RITA GRANT RT00/10 – FINAL REPORT

CLIMATIC BENCHMARKING IN THE SOUTHERN FLINDERS RANGES WINE REGION

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1. EXECUTIVE SUMMARY

At the commencement of this project there was very little understanding of the unique climate of the Southern Flinders Ranges. This project has shown that the region has one of the most diverse climates of any grape growing region in Australia. The project set out to record the climate of the different subregions and in doing so has shown that two distinctive climatic patterns operate within 20km of each other.

Having recorded key indices such as temperature, humidity, rainfall and wind speed and direction over an 18 month period it has been possible to show that the western plains area around Baroota (near Port Germein) has a distinctly maritime climate whereas the Central Ranges and Plains areas have a more continental climate. As part of the project the climate was also compared to a number of other diverse grape growing regions (seasons 2001 & 2002). This comparison is useful when making recommendations on varietal suitability for the newest geographic wine region in Australia.

When comparing the climate of the two subregions it has became obvious that the central Ranges and eastern plains have a very similar climate to that of the Clare and Barossa Valley's. The Western Plains on the other hand has a unique climate, which results in the earliest ripening red grapes of any wine region in Australia. This diversity is unique in Australia and probably the world and means that two different subregions have the ability to produce totally different wine styles.

The dominant grape variety grown in the region is Shiraz and the ripening patterns are very differently between the two subregions, Shiraz grown at Baroota near Port Germein ripening as early as 25 January in 2001 and around the 15 February in 2002. In contrast the Shiraz from the eastern side of the ranges ripened around the third week in March in 2001 and as late as the first week of April 2002. Through studying the climates of the different subregions it has been possible to explain the mechanisms behind these ripening patterns.

2. BACKGROUND

The Southern Flinders Ranges is one of the newest wine-growing regions in Australia. The first planting's occurred in the mid 1980's at Baroota near Port Germein and at Laura on the eastern side of the ranges in 1995. The geographic indication committee has recently ratified the specific regional boundary. To date approximately 140 hectares (350 acres) of wine grapes have been planted with the largest planting's at Port Germein (Baroota 250 acres) on the western coastal plains. The remainder of the planting's are situated between Laura and Wilmington on the eastern side of the Ranges. The major varieties planted in the area are Shiraz and Cabernet Sauvignon with lesser varieties being Merlot and Sangiovese.

The grape growers in the region are very aware that to be successful in the industry they must produce grapes of a high standard and of a regional nature. They are also aware that to remain in the industry in the long term they must produce varietal wines that are in demand by the industry, and that relying on 4 red varieties may not be sustainable in the long run. Unlike many established wine regions there is an opportunity for the Southern Flinders to further expand and for this expansion to successfully occur it should be based on sound varietal and site selection criteria.

The aim of this project therefore is to record climatic indices such as temperature, humidity and evaporation throughout the growing season for use in climatic comparisons with other wine grape growing regions. Having benchmarked the climate with other wine producing regions, it is hoped that analogous regions can be identified. By undertaking a detailed climatic survey from within the different sub regions of the Southern Flinders, data such as varietal suitability and the expected ripening dates for different varieties can also extrapolated (Happ 2000). This information will also be used to predict spring frost risk (Gladstone 2000) and will be used in predicting specific disease outbreak conditions i.e. for downy mildew.

With the use of detailed climatic data, varietal suitability can be objectively assessed and it is the aim of this project to give grape growers meaningful data on varietal choices and site selection. Armed with the right data, growers can plant varieties that are ideally suited to the region and avoid mistakes made in other wine regions. The regional importance of this project should not be underestimated because the wine industry offers an opportunity for considerable employment growth within the region. To fully maximise this opportunity informed planting choices need to be made and this project can give these outcomes.

As there are no permanent weather stations in the Southern Flinders Ranges any climatic comparison is difficult. Davidson Viticultural Consulting Services using data from Port Pirie, Renmark, Bundaleer, Georgetown, Nuriootpa and Clare, have made comparisons of the climate of the region with that of other wine regions. Unfortunately, due to the lack of specific climatic data from within the region, this comparison has limited validity and does not take into account the unique topographic features of the area, i.e. proximity to Spencers Gulf.

Wine grapes have been grown at Baroota for a number of years and from winery experience have produced the earliest ripening red grapes in the state. If we were to use the above climatic comparison it could be assumed that the grapes would be of similar quality to those of the Riverland. From winery experience grapes produced in the area have consistently achieved higher quality levels than equivalent Riverland grapes. The first wine grape planting on the eastern side of the ranges occurred in 1995 at Laura, with the first harvest occurring in 1998. Other planting's have followed since but winery interest in this region has been limited. From the above climatic comparison (Davidson 1998) the indications are that high quality wine grapes could be produced on the both sides of the ranges but at this stage there has only been four varieties planted. If future planting's are to be sustainable there needs to be a diversification in varieties as the red boom cannot last forever.

3. OBJECTIVES

The objectives of the project are;

- to record climatic indices such as temperature, humidity, rainfall and wind direction and speed throughout the growing season for use in climatic comparisons with other wine grape growing regions. *Having benchmarked the climate with other wine producing region's, it is envisaged that a strategic plan for the regions wine grape industry can be developed.*
- By undertaking a detailed climatic survey from within the different sub regions of the southern Flinders, data such as varietal suitability and the expected ripening dates for different varieties can also extrapolated (Happ 2000). This information will also be used to predict spring frost risk (Gladstone 2000) and will be used in predicting specific disease outbreak conditions ie for Downy Mildew.
- With the use of detailed climatic data, varietal suitability can be objectively assessed and it is the aim of this project to give grape growers meaningful data on varietal choices and site selection. Armed with the right data, growers can plant varieties that are ideally suited to the region and avoid mistakes made in other wine regions.
- The regional importance of this project should not be underestimated because the wine industry offers an opportunity for considerable employment growth within the region. To fully maximise this opportunity informed planting choices will need to be made and this project can give these outcomes.

4. METHOD

An initial project outline was submitted to the GWRDC in July 2000. With some adjustments to the format it was accepted in June 2001. Having established the objectives of the project it was then possible to develop the methodology to run the project.

As the project aimed to quantify and compare the regions climate with that of other wine regions there was a need to locate the weather stations/loggers in each of the specific sub regions of the area. From observations of the ripening patterns of Shiraz and other field crops the Southern Flinders can be divided into two main sub regions. The western plains sub region, which is bordered by Spencers Gulf on the west and the Southern Flinders Ranges on the east. The main grape growing site is east of Port Germein in an area known as Baroota. The second sub region is the central ranges area and encompasses an area stretching from Gladstone in the south to Wilmington in the north. The central hills regions ranges from an altitude of 300m at Gladstone up to 960m at Mount Remarkable near Melrose.

Having defined the boundaries of the sub regions it was then possible to choose specific locations for each of the weather stations/temperature loggers. As the weather stations were able to measure a wide range of climatic data it was decided to locate one in each of the sub regions. The vineyards chosen were at Baroota and Murraytown as these were deemed to be representative of each of the sub regions. As the central ranges region contains a number of diverse vineyard sites with specific mesoclimatic influences it was decided that the temperature loggers should be used to identify any climatic differences between these sites. The sites were located at Laura, Melrose and on the Willochra Plains east of Wilmington. The sites were chosen, as they were representative of the various mesoclimates found in this sub region.

Having defined the sub regions there was a need to purchase suitable weather stations and temperature loggers to monitor weather patterns within the various sub regions. A number of quotes were received to supply weather stations for the project but many of the weather stations quoted were very expensive and in the end it was decided to use Weather Pro weather stations as they offered all the features required at an affordable price. The company (GPSE) also offered a range of cheap temperature and humidity loggers which were also used as part of the project.

When the original application was submitted in 2000 an alternative weather station was selected which also predicted downy mildew infections events. This original weather station unfortunately did not record humidity which is critical in any analysis of climate. As part of this original application it was also hoped to install two class A evaporation pans so that evaporation figures could be collected. This option was also not feasible due to the expense of purchasing this equipment and so it was not possible to extrapolate water use as the weather stations finally chosen did not measure evaporation.

Having purchased two weather stations and three temperature loggers it was important to validate them against an existing Bureau of Meterology weather stations. This entailed the setting up of the weather stations/loggers at the Nuriootpa weather station and running them for a 6 day period to see how accurate they were (refer section 5 for validation results). Having validated each of the weather stations they were then transported to the specific sub regions.

The Southern Flinders Winegrape Industry Council (SFWIC) would like to acknowledge the help of the local grape growers involved in the project including Malcolm Orrock, Kevin & Beverley Schultz, Andrew Broadbent, John & Leah Knight and Peter, Mary & Simon Blieshcke. Without their assistance this project would not have been possible. The growers involved were responsible for the downloading of the weather stations/loggers and at the end of the project this data was collated for use in this report. The weather stations/loggers were installed at the sites on the 23rd December 2000 and recordings were taken until Autumn 2002.

The SFWIC would also like to acknowledge the help of GPSE weather stations used in this project. At the initiation of this project a wide variety of weather stations were assess for their suitability for the project but of those assess none delivered the features of the GPSE equipment at the same price.

5. RESULTS

5.1 Weather Station Validation Data

As outlined in the method section it was necessary to validate the weather stations/loggers against an existing weather station to check the validity of weather station/logger readings. After a 6-day period the readings obtained by the various weather stations/loggers were compared with those obtained by the Nuriootpa Weather Station. Figures 1 and 2 show the 9am and 3pm relative humidity readings.

Figure 1. Weather Station Validation - 9am Relative Humidity

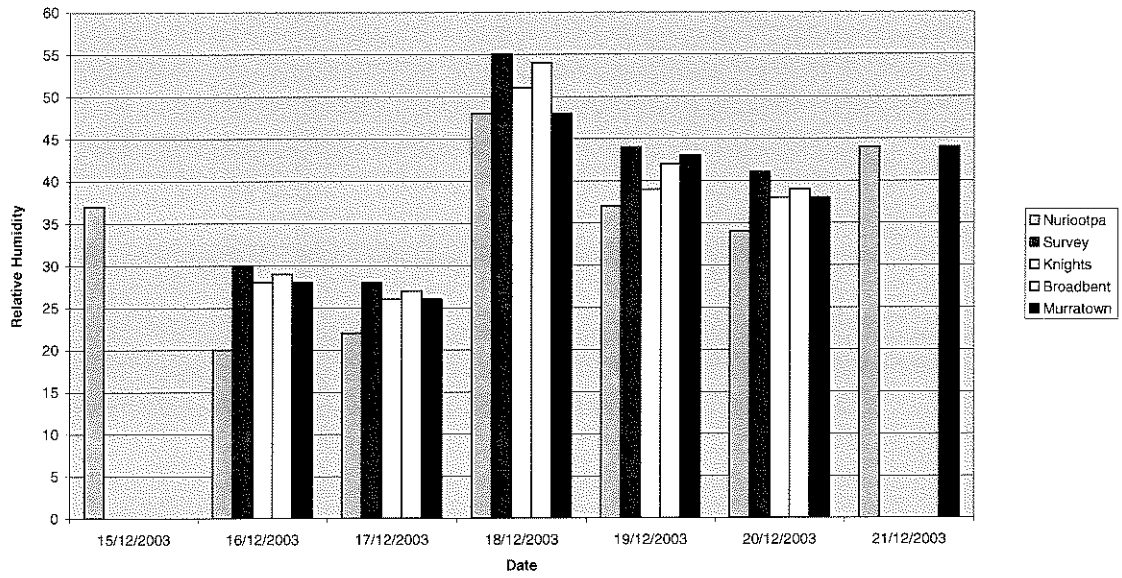
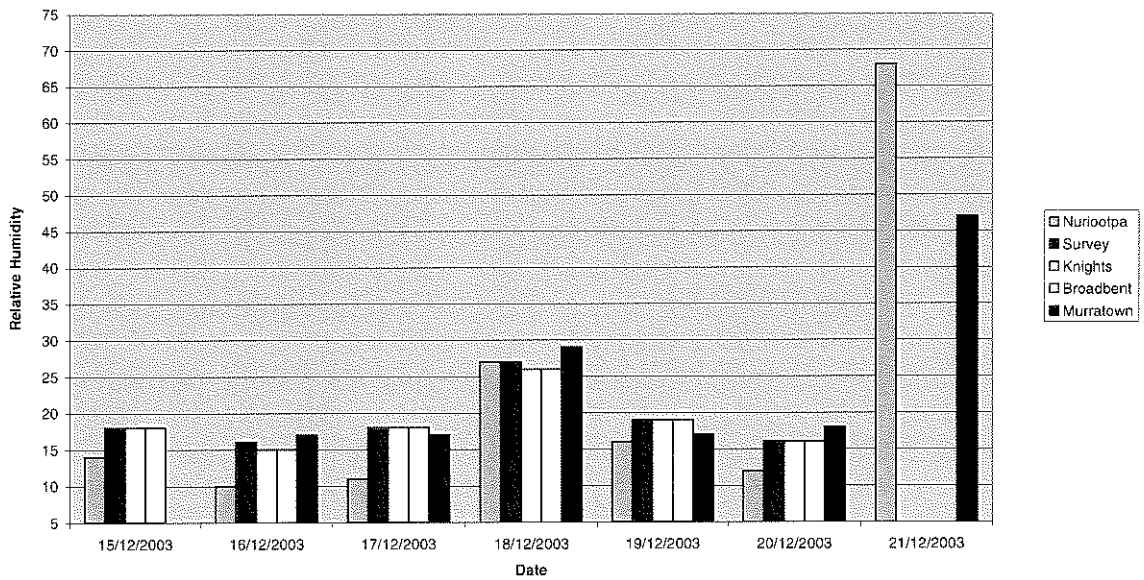


Figure 2. Weather Station Validation - 3pm Relative Humidity



This analysis shows that on five days out of six the weather stations (Murraytown) and the temperature loggers (Knights, Boadbents & Survey Road) read slightly higher than the Nuriootpa weather station. The higher reading may be attributed to the fact that during this validation the weather stations/loggers were fixed onto lower footings than the weather stations and were therefore closer to ground level and so may have recorded slightly higher humidity. Due to computer error humidity data for Baroota was not presented here. Overall the trends were consistent and indicate that the weather station/loggers results were higher than the Nuriootpa station but were indicative of those recorded by the Nuriootpa weather stations and will be presented as recorded and without adjustment for error.

Figure 3. Weather Station Validation - Mean Minimum Temp - GPSE Loggers

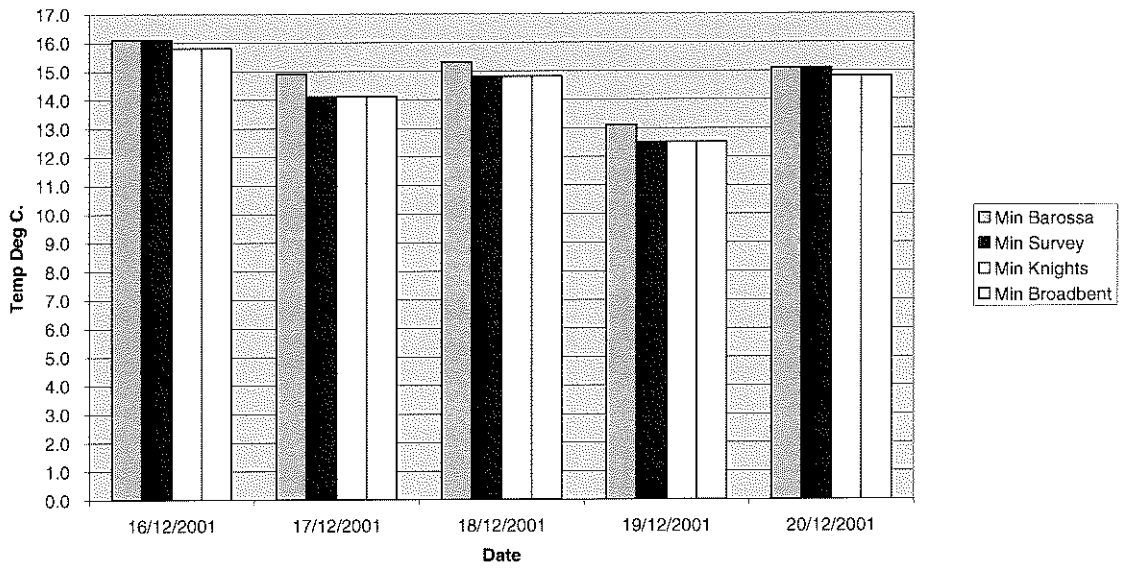


Figure 4. Weather Station Validation - Mean Maximum Temp - GPSE Logger

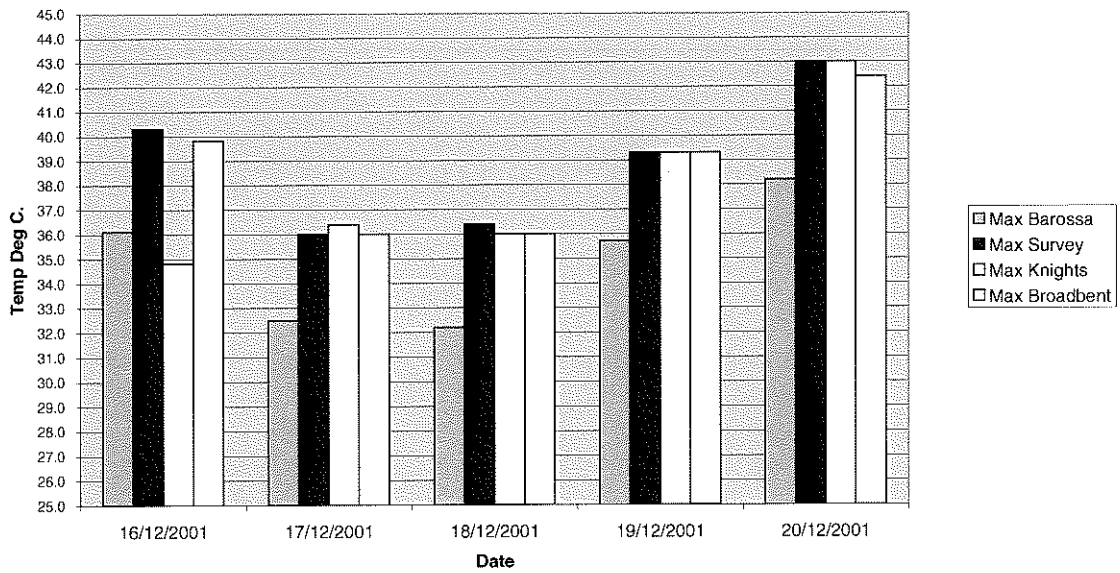


Figure 3 and 4 show the mean minimum and mean maximum temperatures as recorded by the GPSE temperature/humidity loggers. From this we can see that on all days minimum temperature readings were within one degree of the Nuriootpa weather station. In comparison the mean maximum temperatures were between 2-3 degrees warmer than the Nuriootpa weather station (average variance Survey Rd 2.64 degrees, Knights 2.6 degrees and Broadbent 2.34 degrees). This could also be attributed to the lower footing height and therefore higher maximum temperature due to radiated heat. In general the readings are consistent and so are indicative of those recorded by the Nuriootpa weather station. For this comparison mean minimum figures have not been changed but for mean maximum temperature data where there were significant variance adjustment has been made to account for this variance.

Figure 5. Weather Station Validation - Mean Minimum Temperature - Weather Pro

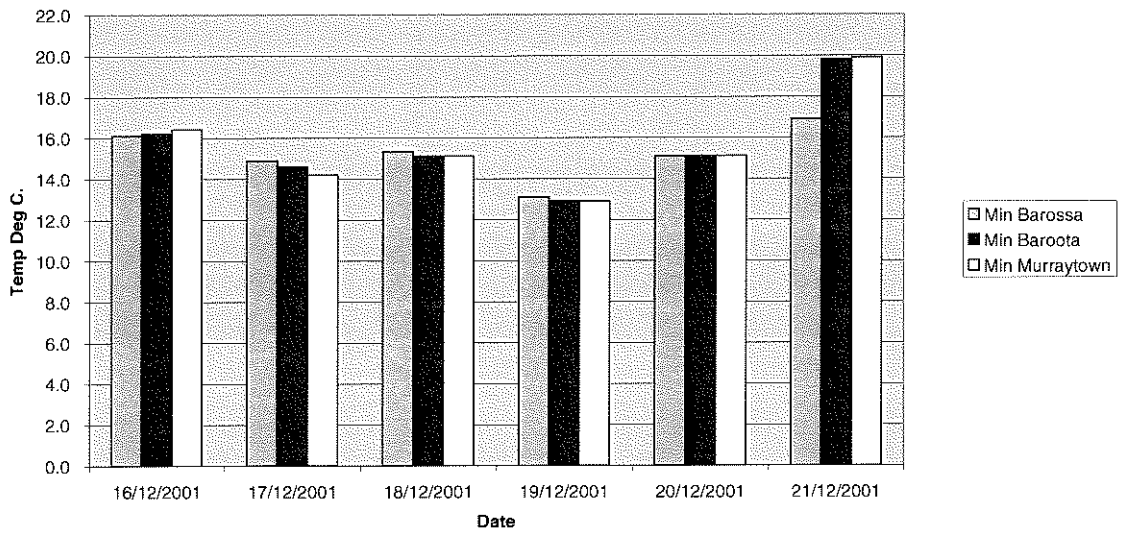


Figure 6. Weather Station Validation Maximum Temperature - Weather Pro

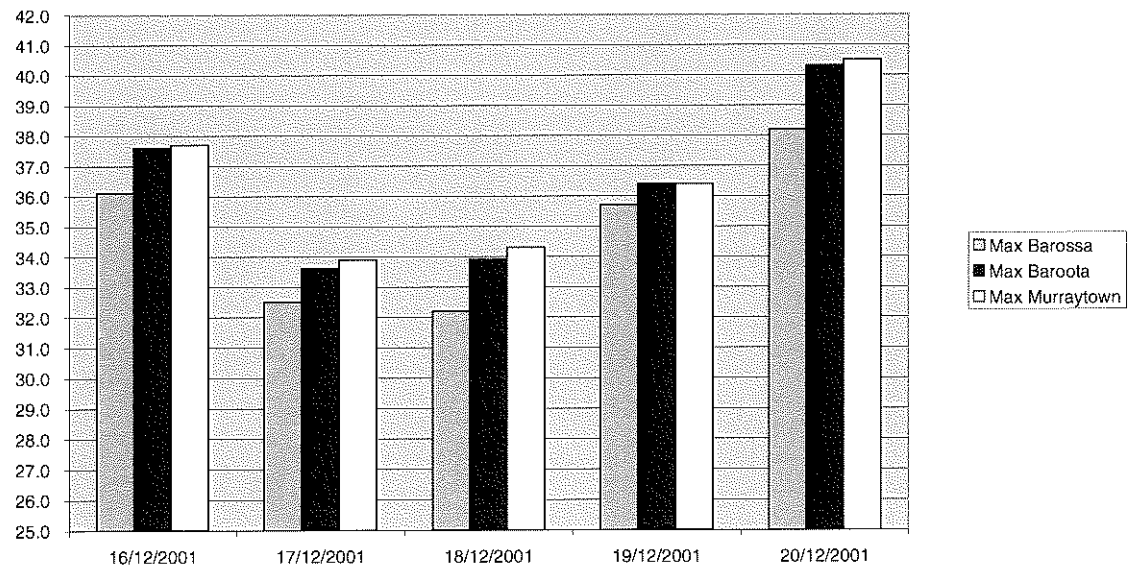


Figure 5 and 6 show the mean minimum and mean maximum temperatures as recorded by the Weather Pro weather stations (Baroota & Murraytown). From this can be seen that on all days minimum temperature readings were within one degree of the Nuriootpa weather station. In comparison the mean maximum temperatures were between 1-2 degrees warmer than the Nuriootpa weather station (Baroota average variance 1.32 degrees and Murraytown average variance 1.62 degrees). This could also be attributed to the lower footing height and therefore higher maximum temperature due to radiated heat. In general the readings are consistent and so are indicative of those recorded by the Nuriootpa weather station. For this comparison mean minimum figures have not been changed but for mean maximum temperature data where there were greater variance adjustment has been made.

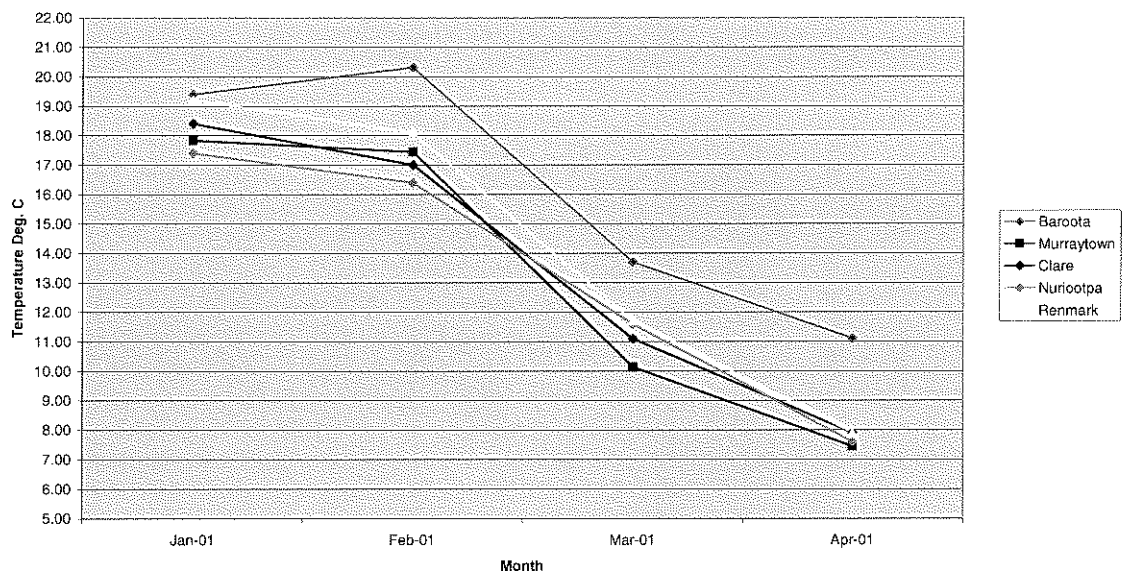
5.2 Temperature

As outlined in the original submission the aim of this project was to collect climatic data, which could be used to characterise the regions climate. Once collected this climatic data could then be used to compare the regions climate with that of other Australian grape growing regions. Presented below is an analysis of the major climatic indices of temperature, humidity, wind direction and rainfall.

Data collection took place between January 2001 and April 2002. The two seasons of the study can be described as extreme opposites one of the hottest years on record (2001) and the coolest years on record (2002). For the purpose of this report comparisons have been made with three other weather stations located in a variety of wine regions namely the Nuriootpa (Barossa Valley), Clare (Clare Valley) and Renmark (Riverland).

Figure 7 is a comparison of 2001 mean minimum temperatures for Baroota (western plains), Murraytown (central ranges) and Clare, Nuriootpa and Renmark. It can be seen that Baroota has the highest mean minimum temperature of the five sites for all months. Murraytowns mean minimum temperature is very similar to that of Clare and

Figure 7. Regional Comparison - 2001 Growing Season Mean Minimum Temperature



Nuriootpa in January and February but is colder in March and in April almost identical to all sites except Baroota. There is a significant divergence from February on wards between the mean minimum temperature of Baroota and the other sites used in this comparison.

Figure 8 is a comparison of the 2001 mean maximum temperatures of the five sites. From this we can see that Renmark has the highest mean maximum temperature. In January and February 2001 Baroota and Murraytown had very similar mean maximum temperatures but in March and April Murraytown's maximum temperature is lower than that of Baroota and marginally more than both Clare and Nuriootpa.

Figure 8. Regional Comparison - 2001 Growing Season Mean Maximum Temperatures

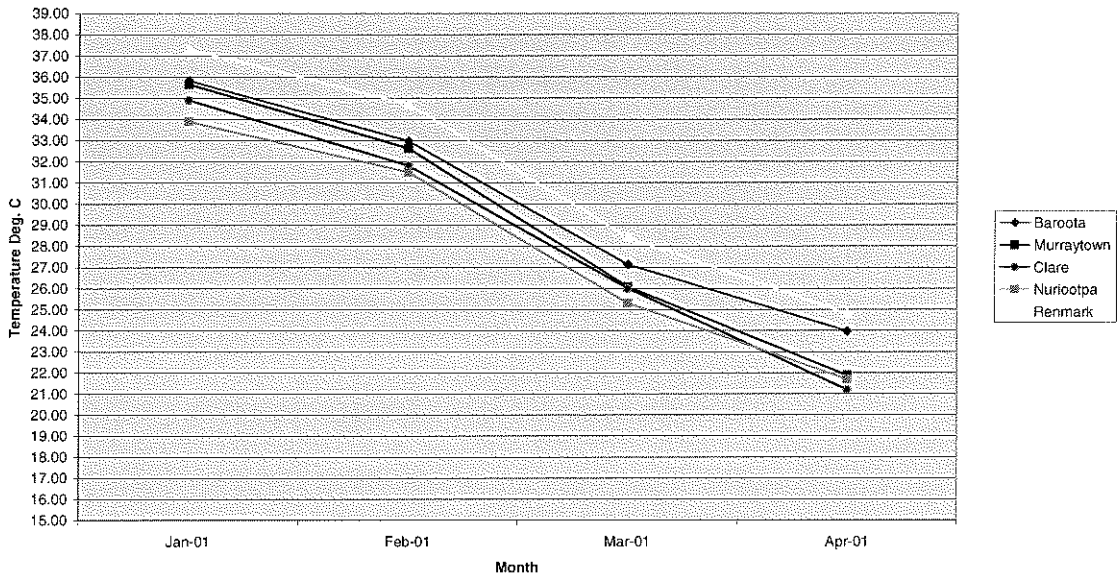
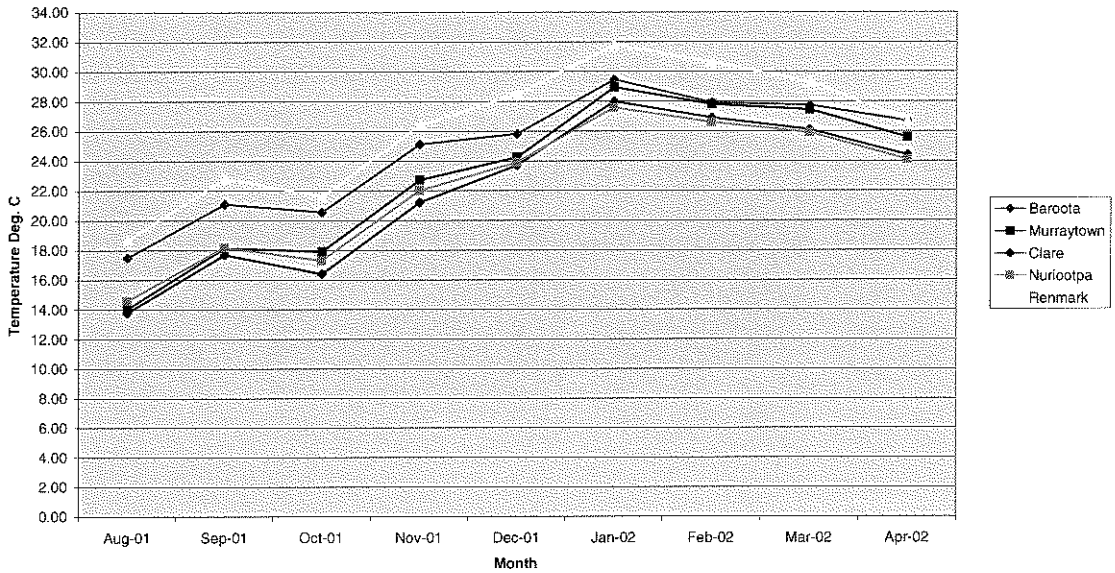


Figure 9 is a comparison of the 2001-02 growing season mean minimum temperatures. From this graph it can be seen that Baroota has the highest mean minimum temperature for August, September and October and it is not until November that Renmarks minimum temperatures exceed that of Baroota. Renmarks has the highest mean minimum temperature in November, December, January and February but in March and April Baroota again has the highest maximum temperature. Murraytown has the lowest mean minimum temperature for all months.

Figure 10 compares the 2001-02 growing season mean maximum temperatures. Renmark has the highest mean maximum temperature for all months except April. Baroota's mean maximum temperature in August to December is significantly higher than that of Murraytown, Nuriootpa and Clare. By January Barootas maximum is only slightly higher than Murraytown and in Febuary and March is very similar to that of Murraytown. The mean maximum temperatures for Murraytown are slightly higher than that of Clare and Nuriootpa for all months except August and September.

Figure 10. Regional Comparison - 2001/02 Growing Season Mean Maximum Temperatures



5.3 Relative Humidity

The assessment of relative humidity was also undertaken and Figure 11 is a comparison of the 2001 growing season 9 am mean relative humidity. In all months except March and April Clare has the highest 9 am relative humidity. In March and April Murraytown had the highest 9 am mean relative humidity. During the months of January and February Clare and Murraytown have the lowest mean 9 am relative humidity and in March and April Baroota has the lowest mean relative humidity.

Figure 11. Regional Comparison - 2001 Growing Season 9am Mean Relative Humidity

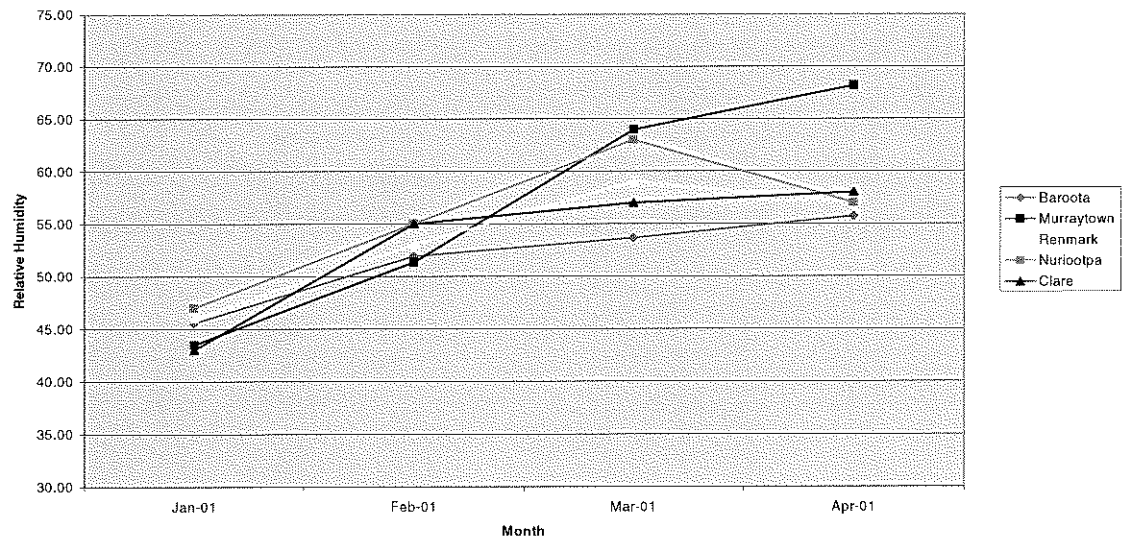


Figure 12 compares the 2001 growing season 3 pm mean relative humidity. In all months except March Baroota has the highest 3pm mean relative humidity. In all months Renmark has the lowest 3 pm mean relative humidity. Murraytown recorded humidity levels very similar to that of Clare and Nuriootpa.

Figure 12. Regional Comparison - 2001 3pm Mean Relative Humidity

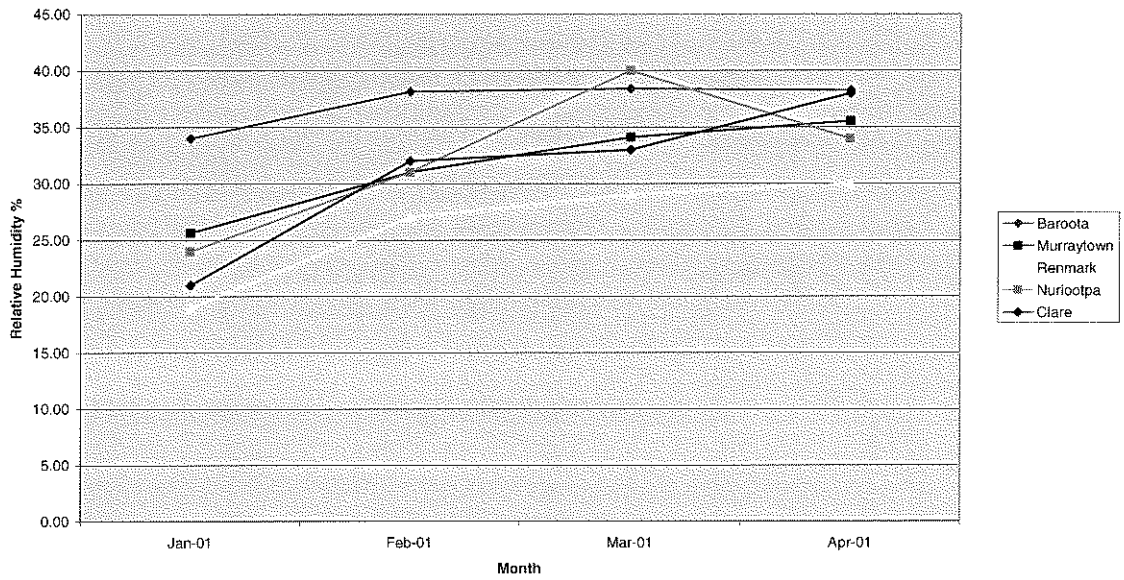


Figure 13 compares the 2001-02 growing season 9 am mean relative humidity. In August, September and April Murraytown has the highest 9 am mean relative humidity. Between October and March Clare recorded the highest relative humidity. Renmark recorded the lowest 9 am relative humidity in the months August through January with Murraytown recording the lowest humidity in February.

Figure 13. Regional Comparison - 2001/02 Growing Season 9am mean Relative Humidity

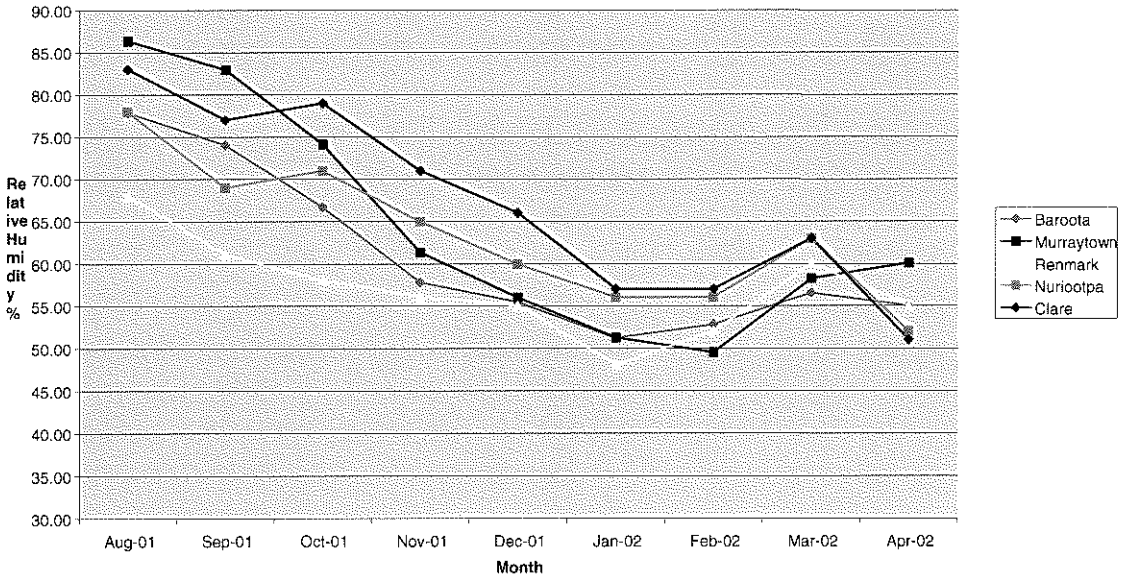
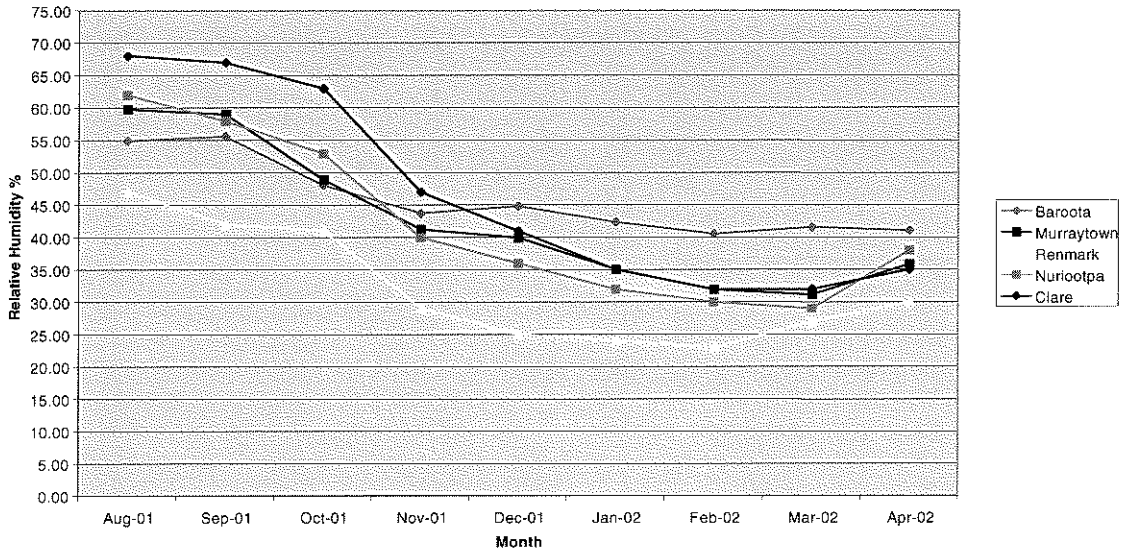


Figure 14 compares the 2001-02 growing season 3 pm mean relative humidity. In the months August to November Clare has the highest 3 pm mean relative humidity. In the months December to April Baroota recorded the highest 3 pm humidity. In all months Renmark recorded the lowest 3 pm mean relative humidity. In all months Murraytown recorded very similar humidity levels to that of Clare and in the months December to April similar levels to that of Nuriootpa.

Figure 14. Regional Comparison –2001-02 Growing Season
3pm Mean Relative Humidity



5.4 Wind Direction

Having analysed the temperature and humidity data an analysis of wind direction was undertaken. Wind direction is significant in the Southern Flinders Ranges as wind direction has a direct influence on the climate of the region. Having an understanding of the relationship of wind direction and its influence on temperature and humidity it can help explain the unique microclimates of the region. The 9 am and 3 pm wind direction frequency was recorded at Murraytown and Baroota between January 2001 and April 2002 (refer appendix A - forwind direction frequency graphs).

Graph 1 & 2 show the 9am and 3pm wind direction frequency for Baroota and Murraytown. At Baroota the predominant 9am wind direction is from the northeast and at Murraytown it is from the east. The 3pm wind direction at Baroota is predominantly from the north west and west and at Murraytown it is predominantly from the northwest although there is high frequency from the north, northeast and west.
Graph 3 shows that in February 2001 the predominant 9am wind direction frequency at Baroota was from the west, southwest and south. The predominant 3pm wind direction was from the northwest and west. Graph 4 shows that for Murraytown the predominant 9am wind direction frequency is from the southeast and east. The predominant 3pm wind direction was northwest, southeast and southwest.

Graph 5 shows that in March 2001 the predominant 9am wind direction frequency at Baroota was from the southeast, south and east. The predominant 3pm wind direction was from the northwest and west. Graph 6 shows that for Murraytown the predominant 9am wind direction frequency are spread evenly between north, east and south. The predominant 3pm wind directions are east, north and northwest.

Graph 7 shows that in April 2001 the predominant 9am wind direction frequency at Baroota were from the south, east, southwest and southeast. The predominant 3pm wind direction was from the west and northwest. Graph 8 shows that for Murraytown the predominant 9am wind direction frequency are generally spread between north, west and south. The predominant 3pm wind directions are north, northeast and east.

Graph 9 shows that in August 2001 the predominant 9am wind direction frequency at Baroota were from the north. The predominant 3pm wind direction was from the southwest, north and south.

Graph 10 shows that in September 2001 the predominant 9am wind direction frequency at Baroota was from the north and northeast. The predominant 3pm wind direction was from the southwest, northwest and north. Graph 11 shows that for Murraytown the predominant 9am wind direction frequency are from the north. The predominant 3pm wind directions are north and west.

Graph 12 shows that in October 2001 the predominant 9am wind direction frequency at Baroota was from the west, southwest and north. The predominant 3pm wind direction was from the southwest and south. Graph 13 shows that for Murraytown the predominant 9am wind direction frequency are from the northwest and west. The predominant 3pm wind directions are from the southwest, northwest and southeast.

Graph 14 shows that in November 2001 the predominant 9am wind direction frequency at Baroota was from the south, east and north. The predominant 3pm wind direction was from the southwest and south. Graph 15 shows that for Murraytown the predominant 9am wind direction frequency are from the southwest, west and southeast. The predominant 3pm wind directions are from the south, northwest and north.

Graph 16 shows that in December 2001 the predominant 9am wind direction frequency at Baroota were from the north and northeast. The predominant 3pm wind direction was from the southwest, south and west. Graph 17 shows that for Murraytown the predominant 9am wind direction frequency are from the west, north and northwest. The predominant 3pm wind directions are from the west, northwest and north.

Graph 18 shows that in January 2002 the predominant 9am wind direction frequency at Baroota was from the north, east and northeast. The predominant 3pm wind direction was from the north. Graph 19 shows that for Murraytown the predominant 9am wind direction frequency are from the northwest, north and west. The predominant 3pm wind directions are from the north, east and southeast.

Graph 20 shows that in February 2002 the predominant 9am wind direction frequency at Baroota were from the south, north and east/southeast. The predominant 3pm wind direction was from the southwest. Graph 21 shows that for Murraytown the predominant 9am wind direction frequency are from the west, northwest and north. The predominant 3pm wind directions are from the north, west and east.

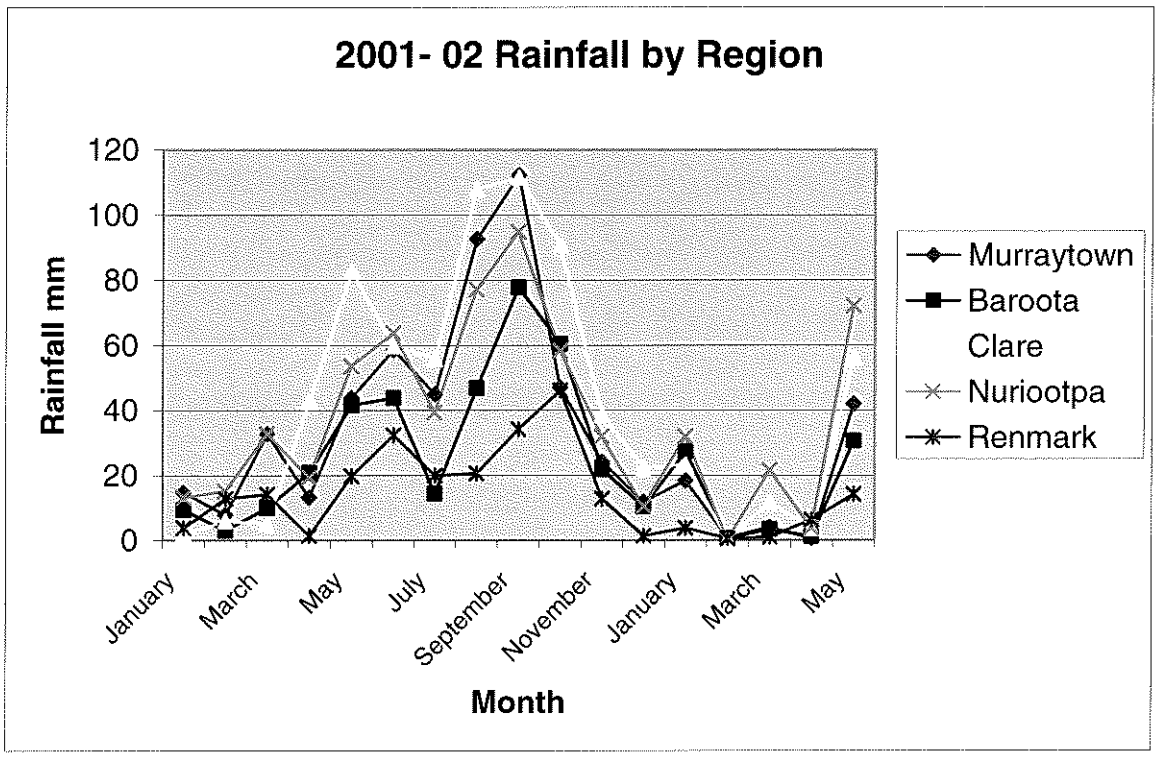
Graph 22 shows that in March 2002 the predominant 9am wind direction frequency at Baroota were from the south and east. The predominant 3pm wind direction was from the southwest. Graph 23 shows that for Murraytown the predominant 9am wind direction frequency are from the north, west and south. The predominant 3pm wind directions are generally spread evenly between north, west, southwest and east.

Graph 24 shows that in April 2002 the predominant 9am wind direction frequency at Baroota was from the northeast, south and east. The predominant 3pm wind direction was from the south and southwest. Graph 25 shows that for Murraytown the predominant 9am wind direction frequency are from the northwest, east and south/southwest . The predominant 3pm wind directions are from the north, northeast and south.

5.5 Rainfall

Over the course of this study rainfall measurements were taken. Figure 15 illustrates the monthly rainfall totals for the different regions

Figure 15 –2001/02 Monthly Rainfall by region



In the year 2001 Clare received the highest total rainfall, Murraytown had a very similar total rainfall to that of Nuriootpa and Baroota and Renmark received the lowest rainfalls. During the first five months of 2002 Nuriootpa received the greatest rainfall followed by Clare and Murraytown. Due to the short time frame of this study it is hard to draw any major conclusions from this data.

Figure 16 – Mean monthly rainfall totals by region (Bureau of Meteorology)

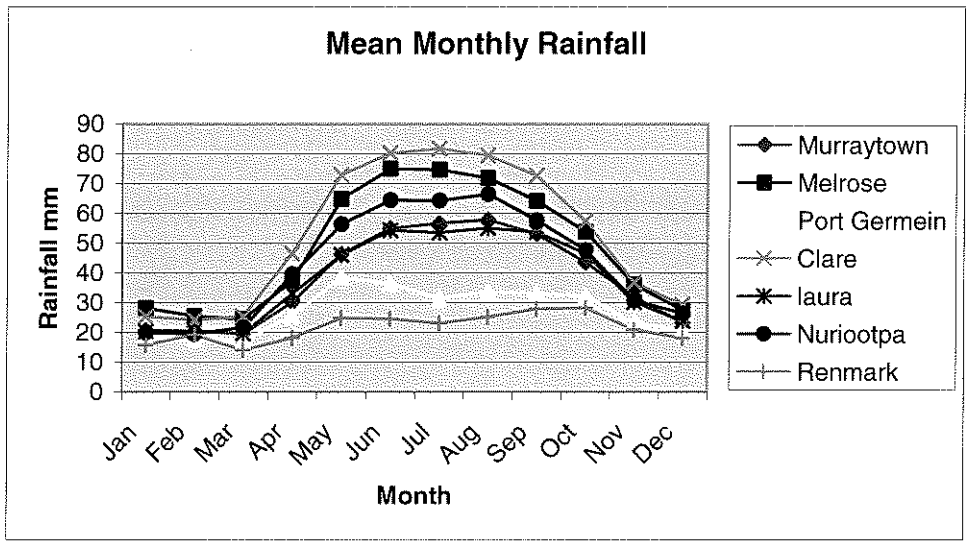


Figure 16 shows the mean monthly rainfall averages of a range of sites including four towns from the Southern Flinders region. The sites include Melrose (365m), Murraytown (400m), Laura (248m), Port Germein (4m), Clare Post Office (385m), Nuriootpa (275m) and Renmark (20m). From this it can be seen that there is distinct variations in mean monthly rainfall within the Southern Flinders ranges. Clare has the highest mean monthly rainfall totals for all months except January and February when Melrose has the highest monthly totals. From Figure 16 it can be seen that Melrose has the second highest mean monthly rainfalls between May and November followed by Nuriootpa and then Laura and Murraytown have similar monthly totals. Port Germein and Renmark have the lowest mean monthly totals in this comparison.

Table One - Annual Rainfall (Bureau of Meteorology)

	Annaual Rainfall mm
Clare	634.1
Melrose	586.8
Nuriootpa	516.1
Murraytown	460.8
laura	456.8
Port Germein	327.3
Renmark	260.1

Table one shows the annual rainfall for the different sites and from this it can be seen that Clare has the highest annual rainfall and Renmark the lowest annual rainfall.

6. DISCUSSION

From this comparison there are major differences between the climates of the two different sub regions in the Southern Flinders Ranges. From the temperature data it can be seen that significant temperature variation exists between the western plains and the central ranges. The western plains (Baroota) in both seasons exhibited higher mean maximum and minimum temperatures than that of the central ranges (and the other regions). This would suggest that the climate is more maritime i.e. a small difference between mean temperature of the hottest and coldest months. The central ranges (Murraytown) in comparison has lower mean maximum temperatures in the early part of the growing season but during the ripening period the differences are not as marked. This would suggest that the climate is more continental i.e. a larger difference between the mean temperature of the hottest and coldest months. The mean temperatures of the hottest and coldest months of both sub regions seen below supports this conclusion.

Table Two – Comparison of mean temperature of hottest and coldest month

Month	Mean Temperature Baroota	Mean Temperature Murraytown
January 2001	28.39	27.61
July 2001	10.99	8.42
January 2002	23.08	21.05
July 2002	12.83	9.14

The mean maximum temperature readings for Clare and Nuriootpa are slightly lower than that of Murraytown. This could be partially explained by the fact that Murraytown is situated further north of both regions and so would experience more sunlight hours than further south. Murraytown is also less affected by southerly fronts than the Barossa and Clare valleys and a high proportion of its rainfall in spring and early summer is derived from tropical low-pressure systems rather than southerly fronts. Another factor at work, which will modify maximum temperatures, would be the fact that the area experiences a high frequency of westerly derived sea breezes during the late afternoon in summer and autumn period which would have a moderating influence on maximum temperatures and humidity.

The data on mean minimum temperature shows that over the two seasons of this study Murraytown's mean minimum temperatures were often lower than that of both Clare and Nuriootpa. Situated at 380m above sea level Murraytown is higher than Nuriootpa 274m and is very similar to the altitude of Clare 398m. The vineyard site where the weather station is located is on a gently undulating northeasterly slope. Due to the surrounding topography the site experiences air draining from the higher hills to the west and north. In the 2001/02 growing season the 9am wind frequency is often highest from the west northwest which would indicate cooling winds emanating from the surrounding hills (Mount Remarkable 960m) or from the coast approximately 25km east.

Bud burst and ripening of Shiraz is very similar or a little earlier at Murraytown than sites at Clare and in the Barossa but vineyards northwest of Murraytown near Melrose bud burst and ripening is later than many Barossa floor vineyards and similar to that of Clare. From a wine perspective the wines from the area are closer in style to Clare rather than the full-bodied wines from the Barossa floor. Whereas wine styles from Baroota and the eastern plains are more full-bodied than the central ranges and are more in style to that of the Barossa floor.

There are also differences in the mean relative humidity for the two sub regions. In general early in the season 9am mean relative humidity are higher at Murraytown than at Baroota. The lower levels recorded at Baroota would be associated with the high incidence of dryer northerly winds common at this time of the year. Murraytown also has higher rainfall at this time of the year, which would help, lift relative humidity, as would the high incidence of morning dews.

As the season progresses 9am relative humidity's decrease and there is little difference between each region. As can be seen from the 9am mean relative humidity graphs there is a decrease in 9am relative humidity for both sites as summer commences. This relates to an increase in temperature and a decrease in water status of the region at this time of year. This is in contrast to the Barossa and Clare valleys, which have higher 9am relative humidity during December through to February. This may relate to the high frequency of warmer northerly breezes and therefore higher maximum temperatures experienced at Murraytown and Baroota during this period

It is interesting to note that the 9am humidity for both Baroota and Murraytown are influenced by different wind patterns during the summer months. At Baroota the predominant 9am wind direction is from the east to northeast direction. Baroota is situated at the base of the Ranges and the surrounding peaks rise rapidly to 500 – 960m above sea level. Whereas at Murraytown the predominant wind direction is from the northwest to north, which would also originating from the higher peaks.

There are also marked differences between the 3pm relative humidity's of Murraytown and Baroota. In the early part of the growing season the 3pm relative humidity is higher at Murraytown than at Baroota and would relate to higher rainfall and general moisture status of the area at this time of the year. By October humidity levels are very similar and for the rest of the growing season the Baroota figures are consistently higher. The higher humidity levels experienced at Baroota can be related to the high incidence of late afternoon sea breezes helping to increase humidity. The decrease in humidity levels at Murraytown also corresponds with increased temperatures and a general drying of the landscape at this time of the year. Both Baroota and Murraytown in 2001 – 02 seasons experienced equal or higher 3pm relative humidity than Clare and Nuriootpa and this would suggest that both sub regions experience increased humidity from moist afternoon sea breezes.

From local experience the phenological stages experienced at Baroota occur up to a month earlier than the equivalent stage of the same varieties grown at Murraytown. The higher mean maximum/minimum temperatures experienced at Baroota early in the growing season may help to explain the advanced development of the vine. The High frequency of warming northerly breezes in the months of August and September at Baroota would help increase average temperatures and allow rapid early vine growth. The early warmth and lower humidity is also important in decreasing the risk of early season frost and also helping limit potential disease outbreaks.

Another feature of the western plains sub region is the 3pm relative humidity. From temperature data the sub region has relatively high mean maximum temperatures compared with the central ranges, Clare and Barossa. From winery experience wine quality has exceeded that of similarly warm to hot regions and the cooling influence would certainly create ideal conditions for photosynthesis and physiological ripening which in turn would lead to early ripening and higher wine quality as is seen at Baroota. The higher 3pm relative humidity would also help moderate the vine water status allowing the vine to recover from mid day water stress and again allowing continued photosynthesis during the afternoon and evening.

Another important factor in any analysis of climate is rainfall. From the rainfall data presented in section 5.5 it can be seen that Melrose has the highest annual rainfall compared with the other towns in the Southern Flinders ranges. Its relatively high rainfall would be as a result of its close proximity to Mount Remarkable (956m). As you move east and west of the central ranges the rainfall drops off markedly and in fact Port Germein is in a rain shadow created by its location on the western side of the ranges. It should also be noted that in the higher areas of the central ranges annual rainfall can reach 600+ mm.

Rainfall also has a major influence on the incidence of disease. As we have concluded that the climate of the central ranges is similar to that of both the Clare and Barossa Valley's it would be logical therefore to suggest that disease pressure would be similar to that of these regions. The relative disease pressure will vary from site to site and will also be influenced by the varieties grown. For instance sites growing Riesling in the higher rainfall areas of the central ranges may well have higher risk of botrytis and powdery mildew outbreaks. By comparison the western plains is a very dry climate with very low disease potential due to the higher maximum temperatures and the limited rainfall.

To date there have been isolated outbreaks of powdery mildew but as yet there has been no reported cases of downy mildew or botrytis. This is not to say that disease is not an issue and that particular attention should not be paid to effective preventative spray programs. As can be seen from the monthly rainfall data the region has relatively high summer rainfall, which is generally associated with tropical lower pressure systems. These rain events are generally associated with high humidity and are ideal for disease outbreaks.

So far the region has very few disease outbreaks and one of the major contributing factors beyond the climate is the regions geographic isolation. The fact that the region is far removed from other established wine regions has mean that there has been little spread of disease from one vineyard to the next. This fact coupled with the relatively dry climate has huge implications in respect to the future marketing of the region. As demand grows around the world for organic and biodynamic produce the region has the opportunity to develop a neiche market for its wines on the back of organic productions. The western plains especially is the ideal climate for the production of organic/biodynamic grapes due to its low rainfall. The central ranges may prove more difficult due to its higher rainfall but with the demand for organic produce set to increase the risk is worth it.

7. VARIETAL SUITABILITY

This report has highlighted similarities between the climate of the central ranges and that of the Clare and Barossa valleys over an 18-month period. It has also highlighted the unique climate of the western plains and endeavoured to explain the reason for this unique climate.

One of the aims of this project was to make an objective assessment of varietal suitability for the region as a whole. Having identified two distinctly different sub regions it is now possible to make some specific recommendations to the different sub regions of the Southern Flinders Ranges.

It should be noted that at present the industry has an over supply of a number of red varieties, mainly Cabernet Sauvignon, Merlot and to a lesser extent Shiraz. As stated in the original project outline the reliance of the region on red varieties is of concern and the current oversupply situation merely confirms this concern. Having said this the varietal recommendations of this report are only examples of varieties that could produce high quality table wines in a given site. The varieties recommended may not necessarily be in demand by wine companies and before any decisions on future planting is made it would be wise to get winery approval.

Although not presented in this report (see conclusion section) data collected by the temperature and humidity data loggers highlighted that there is variation in temperature and humidity between sites at Laura (Broadbent), Melrose (Survey Road) and the Willochra Plains (Knights). From the limited data available the Laura and Willochra sites are warmer than that of Murraytown and Melrose. Sites such as those found on the Survey Road (500 – 600 m above sea level) have proven to ripen later than Murraytown with the Willochra site ripening the earliest but still later than the Baroota site. From this we can conclude that within the region there is potential to produce a variety of wine styles and that certain locations will suit different varieties.

Having concluded that there is reasonable correlation between the climate (and topography) of Murraytown and the Clare Valley it would seem reasonable to assume that the varieties suited to Clare would also preform well in the central ranges region. In his book Viticulture and Environment, John Gladstone presents a method for predicting maturity dates using a number of factors relating to temperature.

By analysing long term temperature data a figure of biologically effective day degrees can be calculated which helps predict potential maturity dates. From these calculations Clare recorded a figure of 1550 biologically effective day degrees BEDD. Given the temperature data collected in this study as well as actual maturity dates it is reasonable to assume that the Murraytown site has a slightly higher BEDD. In Viticulture and Environment, Gladstone has classified the major wine grape varieties into 8 maturity groups dependant on their required BEDD to reach maturity for the production of dry or semi sweet table wines (see table 3). Using the Gladstone method presented in Viticulture and Environment a predicted ripening date for Shiraz at Clare would be March the 8th. From experience this predicted date is relatively accurate for Shiraz harvest at Clare and at Murraytown.

Table three – Winegrape maturity groups and biologically effective day degrees to ripeness, for making dry or semi sweet table wines.

	Red Wines	White or Rose wines
Group 1 1050 BEDD	-	Madeleine-Sylvaner
Group 2 1100 BEDD	Blue Portuguese	Pinot Gris, Pinot Noir Munier
Group 3 1150 BEDD	Pinot Noir, Munier, Gamay, Dolcetto	Traminer, Sylvaner, Chardonnay Sauvignon Blanc, Verdhelo, Sultana
Group 4 1200 BEDD	Malbec, Durif, Zinfandel Tempranillo	Semillon, Riesling
Group 5 1250 BEDD	Merlot, Shiraz Sangiovese, Touriga	Viognier, Marsanne Roussanne
Group 6 1300 BEDD	Cabernet Sauvignon, Nebiolo, Tannat	Colombard, Palomino
Group 7 1350 BEDD	Mataro, Grenache Petit Verdot	Trebbiano, Muscat Gordo Blanco
Group 8 1400 BEDD	Tarrango	Doradillo

Adapted from Viticulture & Environment by John Gladstone

7.1 Central Ranges

Having highlighted the similarities between the climates of the two regions it is now possible to make some informed varietal choices for the central ranges sub region. The predominant varieties grown at Clare include Shiraz, Riesling, Cabernet Sauvignon, Chardonnay, Merlot, Grenache and Semillon. Of the varieties listed Shiraz and Riesling are the predominant varieties grown and have proven to be in highest demand by wineries. As the central ranges has a predominance of red varieties already it would seem logical to plant more white varieties, listed below is a selection of possible choices.

Riesling - from the Clare experience Riesling is a logical choice for the region. As Riesling is a thin-skinned aromatic white variety it is important that excessive exposure is avoided as exposure can lead to sunburn and a marked decrease in aromatics and poor wine quality. Therefore it is important to choose easterly facing sites with soils with high readily available water. Sites located in the higher parts of the ranges will be best suited to high quality table wines but if sufficient water is available to maintain a healthy canopy it will do well in the flatter areas of the region. Using Gladstone's wine grape maturity groupings Riesling is a group 4 variety similar to Semillon but is often picked after group 5 & 6 varieties in Australian conditions (Gladstone 1992), therefore would be expected to ripen early to mid march.

Viognier – a relatively new variety in Australia but is gaining a reputation for producing high quality table wines from a number of wine regions throughout Australia (both cool and warm). A thick-skinned variety, which benefits from moderate exposure, Viognier has proven that it is capable of producing varietal wines in both warm and cool sites. This variety is suitable to a wide range of sites from the higher hills to the western plains. Classified as a group 5 variety it would be expected to ripen around early March but as winemakers tend to pick this variety at high Baumes it may well ripen later than Shiraz.

Chardonnay - another white variety widely planted at Clare is Chardonnay and this variety has been widely planted across much of Australia over recent time. Demand remains strong although this may change as newer plantings come into production. Once again a thin-skinned variety so has similar requirements to that of Riesling. Is a group 3 variety and so would be expected to ripen late February.

Sauvignon Blanc – is a variety, which is widely planted in many Australian wine regions and has proved successful in both warm and cool climates. Like Riesling, Sauvignon Blanc is a thin-skinned aromatic white variety but has higher natural vigour than Riesling. This variety is also susceptible to sun burn and so excessive exposure needs to be avoided and so careful site selection is important. Sites in the higher ranges that have deep soils on easterly slopes have good potential as would warmer sites with adequate water to maintain healthy canopies. A group 3 variety Sauvignon Blanc would be expected to ripen towards the end of February.

Pinot Gris – is an emerging variety, which is gaining popularity in many regions. This variety is widely planted in the Alsace region of France as well as in Italy where it is referred to as Pinot Grigio. A vigorous variety Pinot Gris is productive and produces light easy drinking white wines. Thought to be a sport of Pinot Noir, Pinot Gris is an early ripening variety (group 2), which would be expected to ripen mid to late February depending on the Baume specifications and yield. As with Riesling and Sauvignon Blanc this variety will need careful site selection so as to avoid excessive exposure but sites located on easterly slopes in the high ranges would be expected to produce varietal wines.

Other white varieties, which show some potential under Australian conditions and which may do well in the central ranges include Roussanne and Marsanne. Both varieties originate from the southern Rhone valley of France. Both are group 5 varieties and perform well in the warmer southern Rhone where Grenache and Mataro are widely planted. Varieties such as Semillon and Verdelho would also perform well in the central ranges region but due to poor demand by wineries have not been included here.

As outlined in this report the major red varieties planted in the region are Shiraz, Cabernet Sauvignon and Merlot. These varieties will continue to be the most sort after by winemakers, but there is also opportunity for other red varieties to establish themselves in the market place.

Varieties that are of most interest for the central ranges and indeed the whole of the Southern Flinders are those, which produce high quality wine from warmer climates. The climate of the central ranges sub region offers ideal ripening conditions for a wide range of varieties and due to the cooling influence of altitude and the proximity to Spencers Gulf offers ideal conditions for maintain acid levels and the development of flavour. The combination of these factors gives the region an opportunity to produce high quality wines with unique regional characters. The varieties which are of most interest include the following;

Grenache – is a variety, which was once one of the most widely planted varieties in Australia. Since the late 1980's its area has steadily declined but in recent years there has been a resurgence of interest in the variety due to its use in blends with Shiraz and Mataro as well as straight varietal wines. This variety is a hardy variety which yields well and requires relatively small quantities of water. It is suited to the warmer sites where soil readily available waters are lower so as to keep yields and vigour low. It is a group 7 variety and so would be expected to ripen mid to late March although when grown in Clare and Barossa it ripens as late as mid April and so may not suited to the cooler sites in the central ranges.

Mataro or Mouvedre - is another variety with its origins in the southern Rhone region of France, Mataro is a variety which was widely planted in Australia but has been declining in recent years. Demand for Mataro is still limited but more interest has been shown in the variety in recent times as the popularity of blends with Shiraz and Grenache becomes greater. Mataro is a hardy high yielding variety that will suit the warmest sites as it ripens late in the season. Mataro is a late bursting variety that makes it ideal for frost prone sites as it recovers well from frost injury. Like Grenache, Mataro is a group 7 variety which will often ripen after Grenache.

Tempranillo – is the signature variety of the Spanish wine region of Rioja and produces dry, scented wines with the potential to age. A relative early ripening variety that will perform well in both cool and warm sites. It is interesting to note that in Rioja, Tempranillo is preferred in the cooler mountainous regions with average rainfall of 450mm. A group 4 variety it would be expected to ripen in early March which may mean that in the hotter sites it will be ripening in the hottest period of the season leading to less intense flavour development.

Zinfandel (Primativo) – is the most widely planted grape variety in California and is thought to have originated from southern Italy where it is called Primativo. In California Zinfandel is used to make many wine styles from full bodied dry reds to rose and even white wines. In her book Vines, Grapes and Wines, Jancis Robinson writes in regards to growing Zinfandel in California "Ideal conditions are fairly cool, with lots of sunshine; many high altitude sites work well". Having said this it is also susceptible to rain damage and bunch rot and so areas with high autumn rainfall should be avoided. Zinfandel is a large berried variety that is prone to uneven ripening and shrivelling in hot sites. So sites, which are protected from hot afternoon sun, would have the best potential for high quality table wines. Zinfandel is a group 4 variety which would be expected to ripen in early March.

Durif - is another variety that has its origins in the south of France. Durif has been grown in the Rutherglen region of Victoria for many years and has build a strong reputation for its Durif wines as have other warm irrigated regions such as the MIA region around Griffith. Durif wines tend to have deep colour and are quite tannic but have the potential to age for many years. Durif is a group 4 variety which would be expected to ripen in early march.

7.2 Western Plains

As discussed in this report the western plains has a quite unique climate when compared to other Australian wine regions, the closest region being the Adelaide Plains. This sub region produces the earliest ripening Shiraz in South Australia if not Australia and Shiraz can ripen up to five weeks earlier than the Shiraz grown at Murraytown.

The early ripening nature of this sub region can have some positive implications for wineries and grape growers but also some negative implications as well. The positives for grape growers are that their fruit is harvested early before the onset of winter rains and that there is no chance of the winery not having fermenter space. The positives for wineries are mainly related to having the ability to use red fermenters earlier than normal as well as spreading the intake period over a number of weeks. This also allows the winery to train staff early in the vintage period before the peak period commences.

Some of the negatives of early ripening are that often the winery is not ready to pick red varieties before white varieties from other regions. This is significant as we talk about planting white varieties in this sub region as in general many white varieties ripen much earlier than red varieties. For instance if Chardonnay were to be planted on the western plains it would probably ripen around early January. This would create many problems for wineries and growers alike and so any choice of variety needs to be carefully selected so as to ripen in a manageable time frame. Once again the planting's on the western plains are skewed towards red varieties and so there is a need to focus on white varieties. Listed below are some varieties that may suit the region;

Viognier – as described earlier in this report Viognier is a later ripening variety, it is tolerant to exposure and produces varietal wines in warm climates. As a group 5 variety Viognier will ripen around the same time as (or later than) Shiraz; a variety that has potential for the western plains.

Roussanne – originates from the Rhone valley of France and is capable of producing elegant wines that have the potential to age. Roussanne is also a group 5 variety which should ripen similarly to Shiraz. Unfortunately with Rousanne there is limited quantities vine material available in Australia and much of this is contaminated with virus.

Marsanne – originates from the same regions of France as Roussanne and is more often than note blended with Rousanne and in some areas Viognier. It is also a group 5 variety which is quite vigorous which may be advantageous in a warm climate such as the western plains. Marsanne has been grown in the Goulburn Valley since the 1860's and the wines from these vineyards have proved to age well over many years.

Colombard – is a minor variety from the south west of France. It is one of the most widely planted varieties in California due to its ability to maintain its acid levels in warm climates. It is a high yielding variety but when yields are moderate produces crisp fruity wines. Primo Estate Colombard from the Adelaide Plains is a good example of Colombard and has developed a strong following in Australia. Colombard is a group 6 variety and so would potential ripen at a similar time to Cabernet Sauvignon. A variety that has potential for the western plains if a healthy canopies can be maintained.

Wine grape plantings on the western plains have almost exclusively been to red varieties Shiraz, Cabernet Sauvignon and Merlot. As with the central ranges these varieties will always be sought after by winemakers but there are opportunities to plant alternate red varieties which will grow well in this climate. Varieties of interest include;

Durif – as describe above this variety is already producing wines of note in warm inland climates. With the influence of a cooling late afternoon sea breezes it should produce a unique regional character.

Touriga – originates from the Duoro valley of Portugal, a region renowned for producing the best vintage ports in the world. The Duoro valley is interesting as it is a warm to hot region that is moderated by the cooling influence of the Alantic ocean and may well have a similar climate to that of the western plains. Touriga produces table wines that are perfumed and have deep coloured. It is a group 5 variety which tends to ripen similarly to Mataro in the Barossa Valley.

Grenache & Mataro - as described above both have potential for planting on the western plains. These varieties have the ability to handle warm to hot conditions and still produce high quality wines especially when blended with Shiraz.

8. CONCLUSION

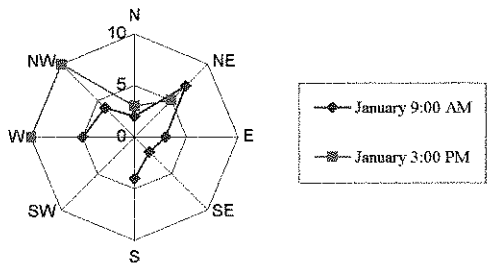
The major outcome of this project has been to quantify and describe the climate of the Southern Flinders Ranges. From this analysis there appears to be two distinct sub regions, namely the western plains and the central ranges. From the data collected it would seem that in the summer of 2001 and the 2001/02 growing season the climate of the central ranges is similar to that of the Clare and Barossa Valleys and displays a continental climate. The Western plains have a very different climate to that of the other viticultural regions in this comparison. The western plains have a unique climate when compared to other Australian wine regions and displays a more maritime climate. Armed with this knowledge it has been possible to predict potential ripening dates for a number of varieties, which are capable of producing high quality table wines from the different sub regions.

Overall the project has achieved what it set out to do and will be a useful document for grape growers and winemakers interested in wine production in the Southern Flinders ranges. As this is only a preliminary analysis there a many other climatic indices, which could be analysed to further quantify the regions climate. Unfortunately with limited time and funding this detailed analysis was beyond the reach of this project.

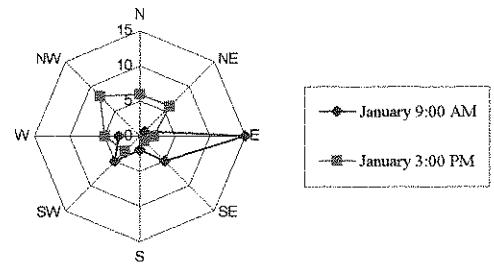
One of the desired outcomes of this project has been to make informed recommendations on varietal suitability. This project has been able to help explain the regions unique climate and armed with this knowledge vignerons and winemakers can now assess the viability of the region for the production of certain grape varieties. As the regions plantings are dominated by red varieties it is hoped that these varieties will be trialled and eventually produce high quality wines. This in turn will lead to sustainable growth of the wine industry in the region.

As the project has just been finalised it will be presented to the Southern Flinders Wine Industry Council at their next meeting. From this point it will be distributed to major wine companies as well as being made available to the wider community.

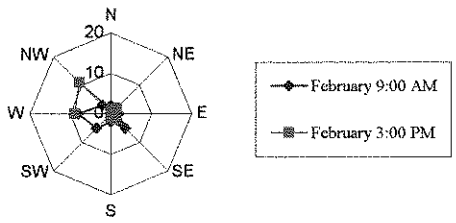
Graph 1 - 9am & 3pm Wind Direction
Baroota January 2001



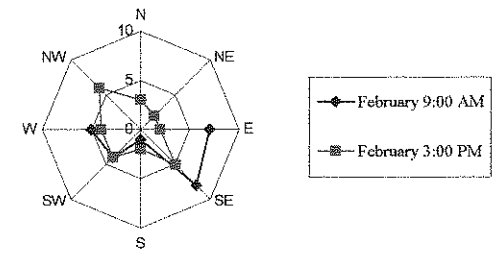
Graph 2 - 9am & 3pm Wind Direction
Murraytown January 2001



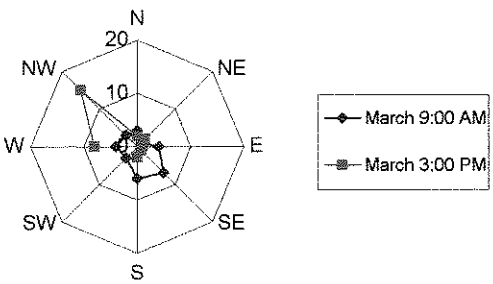
Graph 3 - 9am & 3pm Wind Direction
Baroota Febraury 2001



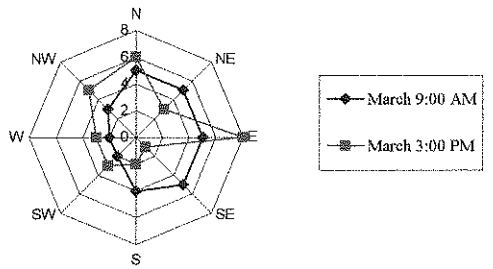
Graph 4 - 9am & 3pm Wind Direction
Murraytown February 2001



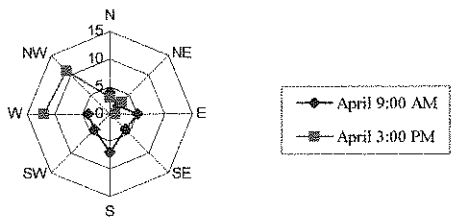
Graph 5 - 9am & 3pm Wind Direction
Baroota March 2001



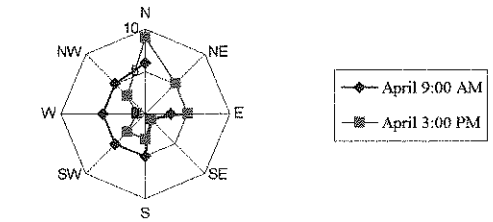
Graph 6 - 9am & 3pm Wind Direction
Murraytown March 2001



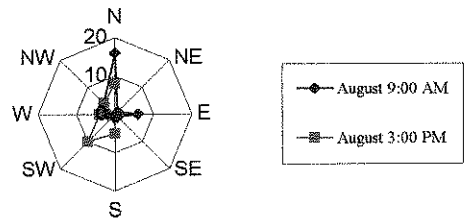
Graph 7 - 9am & 3pm Wind Direction
Baroota April 2001



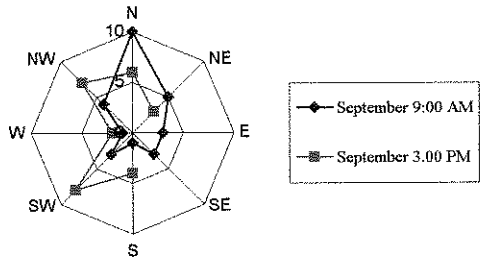
Graph 8 - 9am & 3pm Wind Direction
Murraytown April 2001



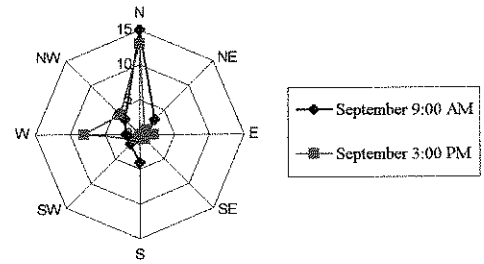
Graph 9 - 9am & 3pm Wind Direction
Baroota August 2001



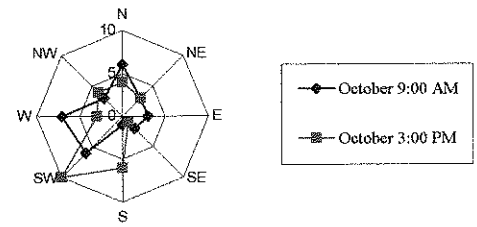
Graph 10 - 9am & 3pm Wind Direction
Baroota September 2001



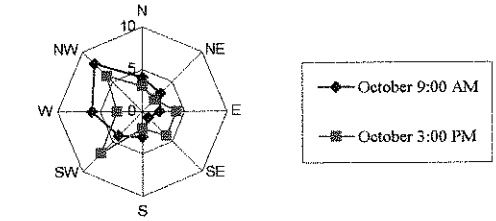
Graph 11 - 9am & 3pm Wind Direction
Murraytown September 2001



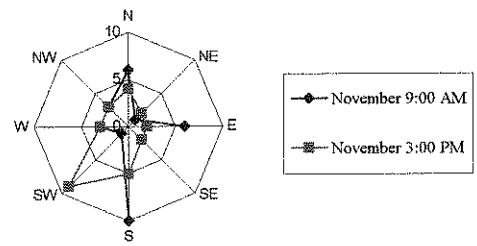
Graph 12 - 9am & 3pm Wind Direction
Baroota October 2001



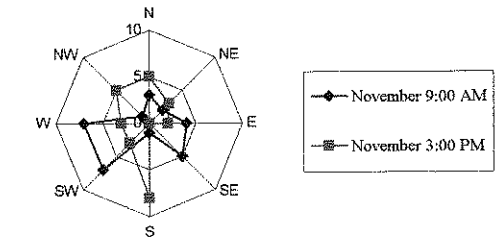
Graph 13 - 9am & 3pm Wind Direction
Murraytown October 2001



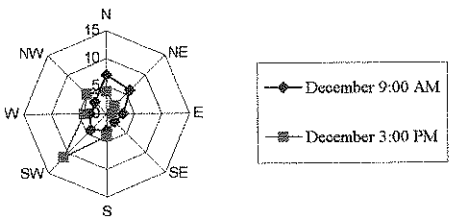
Graph 14 - 9am & 3pm Wind Direction
Baroota November 2001



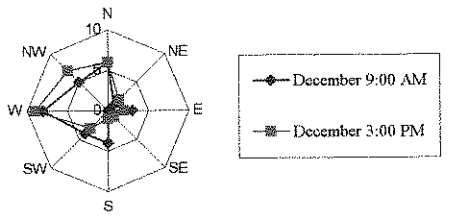
Graph 15 - 9am & 3pm Wind Directon
Murraytown November 2001



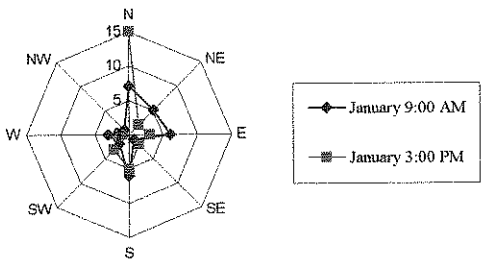
Graph 16 - 9am & 3pm Wind Direction
Baroota December 2001



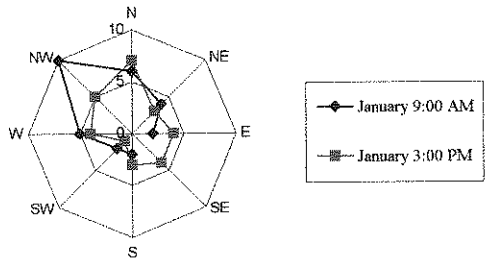
Graph 17 - 9am & 3pm Wind Direction
Murraytown December 2001



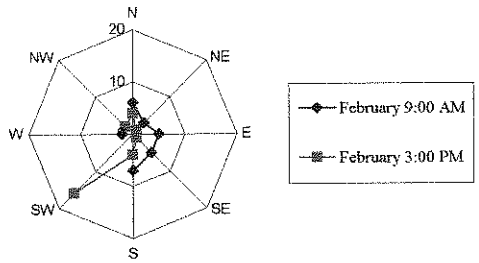
Graph 18 - 9am & 3pm Wind Direction
Baroota January 2002



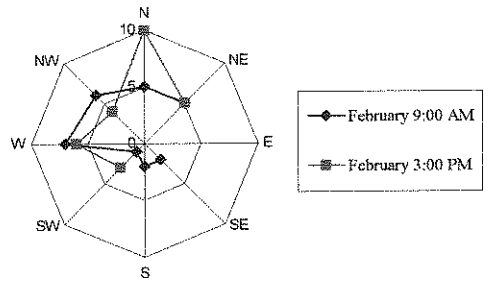
Graph 19 - 9am & 3pm Wind Direction
Murraytown January 2002



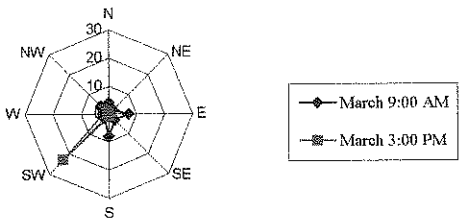
Graph 20 - 9am & 3pm Wind Direction
Baroota February 2002



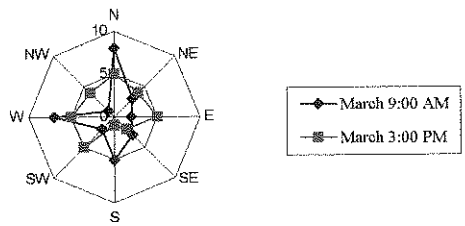
Graph 21 - 9am & 3pm Wind Direction
Murraytown February 2002



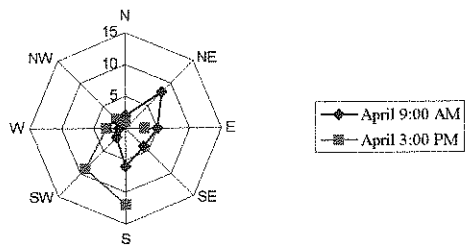
Graph 22 - 9am & 3pm Wind Direction
Baroota March 2002



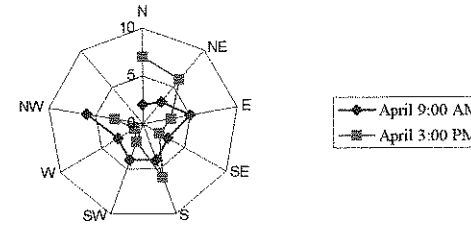
Graph 23 - 9am & 3pm Wind Direction
Murraytown March 2002



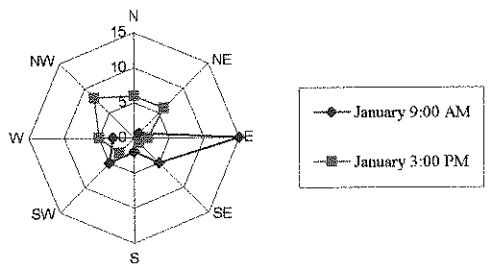
Graph 24 - 9am & 3pm Wind Direction
Baroota April 2002



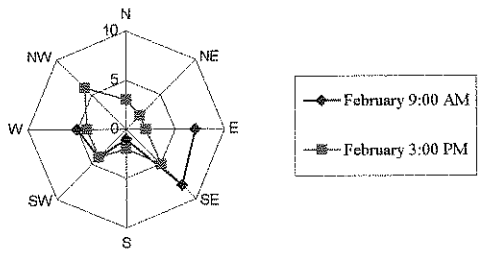
Graph 25 - 9am & 3pm Wind Direction
Murraytown April 2002



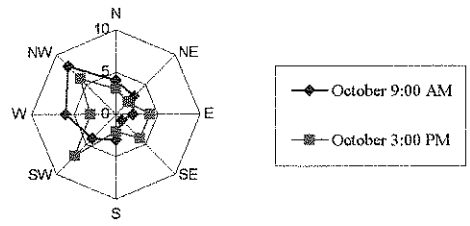
Graph 2 - 9am & 3pm Wind Direction
Murraytown January 2001



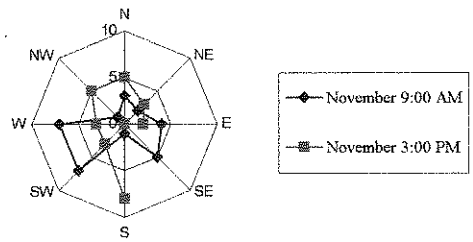
Graph 4 - 9am & 3pm Wind Direction
Murraytown February 2001



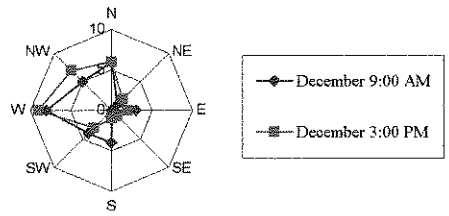
Graph 13 - 9am & 3pm Wind Direction
Murraytown October 2001



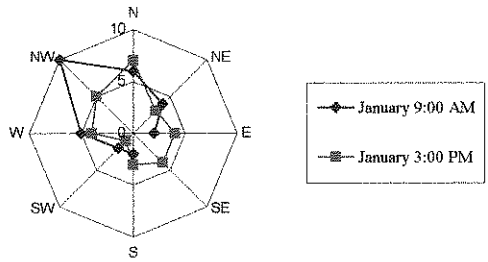
Graph 15 - 9am & 3pm Wind Directon
Murraytown November 2001



Graph 17 - 9am & 3pm Wind Direction
Murraytown December 2001



Graph 19 - 9am & 3pm Wind Direction
Murraytown January 2002



APPENDIX A - Wind Direction