Maximum Air Temperature
- Standard (std) Day mean Temperature
- Low Daily Mean Temperature
- High (hi) Daily Mean Temperature
- Mean 9 am Relative Humidity (RH)
- Mean 9 am Temperature

wine	variable	F	sig	wine	variable	F	sig
white	Dec rainfall	9.113	0.003	red	Dec rainfall	5.381	0.022
	Feb rainfall	4.061	0.046		Feb rainfall	6.960	0.009
	March rainfall	11.906	0.001		March rainfall	19.581	0
	May extreme Max air T	6.473	0.013		April rainfall	6.127	0.014
	Sep extreme Max air T	12.233	0.001		July mean air T	4.527	0.035
	Dec extreme Max air T	5.792	0.019		Aug low Max air T	6.719	0.011
	Mar extreme Max air T	4.470	0.038		Feb mean 9am RH	6.038	0.015
	April extreme Max air T	6.750	0.011		March mean 9am RH	12.803	---
	Feb mean 20cc Earth T	4.744	0.032				
	March mean 20cc Earth T	4.020	0.048				
	May std daily mean T	3.971	0.048				
	Sep high daily mean T	7.938	0.006				
	Feb mean 9am RH	4.965	0.027				
	March mean 9am RH	13.710	---				
	April mean 9am RH	7.479	0.007				



@ the regional scale

wine rating and independent variables

region	rate	rule No	Condition 1	Condntion 2	Condition 3	Condition 4
Auckland 1	5	2/11	Mar mean 9am RH > 72.8	Mar mean 9am RH <= 81.9	Aug low max air temp > 12.7	
	5	3/11	Mar mean 9am RH > 72.8	Mar mean 9am RH > 81.9		
	6	4/12	Mar mean 9am RH > 72.8	Mar mean 9am RH <= 81.9	Aug low max air temp <= 12.7	Mar mean 9am RH > 80.6
	7	1/9	Mar mean 9am RH <= 72.8			
	7	7/9	Mar mean 9am RH > 72.8	Mar mean 9am RH <= 81.9	Aug low max air temp <= 12.7	Mar mean 9am RH <= 80.6
Caterbury 2	4	1/7	Mar mean 9am RH <= 72.8	FebRain > 62		
	4	2/7	Mar mean 9am RH > 72.8	DecPRain > 83.6		
	6	1/12	Mar mean 9am RH <= 72.8	FebRain <= 62	FebRain <= 40.8	
	6	5/12	Mar mean 9am RH > 72.8	DecPRain <= 83.6	FebRain > 18.6	
	7	2/9	Mar mean 9am RH <= 72.8	FebRain <= 62	FebRain > 40.8	
	7	8/9	Mar mean 9am RH > 72.8	DecPRain <= 83.6	FebRain <= 18.6	
Gisborne 3	4	3/7	Mar mean 9am RH > 72.8	JulPMeanAirTemp > 8.9	DecPRain <= 54.8	
	5	4/11	Mar mean 9am RH > 72.8	JulPMeanAirTemp > 8.9	DecPRain > 54.8	
	6	6/12	Mar mean 9am RH > 72.8	JulPMeanAirTemp <= 8.9		
	7	3/9	Mar mean 9am RH <= 72.8			
Hawkes Bay 4	4	4/7	Mar mean 9am RH > 72.8	FebRain > 47.8		
	5	5/11	Mar mean 9am RH > 72.8	FebRain <= 47.8	Aug low max air temp > 10.1	
	6	2/12	Mar mean 9am RH <= 72.8	DecPRain > 38.4		
	6	7/12	Mar mean 9am RH > 72.8	FebRain <= 47.8	Aug low max air temp <= 10.1	
	7	4/9	Mar mean 9am RH <= 72.8	DecPRain <= 38.4		
Marlborough 5	4	5/7	Mar mean 9am RH > 72.8	MarRain > 68		
	5	6/11	Mar mean 9am RH > 72.8	MarRain <= 68		
	7	5/9	Mar mean 9am RH <= 72.8			
Nelson 6	4	6/7	Mar mean 9am RH > 72.8	MarRain > 113		
	5	7/11	Mar mean 9am RH > 72.8	Aug low max air temp > 10		
	6	8/12	Mar mean 9am RH > 72.8	Aug low max air temp <= 10		
	7	6/9	Mar mean 9am RH <= 72.8			
Northland 7	4	7/7	Mar mean 9am RH > 72.8	MarRain > 33.7	Mar mean 9am RH <= 88.1	MarRain > 62.2
	5	8/11	Mar mean 9am RH > 72.8	MarRain <= 113	MarRain > 84.8	
	6	9/12	Mar mean 9am RH > 72.8	MarRain <= 113	MarRain <= 84.8	
Waikato 8	2	1/1	Mar mean 9am RH > 72.8	MarRain <= 33.7		
	3	1/2	Mar mean 9am RH <= 72.8			
	5	9/11	Mar mean 9am RH > 72.8	MarRain > 33.7	Mar mean 9am RH <= 88.1	MarRain <= 62.2
Wairarapa 9	3	2/2	Mar mean 9am RH > 72.8	DecPRain > 102.6		
	5	10/11	Mar mean 9am RH > 72.8	DecPRain <= 102.6	Mar mean 9am RH <= 80	
	6	10/12	Mar mean 9am RH > 72.8	MarRain > 33.7	Mar mean 9am RH > 88.1	
	6	11/12	Mar mean 9am RH > 72.8	DecPRain <= 102.6	Mar mean 9am RH > 80	Mar mean 9am RH <= 86.9
	7	9/9	Mar mean 9am RH > 72.8	DecPRain <= 102.6	Mar mean 9am RH > 80	Mar mean 9am RH > 86.9
Otago 10	5	1/11	Mar mean 9am RH <= 72.8	FebRain > 36.6		
	5	11/11	Mar mean 9am RH > 72.8	FebRain <= 57.2		
	6	3/12	Mar mean 9am RH <= 72.8	FebRain <= 36.6		
	6	12/12	Mar mean 9am RH > 72.8	FebRain > 57.2		

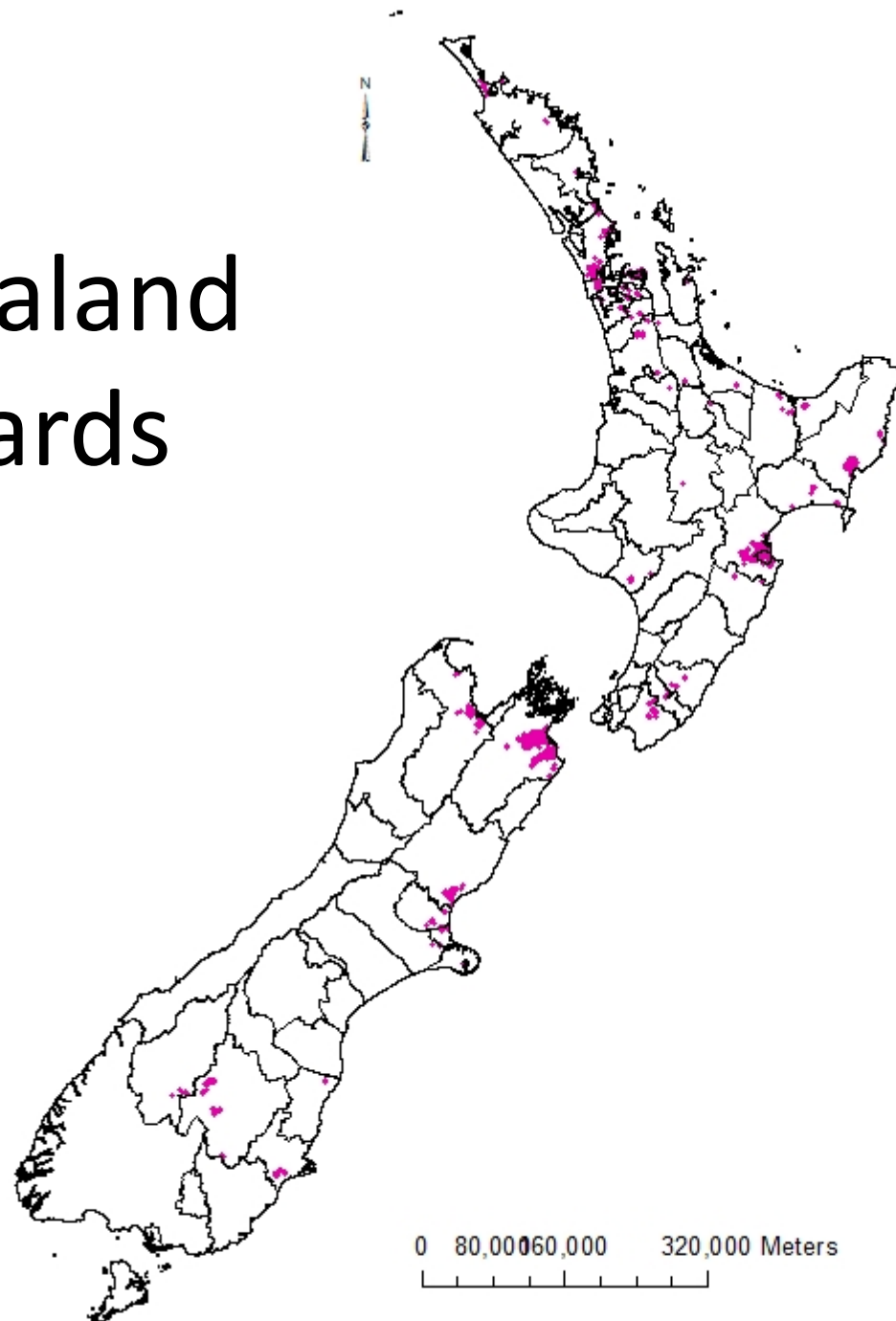
region	rate	rule No	Condition 1	Condntion 2	Condition 3	Condition 4		
		6	1/10	Feb rain <= 18.5				
Auckland 1	4	1/7	Feb rain > 15.8	Feb mean 9am RH <= 85.5	Sep hi dmean temp <= 15.2			
	5	1/11	Feb rain > 15.8	Feb mean 9am RH > 85.5				
	6	2/10	Feb rain > 15.8	Feb mean 9am RH <= 85.5	Sep hi dmean temp > 15.2	Mar Ex max air temp <= 24.8		
	7	1/6	Feb rain > 15.8	Feb mean 9am RH <= 85.5	Sep hi dmean temp > 15.2	Mar Ex max air temp > 24.8		
Caterbury 2	4	2/7	Feb rain > 15.9	Sep hi dmean temp <= 14.2	Sep Ex max air temp > 20.9			
	5	2/11	Feb rain > 15.8	Sep hi dmean temp <= 14.2	Sep Ex max air temp <= 20.10			
	6	3/10	Feb rain > 15.8	Sep hi dmean temp > 14.2	Mar mean 9am RH > 67.3			
	7	2/6	Feb rain > 15.8	Sep hi dmean temp > 14.2	Mar mean 9am RH <= 67.3			
Gisborne 3	4	3/7	Feb rain > 15.8	Mar mean 9am RH > 76.9	Feb rain > 37.6			
	5	3/11	Feb rain > 15.8	Mar mean 9am RH > 76.10	Feb rain <= 37.6			
	6	4/10	Feb rain > 15.8	Mar mean 9am RH <= 76.10	Mar mean 9am RH > 73.2			
Hawkes Bay 4	7	3/6	Feb rain > 15.8	Mar mean 9am RH <= 76.10	Mar mean 9am RH <= 73.2			
	4	4/7	Feb rain > 15.8	Apr mean 9am RH <= 77.3	Sep hi dmean temp <= 17			
	5	4/11	Feb rain > 15.8	Apr mean 9am RH > 77.3	Sep hi dmean temp <= 17			
	6	5/10	Feb rain > 15.8	Apr mean 9am RH <= 77.3	Sep hi dmean temp > 17			
Marlborough 5	7	4/6	Feb rain > 15.8	Apr mean 9am RH > 77.3	Sep hi dmean temp <= 15.1			
	3	1/3	Feb rain > 15.8	Apr ex max air temp <= 22.8				
	5	5/11	Feb rain > 15.8	Apr Ex max air temp > 22.8	Mar Ex max air temp <= 26	Sep Ex max air temp > 15.8		
	6	6/10	Feb rain > 15.8	Apr Ex max air temp > 22.8	Mar Ex max air temp <= 26.7			
Nelson 6	7	5/6	Feb rain > 15.8	Apr Ex max air temp > 22.8	Mar Ex max air temp > 26.7	Sep Ex max air temp > 15.8		
	5	6/11	Feb rain > 15.8	Mar mean 20cc Earth temp <= 18.6				
Northland 7	6	7/10	Feb rain > 15.8	Mar mean 20cc Earth temp > 18.6				
	3	2/3	Feb rain > 15.8	Mar mean 20cc Earth temp > 19	Dec rain <= 123.6	Mar rain > 46.6	Maysd dmean temp <= 1.4	
	3	3/3	Feb rain > 15.8	Mar mean 20cc Earth temp > 19	Dec rain <= 123.6	Mar rain > 46.6	Maysd dmean temp > 1.4	Dec rain > 79.4
	4	5/7	Feb rain > 15.8	Mar mean 20cc Earth temp > 19	Dec rain < 123.6	Mar rain > 46.6	Maysd dmean temp > 1.4	Dec rain <= 79.4
	5	7/11	Feb rain > 15.8	Mar mean 20cc Earth temp > 19	Dec rain <= 123.6	Mar rain <= 46.6		
Waikato 8	5	8/11	Feb rain > 15.8	Mar mean 20cc Earth temp > 19	Dec rain > 123.6			
	6	8/10	Feb rain > 15.8	Mar mean 20cc Earth temp <= 19.5				
	4	6/7	Feb rain > 15.8	Sep hi dmean temp > 15.3				
Wairarapa 9	5	9/11	Feb rain > 15.8	Sep hi dmean temp <= 15.3				
	5	10/11	Feb rain > 15.8	Feb rain > 57.2	Feb mean 9am RH <= 83.4			
	6	9/10	Feb rain > 15.8	Feb mean 9am RH > 83.4				
Otago 10	7	6/6	Feb rain > 15.8	Feb rain <= 57.2				
	4	7/7	Feb rain > 15.8	Apr mean 9am RH > 77				
	5	11/11	Feb rain > 15.8	Mar mean 9am RH <= 77	Apr Ex max air temp <= 16.3			
	6	10/10	Feb rain > 15.8	Mar mean 9am RH <= 77	Apr Ex max air temp > 16.3			

Auckland: August low maximum (max) air temperate. Other regions December, February and March monthly total rainfall as deterministic factors

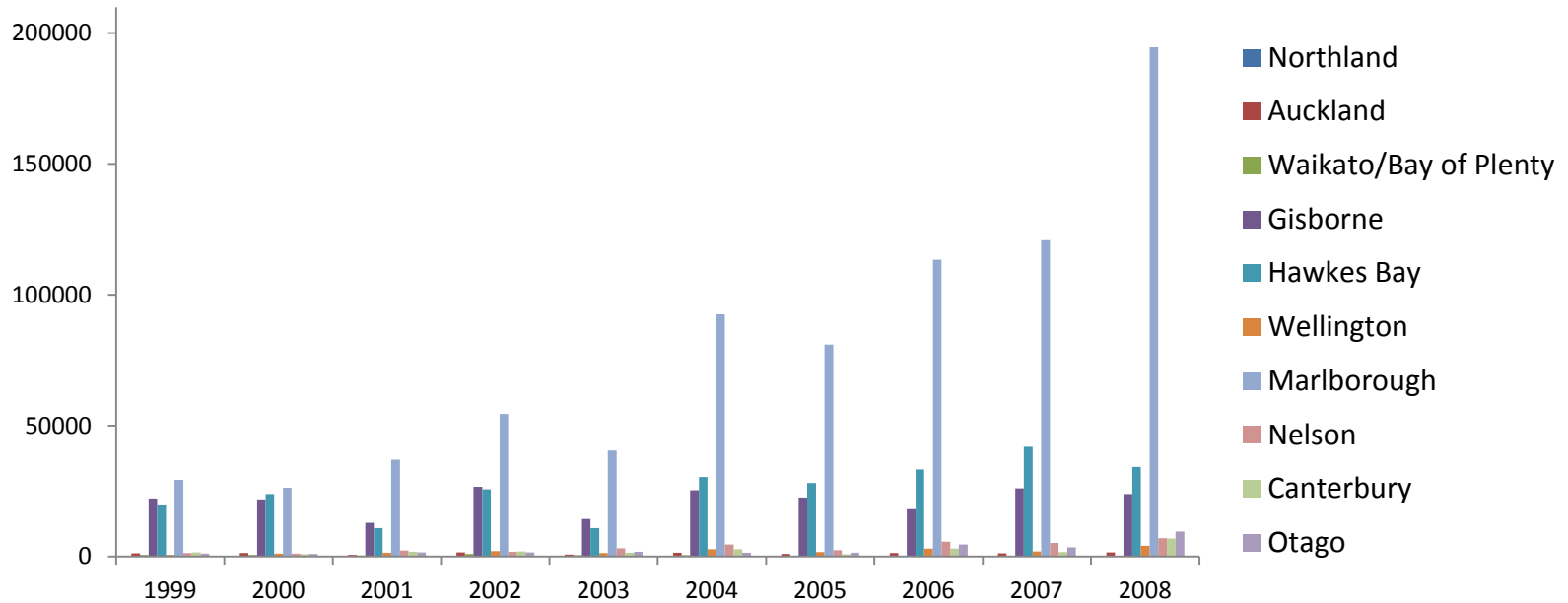
red wine regional rating is March mean 9 am relative humidity (RH)

RASTER BASED

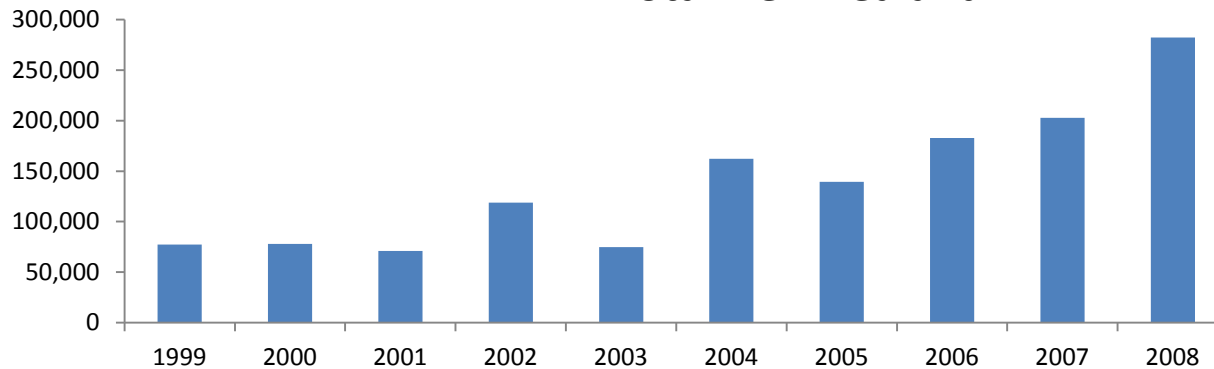
New Zealand Vineyards



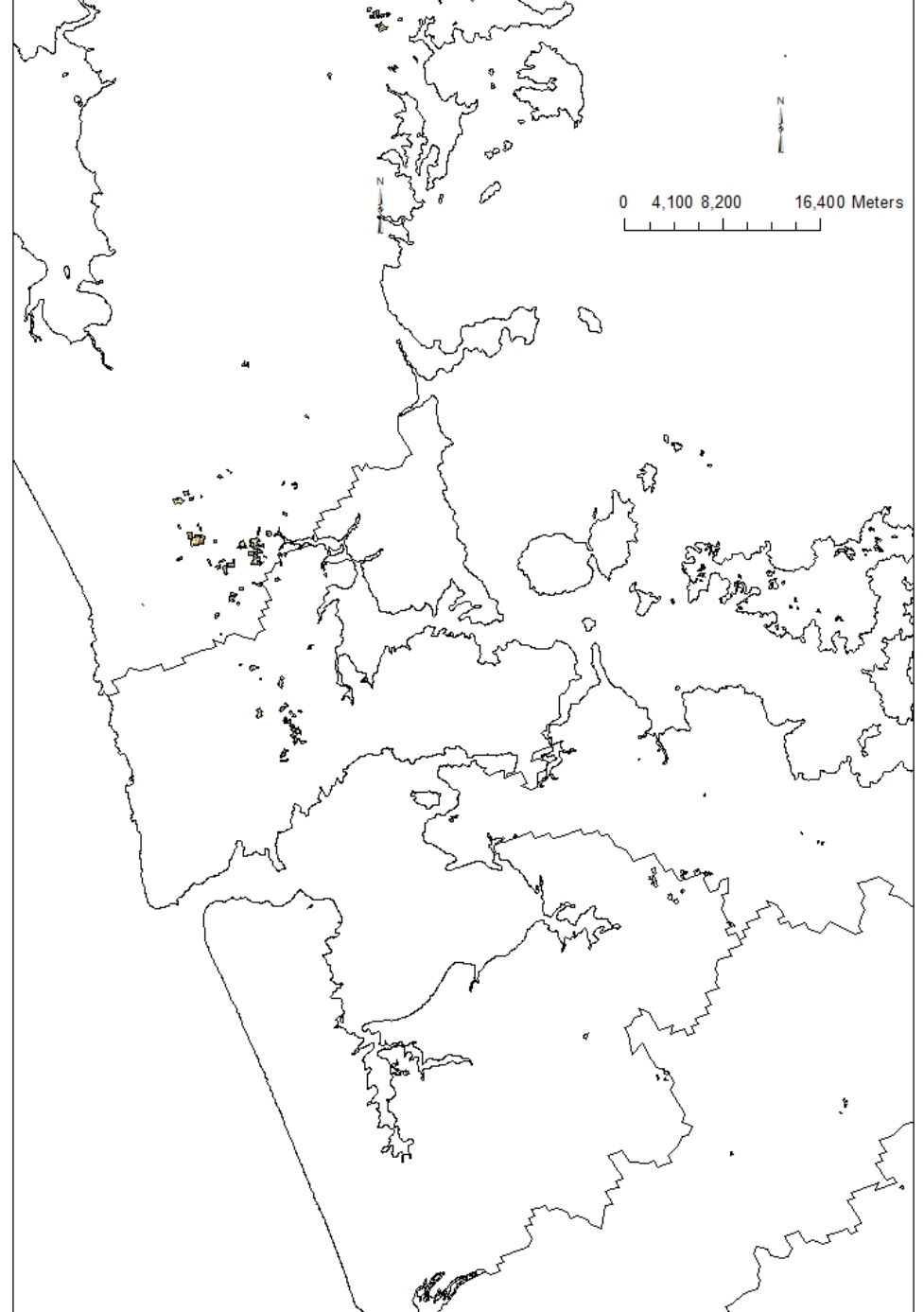
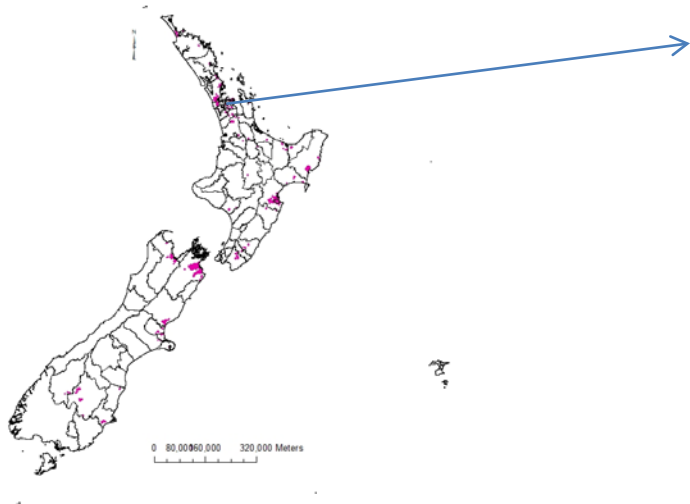
by Region (tonnes crushed)



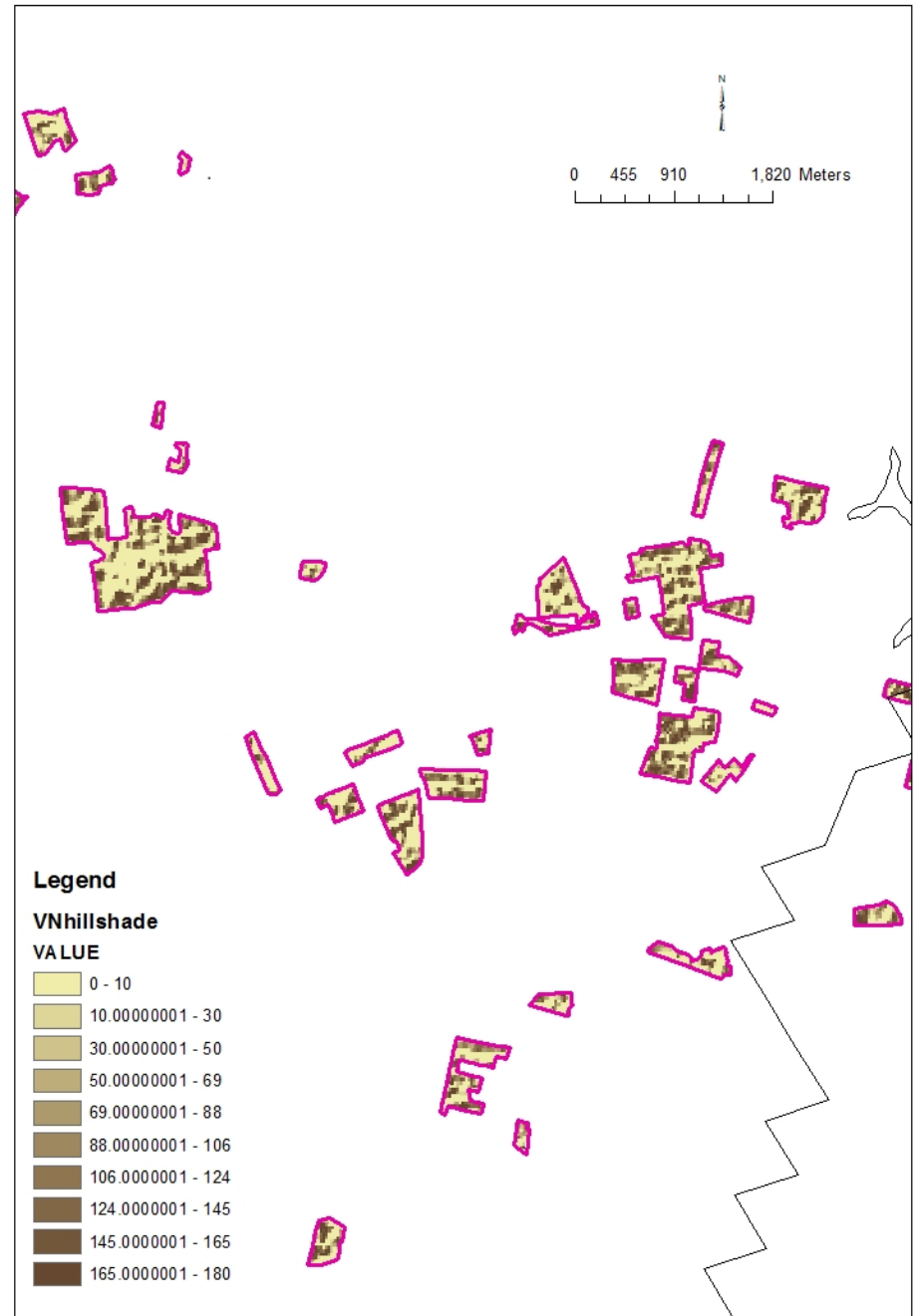
Total New Zealand



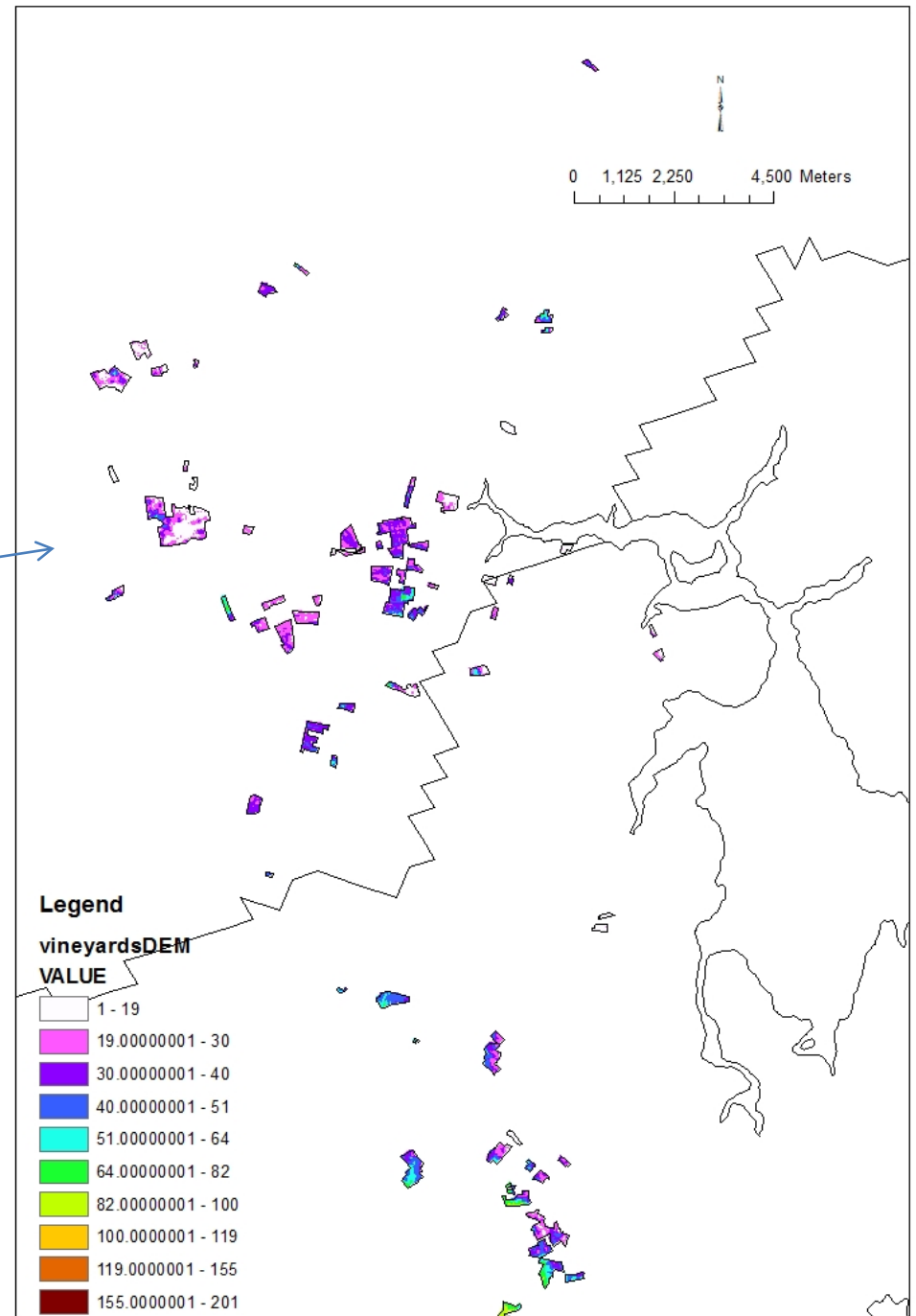
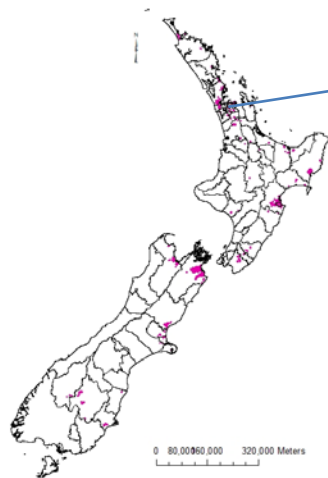
Digital Elevation Map DEM hill shade

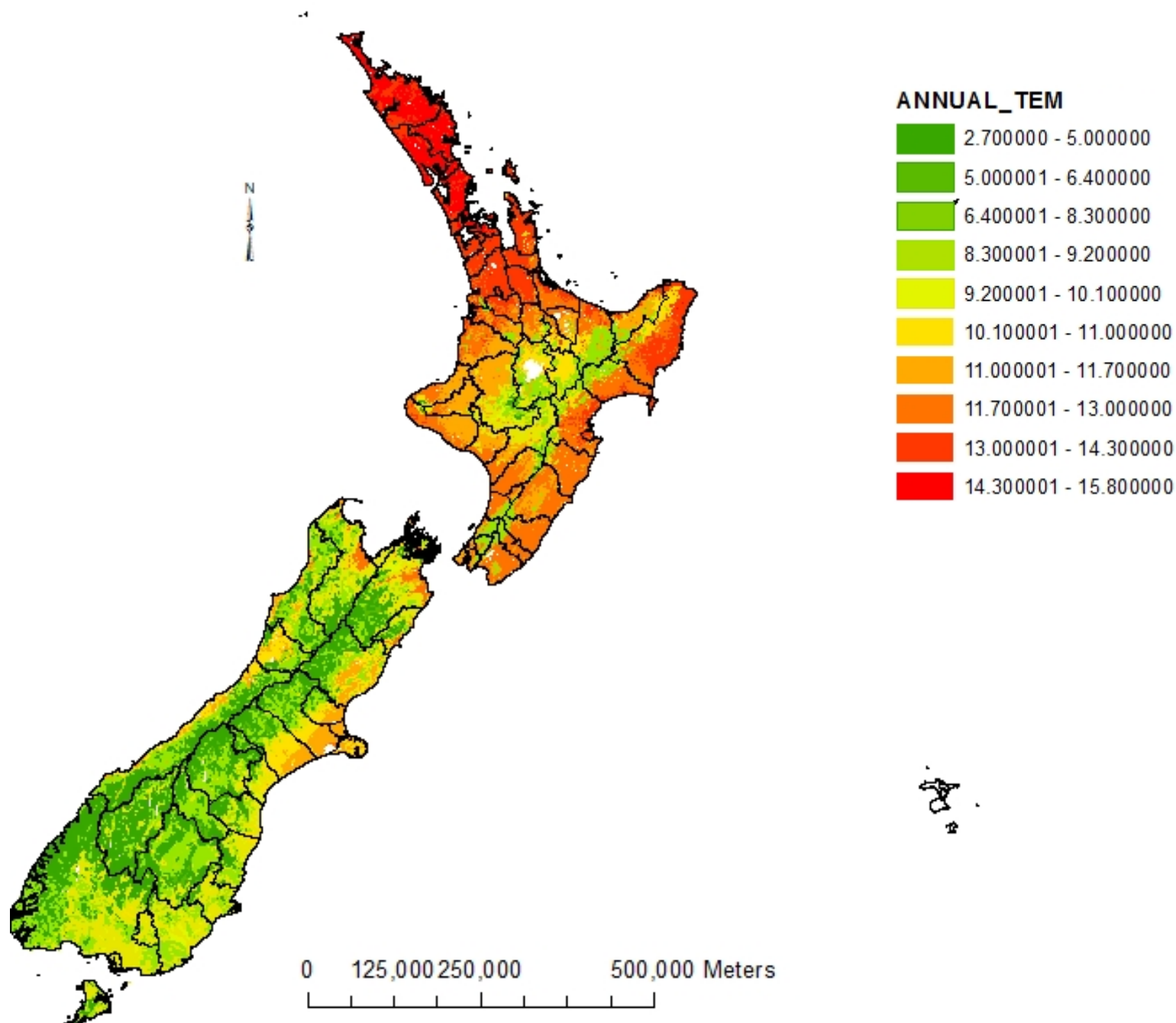


Digital Elevation Map DEM Hill shade



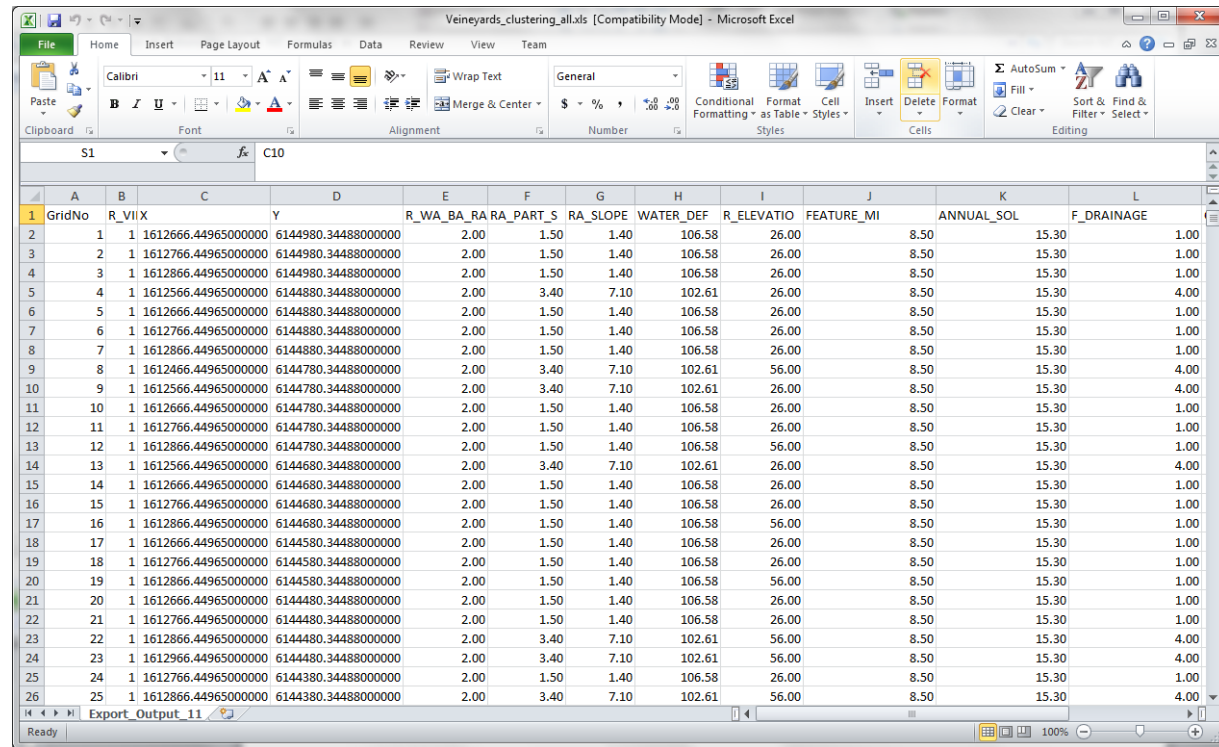
Digital Elevation Map DEM Elevation





Dependent variables for NZ vineyard polygons

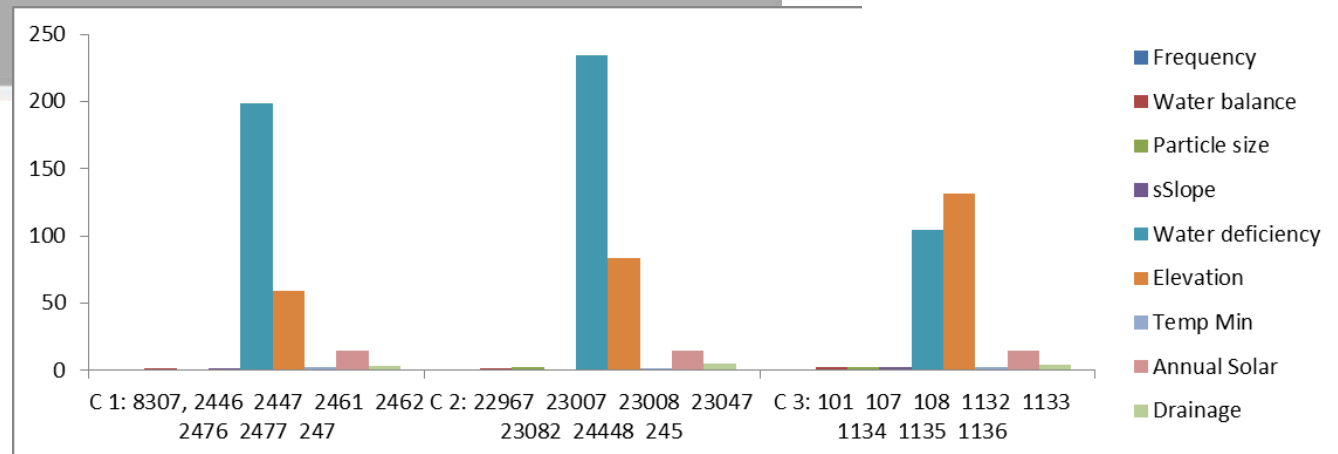
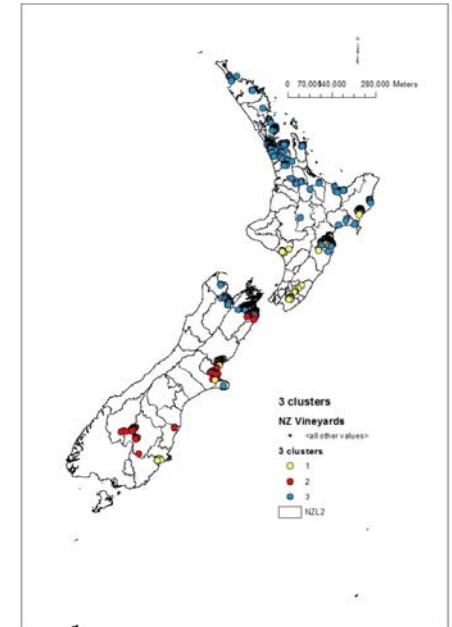
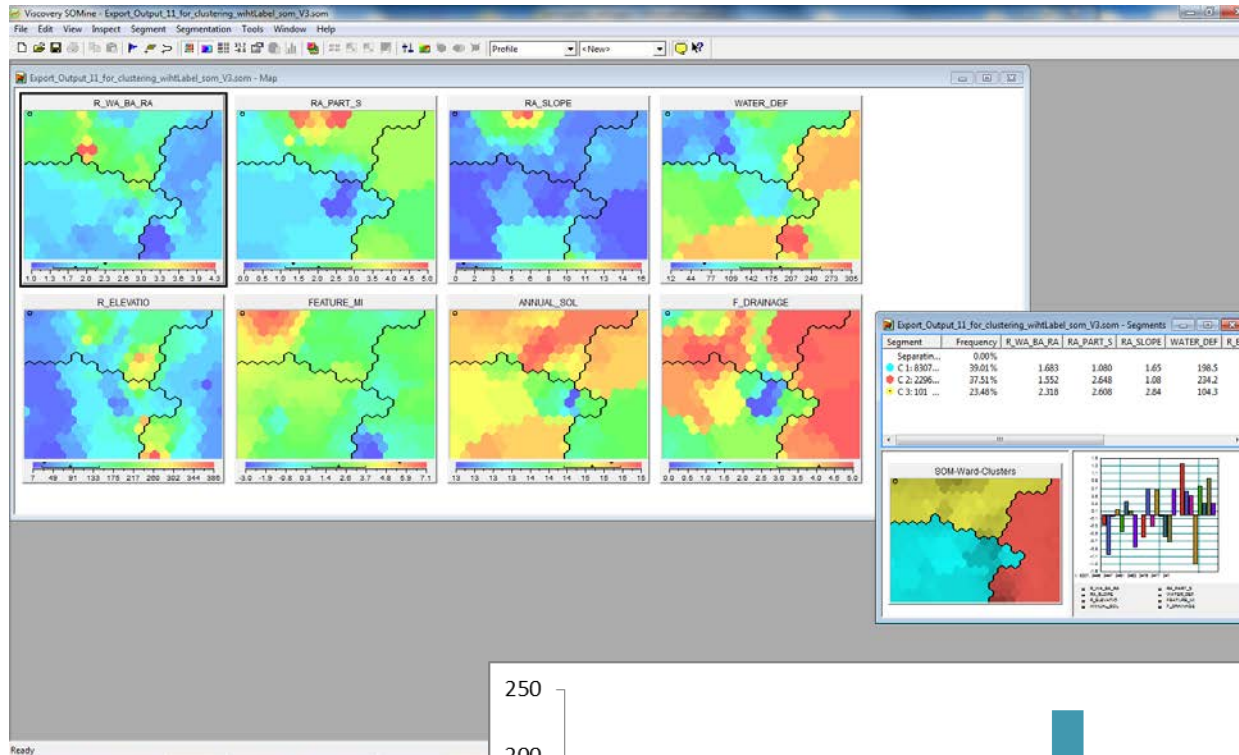
1. Water balance
2. Particle size
3. Slope
4. Water deficiency
5. Elevation
6. Temp Min
7. Annual Solar
8. Drainage
9. For 27343 pixels

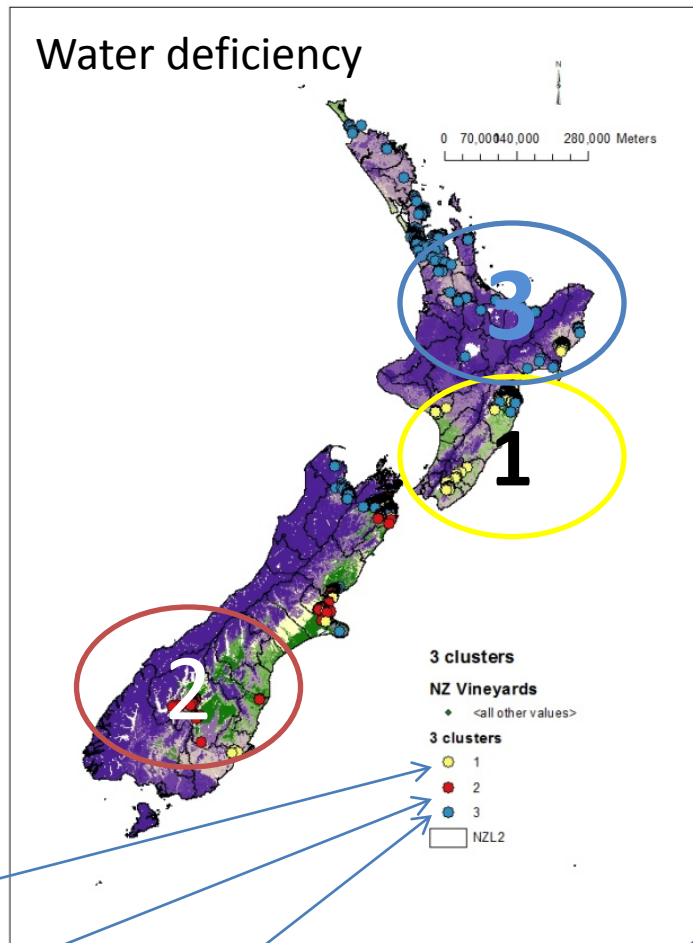
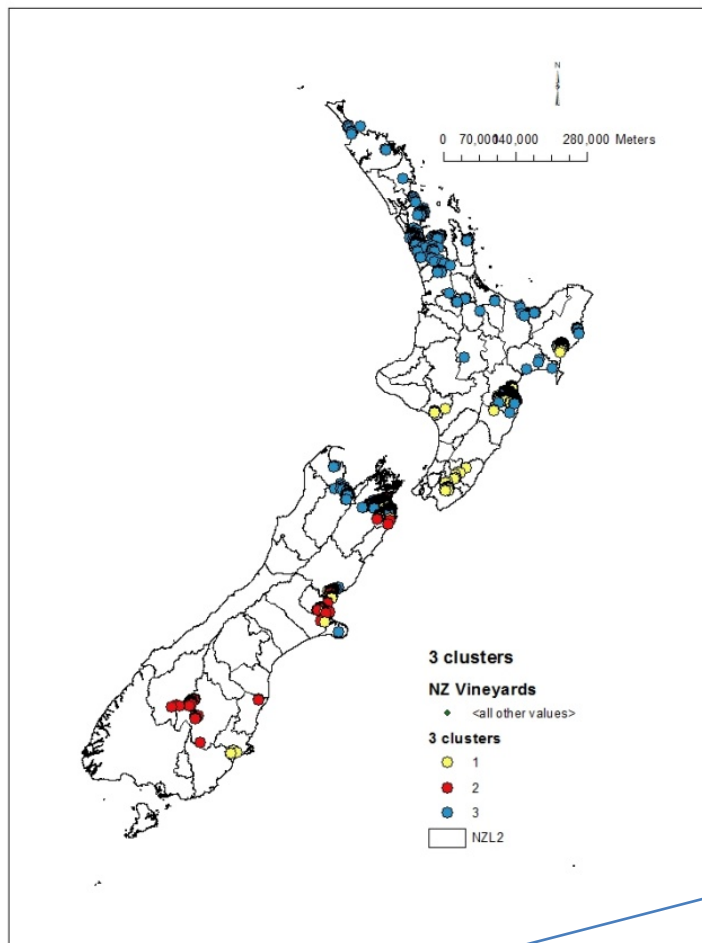


The screenshot shows a Microsoft Excel spreadsheet titled "Veineyards_clustering_all.xls" in Compatibility Mode. The spreadsheet contains a table with 12 columns and 26 rows of data. The columns are labeled as follows: A (GridNo), B (R_VII X), C (Y), D (R_WA_BA_RA_RA_PART_S), E (RA_SLOPE), F (WATER_DEF), G (R_ELEVATIO), H (FEATURE_MI), I (ANNUAL_SOL), J (F_DRAINAGE), K, and L. The data rows contain numerical values for each of these variables across 26 different grid locations.

	A	B	C	D	E	F	G	H	I	J	K	L
1	GridNo	R_VII X	Y	R_WA_BA_RA_RA_PART_S	RA_SLOPE	WATER_DEF	R_ELEVATIO	FEATURE_MI	ANNUAL_SOL	F_DRAINAGE		
2	1	1	1612666.44965000000	6144980.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
3	2	1	1612766.44965000000	6144980.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
4	3	1	1612866.44965000000	6144980.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
5	4	1	1612566.44965000000	6144880.34488000000	2.00	3.40	7.10	102.61	26.00	8.50	15.30	4.00
6	5	1	1612666.44965000000	6144880.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
7	6	1	1612766.44965000000	6144880.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
8	7	1	1612866.44965000000	6144880.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
9	8	1	1612466.44965000000	6144780.34488000000	2.00	3.40	7.10	102.61	56.00	8.50	15.30	4.00
10	9	1	1612566.44965000000	6144780.34488000000	2.00	3.40	7.10	102.61	26.00	8.50	15.30	4.00
11	10	1	1612666.44965000000	6144780.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
12	11	1	1612766.44965000000	6144780.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
13	12	1	1612866.44965000000	6144780.34488000000	2.00	1.50	1.40	106.58	56.00	8.50	15.30	1.00
14	13	1	1612566.44965000000	6144680.34488000000	2.00	3.40	7.10	102.61	26.00	8.50	15.30	4.00
15	14	1	1612666.44965000000	6144680.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
16	15	1	1612766.44965000000	6144680.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
17	16	1	1612866.44965000000	6144680.34488000000	2.00	1.50	1.40	106.58	56.00	8.50	15.30	1.00
18	17	1	1612666.44965000000	6144580.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
19	18	1	1612766.44965000000	6144580.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
20	19	1	1612866.44965000000	6144580.34488000000	2.00	1.50	1.40	106.58	56.00	8.50	15.30	1.00
21	20	1	1612666.44965000000	6144480.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
22	21	1	1612766.44965000000	6144480.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
23	22	1	1612866.44965000000	6144480.34488000000	2.00	3.40	7.10	102.61	56.00	8.50	15.30	4.00
24	23	1	1612966.44965000000	6144480.34488000000	2.00	3.40	7.10	102.61	56.00	8.50	15.30	4.00
25	24	1	1612766.44965000000	6144380.34488000000	2.00	1.50	1.40	106.58	26.00	8.50	15.30	1.00
26	25	1	1612866.44965000000	6144380.34488000000	2.00	3.40	7.10	102.61	56.00	8.50	15.30	4.00

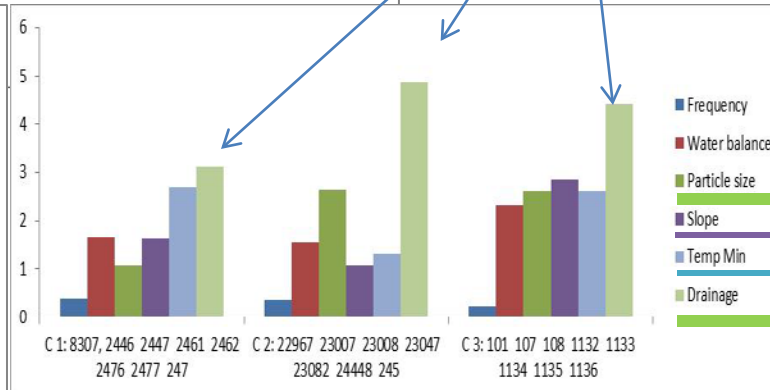
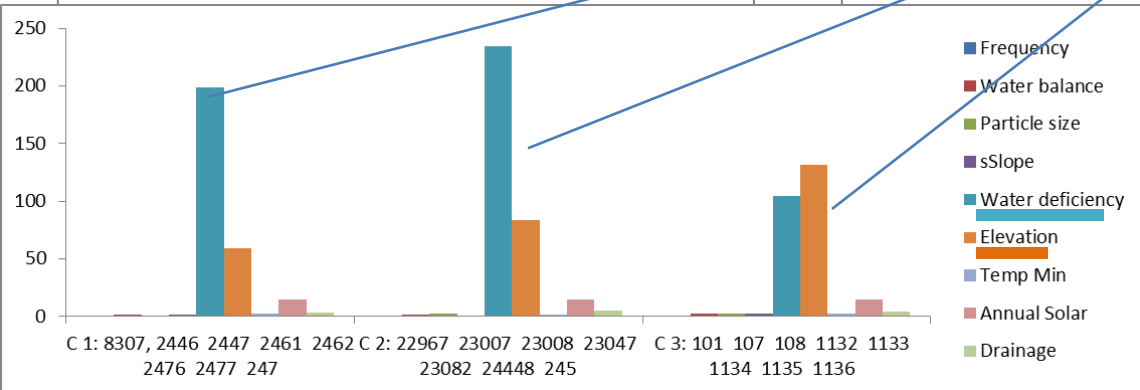
Pixel (data) clustering with SOM

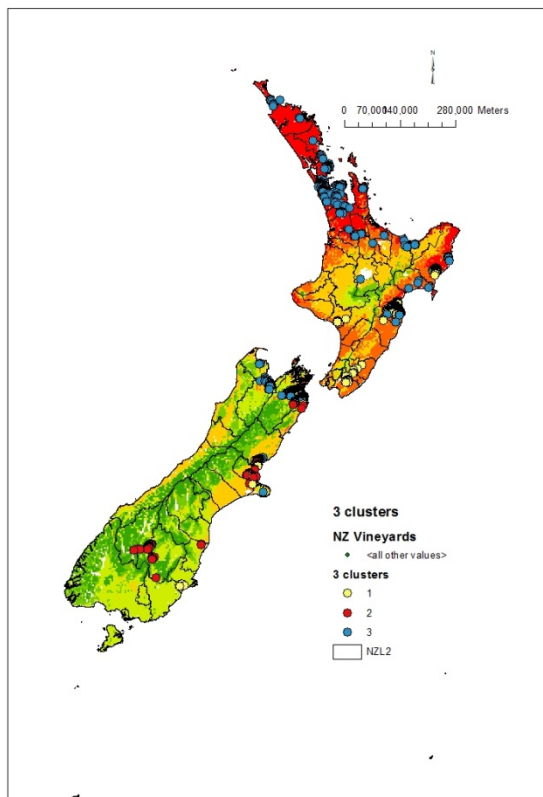
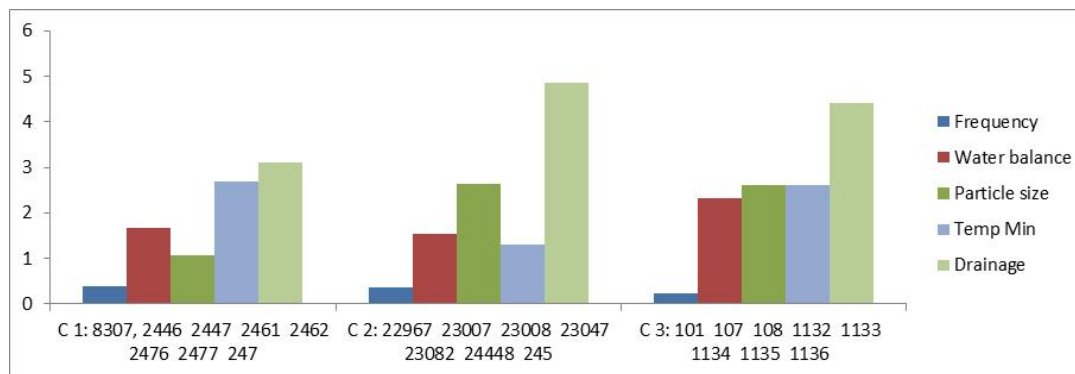




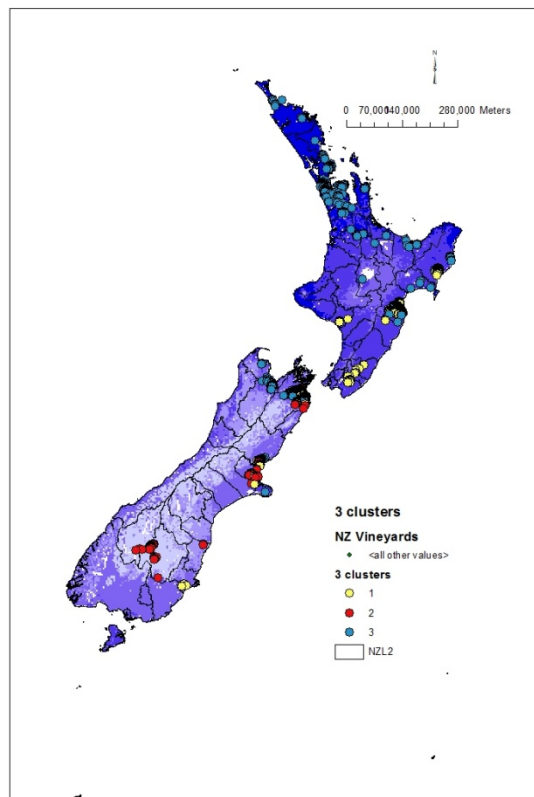
Separation...

- C 1: 8307...
- C 2: 2296...
- C 3: 101 ...

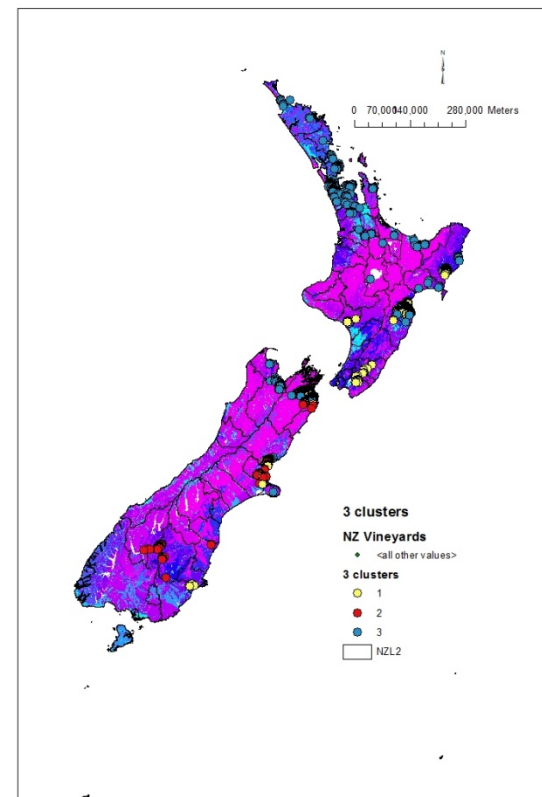




Annual temperature

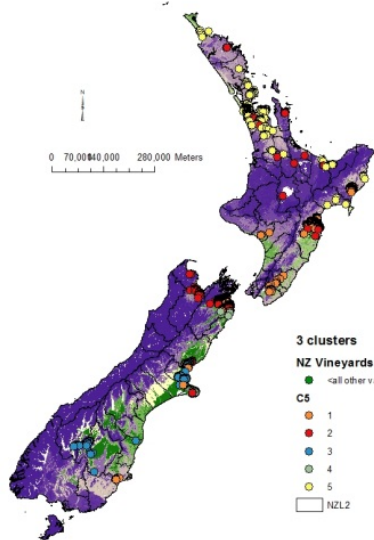
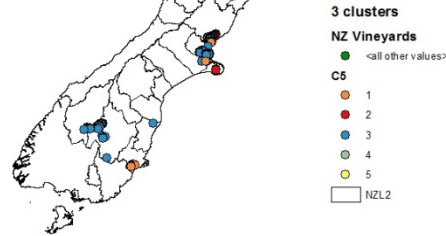
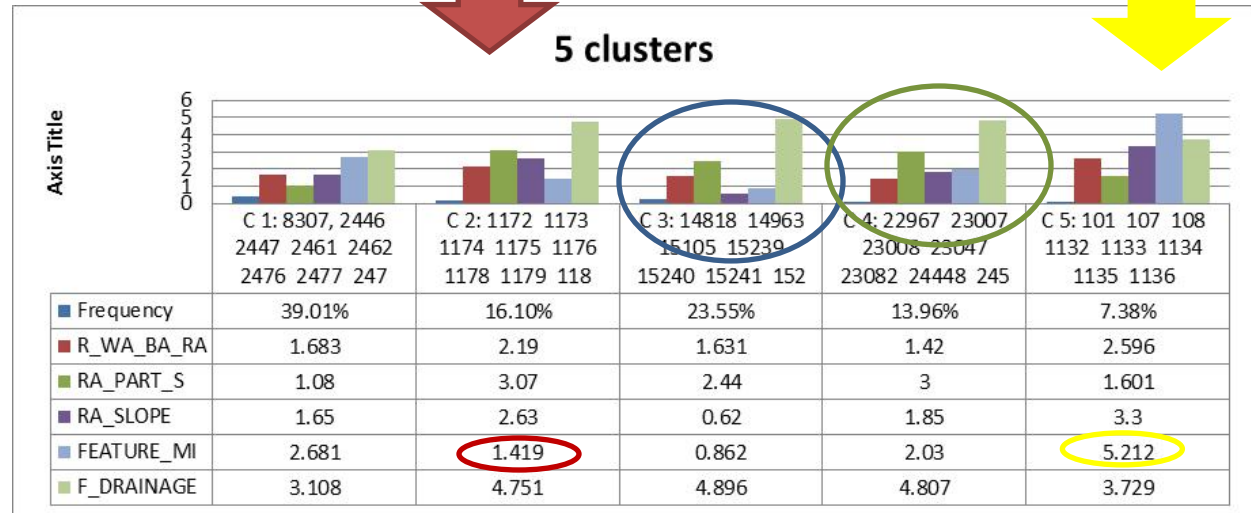
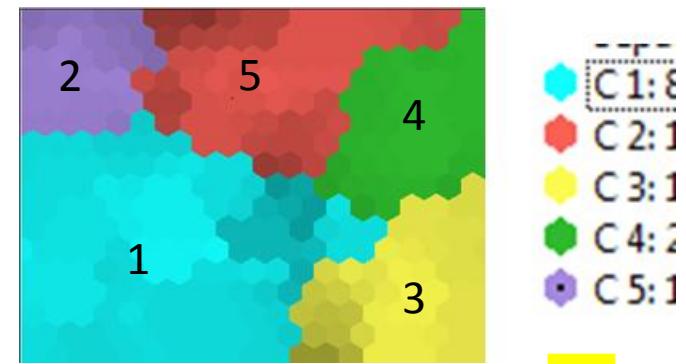


Temperature minimum

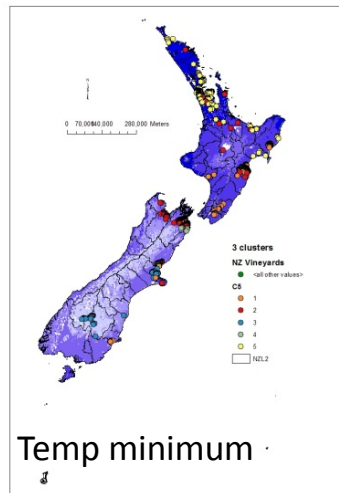


Drainage

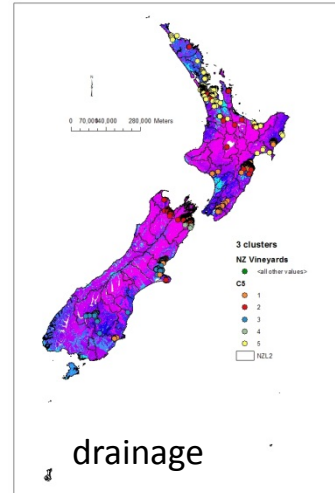
5 clusters



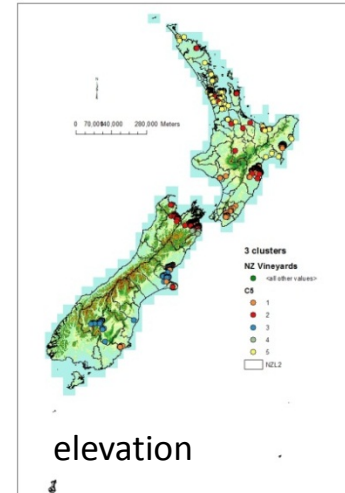
Water deficiency



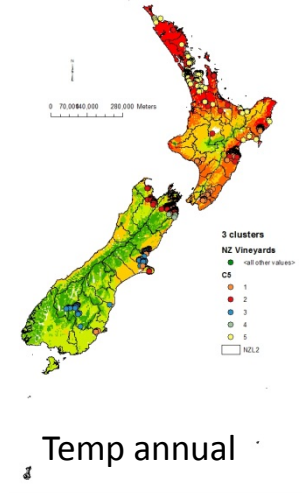
Temp minimum



drainage



elevation



Temp annual

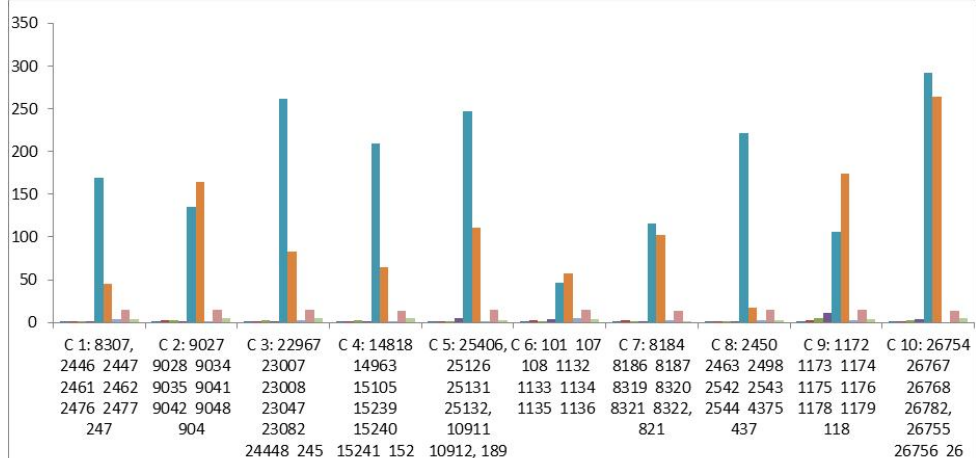
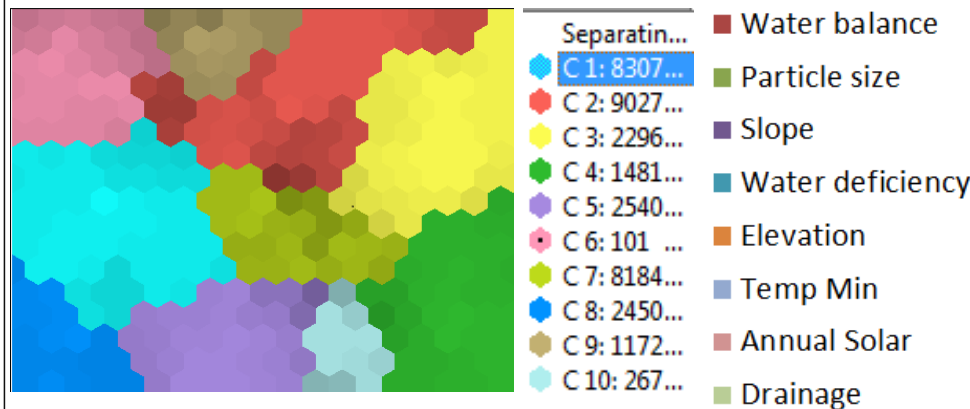
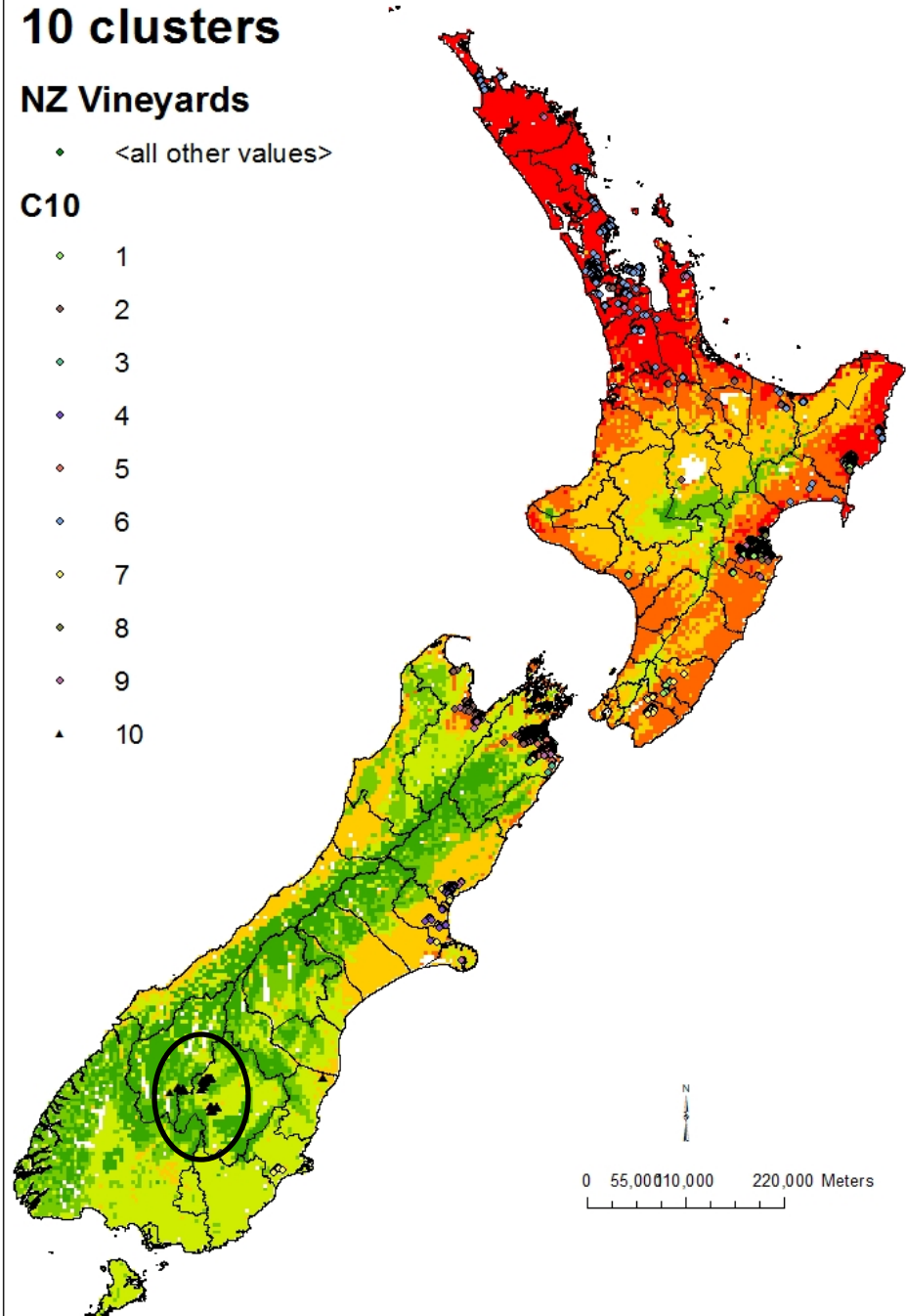
10 clusters

NZ Vineyards

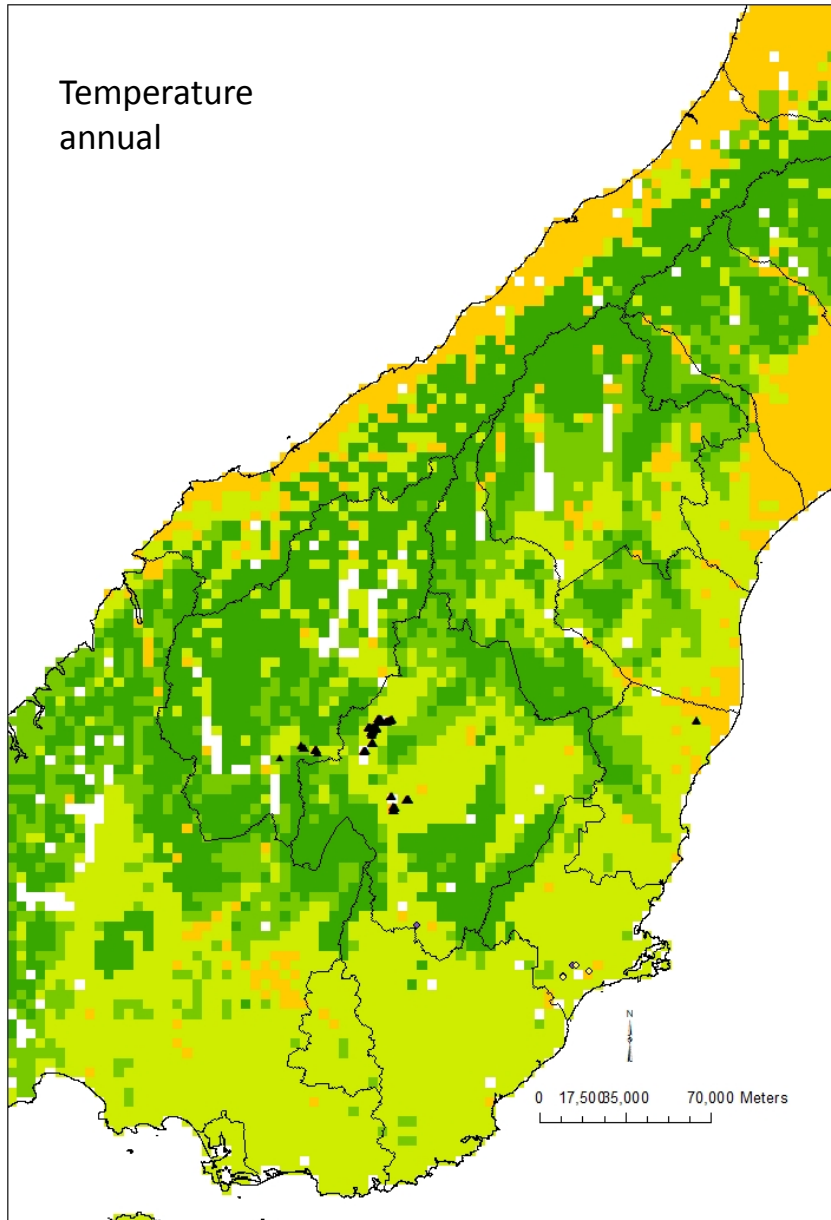
• <all other values>

C10

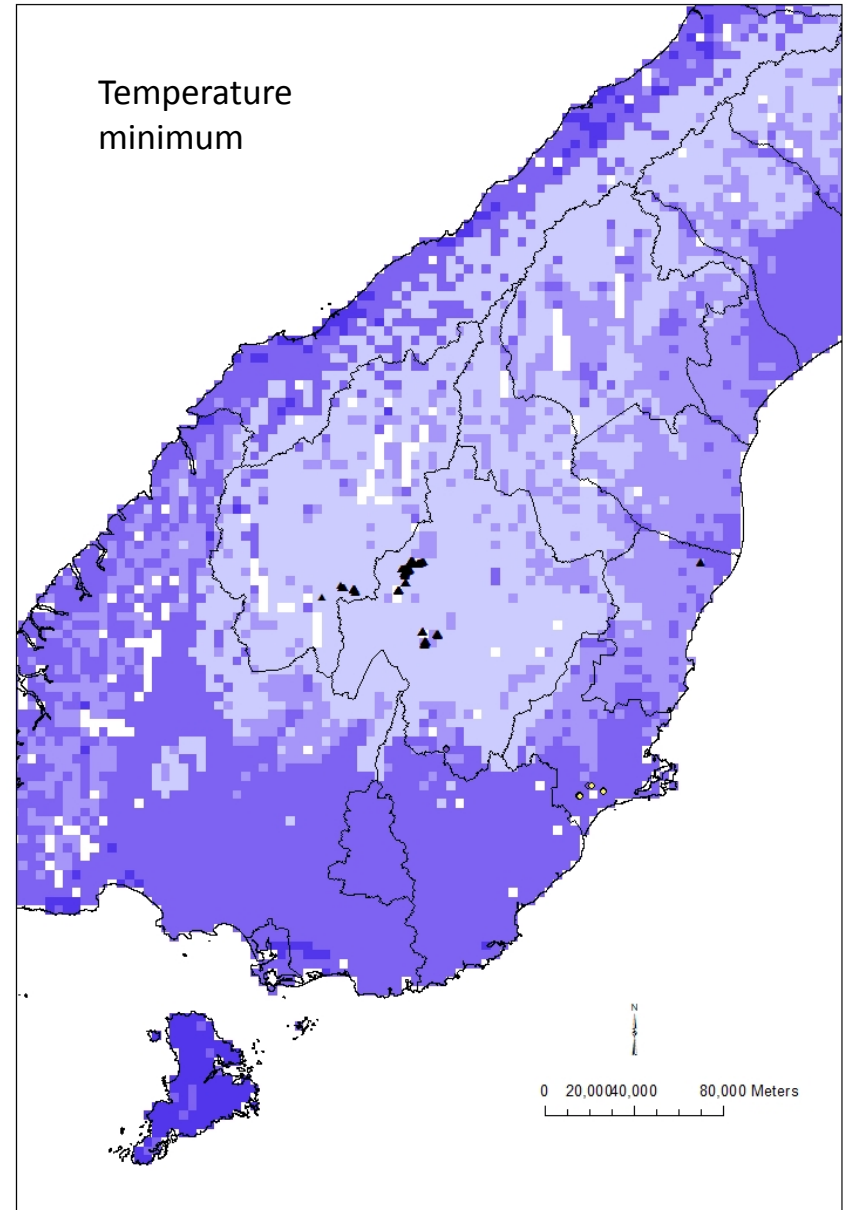
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- ▲ 10



Temperature
annual



Temperature
minimum



NZ Vineyards

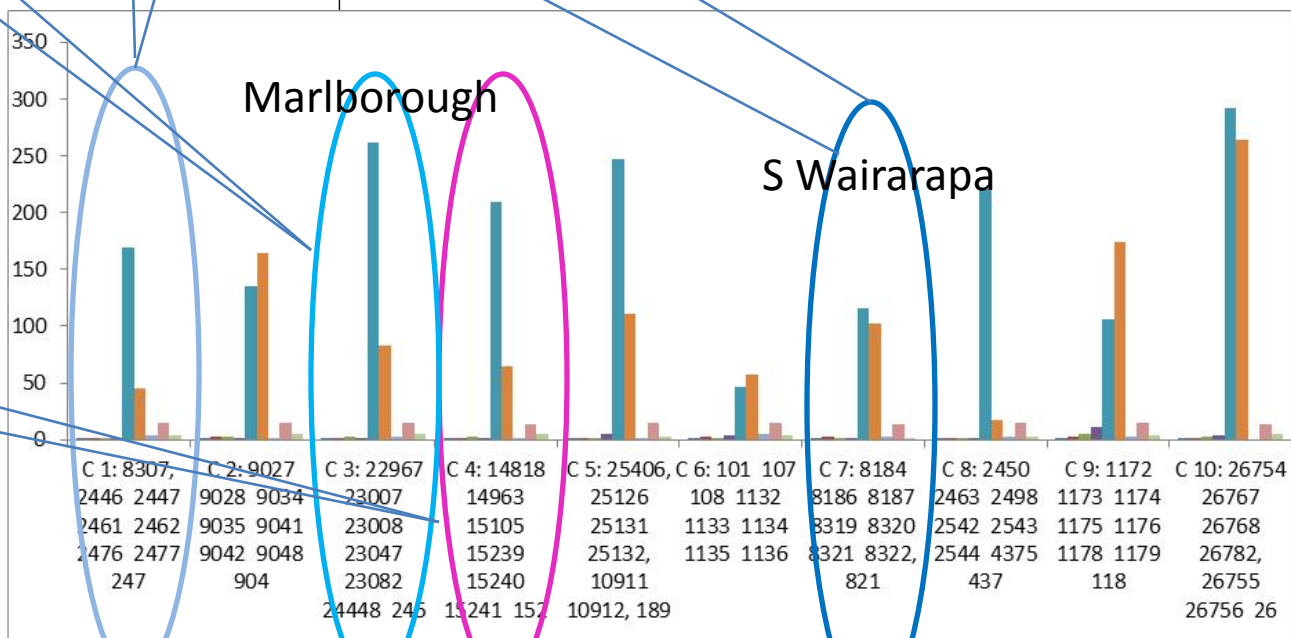
● <all other values>

C10

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

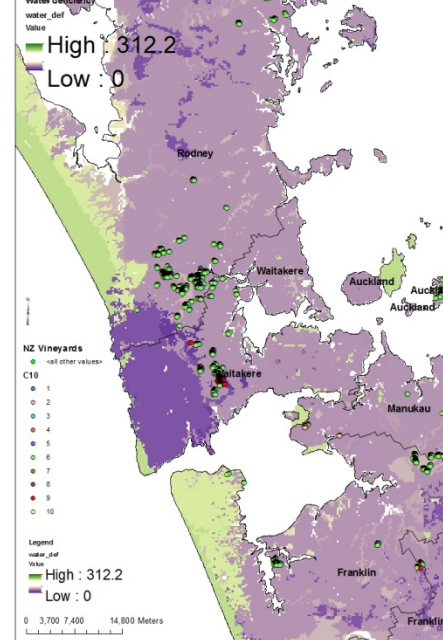
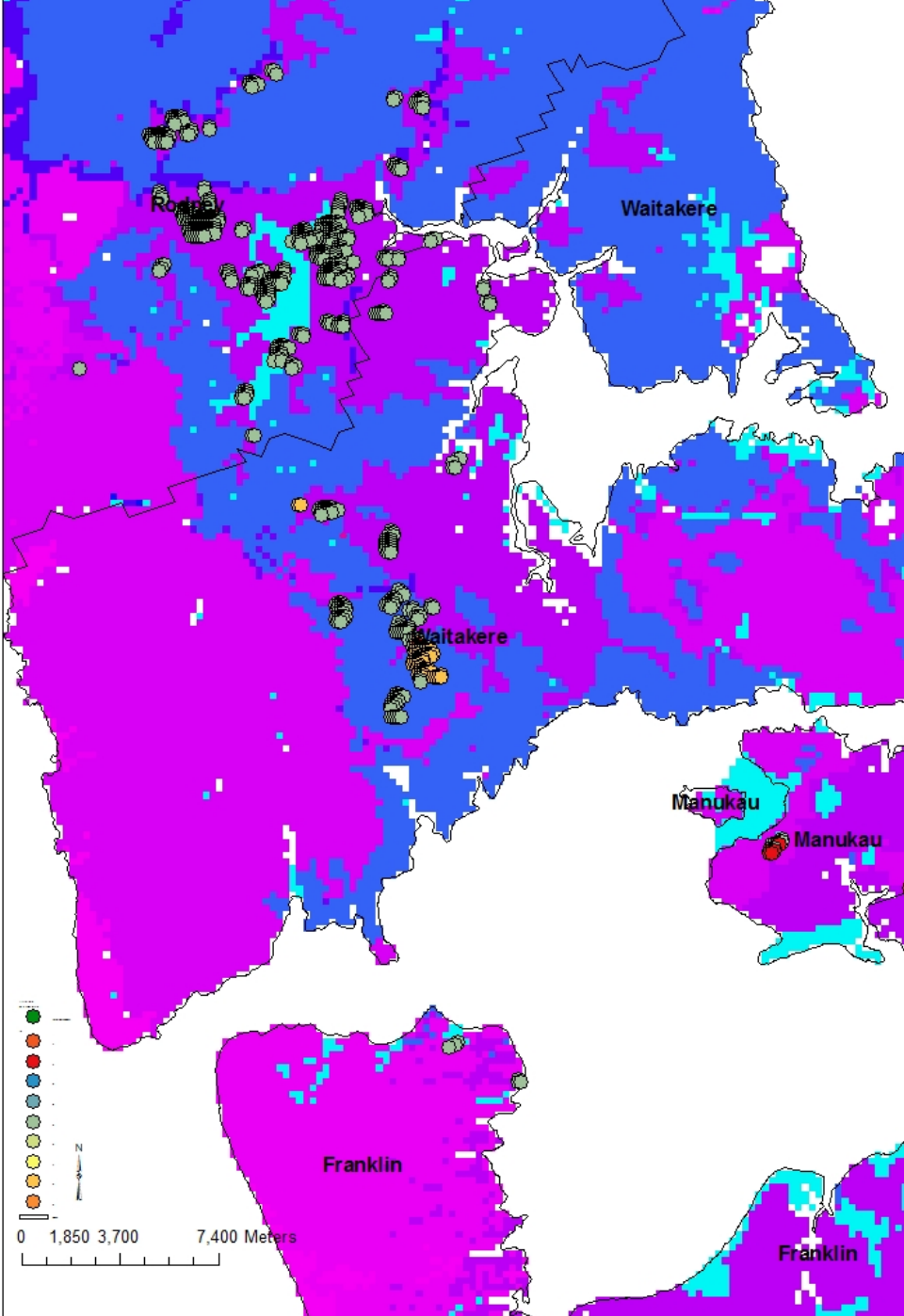
Temperature annual

- Water balance
- Particle size
- Slope
- Water deficiency
- Elevation
- Temp Min
- Annual Solar
- Drainage



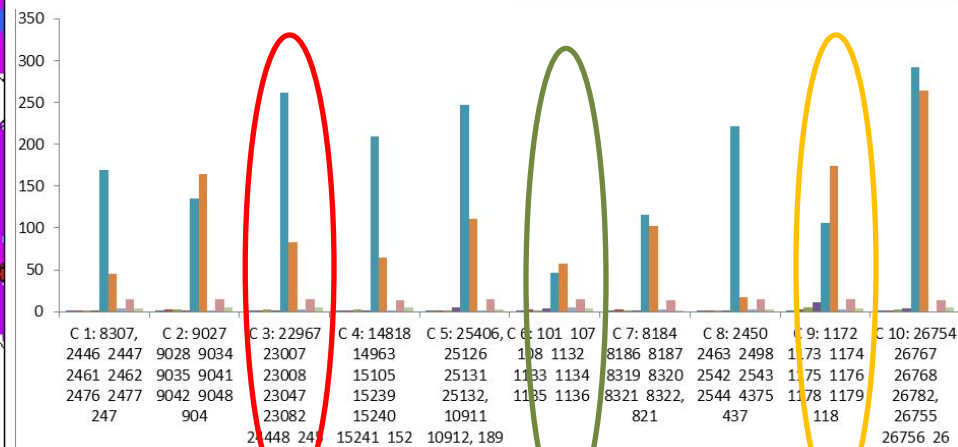
0 23,000 46,000 92,000 Meters

247 904 23008 15240 10911 821 437 118 26755 26756 26

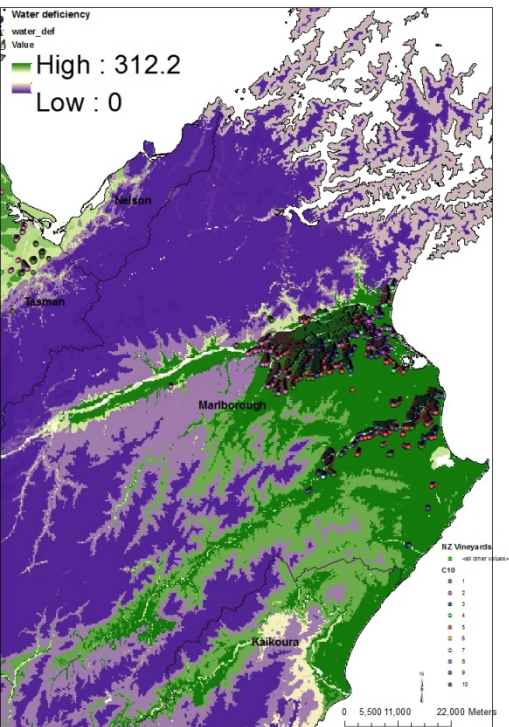
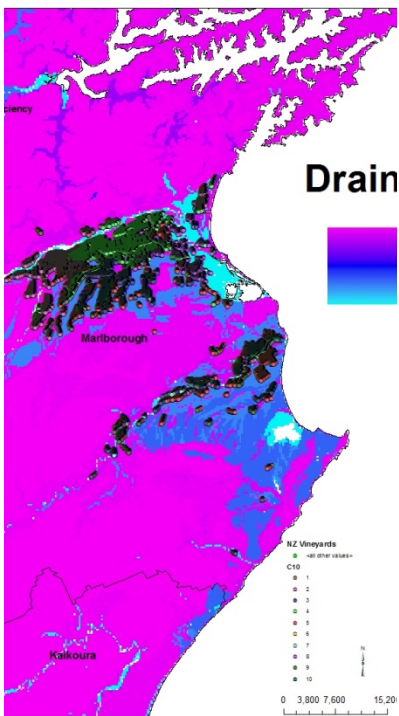
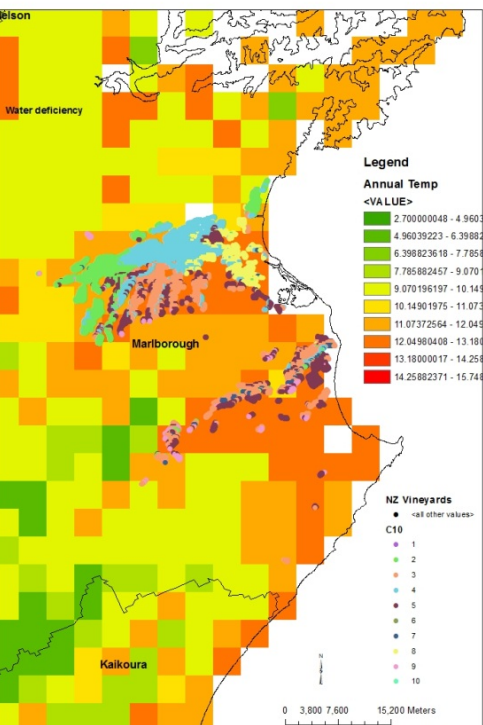
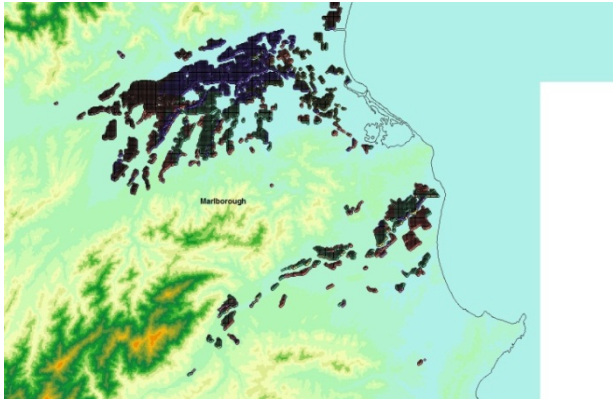
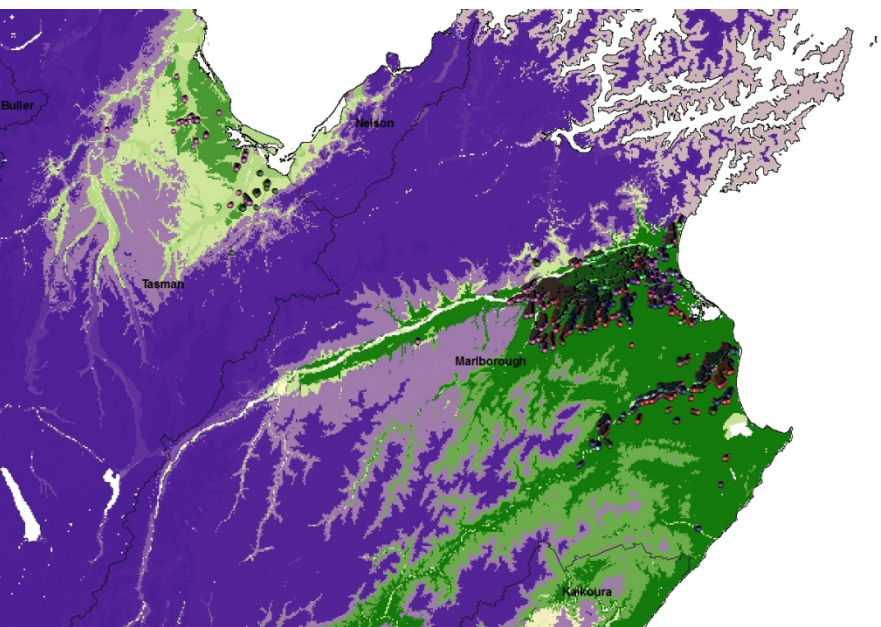


Water deficiency

- Water balance
- Particle size
- Slope
- Water deficiency
- Elevation
- Temp Min
- Annual Solar
- Drainage



Drainage



Water deficiency

conclusions

- Climate and “terroir “ of NZ wine regions are very unique and can be defined.
- Of the variable studied:
 - @ the regional scale and within regions
 - water deficiency
 - elevation
 - soil particle
 - water balance
 - Temperature min

The methodology showed potential

Further analysis required to exactly define NZ “terroirs”