

# Modelling the seasonal climate variability and its effects on vintage wines from Marlborough, NZ

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**Abstract**— *The paper presents some interim results from an ongoing research on the application of data/text mining methodologies being investigated to modelling the seasonal climate variability and its effects on the world famous Marlborough vintage wines. The research in an extension to the investigations thus far conducted on modelling the effects of seasonal climate variability on Kumeu wines and all the sub-projects contribute to an overarching project which is aimed at developing a suitable set of schemes/ procedures for the identification and characterisation of wines produced from New Zealand's major wine regions. The distinctive New Zealand wine styles along with the regions from where the wines come from are initially elaborated. The major issues regarding the topic are; firstly, there is no single method that could be considered as the best way to establish the links between precise independent (climate/ weather) and the rather imprecise dependent (subjective wine quality) data sets. Secondly, the data on New Zealand wine quality is not sufficient enough to perform any conventional rigorous analytical approaches as data on wine quality spans only a decade, hence we look at data/text mining methods and a combination of explorative and statistical data analysis methodologies to resolve the issues. Following a brief outline on the methods investigated and results achieved in the Kumeu wine case study, the paper presents the new methods and approaches explored with Marlborough wines produced from 1996 to 2007. Finally, wine descriptors that are found to be linked with wine quality and therefore considered as correlated to the regional climatic conditions experienced in different wine regions of New Zealand, are discussed.*

**Keywords-component; formatting; style; styling; insert (key words)**

## I. INTRODUCTION

The quality of a vintage wine depends on the climate, the seasonal weather conditions that ripened the grapes as much as the winemaker experience and talent. This has been well-documented in literature as seen in (1) (2). But knowledge on “how” and the “exact” weather conditions that affect the grape composition and the ripening process is fragmented (3). The major reason for this being lack of consistent data on wine quality to scientifically validate the anecdotal evidence, by establishing the correlation/s between two vital sets of factors, namely, the wine quality which is arguably a subjective issue when compared with the more precise and readily available weather data. This is especially the case with wines produced from most of the *new* wine producing countries, such as New Zealand, Australia, Chile and South Africa. However, in recent

years, the interest in scientifically understanding the effects of long- and short-term effects of climate change has been significant in both *old* as well as *new* world wine producing countries to improve vineyard and grape wine production. Nonetheless lack of consistent data makes the modelling of climate change effects of grapevine growth and wine quality difficult using conventional methodologies.

In view of the above facts, researchers at AUT's Geoinformatics Research Centre (GRC) began investigating into experimenting with approaches that are generally referred to as other than the rigorous statistical data analysis methodologies to modelling the influences of weather conditions on the quality of wine vintages of different regions within New Zealand. The ultimate aim of this effect is to find a set of ideal features that can be used for the identification and characterisation of wines produced from New Zealand's regions under different seasonal conditions (4). Section II gives an outline on the results obtained with approaches already investigated using wine ratings (and sommelier comments (5) and grape yield (6) from Kumeu River Wines with data spanning only a decade or so. Section III looks at Marlborough wine and climate data being used in the research, following which future direction of this research is briefly outlined.

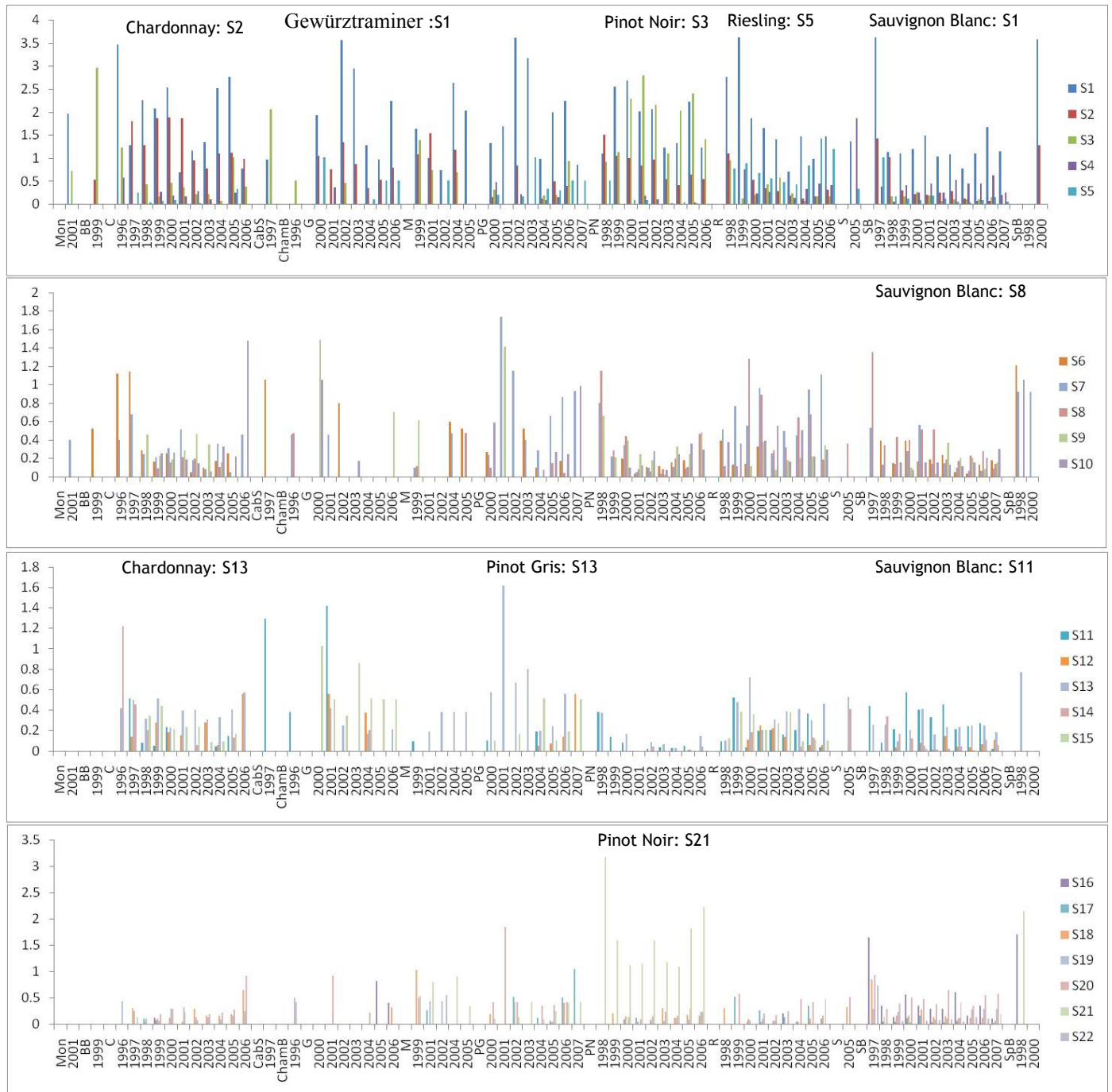
## II. CLIMATE EFFECTS ON WINES OF DIFFERENT VINTAGES

Recent research in modelling the seasonal variability in weather conditions and its effects on grapevine phenology and wine produced from the grapes of that season showed that, of the many factors, weather as the main influencing factor at this temporal scale (7).

### A. Year- to year-variability in climate and its effects on wine

In viticulture it is believed through cultivation practices that vintage-to-vintage variability effects, especially on fruit quality is imposed by two broader categories, namely *terroir* (climate, soil) and *cultiva* (or variety). Of these two, the influence from *terroir* factors is described to be major at this temporal scale with their impacts established scientifically as (50%) for climate, (25%) for soil and (10%) for *cultivar* by van Leeuwen (8). In this research climate is concluded to be the major influencing factor, its affects described as realised specifically through vine water balance status. The study looked at the influence of all variables representing *terroir* and





**Figure 2. S1 (Sauvignon Blanc):** eleg-61, tea-176, layer-92, flower-70, ampl-6 earthi-60, cranberri-48, meati-106, bake-16, brown-28, red-142, gri-79, perfum-128, dusti-59, leather-96, menthol-110, ag-2, woodi-193, anis-7 heavi-85 strawberri-164, live-102, hai-82, blossom-24, blackberri-23, raspberri-140, bitter-21, tannic-173, cook-47, currant-51, integr-90, cedar-33 oaki-120, slight-154, fat-62, luscioi-103, pure-137, tight-178, wood-192, leafi-94, capsicum-31, auster-14, develop-55, muscular-114, success-168, young-194, hard-83 round-150, concentr-46, length-98, flinti-68, thick-177, warm-189, lemon-97, group-80 orang-123, apricot-10, steeli-163, citric-39, leaf-93 tomato-181, persist-129, fig-63, herbac-87 power-135, bai-15 harmoni-84 sharp-151, open-122, sour-160, alcohol-4 aromati-11 strong-165,

viscou-188, dessert-54, variet-184, medicin-107 syrupi-172, rough-149, approach-9 astring-13 flabbi-66 fleshi-67 zesti-195, quinc-138, almond-5 butterscotch-30, distinct-56 mint-112 nutti-118, banana-1 S2 (Chardonnay): smoki-156, oak-119, vanilla-183, spice-161, subtl-167, toast-180, butter-29, delic-53, smoke-155, spici-162, linger-101, fine-64, floral-69 (chardonnay) S3: smooth-157, suppl-169, complex-45, tannin-174, plum-134 silki-152, dri-57, vintag-187, cinnamon-38, structur-166, firm-65, chocol-37, clove-42, mushroom-115, dark-52, berri-20 caramel-32, velveti-186, roast-147, coffe-43, readi-141 (Pinot Noir) S19: herbal-88 tropic-182 S20: clean-41 crisp-50 fresh-71 herb-86 melon-109, grapefruit-75 S21: black-22 cherri-36 noir-117 pinot-133, cola-44 S22: grassi-77

The 22 word segments (figure 2) generated from the WEBSOM (figure 1) illustrate the correlations between the Marlborough wines styles and the wine descriptors (figure 2). Correlations were found between Chardonnay: S2, Pinot Noir: S3, Riesling: S5, Sauvignon Blanc: S1 Pinot Gris: S13 and Gewürztraminer: S1 descriptors. The 195 wine descriptors used were extracted from sommelier comments from a web magazine (<http://buyingguide.winemag.com/regions/new-zealand>) for the vintages 1996-2007.

Based the DM results some descriptors can be attributed to certain styles. For example, either a) higher weight of lychee or b) higher pear and spice along with low values of butter and ripe relate to *Gewürztraminer* style of Marlborough. Similarly, the descriptors and their respective weights relating to Marlborough's Pinot Noir, Pinot Gris, Riesling and Chardonnay are listed in Table 1. Anything that does not meet the conditions in the Table 1 is stated as Sauvignon Blanc (SB). Hence, to reveal the exact descriptors to SB, comments of SB vintages are analysed alone. Similarly, Chardonnay from New Zealand regions produced during 1996 and 2006 as well are studied as individual collections and the results are discussed in the next section.

TABLE I. MARLBOROUGH VINTAGES (1997-2007) AND STYLES

(lyche104 >= 0.97) => style2=G (9.0/1.0)
(pear126 >= 0.51) and (spice161 >= 0.53) and (butter29 <= 0) and (ripe146 <= 0) => style2=G (4.0/0.0)
(gri79 >= 0.57) => style2=PG (15.0/1.0)
(appl8 >= 0.23) and (bai15 >= 1.4) => style2=PG (4.0/1.0)
(almond5 >= 0.73) => style2=PG (4.0/1.0)
(riesl145 >= 0.46) => style2=R (33.0/1.0)
(lime100 >= 0.31) and (sweet171 >= 0.35) => style2=R (10.0/3.0)
(apricot10 >= 0.87) => style2=R (9.0/4.0)
(dry58 >= 0.34) and (bodi25 >= 0.3) => style2=R (4.0/1.0)
(oak119 >= 0.35) and (cherri36 <= 0) and (pinot133 <= 0) => style2=C (46.0/11.0)
(pear126 >= 0.34) and (butter29 >= 0.75) => style2=C (8.0/0.0)
(toast180 >= 0.43) and (cherri36 <= 0) => style2=C (13.0/4.0)
(chardonnai35 >= 0.52) => style2=C (13.0/2.0)
(cherri36 >= 0.24) => style2=PN (148.0/8.0)
(pinot133 >= 0.42) => style2=PN (19.0/1.0)
(plum134 >= 0.71) => style2=PN (6.0/2.0)
(tannin174 >= 0.43) => style2=PN (3.0/1.0)

JRip rules (WEKA) show the correlations between the descriptors and Marlborough wine styles

TABLE II. MARLBOROUGH 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

## 2) Marlborough Sauvignon Blanc vintages and descriptors

The collection of comments given for 381 Marlborough vintages was converted into matrix of 118 wine descriptors and their rates transformed into "low <80" "medium (med) >79 and <90" and "high >89" based on their rating (100 point) for analysing with DM techniques using WEKA software. The JRip rules listed in Table 2 produced (at training 76% and cross validation 70%) for this indicate that high values of the descriptor *veget* (meaning vegetable 6 vegetal 26) and low values of fruit and fresh as related to "low" (<80) rate in Marlborough SB vintages. Similarly, either higher weights of a) asparagus (>= 0.6) and fruit (<= 0) or b) high sour-99 (0.94) or c) heavy (>= 0.9) group-45 (>= 0.84) are related to low rated SB vintages. On the other hand, high value of complex (>= 0.4) if related to higher ratings with an accuracy of 24.0 correct and 10.0 wrong.

TABLE III. MARLBOROUGH SB VINTAGES (1997-2007) & RATINGS

complex-22 <= 0
asparagu-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 (3.0)
veget-111 > 0: low (2.0)
asparagu-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)

Meanwhile, classifier model created J48 pruned trees (Table III, with WEKA, (at training 82% and cross validation 67%)) produced rules with additional (to the JRip) words relating to rate classes (low, medium and high). The additional words being, *creami (creamy), bean, honei (honey), lime, melon, grassy (grassy), sweet, tropic, nectarine, eleg (elegant), apple, fruit, herbal, and linger*.

### 3) New Zealand's Chardonnay vintages and descriptors

Finally, Chardonnay vintages produced from regions in New Zealand between 1996 and 2007 are analysed separately to identify the region related words and their correlations between ratings as analysis conducted all the vintages together using either WEBSOM descriptor groupings or JRip/ J48 model classifiers did not produce any interesting rules. However, rules obtained analysing the chardonnay vintages separated based on the regions produced interesting rules to establish the correlations between "low", "med" and "high" rate classes and are presented in Table IV.

TABLE IV. HAWK'S BAY VINTAGES (1996-2006) AND DESCRIPTORS

<p><u>Gisborne</u></p> <p>sweet-19 &lt;= 0    spice-18 &lt;= 0      appl-1 &lt;= 0.27: med (28.0/7.0)      appl-1 &gt; 0.27: high (2.0)    spice-18 &gt; 0: high (3.0/2.0)  sweet-19 &gt; 0    vanilla-23 &lt;= 0: med (3.0)    vanilla-23 &gt; 0: low (3.0)</p> <p>Training: 76%  Cross validation : 46%</p> <p><u>Waipara</u></p> <p>toast-8 &lt;= 0.26    citru-3 &lt;= 0: med (8.0/2.0)    citru-3 &gt; 0: high (2.0/1.0)  toast-8 &gt; 0.26: high (3.0)</p> <p>Training: 76%  Cross validation : 38%</p> <p><u>Hawke's Bay</u></p> <p>lime-19 &lt;= 0    ripe-28 &lt;= 0.23      orang-23 &lt;= 0        creami-9 &lt;= 0          honei-17 &lt;= 0            intens-18 &lt;= 0: med (19.0/3.0)            intens-18 &gt; 0: high (5.0/1.0)            honei-17 &gt; 0: high (2.0)        creami-9 &gt; 0: high (2.0)      orang-23 &gt; 0: high (3.0)    ripe-28 &gt; 0.23: med (8.0/1.0)  lime-19 &gt; 0: med (6.0/1.0)</p> <p>Training: 86%  Cross validation : 48%</p>
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## V. CONCLUSIONS

The paper illustrated statistical and data mining approaches being investigated to establishing the correlations between wine descriptors (embedded in sommelier comments) and wine ratings in order to modelling the seasonal weather influences on New Zealand wine vintages. The results show potential for establishing the variability in wine styles and regions. The approaches can be further developed to identify the special attributes i.e., wine descriptors, that could be used to relate wine style as well as quality i.e., ratings and then to model the seasonal weather variability on New Zealand vintage wines. The methods can as well provide a means to develop a viticulture zoning scheme as well as geographical indicators for New Zealand vintage wines.

## VI. FUTURE WORK

The research is on going and it is anticipated that once the specific descriptors for different wine styles and regions are identified and verified they could be incorporated into an GIS to model the climate as well as other local influences, such as environmental (soil, aspect, slope) at more finer scales, i.e., within vineyards on grapevine phenology and wine quality.

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