Digitising New Zealand wine regions: an initial investigation

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overview

• Background
  – “terroir” x “cultiva”
  – Viticulture
  – wine making

• Methods
  – Vector
  – Raster

• Initial results

• conclusions
“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/thelclub/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

Source: http://lfbisson.ucdavis.edu/
lfbisson.ucdavis.edu/PPT/VEN124_Sec_I_Lec_01.ppt

Cultivation practices
Grape varieties ("cultiva")
+ 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
Grapevine phenology

precise data
Grapevine phenology
Wine tasting

Source: www.bryandownes.com/page9.html
Sommelier comments come in many forms:

- video
- text
- ratings
- Audio
- web

and a note about sommelier comments...

What flavors are on the nose?

Source: http://winedinedaily.com/wine/wine-quotes/item/wine-cartoon
Figure 2. The map of potential lands for vineyards, and the existing vineyards

Agrometeorology (frequency of winter frost damage, spring, fall frost damage),
Soil (Soil type, Soil forming rock, PH and lime state, physical soil kind, water management features, Humus level, thickness of the production layer of soil. The area homogeneity concerning the soil type),
Water management (water management of the area based on site observation), degree of erosion, The lie of the land, Elevation (slope degree and aspect, elevation above sea level on hill and mountainside, emergence from the environment on the plain and flat areas, relief, area surface on hill and mountainside, relief, area surface on plain and flat areas, environment proximity of woods, degree of built up areas), area utilization, road conditions.
Figure 3. Vineyards with protected origin in Andornaktálya (Eger wine-growing region) Superior: Wine growing sites with more than 300 points. Wine: Bull's blood of Eger superior: Kékfrankos, Kadarka, Portugaise (Kékportó) Blauburger, Kék medoc, Zweigelt, Cabernet franc, Cabernet Sauvignon, Merlot, Pinot noir in accordance with Regulation of FVM No. 130/2003 (XII.31.)

“The winery Clarendon Hills is famous for making Blewitt Springs wines and selling them for super prices in the US market”

Topography and ripening patterns


<table>
<thead>
<tr>
<th>Region</th>
<th>McLaren Vale (Main Rd)</th>
<th>Willunga</th>
<th>McLaren Vale (Stroude Rd)</th>
<th>McLaren Flat</th>
<th>Seaview</th>
<th>Kingscote - Clarendon</th>
<th>Blewitt Springs</th>
<th>Aldinga</th>
</tr>
</thead>
</table>

The Table shows the Mean January Temperature (MJT) and how it changes across the region. In McLaren Vale vineyard that are close to the ocean are warmer (and ripen earlier). Mean January Temperature is a simple way to describe the weather conditions that grapes experience before harvest.

Should McLaren Vale’s differences be explained and celebrated or is in enough to know the whole area is a good wine region?
Grape variety block boundaries overlaid onto a soil map for Inkameep vineyard in Vaseaux – Oliver

Type of soil (textural class): depth to bedrock; surface stoniness; texture (resulting from the size distribution of mineral particles); perviousness class; drainage class; depth to root restriction; shear strength; permeability; pH; salinity class and cation exchange capacity

http://journals.hil.unb.ca/index.php/gc/article/view/2718/3167

Figure 3. Grape variety block boundaries overlaid onto a soil map for Inkameep vineyard in Vaseaux – Oliver (Region 3). Type of soil (textural class) for each series is shown in the inset at top centre.
independent Vs dependent factors

Methods used
• Vector (Point, Polygon ... )
• Raster
Point based

Wine labels
Vintages and sommelier comments

750ml Kumeu River Estate Chardonnay Auckland
The 2007 vintage was terrific and produced wonderful Chardonnay throughout the entire Kumeu River stable. The Estate Chardonnay from this vintage is ripe, rich and beautifully concentrated. The beautiful peach and hazelnut aromas along with the rich silky texture are distinct characteristics that we expect to see from this wine. Cellar to 2011/2012.

Editors' Choice!

WineEnthusiast.com

Viu Manent 2007 Reserva Chardonnay (Casablanca Valley)
For a first effort from Casablanca, Viu Manent has hit a home run. This wine is a classic New World Chard, meaning it’s liberally oaked, vibrant, ripe and full of tropical fruit. But along with the obvious there are also notes of cinnamon, mineral, exotic apple and butterscotch. Imported by Baystate Wine Co. — M.S. Published 7/1/2008

WineEnthusiast.com

Undurraga 2005 Aliwen Reserva Chardonnay (Central Valley)
This new wine from a venerable Chilean producer scores points all over the map. The nose is a smooth ride of white fruits and cleanliness, while the mouth pulsatates with pear, green
Web text mining wine comments
Pinot Noir - Canterbury 1998-2004

C 1: sour, length, flower, mint, mellow youth, hot mocha success, chalki, muscular purpl, molass, anis approach char cranberri deep group integr raspberri roast strawberry wood, open, cook jammi, disjoint flabbi forest hollow inki neutral robust, characterist, woodi, apricot, citric, cashew fragrant ginger, auster bacon develop lactic licor oliv rhubarb rubi, orang, dessert, coconut dill golden, gentl rough, astring leafi, guava menthol, leesi, leaf tomato, aromat oili round, blossom currant grass harmoni sharp thick ting warm, bean capsicum lusciou opul sweati viscou, almond cloi hai medicin quinc syrupi, bark butterscotch cut hazelnut slight thin tree, banana mango pure, aggress bitter distinct fat fleshi flinti hard live lyche perfum petal rose steeli tight variet young C 2: raci, concentr, pea, fig zesti, asparagu C 3: chocol, dark, tea, coffe dusti earthi meati mushroom, tannic, blackberri, cinnamon clove, cedar, brown leather persist readi syrah velveti C 4: bake, oaki, alcohol floral lemon linger spici, delic fine heavi modest, ag ampl caramel gri subtl, nutti power strong C 5: balanc, honei, riesl, appl, sweet C 6: grassi, lean simpl, pink, pungent C 7: citru, lime, melon, refresh C 8: white, nectarin C 9: soft soli...
Observation on the graph is that year 1998^, the shows the highest ssd/meanT within the period analysed herein consists of high descriptor frequencies for clusters C 2, C 3, C 6 and C 10 descriptors. Meanwhile, year 2002 with the lowest ssd/meanT consists of higher frequencies for C 5, C 8 and C 11 descriptors. Discriminant analysis run on the data set produced 11 words (boxed in the left) as contributing factors in determining the variable vintage (or year considered as a dependent variable on the 11 descriptors).
Statistical methods - discriminant

<table>
<thead>
<tr>
<th>Variables Entered/Removed</th>
<th>Entered</th>
<th>Residual Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>spice-42</td>
<td>29.138</td>
<td></td>
</tr>
<tr>
<td>sweet-45</td>
<td>22.022</td>
<td></td>
</tr>
<tr>
<td>pineappl-34</td>
<td>17.459</td>
<td></td>
</tr>
<tr>
<td>dri-12</td>
<td>13.715</td>
<td></td>
</tr>
<tr>
<td>complex-10</td>
<td>11.796</td>
<td></td>
</tr>
<tr>
<td>zesti-51</td>
<td>9.902</td>
<td></td>
</tr>
<tr>
<td>citru-9</td>
<td>7.384</td>
<td></td>
</tr>
<tr>
<td>fresh-16</td>
<td>5.851</td>
<td></td>
</tr>
<tr>
<td>open-31</td>
<td>5.038</td>
<td></td>
</tr>
<tr>
<td>tropic-48</td>
<td>3.675</td>
<td></td>
</tr>
<tr>
<td>structur-43</td>
<td>3.124</td>
<td></td>
</tr>
</tbody>
</table>

11 descriptors (from 30 Kumeu wine comments) found to be major contributing factors and their contribution in vintage-to-vintage variations within the period of 1997-2006.

### Standardized Canonical Discriminant Function Coefficients

<table>
<thead>
<tr>
<th>Function</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>citru-9</td>
<td>-2.473</td>
<td>.591</td>
<td>.211</td>
<td>.553</td>
<td>-.764</td>
<td>.604</td>
<td>-.950</td>
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<tr>
<td>complex-10</td>
<td>12.264</td>
<td>-1.558</td>
<td>1.124</td>
<td>1.146</td>
<td>-.768</td>
<td>.863</td>
<td>-.452</td>
</tr>
<tr>
<td>dri-12</td>
<td>-10.025</td>
<td>1.610</td>
<td>.192</td>
<td>.012</td>
<td>.424</td>
<td>-.011</td>
<td>.608</td>
</tr>
<tr>
<td>fresh-16</td>
<td>-7.063</td>
<td>.772</td>
<td>-.648</td>
<td>-.850</td>
<td>1.166</td>
<td>-.046</td>
<td>-.132</td>
</tr>
<tr>
<td>open-31</td>
<td>4.818</td>
<td>1.016</td>
<td>-.878</td>
<td>-.044</td>
<td>-.420</td>
<td>.389</td>
<td>-.321</td>
</tr>
<tr>
<td>pineappl-34</td>
<td>5.751</td>
<td>1.290</td>
<td>1.193</td>
<td>-1.262</td>
<td>-.019</td>
<td>.184</td>
<td>.192</td>
</tr>
<tr>
<td>structur-43</td>
<td>-3.040</td>
<td>-1.417</td>
<td>-1.103</td>
<td>.493</td>
<td>.175</td>
<td>-.116</td>
<td>.535</td>
</tr>
<tr>
<td>sweet-45</td>
<td>-3.033</td>
<td>2.587</td>
<td>-.343</td>
<td>-.286</td>
<td>.750</td>
<td>-.457</td>
<td>.367</td>
</tr>
<tr>
<td>tropic-48</td>
<td>-1.467</td>
<td>-.170</td>
<td>1.220</td>
<td>.504</td>
<td>.094</td>
<td>.487</td>
<td>.319</td>
</tr>
<tr>
<td>zesti-51</td>
<td>7.981</td>
<td>-.342</td>
<td>-1.257</td>
<td>.084</td>
<td>-.171</td>
<td>.348</td>
<td>.116</td>
</tr>
</tbody>
</table>

Coefficients of 7 functions used in the prediction of 9 classes of wines vintage 1997-2006 (without 2001) show relative impact (positive, negative) of descriptors.
regional ratings against climate: NZ wine regions

Marlborough SB vintage (1996-2006) descriptors & ratings

(veget-111 >= 0.37) and (fruit-37 <= 0) and (fresh-36 <= 0.26) => rate scale=low (11.0/3.0)
(asparagu-8 >= 0.6) and (fruit-37 <= 0) => rate scale=low (7.0/2.0)
(sour-99 >= 0.94) => rate scale=low (3.0/0.0)
(heavi-50 >= 0.9) => rate scale=low (6.0/2.0)
(group-45 >= 0.84) => rate scale=low (5.0/2.0)
(complex-22 >= 0.4) => rate scale=high (24.0/10.0)
=> rate scale=med (325.0/71.0)

JRip rules show the correlations between Marlborough SB vintages and descriptors. 381 Marlborough vintages was converted into matrix of 118 wine descriptors and their rates transformed into low <80 medium (med) >79 and <90 high >89 (100 point)
Marlborough SB vintages (1997-2007) & ratings

J48 creami (creamy), bean, honei (honey), lime, melon, grassi (grassy), sweet, tropic, nectarine, eleg (elegant), apple, fruit, herbal, and linger.

complex-22 <= 0
| asparag-8 <= 0.4
|   | rich-88 <= 0.36
|   |   creami-25 <= 0
|   |   | group-45 <= 0
|   |   |   bean-12 <= 0
|   |   |   honei-54 <= 0.49: med (278.0/57.0)
|   |   | honei-54 > 0.49
|   |   |   finish-34 <= 0.1: med (4.0)
|   |   |   finish-34 > 0.1: high (6.0/1.0)
|   |   bean-12 > 0
|   |   |   bean-12 <= 0.75
|   |   |   fresh-36 <= 0: med (3.0)
|   |   |   fresh-36 > 0: low (2.0)
|   |   |   bean-12 > 0.75: low (2.0)
|   |   group-45 > 0
|   |   |   lime-63 <= 0: low (5.0)
|   |   |   lime-63 > 0: med (2.0)
|   creami-25 > 0
|   | melon-68 <= 0: med (8.0/1.0)
|   | melon-68 > 0: high (2.0)
| rich-88 > 0.36
|   |   |   | veget-111 <= 0
|   |   |   | melon-68 <= 0
|   |   |   |   grassi-43 <= 0
|   |   |   |   sweet-104 <= 0.52
|   |   |   |   | lime-63 <= 0
|   |   |   |   | tropic-109 <= 0: med (10.0)
|   |   |   |   | tropic-109 > 0: high (3.0/1.0)
|   |   |   |   | lime-63 > 0: high (3.0/1.0)
|   |   |   |   sweet-104 > 0.52: high (2.0)
|   |   |   |   | grassi-43 > 0: high (2.0)
|   |   |   |   | melon-68 > 0: high (2.0)
|   |   |   |   | veget-111 > 0: low (2.0)
|   |   |   |   asparag-8 > 0.4
|   |   |   |   fruit-37 <= 0.05: low (9.0/2.0)
|   |   |   |   fruit-37 > 0.05: med (11.0/2.0)
complex-22 > 0
|   | linger-64 <= 0
|   |   | herbal-53 <= 0.36
|   |   |   | fruit-37 <= 0.17
|   |   |   | appl-5 <= 0
|   |   |   | eleg-30 <= 0
|   |   |   | nectarin-72 <= 0: med (8.0)
|   |   |   | nectarin-72 > 0: high (2.0)
|   |   |   | eleg-30 > 0: high (2.0)
|   |   |   | appl-5 > 0: high (2.0)
|   |   |   | fruit-37 > 0.17: high (5.0)
|   |   |   | herbal-53 > 0.36: high (3.0)
|   |   | linger-64 > 0: med (2.0)
Descriptors-Marlborough SB - j48

bean-12 > 0.75: low (2.0) veget-111 > 0: low (2.0)
fruit-37 <= 0.05: low (9.0/2.0) fresh-36 > 0: low (2.0)
honei-54 <= 0.49: med (278.0/57.0) finish-34 <= 0.1: med (4.0) bean-12 <= 0.75 lime-63 > 0: med (2.0) fruit-37 > 0.05: med (11.0/2.0) linger-64 > 0: med (2.0)
finish-34 > 0.1: high (6.0/1.0) group-45 > 0 creami-25 > 0 melon-68 > 0: high (2.0) tropic-109 > 0: high (3.0/1.0) lime-63 > 0: high (3.0/1.0) sweet-104 > 0.52: high (2.0) grassi-43 > 0: high (2.0) melon-68 > 0: high (3.0) nectarin-72 > 0: high (2.0) eleg-30 > 0: high (2.0) appl-5 > 0: high (2.0) fruit-37 > 0.17: high (5.0) herbal-53 > 0.36: high (3.0)
NZ Chardonnay descriptors

Waipara
toast-8 <= 0.26
| citrus-3 <= 0: med (8.0/2.0)
| citrus-3 > 0: high (2.0/1.0)
toast-8 > 0.26: high (3.0)

Gisborne
sweet-19 <= 0
| spice-18 <= 0
| | appl-1 <= 0.27: med (28.0/7.0)
| | appl-1 > 0.27: high (2.0)
| spice-18 > 0: high (3.0/2.0)
sweet-19 > 0
| vanilla-23 <= 0: med (3.0)
| vanilla-23 > 0: low (3.0)

Hawke’s Bay
| | | | honei-17 > 0: high (2.0)
| | | creami-9 > 0: high (2.0)
| | orang-23 > 0: high (3.0)
| ripe-28 > 0.23: med (8.0/1.0)
lime-19 > 0: med (6.0/1.0)
Point based

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

Maps showing locations and graphs for monthly temperature and precipitation.
Polygon based @ the regional scale
1. Rainfall
2. Mean Air Temperature
3. Extreme Maximum Air Temperature
4. Mean 20cc Earth Temperature
5. Mean 20cc Earth Temperature
6. Mean Vapour pressure
7. Growing degree days (GDD)
8. Days of Snow
9. Low Maximum Air Temperature
10. Standard (std) Day mean Temperature
11. Low Daily Mean Temperature
12. High (hi) Daily Mean Temperature
13. Mean 9 am Relative Humidity (RH)
14. Mean 9 am Temperature
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
The methodology

Raster images

Rasterise (sample)

Cluster (unsupervised)

Re project cluster results / profile

Analyse results
New Zealand Vineyards
by Region (tonnes crushed)

Total New Zealand

- Northland
- Auckland
- Waikato/Bay of Plenty
- Gisborne
- Hawkes Bay
- Wellington
- Marlborough
- Nelson
- Canterbury
- Otago
Digital Elevation Map DEM
hill shade
Digital Elevation Map (DEM)
Hill shade
## Dependent variables for NZ vineyard polygons

1. Water balance
2. Soil particle size
3. Slope
4. Water deficiency
5. Elevation
6. Temp Min
7. Annual Solar
8. Drainage
9. For 27343 pixels
Pixel (data) clustering with SOM
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 size
    water balance
    Temperature min
The methodology show potential
Further analysis required to exactly define NZ “terroirs”