

VININTELL

May 2012, Issue 12



Future scenarios for the South African Wine Industry

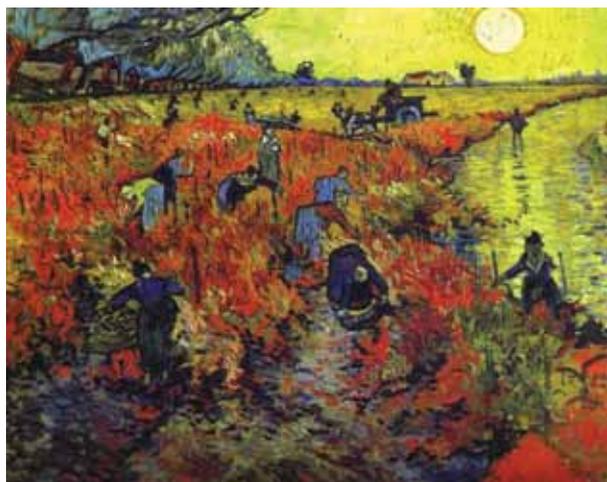
Part 1: Impact of climate change





Welcome to this edition of the quarterly newsletter as a value-added service to members of the S A Wine Industry. The purpose is to provide you, the decision-maker, with meaningful insight into events, trends, opportunities and threats through the analysis of the ever-changing competitive environment. The analytical approach is a multifaceted, multidisciplinary combination of scientific and non-scientific processes.

We trust that this publication will become part of your strategic thinking, strategic planning and decision-making process. You are welcome to send comments and suggestions to the publisher.



Red Vineyards near Arles (1888), Vincent van Gogh.

Introduction	3
Climate change is nothing new.....	3
Impact of climate change on the wine industry.....	6
Climate change and the south africa wine industry.....	9
Changes in distribution of pests and diseases.....	9
Changes in energy and fuel prices.....	10
Changes to regional climatic patterns.....	10
Increase in market pressure.....	12
Potential impact of carbon pricing	13
Conclusion	14

Introduction

The South African and global wine industry, like all industries, is in a perpetual state of change and adaptation. There are many factors in the macro environment that interact with one another to create complex and interesting plots and that lie at the basis on change in industries and on the decisions of the managers of any organisation. Tax changes, new laws, trade barriers, demographic change, climate change and government policy changes are all examples of macro change. To help analyse these factors they can be categorised using the PESTEL model. This classification distinguishes between *political factors* (that refer to government policy such as the degree of intervention in the economy); *economic factors* (such as interest rates, economic growth, inflation and exchange rates), *social factors* (for example changes in social trends can impact on the demand for a particular product and other market factors); *technological factors* (such as online shopping, social media, production methods and innovation that can lead to reduced costs and improved quality); *environmental factors* (the weather and climate change); and *legal factors* (i.e. those related to the legal environment that impacts on industries and players such as consumer laws, competition laws, employment laws and health and safety regulations). Regarding environmental factors, changes in temperature can impact on many industries including the wine industry. With major climate

changes occurring due to global warming and with greater environmental awareness this external factor is becoming a significant issue for players in the wine industry to consider. The growing desire to protect the environment is having an impact on many industries and the general move towards more environmentally friendly products and processes is affecting demand patterns and creating business opportunities. Specifically, in the wine industry, climatic factors include the warming climates in some parts of the world and how this is affecting terroir and appellation, the types of cultivars that are planted and even pruning methods and also the taste of wine.

The following few editions of VinIntell will focus on each of these factors and how they will probably impact on the global and South Africa wine industry. At the end of the series, a consolidated future picture featuring a high road (*Cup Runneth Over*) and a low road scenario (*Scraping the Barrel*) will be published based on the macro factors mentioned earlier. This first edition of the series will focus on climatic change under the broader theme of the environment. Climatic change is a broad theme that encompasses numerous sub themes including global warming, water, greening of business practices and in terms of the wine industry, changing vines, changing viticulture practices, terroir, rainfall and temperatures and greener production and marketing practices. For purposes of the VinIntell readership, climate change will be broadly discussed.

Climate change is nothing new

What is climate change? The climate has always been changing and several centuries ago the causes of this change would have

been primarily natural in origin. There can be no longer a question about the reality of climate change. The Intergovernmental Panel on Climate Change (IPCC)ⁱ, a leading international body for the assessment of climate



change, reported in 2007 that the climate has warmed in recent decades and that human actions are a primary driver of most of the warming. During the 20th century, the global mean temperature increased by 0.74°C. Only limited areas have experienced cooling, mostly over oceans. Exacerbating the situation the rate of warming has been rapid in the last few decades. All climate models substantially agree about the warming trend currently underway, and project continued and accelerated warming in the future. The IPCC panel also found that due to inertia in the climate system, warming will continue even if all greenhouse pollution is stopped immediately.

Nowadays, although natural changes in the climate continue to occur, the term climate change is generally used when referring to changes in the earth's climate which have been identified since the early part of the 1900s. Many of the causes of these changes are related to humanity's emissions of greenhouse gases (GHG)^{iv}. Rising levels of GHGs, such as carbon dioxide (CO₂), are already changing the climate and are expected to continue to do so. However, there are many uncertainties about the scale and impacts of climate change particularly at the regional level. What is certain, however, is that climate change is likely to have a significant impact on the global environment through increases in temperature, increases in sea level, changes in levels and patterns of precipitation, changes in the severity and frequency of extreme events and so on. Climate zones could shift towards the poles and vertically disrupting ecosystems and threatening the survival of some species. Human society will face new risks and pressures due to climate related threats to food security and availability of water resources and will therefore need

to adapt in a variety of ways to future climatic regimes.

Examining the situation closer to home, climate change is predicted to directly impact South Africa's mean annual temperature and rainfall ranges, influencing pest and disease distribution, flowering and fruiting seasons, and ground water resources. Increased severity of drought is predicted to be one of the major impacts of climate change to the agricultural sector in South Africa, particularly within the Western Cape, the major fruit and wine region. The South African Fruit and Wine Initiative argues in its strategic framework initiative^v that climate change also impacts indirectly, through the growing awareness amongst consumers and the corresponding demand for carbon-efficient business processes. These different impacts will be discussed in a little more detail later in this report.

The agricultural sector is a large source of GHGs through its various activities including water use, pesticide use and fuel use. The Initiative also provides a number of remedial actions that can be taken and implemented to manage down the effect of agri practices on climate change.^v Warming temperatures associated with climate change are already affecting vineyards from France to Chile, often in beneficial ways. As the world continues to warm, some traditional winemaking regions are scrambling to adapt, while other areas see themselves as new wine frontiers (see boxes for experiences in the UK, France, Chile and Spain). Temperatures will continue to become warmer on average between now and 2100, and that will have a direct impact on the growing of grapes and the resulting types of wines that the various established wine regions can produce. It could also change the typical characteristics that are associated with various wine-growing regions.^{vi}

BOX 1: Case in point: Wine production in the UK^{vii}

Not long ago, the UK was not considered to be a serious wine producing country. "Wine making was for the very eccentric. It was drunk as a curiosity and often spat out," says Richard Selley, Emeritus Professor of Geology at Imperial College, London and author of the book *The Winelands of Britain*. The main reason was the hostile climate from a wine production perspective. However, since 1961 there have been consistent increases in temperatures which meant that wines production increased thanks to longer ripening periods and warmer temperatures. By 2011, there were approximately 400 commercial vineyards. English sparkling wines are beating their French rivals in international competitions. One wine estate, in anticipation of warmer temperatures in future, planted Sauvignon Blanc vines, a grape originating from the warmer Bordeaux region of France.



Source: Appellation America, 2007

BOX 2: Case in point: Wine production in France^{viii}

French wine maker Philippe Bardet who produces Merlot, Cabernet Sauvignon and Cabernet Franc grapes in the Bordeaux region, says that over the past 25 years his harvests have moved from late October to the beginning of September as grapes ripen ever faster. In reaction to this trend, he started planting slower-ripening grape varieties to push it back. A study *Climate change and global wine quality in 2005*^x found that some warmer wine producing regions globally are already reaching a heat threshold beyond which quality began to decline. France, famous for its unique wine varieties, stands to lose an important part of its cultural heritage as rising temperatures impact vineyards. For optimum quality each variety (like Chardonnay or Pinot Noir) is grown in specific regions within narrow climatic variability. But the climate is changing now. The average annual temperature has significantly increased, leading to major shifts in the wine production calendar. The harvesting season is occurring much earlier than normal and higher temperatures are proving detrimental to the vines. Wines end up having higher sugar levels and alcohol content while retaining fewer acids – which means they are unbalanced with an overripe flavour and heavier texture.^x



Source: Greenpeace



BOX 3: Case in point: Wine production in Spain^{xi}

In Spain, changes are now coming rapidly, according to a leading wine maker in Spain, Bodegas Torres. In the last four years, temperatures have increased 1 degree Celsius and although quality has not changed thus far, it holds concerns for the future. In anticipation of continued rising temperatures, the estate is moving vineyards from sea level to central valley and from central valley to mountain areas.



BOX 4: Case in point: Wine production in Chile^{xii}

For Chilean wine producer Concha y Toro the motto is "Adapt or die." Convinced that temperatures in Chile's central grape growing valley will continue rising over time, it participated in a thermographic study of the region that allowed it to identify new growing regions along river basins that act as corridors of air from the Pacific Ocean or the Andes mountains. An initial result is Concha y Toro's released Gran Reserva Serie Riberas line of wines, which promised to have a freshness uncommon to Chilean cuvées. Doing something was more a forced action than a choice. In December 2007, the government export promotion agency ProChile saw a story from the BBC urging UK consumers not to buy Chilean cherries because they come from far away and contain a great deal of CO2. That sounded the alarm that Chilean exporters needed to start paying attention to this issue. Chilean wine producers are now on board, working to measure the carbon footprint of their operations and reduce, or offset, their emissions.



Impact of climate change on the wine industry

Few products are more sensitive to changes in temperature than wine and rising temperatures associated with climate change are already reshaping the industry. Production as a whole is moving south in the southern hemisphere and north in the northern hemisphere as opportunities open up in once-unconsidered areas. Some production is

moving vertically as is illustrated by the Spanish winery's experience (see box 3). Meanwhile, vineyards in warmer climates are facing mounting problems as it gets warmer and many winemakers will be forced to change their signature products, move, or fail regardless of the remedial actions that they might take. Even modest temperature and

weather changes can have effects that reverberate through crop yields, business strategies, and economies and on into culture, traditions, and the characteristics that define national identities e.g. Pinotage in South Africa.

Scientists have been analysing the influence of climate and weather on wine since long before global warming became an issue. Many studies have mapped the emerging impacts of warming temperatures on vineyards in Europe, the Americas, and wine producing regions in the southern hemisphere like South Africa, Chile, Australia and New Zealand. Studies have modelled the possible effects over the next 100 years and the future that emerges is one of unprecedented accelerating change. Some studies suggest higher temperatures could end up shrinking Northern California's prime vineyards by half (Difffenbach study, 2011). Historical data indicates that on balance, changes underway at present are as profound as anything in historical and ancient records.^{xiii}

Interestingly and contradictory, rising temperatures have been mostly good for wine. A 2005 study^{xiv} found that the average growing-season temperature in 27 prime wine-producing regions around the world had risen close to 1 degree Celsius in the previous 50 years. In the vineyards of Spain, Portugal, southern France, and parts of California and Washington State, it rose even more. With the rising temperatures the wine quality ratings also rose^{xv} because warmer temperatures in general tend to produce more consistent grape harvests. The heat also hastens ripening, producing grapes with bolder flavours, more sugar, and wine with more alcohol. This trend has coincided with rising popularity of robust, fruitier wines.

Climate change and its effects will undoubtedly also affect culture and tradition. In many European countries including Spain, Portugal, France, and Italy, wine production is governed by appellation systems that link specific wines to their geographical locations. This is based on the concept of *terroir* (ascribing a wine's uniqueness to the soil, landscape, climate)^{xvi}, and viticulture practices of the location where it is produced. A genuine French Sauvignon Blanc must come from Bordeaux, for instance. However, as temperatures climb, it will get increasingly difficult to grow the right grapes. A recent study projected that by 2049, Bordeaux, France will have reached the upper temperature limits for growing red varieties and will be outside the ideal climate for its white grapes so there will be no more Sauvignon Blanc.^{xvii} The appellation system and the maps of the European appellations will also undergo dramatic change. The question is asked if temperatures continue to rise, where will one place a Burgundy, for example. Chilean, South African and Australian wine producers can still move their territories but in France, wineries are demarcated by appellation of origin. Burgundy wines therefore have to come from Burgundy. French experts believe the taste of wine has already begun to change. The annual harvest – the *vendange* – has been earlier and earlier in France over the past three decades. The very definition of wine will change, and the world wine map will be radically re-drawn. Higher temperatures will mean higher alcohol levels, over-sunned aromatic ranges and denser textures. Each one degree increase in temperature in France is equivalent to moving 200 kilometres north^{xviii}.

So, for the global wine industry as a whole, the challenge is therefore not merely warmer temperatures, but the coming, continuous



tsunami of change. Scientists have projected that the geographical bands suitable for winemaking would shift on average between 275 and 550 km toward either pole in the next hundred years, a geographically small yet momentous shift. Some regions will become inhospitable to winemaking, others will have to keep swapping varieties and new frontiers will continually open up. New varieties and new flavours will come to market.^{xxv} The question arises how the market will react to new varieties. Such projections have become a sensitive issue; the Napa Valley Vintners, the wine industry trade association, commissioned a scientific temperature survey to demonstrate that the effects of climate change were being exaggerated. The results, overall, provide good short-term news that consumers are not tasting climate change in Napa Valley wines^{xxvi}. However, the study did show that temperatures had risen an average of 1 degree Celsius, mostly at night from January to August, a change that could affect the taste of wines. Scientists have however suggested that it is possible to make viticulture far more adaptable, preserving some vineyards and traditional grapes, even as the temperature rises by means of altered pruning practices to increase shading, while the orientation of the vines on a given piece of land can help reduce excess heat. Irrigation and trellising practices can be used to cool the plants.^{xxvii}

Still, one of the principal problems wine makers everywhere will face is business decisions based on basic biology: Vines typically take several years to mature and then produce grapes for decades. Replacing them is both a disruption and a major investment. Once a vine is planted it is in the ground for a number of decades. This is a serious decision to make for wine producers, also in South Africa.

Overall, scientists argue that there is reason for optimism because the world is expansive, with many potentially suitable sites for vineyards although this will require substantial investment. In another trust-inducing and positive development, the international wine sector in 2011 became one of the first trade sectors worldwide to develop a system for calculating the industry's carbon dioxide and greenhouse gas (GHG) emissions.^{xxviii} The deal was agreed by the International Organisation of Vine and Wine (OIV) and ensures all businesses around the world producing, supplying, transporting and retailing wine will be able to rate their environmental performance according to a standard methodology. The result is the Green House Gas Accounting Protocol. It has two main elements:



- Enterprise Protocol, a tool enabling consistent assessment of greenhouse gas emissions associated with vine and wine companies' activities; and
- Product Protocol, general guidance on emissions associated with vine and wine products enabling companies to collate information against an agreed benchmark about carbon footprint.

The increasing focus of policy makers on the impact of GHG means it will become vital that vintners are able to accurately calculate the contribution the wine sector makes. The initiative has not come too soon as from 2012; the European Union will require all products to carry eco-labels. France had a trial with carbon footprint labelling while Japan is also experimenting with a carbon footprint label for dozens of beverage and food companies.^{xxix}



Climate change and the south africa wine industry

South Africa falls within a vulnerable region as far as climatic change is concerned due to its geographical location and its low level of coping capacity. Furthermore, South Africa is one of the highest emitters of GHGs in the world, ranked 19th in 2005 if emissions from land-use change and forestry are excluded. Of all the sectors, the agricultural sector has been identified as being particularly vulnerable to climate change impacts. The South African Fruit and Wine Initiative recently took the initiative called the *Confronting Climate Change Initiative* to develop an industry-wide response to climate change through a better understanding of the relevant physical and market-related climate change impacts. Based on scientific findings^{xxx} the South African Fruit and Wine Initiative says the most prominent biophysical impacts of climate change on the South African agricultural sector include a decrease in water availability, a shift in seasonal temperatures and climatic patterns, and an increase in the prevalence of pests and diseases. The indirect impacts include an increase in energy and fuel costs, an increase in market pressure and retail demands, and the likelihood of carbon pricing in the near future. In Box 5, the South African Fruit and Wine Initiative provides a summary of the potential impact of a number of climate factors on the South African wine industry. Specifically, according to the South African Fruit and Wine Initiative the impact is five-pronged namely change to regional climatic patterns, changes in the distribution of pests and diseases, in energy and fuel prices, increases in market pressures and the impact of carbon pricing.^{xxxi} Each of these factors will subsequently be briefly discussed.



Changes in distribution of pests and diseases

Climate change will affect plant pests and diseases in the same way it affects infectious disease agents.^{xxxii} The range of many insects will expand or change, and new combinations of pests and diseases may emerge as natural ecosystems respond to altered temperature and precipitation profiles. Any increase in the frequency or severity of extreme weather events, including droughts, heat waves, windstorms, or floods, could also disrupt the predator-prey relationships that normally keep pest populations in check. Predictions show that certain pests and diseases associated with specific crops may increase in their distributional range, and may become more active, with an increase in temperature. In addition, the short life cycles of insects, their mobility, high reproductive potential and sensitivity to temperature means that even small changes in climate can result in a rapid and prolific response.^{xxxiii} On the other hand, some pests will become more serious while other will become less of a threat. The regions thought to be most vulnerable to productivity declines are semi-arid and arid areas where rain-fed, non-irrigated agriculture predominates. Unfortunately, many of these areas are in sub-Saharan Africa.^{xxxiv}



Changes in energy and fuel prices

The agricultural industry is an intensive user of fuel and other fossil-fuel based products such as fertilisers, chemicals and plastic based packaging products. Together these inputs can make up 30%-50% of the total farm costs in cropping operations^{xxxi}. Escalating costs of these products and the related activities, specifically fertiliser and transport, will have a direct impact on the already low profit margins of producers. South African producers are feeling the effects of rising energy prices on their profit margins most notably electricity and fuel. Carbon pricing in South Africa is also likely to lead to an increase in the cost of both fuel and electricity. Also, the increasing focus of policy makers on the impact of GHG means it will become vital for players to indicate their contribution to the lowering of the emission of GHGs.



Changes to regional climatic patterns

There will be a decrease in water availability, specifically in the southern and western parts of the country^{xxvii} and an increase in the frequency and intensity of extreme events such as flooding. Overall, there will be general warming which makes fruit species, including grapes, even more vulnerable.



BOX 5: Potential impact on the South African Wine industry

Summer temperature increase during the growing season

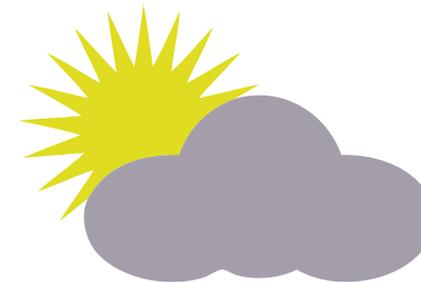
- Warmer September = better and more even budding
- Warmer spring/early summer = better fertility
- Warmer flowering period = depending on regions and cultivars, set can be better or worse
- Warmer harvesting period = sunburn grapes, quick sugar accumulation, lower acid – vines under stress during the harvest period, more irrigation required, weak colour expression with some red cultivars, lack of character expression with certain cultivars (red & white)

Winter temperature increase during dormant season

- Sooner uplift of dormancy
- Higher temperature during May/June causes delayed budding

Rainfall

- Dry spring = Control growth of vigorous growing cultivars better, control berry size
- Dry summer = Less disease problems (Botrytis, more irrigation requirements, low production for dry land)
- Dry winter = Not enough irrigation water, less rainfall in mountain ranges to fill dams, competition with other crops for limited irrigation



Possible positive climatic aspects

- Dry conditions before and during harvest
- Limited rainfall during flowering
- Enough sunshine hours
- Winters in continental regions are colder than near the coast

Cultivar adaptation to climate change

- Both rootstock and scion cultivar selection should be site specific to best respond to climate change (increased temperature, less availability of water, changes in pest and disease patterns, etc.)

Winery adaptation to climate change

- Improved insulation and heating/cooling exchanges will reduce the energy requirements
- Installation of solar panels which, depending on the scale, can supplement or completely replace the reliance on expensive and carbon-intensive grid-electricity for both heating and cooling requirements, resulting in cost and carbon savings and allowing a relatively fast pay-back rate of 5 to 10 years.

Source: The South Africa Fruit and Wine Initiative, 2012



working with
the Carbon Trust



Source: www.carbontrust.com

Increase in market pressure

Globally, also in South Africa, awareness of green environment is increasing and players in the economy are being held accountable for the effects of their operations on climate change. Sustainability reports are being scrutinised and share prices are influenced by players' greening practices. Such pressure is being supported by emerging Government policies and the need for developed nations to meet Kyoto Protocol emission allowances. The effects are wide ranging. The growing concern regarding climate change within the retail sector has resulted in development of labelling schemes. The UK's Carbon Trust in 2006 introduced the Carbon Reduction Label with the proviso that products need to reduce emissions by 20% over two years. Importantly from a South Africa wine exporter point of view, the UK Government has established an enquiry into the environmental labelling under Environmental Audit Committee that is to focus on issues around labelling including feasibility of an international labelling scheme. This is an important initiative that shows that carbon footprinting is not just desired in the private sector, but that government involvement may well lead to regulation as has been seen with other labelling schemes. Carbon footprinting and requirements to reduce embodied-emission in exports seems likely to become standard for export markets and likely to be introduced in the next few years.

Packaging is another area that is adapting to the impact of climate change. Alternative options are becoming more available including lighter glass bottles and plastic polyethylene terephthalate (PET) bottles. In turn, issues such as recycling and transport costs come into play due to their impact on GHGs.



Potential impact of carbon pricing

For South Africa in particular, the greatest development challenge is finding the best development pathway that ensures energy security and access to electricity, at the same time as laying a foundation to a low carbon economy. In response, the South African government has committed to undertake mitigation actions that would result in a substantial decrease in emissions relative to a 'business as usual scenario' by 2020, followed by a steeper decrease by 2025.^{xxiii} The use of economic instruments like carbon taxes is highlighted as a key element in such an overall approach to reducing its GHG emissions in the National Climate Change Response White Paper.^{xxiii} The white paper outlines the policies, principles and strategies the country will use to respond to climate change. As a responsible global citizen with moral as well as legal obligations under the UNFCCC and its Kyoto Protocol, South Africa is committed to contributing its fair share to global GHG mitigation efforts. Producers can adapt to carbon taxes by making their operations more carbon efficient (and thus reduce the amount of carbon tax to be paid) and identify efficiencies elsewhere that can lead to cost savings that can offset the impact of carbon taxes. The South African government is still in the process of

considering various carbon tax design features, but there is a broad consensus that South Africa will need to implement such broad-based carbon tax if it is to remain on the emissions path adopted by the government as an outcome of the Long Term Mitigation Scenario (LTMS) process, and formalised in the targets submitted at the COP 15 (2009) COP 16 (2010) and COP 17 (2011) Agreements. On the positive side, South Africa, a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), is classified as a developing country in terms of the UNFCCC and is therefore not obliged to adhere to the more demanding commitments placed on developed countries. However, related South African policies such as the policy on Integrated Pollution and Waste Management, place an emphasis on cleaner technology and production, and a shift to sustainable development. This accordingly supports a proactive approach in formulating a climate change policy. In addition, a proactive approach including early mitigation action, adaptation plans and improvement of knowledge may have some advantages, including helping to reduce the global problem proactively, giving South Africa more time to prepare for meeting greenhouse gas reduction targets when they are imposed on developing countries.



Conclusion

Climate change is not something that will happen in the distant future. It is something that is occurring now and can already be felt. The emissions pathway that will be followed in the immediate future will set the trajectory for big differences at the end of the 21st century. This is because effects of GHGs are cumulative and will continue to exert their full climate-warming impact for up to a century. The climate for the next several decades is therefore likely to experience similar amounts of warming, because differences in emissions have not had a chance to take full effect yet.^{xxxiv} After 2020, warming will be more than has been experienced with historical variability. This means that the world would be experiencing essentially new climates and differently behaving climates in familiar places. Given that the average lifetime of a vine is at least 20 years, this means that vines in the ground now and those planted in the future will be experiencing new climate regimes that could affect their growth and quality.

Against the background that the world is dealing with a climatic situation that is unlikely to turn around, it is a positive sign and the wine industry is starting to recognise the issue of climate change on national and international levels, which is essential to be proactive in developing response strategies. Sound strategy will involve both adaptation to the inevitable warming (for example, investments in new technology) and mitigation to reduce greenhouse pollution to leave open the widest array of options in the future. Reductions in GHGs can come from many sources including national policies for example incentives. The wine industry has the opportunity to contribute to mitigation efforts through attention to its own CO₂ footprint and on the business side, many opportunities exist to mitigate the effects of climate change and even turn the challenges into business opportunities.



ENDNOTES

ⁱ Gillespie, A. 2007. Foundations of Economics. Oxford University Press. Available online: http://www.oup.com/uk/orc/bin/9780199296378/01student/additional/page_12.htm

ⁱⁱ The IPCC was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. The UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC. The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters. A panel convened by the world's governments assess knowledge about climate change about once every six years. The cumulative contributions of this international team of expert scientists earned them a share of the Nobel Peace Prize in 2007.

ⁱⁱⁱ www.environment.gov.za/climatechange2005/What_is_climate_change.htm

^{iv} Strategic Framework Reference document Version 1.2 January 2012 www.winetech.co.za/docs2012/Strategic-Framework-Reference-Documents-Documents-Version1-2-Jan-2012.pdf

^v www.climatefruitandwine.co.za/download/Information.Document.One-pager.English.March.09.pdf

^{vi} Berger, D. 2007. As the Climate Changes So Does Our Wine. Available online: <http://wine.appellationamerica.com/wine-review/522/Global-Climate-Change.html>

^{vii} McQuaid, J. 2011. What Rising Temperatures May Mean for World's Wine Industry. 19 December. http://e360.yale.edu/feature/what_global_warming_may_mean_for_worlds_wine_industry/2478/

^{viii} McQuaid, J. 2011. What Rising Temperatures May Mean for World's Wine Industry. 19 December. http://e360.yale.edu/feature/what_global_warming_may_mean_for_worlds_wine_industry/2478/

^{ix} Jones, G.V., White, M. A., Cooper, O. R., and Storchmann, K. 2005. Climate change and global wine quality, 2005. www.recursosdeenologia.com/docs/2005/2005_climate_change_and_global_wine_quality.pdf

^x Greenpeace, 2009. www.greenpeace.org/usa/en/news-and-blogs/news/french-wine-threatened/

^{xi} McQuaid, J. 2011. What Rising Temperatures May Mean for World's Wine Industry. 19 December. http://e360.yale.edu/feature/what_global_warming_may_mean_for_worlds_wine_industry/2478/

^{xii} <http://carbon-based-ghg.blogspot.com/2011/04/fight-to-save-wine-from-extreme-weather.html>

^{xiii} Gregory V. Jones, a climatologist at the University of Southern Oregon who specializes in climate's effects on wine.

^{xiv} Jones, G.V., White, M. A., Cooper, O. R., and Storchmann, K. 2005. Climate change and global wine quality, 2005. www.recursosdeenologia.com/docs/2005/2005_climate_change_and_global_wine_quality.pdf

^{xv} Jones, G.V., White, M. A., Cooper, O. R., and Storchmann, K. 2005. Climate change and global wine quality, 2005. www.recursosdeenologia.com/docs/2005/2005_climate_change_and_global_wine_quality.pdf

^{xvi} 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. French Wine Guide. 2012. www.terroir-france.com/theclub/meaning.htm

^{xvii} Jones, G.V., White, M. A., Cooper, O. R., and Storchmann, K.

2005. Climate change and global wine quality, 2005. www.recursosdeenologia.com/docs/2005/2005_climate_change_and_global_wine_quality.pdf

^{xviii} The Evening Herald, 2009. Global warming will ruin Languedoc wine, 4 October.

^{xix} Tyler Colman, writer of the Dr. Vino wine blog www.drvinoblog.com/
^{xx} Environmental Research Letters Volume 6 Number 2 Noah S Difenbaugh et al 2011 Environ. Res. Lett. 6 024024 doi:10.1088/1748-9326/6/2/024024 Climate adaptation wedges: a case study of premium wine in the western United States

^{xxi} http://www.napavintners.com/trade/tm_3_release_detail.asp?ID_News=3221202

^{xxii} Environmental Research Letters Volume 6 Number 2 Noah S Difenbaugh et al 2011 Environ. Res. Lett. 6 024024 doi:10.1088/1748-9326/6/2/024024 Climate adaptation wedges: a case study of premium wine in the western United States

^{xxiii} <http://www.thedrinksbusiness.com/2011/11/wine-sector-strikes-co2-emissions-deal/>

^{xxiv} Minnesota Post, 2010. Chilean wine for the environmentally conscious. 17 December

^{xxv} Global temperatures are rising, extreme events are increasing in frequency and intensity, and industrial development is to blame. 11 of the past 12 years have been the hottest in recorded history (since 1850) – and this warming is directly attributed to increases in atmospheric Greenhouse Gas (GHG) levels due to human activities. The science indicates that if global warming is to be limited to within 2oC above pre-industrial values, global emissions need to peak between 2015 and 2020 and then decline rapidly. Recent reports show that due to the continued increase in atmospheric GHGs, a 4°C temperature shift is highly likely, having grave consequences for human living conditions and food security in particular.

^{xxvi} Strategic Framework Reference document Version 1.2 January 2012 www.winetech.co.za/docs2012/Strategic-Framework-Reference-Documents-Documents-Version1-2-Jan-2012.pdf

^{xxvii} Consulting Engineers South Africa (CESA), February 2010: CESA predicted that South Africa's demand for water will exceed available supply by 2025 if no alternative action is taken. The National Climate Change White paper of 2011 mentions that current projections indicate that by 2050 South Africa will exceed the limits of economically viable land-based water resources.

^{xxviii} Sustainable Wine South Africa (SWSA): www.swsa.co.za/climate_change.htm

^{xxix} Strategic Framework Reference document Version 1.2 January 2012 www.winetech.co.za/docs2012/Strategic-Framework-Reference-Documents-Documents-Version1-2-Jan-2012.pdf

^{xxx} World Resources Institute: www.wri.org/publication/content/8486

^{xxxi} Strategic Framework Reference document Version 1.2 January 2012 www.winetech.co.za/docs2012/Strategic-Framework-Reference-Documents-Documents-Version1-2-Jan-2012.pdf

^{xxxii} Strategic Framework Reference document Version 1.2 January 2012 www.winetech.co.za/docs2012/Strategic-Framework-Reference-Documents-Documents-Version1-2-Jan-2012.pdf

^{xxxiii} Strategic Framework Reference document Version 1.2 January 2012 www.winetech.co.za/docs2012/Strategic-Framework-Reference-Documents-Documents-Version1-2-Jan-2012.pdf

^{xxxiv} Lobell, D.B., C.B. Field, K.N. Cahill, C. Bonfilis, 2006. Impacts of future climate change on California perennial crop yields: Model projections with climate and crop uncertainties. Agricultural and Forest Meteorology 141: 208-18.

*Enquiries & contributions to
Dr Marie-Luce Kuhn, IBIS Business and Information
Services (Pty) Ltd, PO Box 7048, Stellenbosch 7599
tel +27 21 8832855
e-mail mlm@ibis.co.za website www.ibis.co.za*

A SAWIS Publication.
©SAWIS, 2010

ibisTM

strategic environmental analysis

