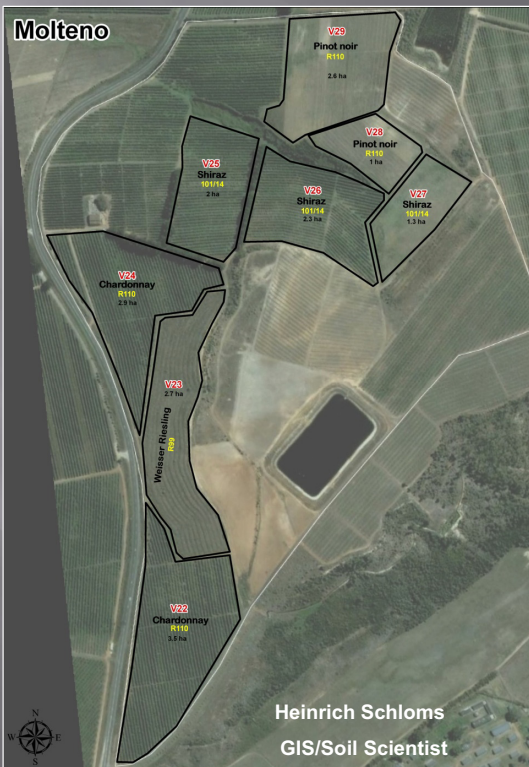
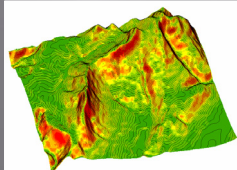
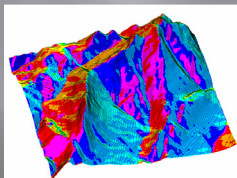
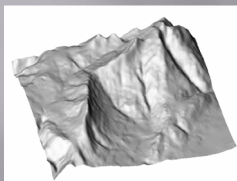
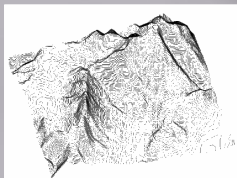


CHOOSING THE RIGHT TERROIRS TO MINIMIZE THE RISKS OF CLIMATE CHANGE



CLOSE

What risks?

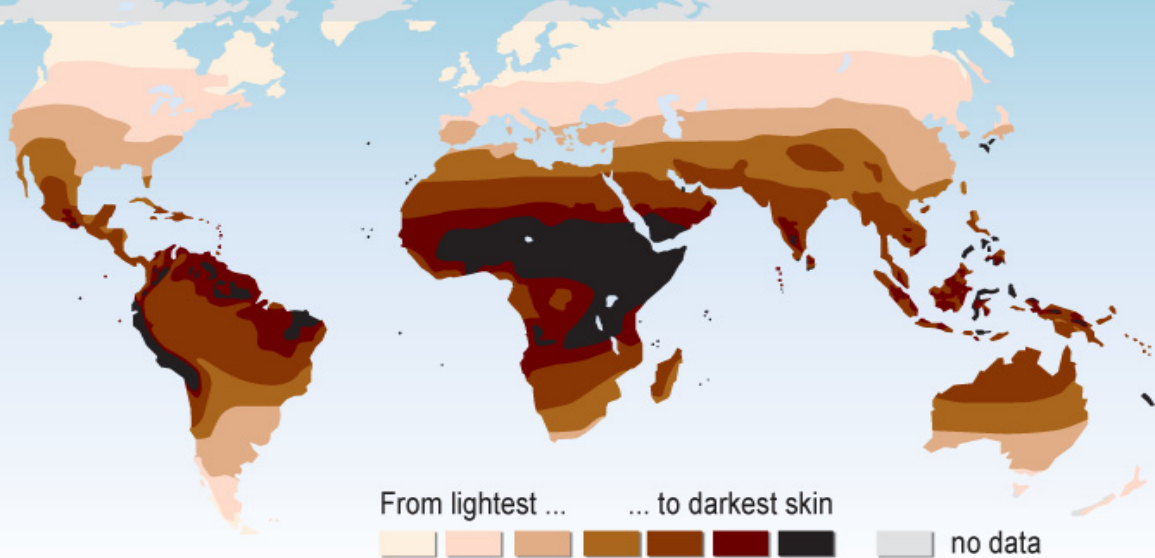
- ▣ Increased average temperatures
- ▣ Increased growing degree days
- ▣ Heat waves
- ▣ Strong winds
- ▣ Floods
- ▣ Droughts
- ▣ Cold units

What is Terroir?

- ▣ It's easy to illustrate this by comparing wines made identically in the same winery, with the same grape variety, but from different vineyards. They taste different- sometimes subtly; sometimes markedly. There you are: terroir's existence is proved.



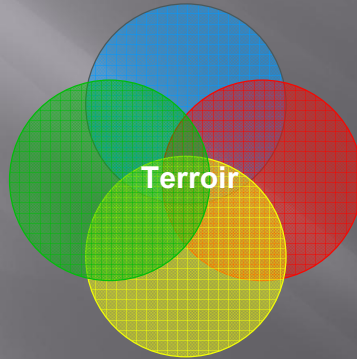
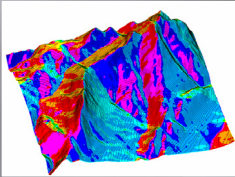
Global location and human skin color





Climate

Terrain and aspect



Soil properties



History



Main concept

- ▣ Climate change will force existing wine regions to move their vineyards to cooler sites, or to try out different grape varieties, as they seek to minimise the impact of warmer temperatures.

OBJECTIVE OF THE WINE GRAPE TERROIR PROGRAM

- ▣ The overarching aim of the wine grape terroir program is to integrate all data pertaining to the interaction of different cultivars with their growing environment in a data base and **GIS platform** in order to be able to formulate a model to serve as a decision aid for site selection.

What factors affect climate?

Latitude

Temperature range increases with distance from the equator. Also, temperatures decrease as you move away from the equator. This is because the sun's rays are dispersed over a larger area of land as you move away from the equator. This is due to the curved surface of the earth. In addition, polar regions are colder because the sun's rays have further to travel compared to places on the equator.

Altitude

Temperatures decrease with height. The air is less dense and cannot hold heat as easily. Average summer temperatures will decrease with 0.3°C with every 100m.

Winds

If winds are warm - they have been blown from a hot area - they will raise temperatures. If winds have been blown from cold areas they will lower temperatures.

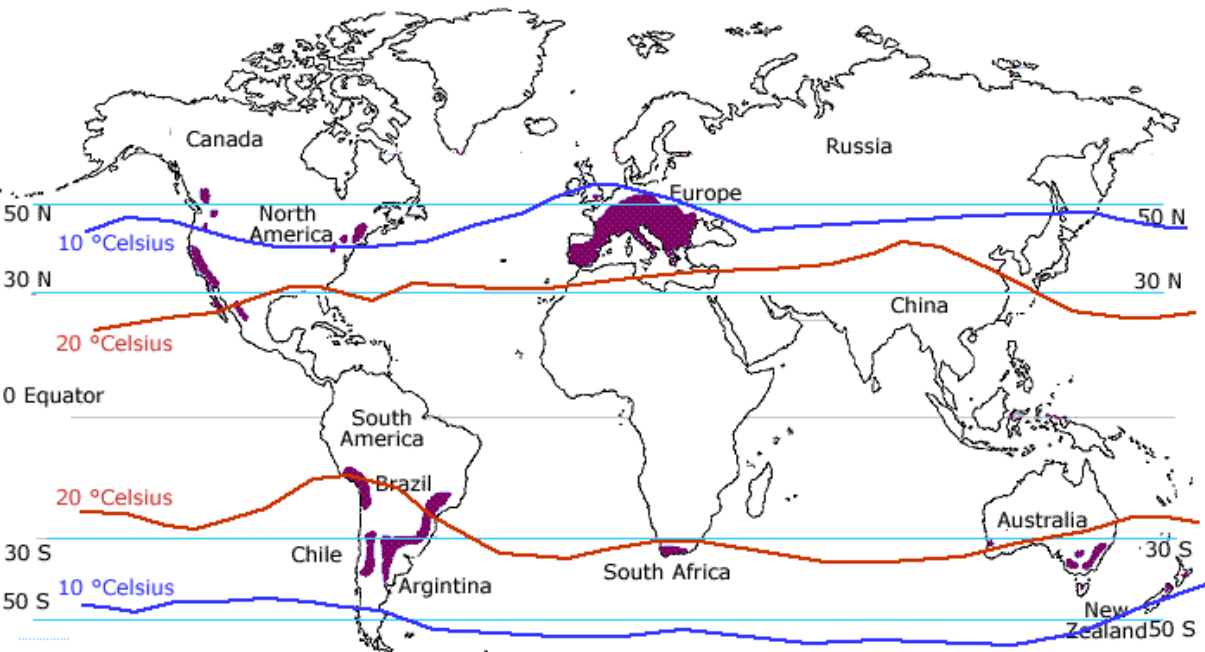
Distance from the sea (continentality)

Land heats and cools faster than the sea. Therefore coastal areas have a lower temperature range than those areas inland. On the coast winters are mild and summers are cool. In inland areas temperatures are high in the summer and cold in the winter.

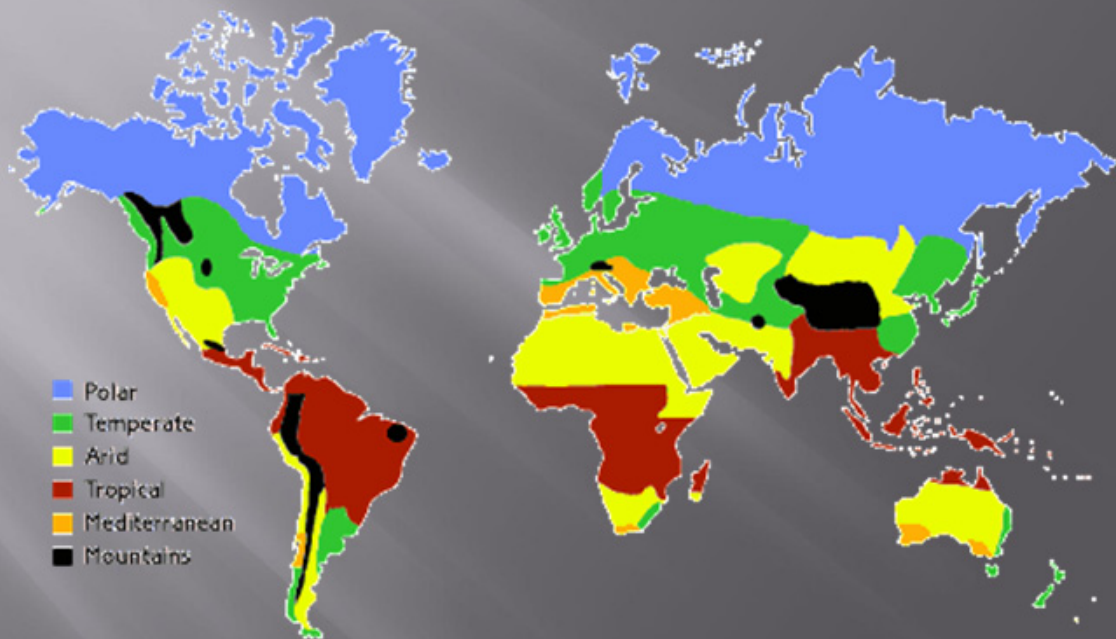
Aspect

Slopes facing the sun are warmer than those that are not. Thus south-facing slopes in the northern hemisphere are usually warm. However, slopes facing north in the southern hemisphere are warmest.

Wine Producing Regions of the World



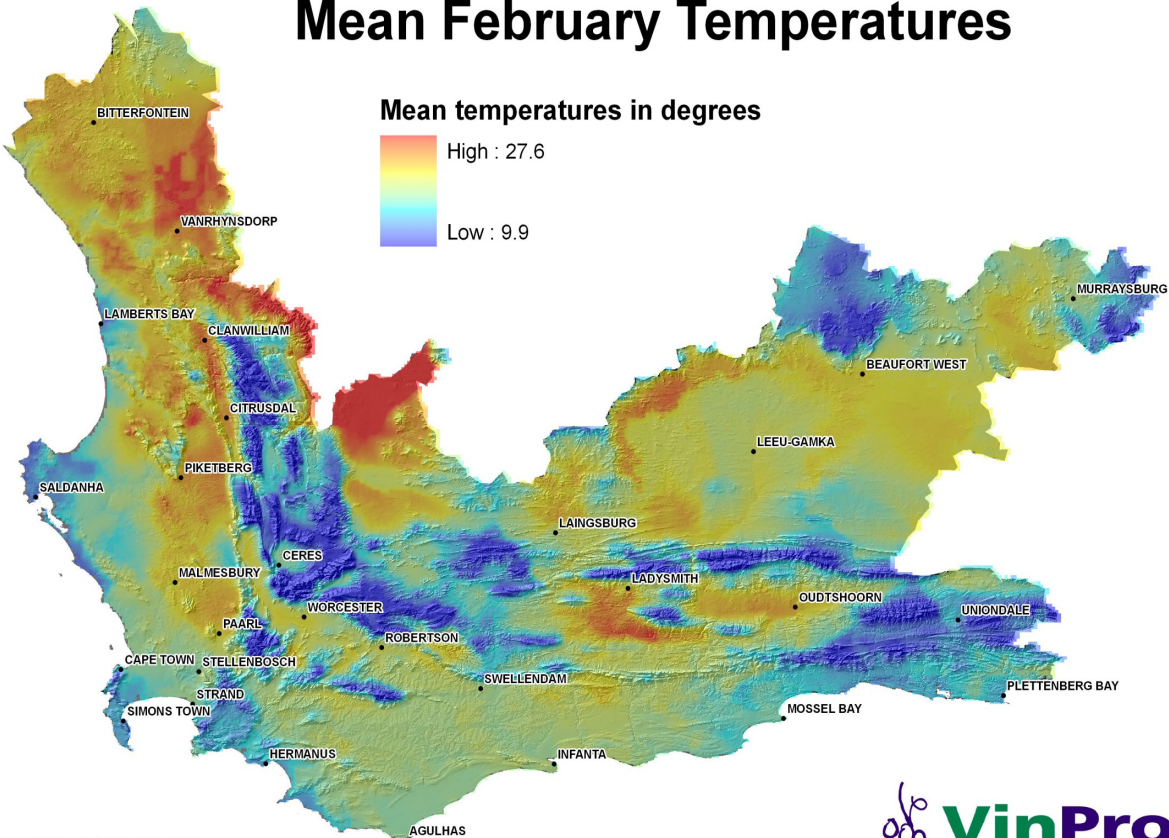
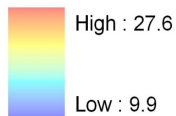
Climate



(Image courtesy of the UK Meteorological Office)

Mean February Temperatures

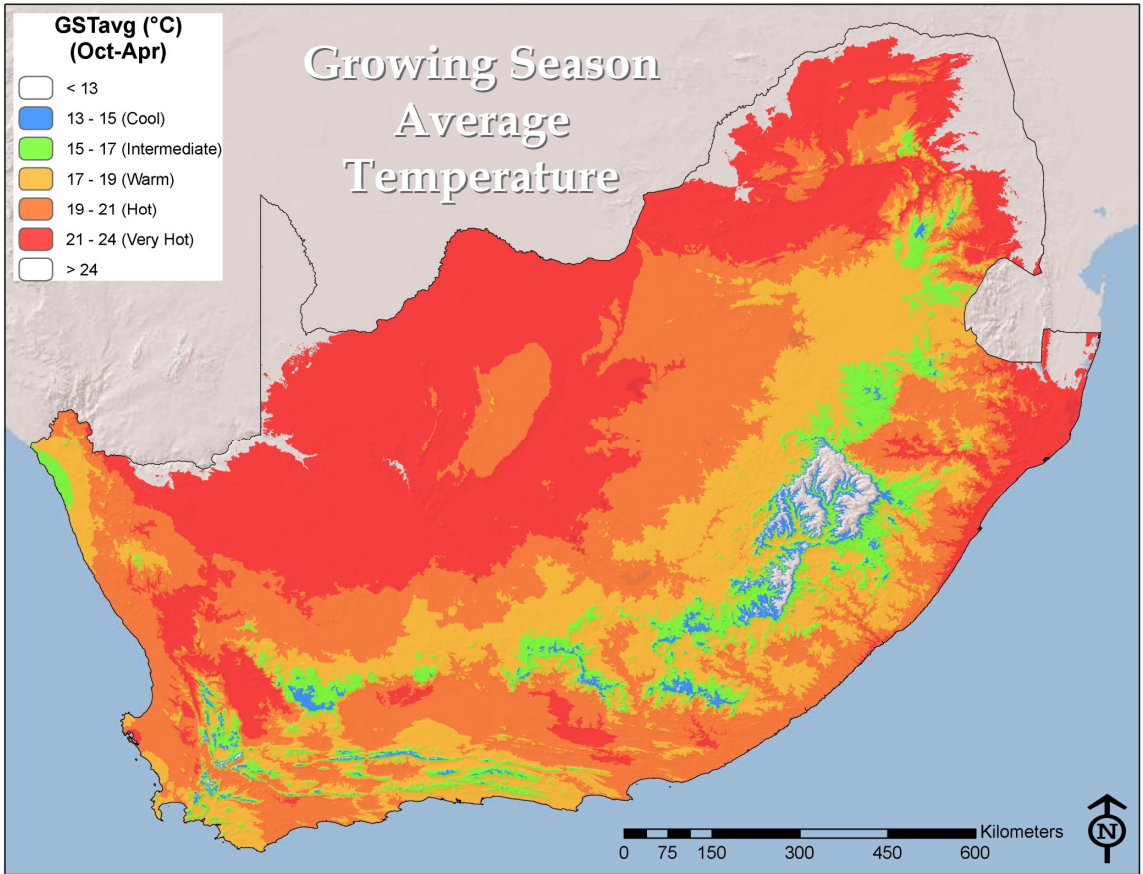
Mean temperatures in degrees



**GSTavg (°C)
(Oct-Apr)**

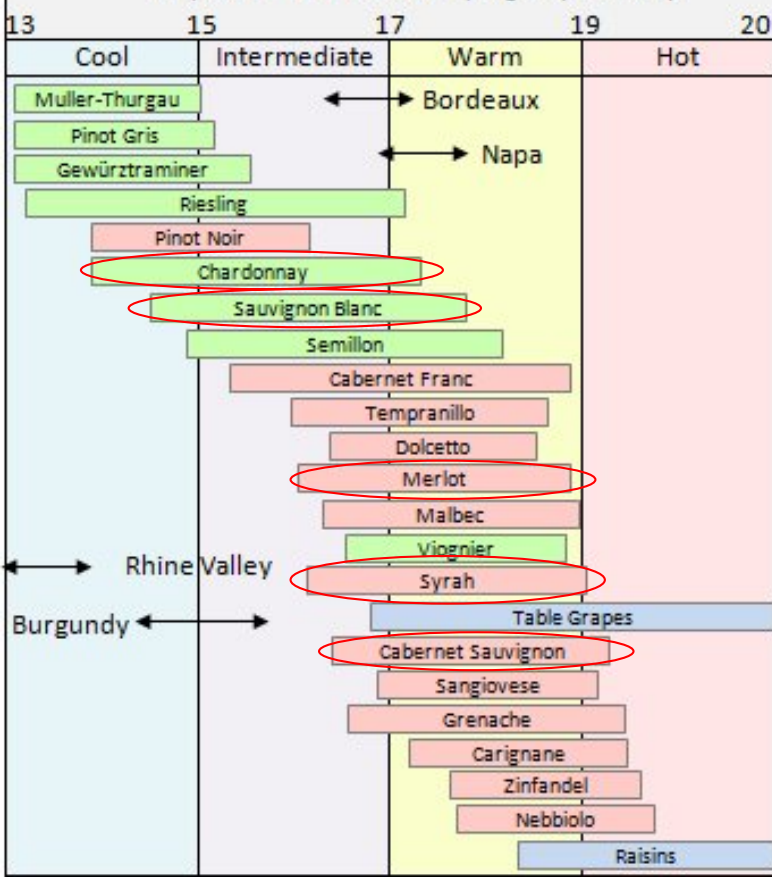


Growing Season Average Temperature



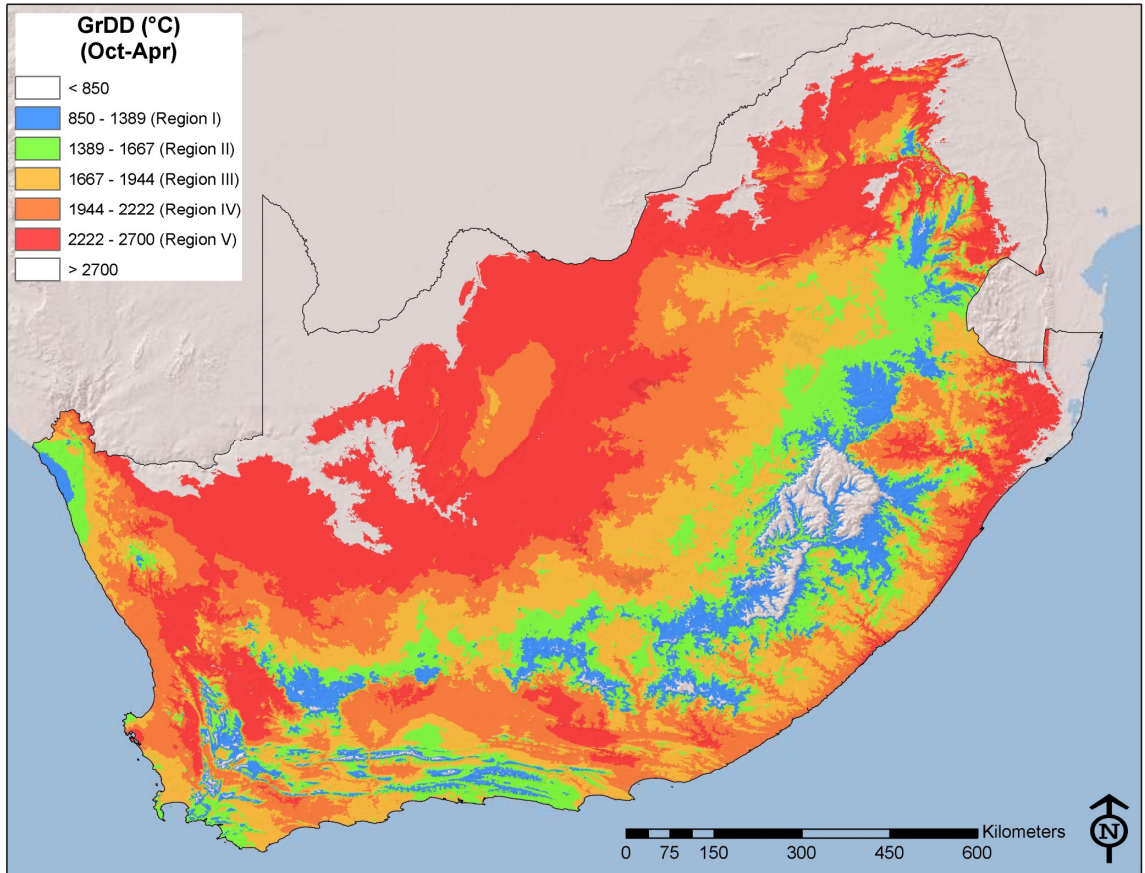
CLOSE

Grapevine Climate Groupings (Celsius)



Cultivars

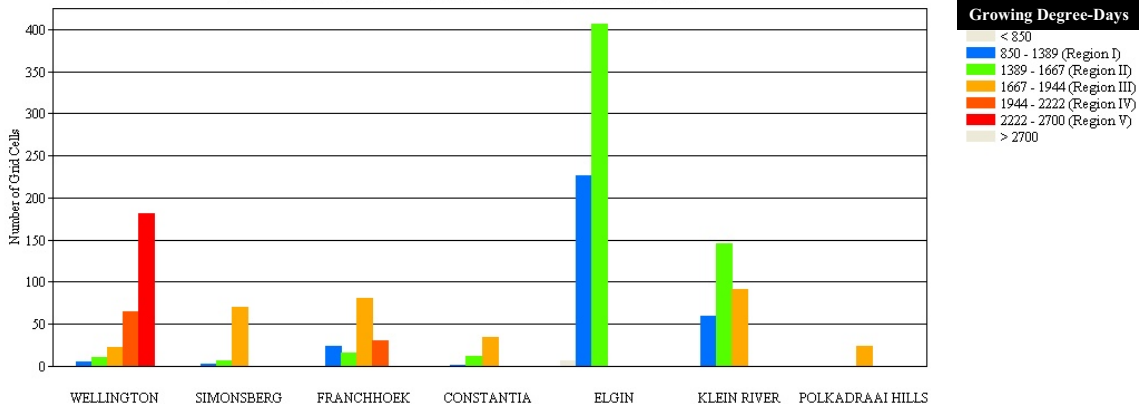
- ▣ Greece
 - Red: Agiorgitiko and Kotsifali
 - White: Moschato Alexandrias
- ▣ Spain:
 - Red: Bobal, Garnacha Tinta, Tempranillo
 - White: Airén, Macbeo



Source: Gregory V. Jones: Department of Environmental Studies, USA

Growing Degree-Days Wine Region Spatial Distribution

Histograms of Growing Degree-Days in Wine of Origin Wards



CLOSE

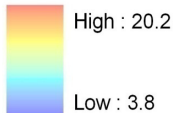
Comparative Median Spatial Climate Structures

Country	Region	GSTAvg (°C)	BEDD (DD)	WI (DD)	HI (DD)	CI (°C)	DI (mm)
Germany	Mosel	14.0	966	891	1411	9.7	131
Germany	Rhine Valley	14.1	989	922	1473	9.5	109
USA	Willamette Valley	14.3	992	881	1504	7.8	
France	Burgundy	15.2	1171	1118	1648	11.0	125
Australia	Yarra Valley	16.2	1251	1236	1652	11.1	
France	Bordeaux	16.5	1382	1387	1890	12.1	85
Spain	Rioja	16.6	1343	1410	1886	12.3	14
Australia	Coonawarra	16.7	1373	1328	1833	10.9	
USA	Walla Walla	16.8	1350	1380	2120	9.0	
South Africa	Elgin	17.1	1414	1420	1668	12.6	
Italy	Barolo	17.5	1559	1600	1960	14.6	90
Spain	Vinho Verde	17.6	1576	1635	1987	13.7	19
Italy	Chianti Classico	17.9	1507	1685	2112	13.8	32
Portugal	Porto	17.9	1489	1684	2155	13.1	-45
South Africa	Klein River	18.0	1546	1572	1792	13.7	
Australia	Barossa Valley	18.1	1570	1661	2063	12.2	
USA	Napa Valley	18.3	1766	1684	2294	10.8	
USA	Paso Robles	18.4	1892	1685	2399	9.2	
Australia	Margaret River	18.4	1523	1662	1850	14.6	
South Africa	Constantia	18.4	1636	1723	1880	14.2	
South Africa	Polkadraai Hills	18.8	1667	1752	2092	13.6	
Spain	La Mancha	18.9	1445	1912	2417	13.5	-122
South Africa	Franschhoek	19.0	1666	1813	2182	13.4	
South Africa	Simonsberg	19.2	1698	1873	2245	13.7	
USA	Lodi	20.2	1906	2082	2637	13.0	
South Africa	Wellington	20.4	1839	2237	2575	14.8	

Diurnal Temperature Range for February

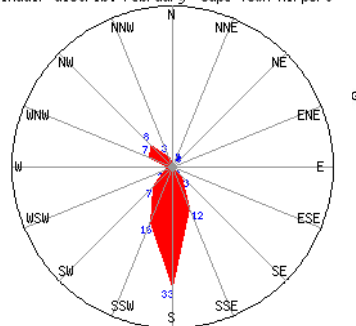
trange02

Value

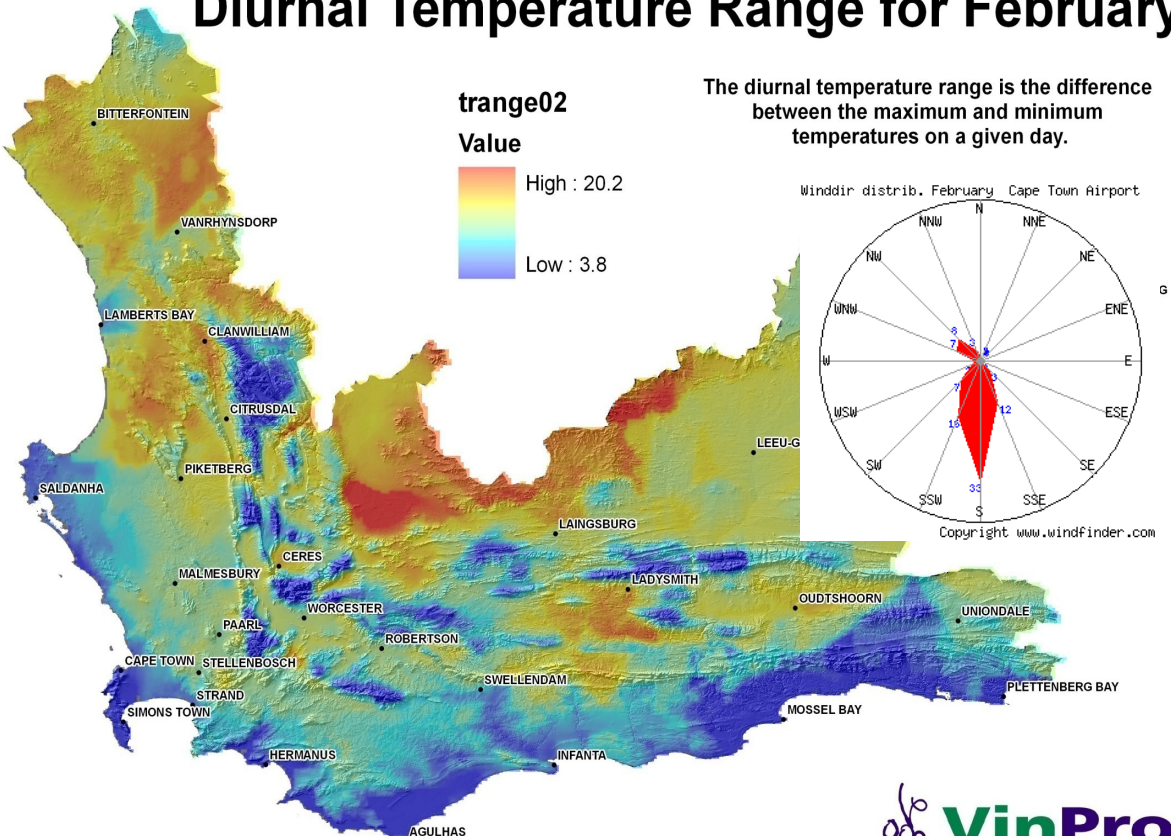


The diurnal temperature range is the difference between the maximum and minimum temperatures on a given day.

Winddir distrib. February Cape Town Airport



Copyright www.windfinder.com



Diurnal Temperature Range for February

The diurnal temperature range is the difference between the maximum and minimum temperatures on a given day.

Legend

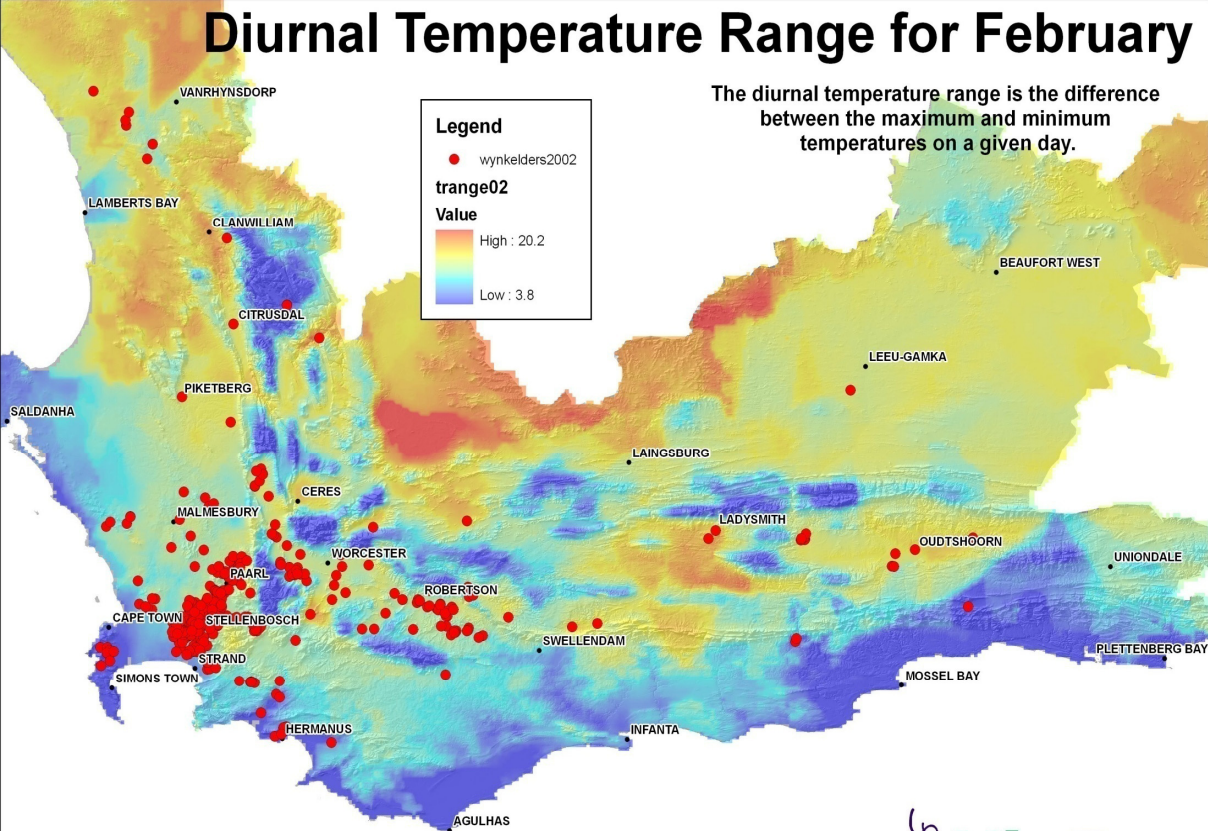
• wynkelders2002

trange02

Value

High : 20.2

Low : 3.8



CLOSE

Diurnal Temperature Range for February

Legend

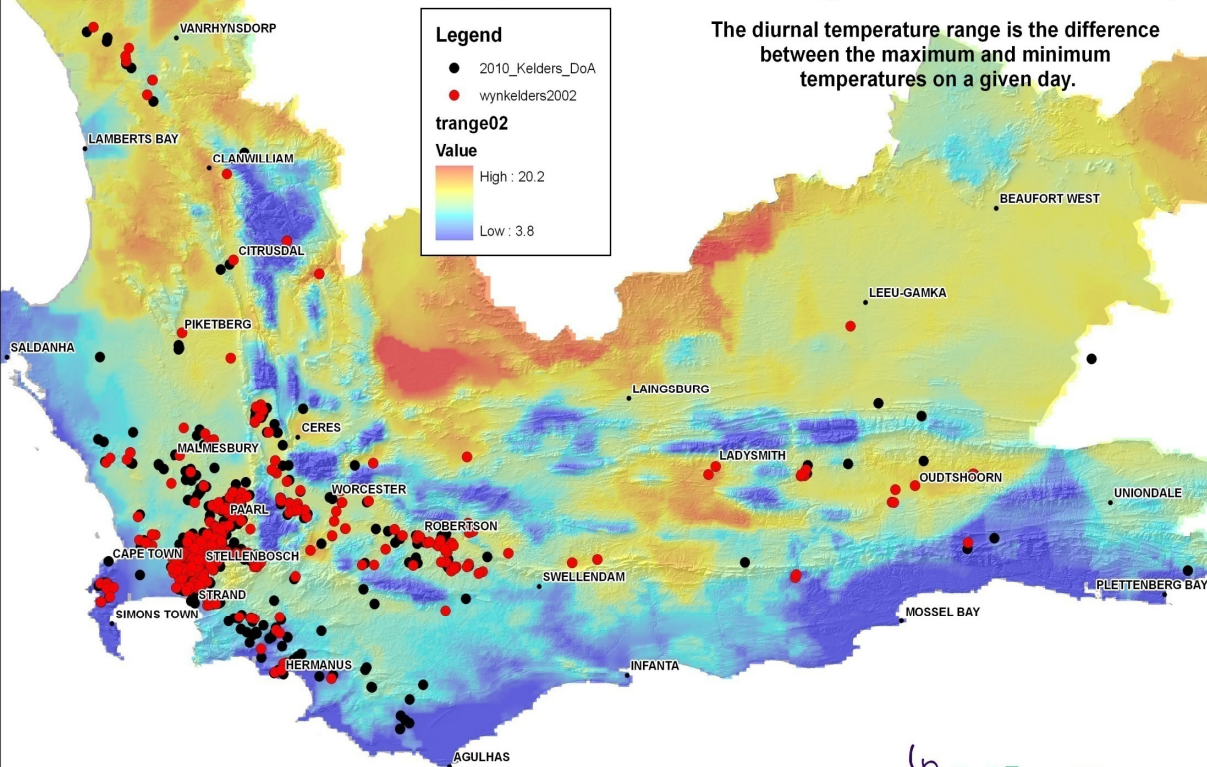
- 2010_Kelders_DoA
- wynkelders2002

trange02

Value



The diurnal temperature range is the difference between the maximum and minimum temperatures on a given day.



CLOSE

Important soil characteristics that can buffer the effects of climate change

- ▣ The soils ability to provide water to the plant for the longest periods of time depends on the following:
 - Effective rooting depth (depth to limitation)
 - Internal drainage
 - Soil texture
 - Soil structure
 - Soil organic matter
 - Soil nutrient status

Land type soil data



Fa197

Surface area (sq km): 0.002
Dominant soil forms: Av21Av24
Flooding occurrence: F1
Erosion: E4
Slope: 6
Water Erodibility: 4
Wind Erodibility: 3
Soil Texture: T3
Soil Depth: D1
Internal drainage: W3
Mechanical Limitations: MB0
pH: P1
Soil capability: IV
Land type soil capability: 6
Available soil: C6
Available water: C1
LT capability: 6

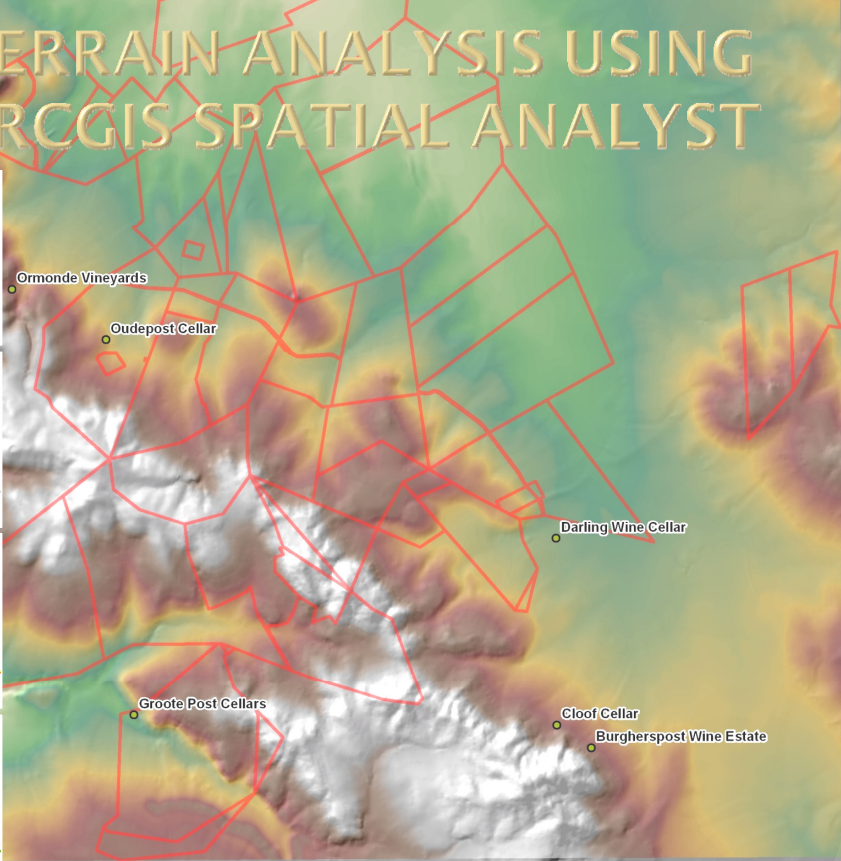
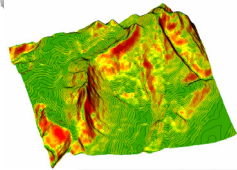
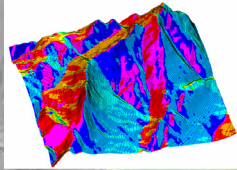
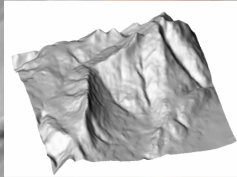
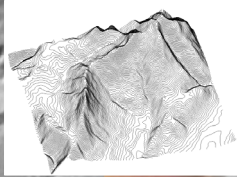
Directions: [To here](#) - [From here](#)

CLOSE

Correct soil management

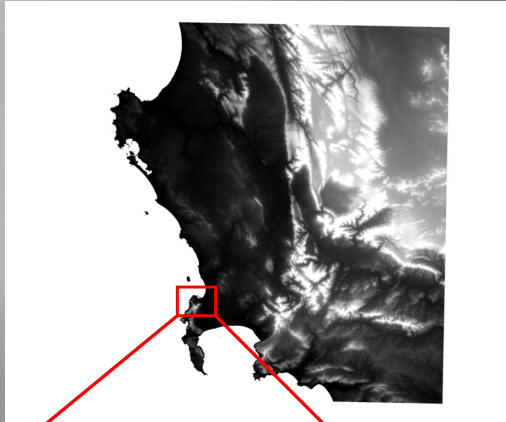
- ▣ Correct soil preparation
- ▣ Selective soil nutrient applications
- ▣ Increase soil organic matter
 - Cover crops
 - Mulching
- ▣ Conserve soil structure
- ▣ Precision irrigation

TERRAIN ANALYSIS USING ARCGIS SPATIAL ANALYST

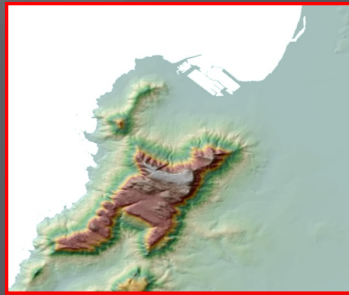
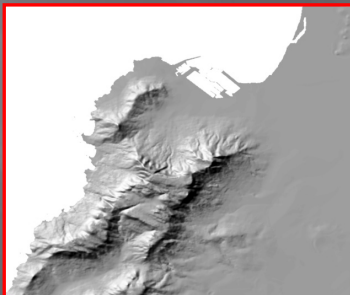
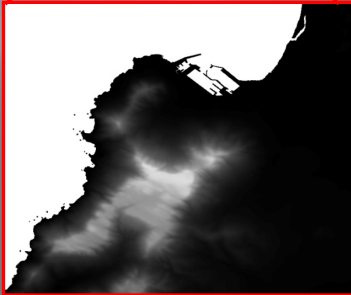


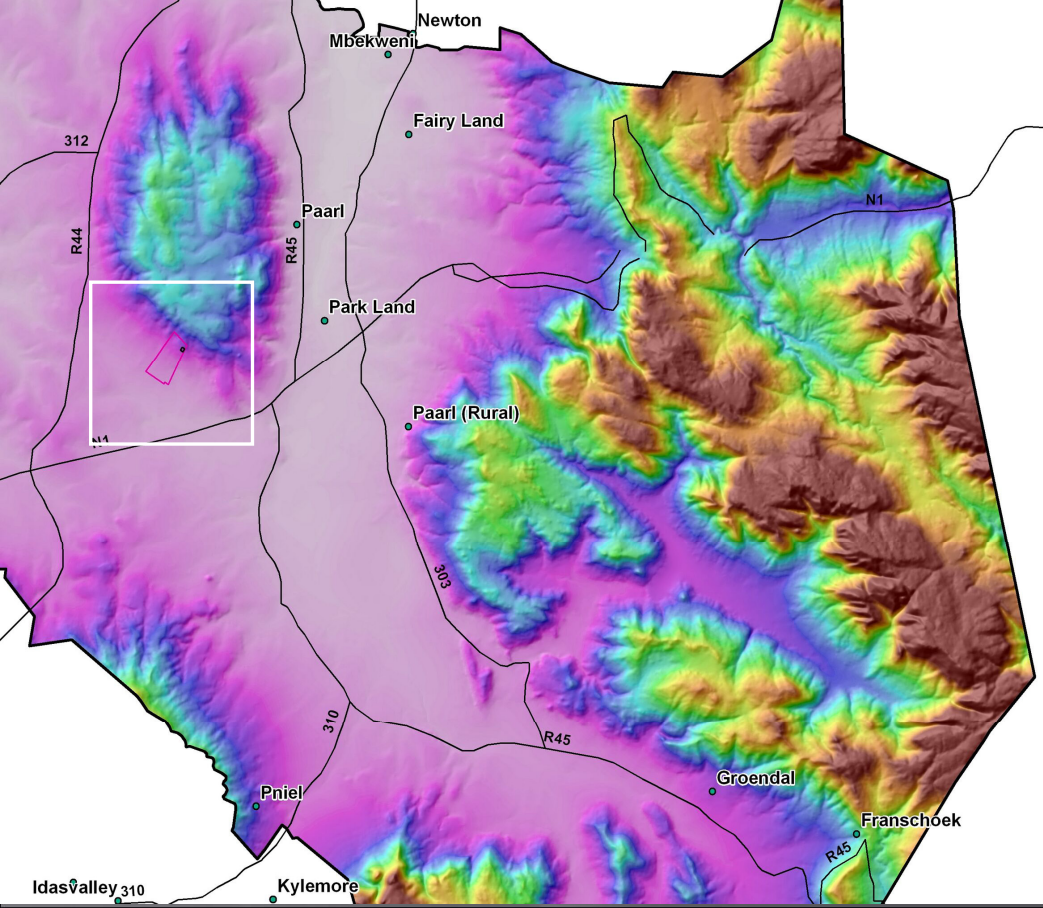
CLOSE

DEM (Digital Elevation Model)



- ▣ Different resolutions
 - 80m - RSA
 - 20m - district level
 - 5m - farm level
 - 1m - block level
- ▣ Terrain analysis





Digital Elevation Model

CLOSE

Sauvignon blanc
with perfect
typicity



Extract GIS and DEM data



Terrain data (from DEM)

- ▣ Elevation: 273m – 306m
- ▣ Slope: 10 – 15 grade
- ▣ Aspect: 180 – 200 (S – SW)
- ▣ SRAD: 4540 – 4890Wh/m²/day

External database

- ▣ Soil: B + E (Oa, Hu)
- ▣ Geology: N-Cp / Nm (granite)
- ▣ Rainfall: 800mm/year (long-term)
- ▣ SAWIS/WineMS block records
- ▣ Imagery / Topo sheet: 3318DD4

Spatial data

- ▣ Surface area: 1.08ha
- ▣ Distance from ocean: 37km
- ▣ Coordinates: 18°55'21"E
33°45'48"S

Data

Collect Options Close

File: R103010A

Choose Feature: Create

Type	Feature Name
x	oAG
x	oAEG
x	oAEsp
x	oAEhp
x	oAEyeB
x	oAepdBpp
x	oAepdBwet
x	oAepdBdry
x	oAepdBsap
x	oAepRB
x	oAepvB
x	oAEncB
x	oAELcB
x	oAE
x	oAsp
x	oAhpB
x	oAyeBsp
x	oAyeBhp
x	oAyeBwet
x	oAyeBreB



Data

Collect Options Log

1 oAEsp OK Cancel

Photo:

SOIL FORM: Longlands

SMU: Lo

FAMILY: Grey E

Depth of A (cm): 25

Eff Depth (cm):

Colour of A: 70

Struc of A:

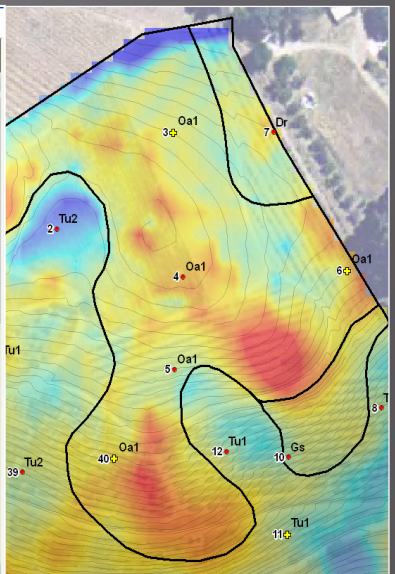
Cons_A:

Clay_top:

Tex_top: me/co

C_F (A): 2f

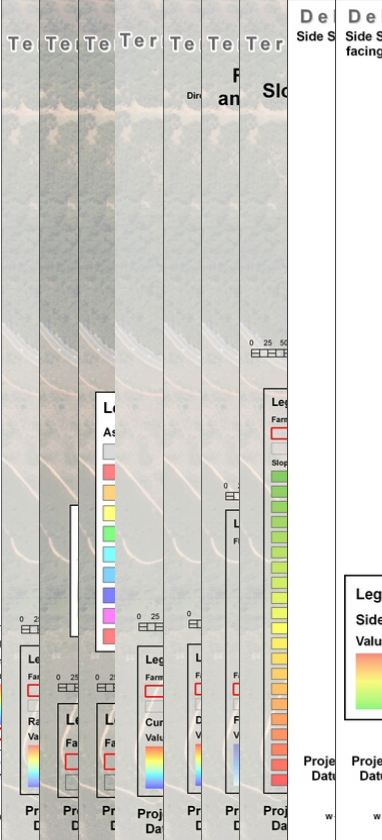
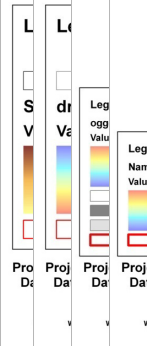
C_F (E): 1f



Profilnummer	Quadrat van A	Quadrat van A	Quadrat van A	Horizon omschrijving	Quadrat Ken. Eenheden	Familie code	Familie naam	Familie	Quadrat potentiaal	Ondergrond textuurklasse	Kleur van A	Kleur van A	Kleur van A	Kleur van A	Verloop van bodemprofiel	Grootte (oppervlakte in A)	Grootte (oppervlakte in B)	GPS Hoogte (voorspelling)	Latitude	Longitude		
1	30	150	60	Ashdam	OrtelseA-geelbruin apedale B-harde karbonaathorison	Ak	2000	Moensiept	luv B1	6.0	hk > sc	rebr	Vk	so	8-10	meico	1f	2f	888.148	-28.806019400	-28.660009692	
2	30	150	30	Brandheijl	OrtelseA-zagte karbonaathorison	Br	1000	Groefvloer	non wet B	3.0	sc	rebr	Ap	so	0-3	meico			897.115	-28.806081229	-28.660862824	
3	40	100	60	Trelwal	OrtelseA-neckarbonaat B-dorbank	Tr	1210	Graalste	n ble A - reB - non luv	5.0	db	rebr	Ap	so	0-3	meico			892.432	-28.806165623	-28.662103498	
4	30	150	150	Hutton	OrtelseA-rooi apedale B-ongespesifiseerd	Hu	3100	Stella	eutrophic - non luv	7.5	re	rebr	Ap	so	0-3	0-3	meico	1f	888.407	-28.806274921	-28.664042373	
5	20	150	150	Hutton	OrtelseA-rooi apedale B-ongespesifiseerd	Hu	3100	Stella	eutrophic - luv	7.5	re	rebr	Ap	so	4-7	meico	2f		705.985	-28.806431837	-28.665920799	
6	30	150	150	Hutton	OrtelseA-rooi apedale B-ongespesifiseerd	Hu	3100	Stella	eutrophic - non luv	8.0	re	rebr	Ap	so	4-7	meico			707.985	-28.807070002	-28.665821180	
7	20	150	150	Hutton	OrtelseA-rooi apedale B-ongespesifiseerd	Hu	3100	Stella	eutrophic - non luv	7.5	re	rebr	Ap	so	0-3	0-3	meico	1f	2f	699.876	-28.806449120	-28.667717803
8	30	60	40	Garies	OrtelseA-rooi apedale B-dorbank	Gr	1000	Nuwerus	Non luv B1	3.5	db	rebr	Vk	lo	4-7	me	8g		705.985	-28.806540435	-28.668129453	
9	20	150	60	Plooyenberg	OrtelseA-rooi apedale B-harde karbonaathorison	Py	1000	Brakies	Non luv B1	6.0	hk	rebr	Vk	so	4-7	meico			702.268	-28.806590506	-28.669040084	
10	20	90	70	Garies	OrtelseA-rooi apedale B-dorbank	Gr	1000	Nuwerus	Non luv B1	6.0	db/Ro+Ca	rebr	Ap	so	0-3	0-3	meico	1f	713.674	-28.806625465	-28.669759884	
11	20	20	20	Mispah	OrtelseA-harde rots	Ma	1100	Myhill	n ble A-no calc	2.0	Ro	rebr	Ap	so	4-7	meico			711.994	-28.807065921	-28.669850583	
12	20	110	90	Garies	OrtelseA-rooi apedale B-dorbank	Gr	1000	Nuwerus	Non luv B1	6.0	db	rebr	Ap	so	4-7	meico			719.924	-28.808769258	-28.674516563	
13	20	150	150	Hutton	OrtelseA-rooi apedale B-ongespesifiseerd	Hu	3100	Stella	eutrophic - non luv	7.5	re	rebr	Vk	so	0-3	4-7	me		707.728	-28.808413987	-28.676353752	
14	20	150	150	Augrabies	OrtelseA-neecarbonaat B-ongespesifiseerd	Ag	1210	Khubus	hardB-dry-calc	7.0	nc	rebr	Ap	so	4-7	meico			712.264	-28.809593330	-28.676664754	
15	20	150	150	Hutton	OrtelseA-rooi apedale B-ongespesifiseerd	Hu	3100	Stella	eutrophic - non luv	7.5	re	rebr	Vk	so	4-7	meico			715.301	-28.811442026	-28.676129509	
17	20	150	100	Augrabies	OrtelseA-neecarbonaat B-ongespesifiseerd	Ag	1210	Khubus	hardB-dry-calc	6.0	nc	rebr	Ap	so	4-7	meico			703.892	-28.814681901	-28.674312624	
18	20	150	120	Augrabies	OrtelseA-neecarbonaat B-ongespesifiseerd	Ag	1210	Khubus	hardB-dry-calc	6.8	nc	rebr	Ap	so	8-10	10-12	meico			717.909	-28.814478731	-28.674617086

CLOSE

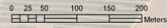
Delaire terrain analysis
 Delaire terrain analysis
 Delaire terrain analysis
 Delaire terrain analysis



Projection: Lo 19°
 Datum: WGS84



Map compiled by: Heinrich Scholms
 heinrich@vinpro.co.za



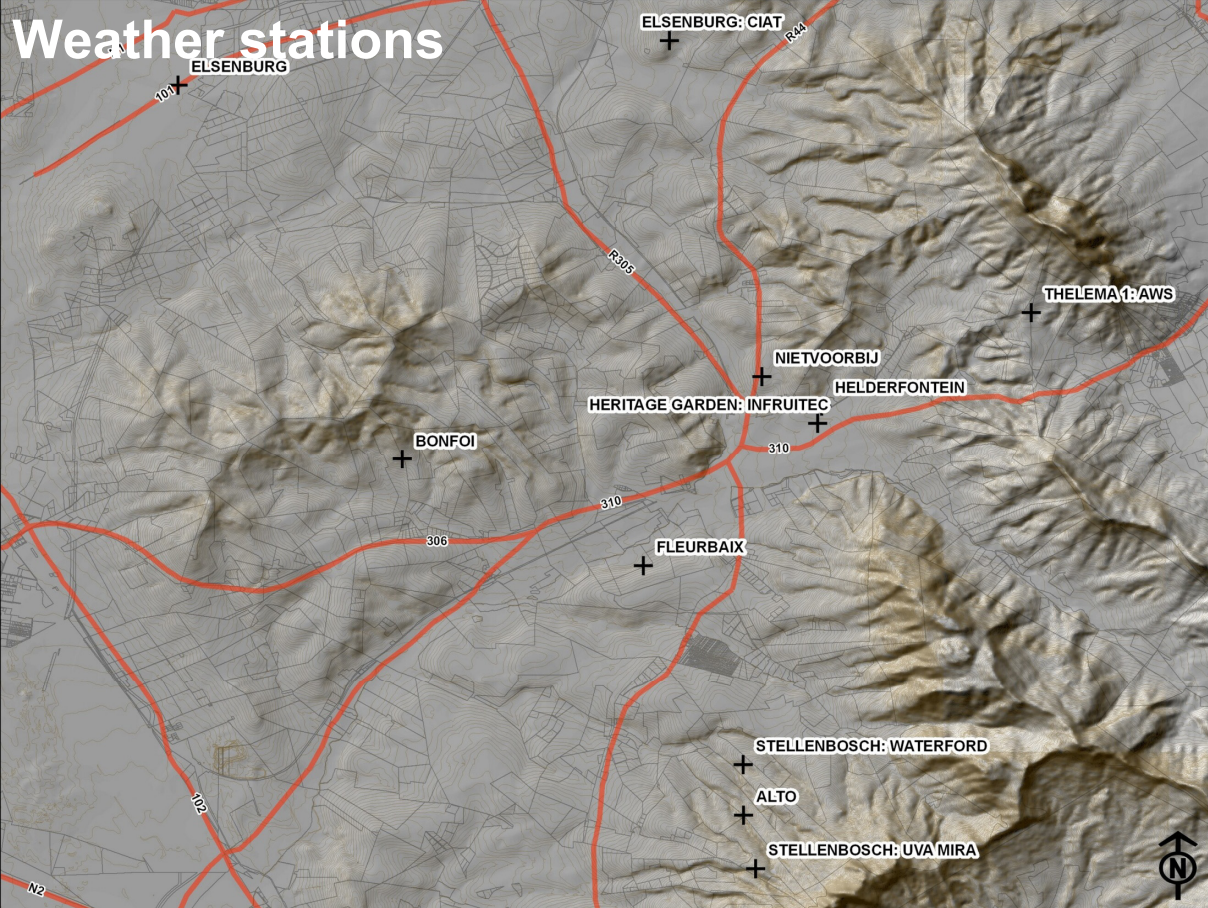
CLOSE

Do we know the natural factors that influence the typicity of Sauvignon blanc (vegetative character)?

- Climate
 - Ave Feb temp between 18 and 19.9° Celsius
 - Cool sea breeze
- Soil
 - Fertile soils with more than 12% clay
- Topography
 - Southern slopes (cooler slopes)
 - Openness to the sea
 - Elevation (upper slopes)

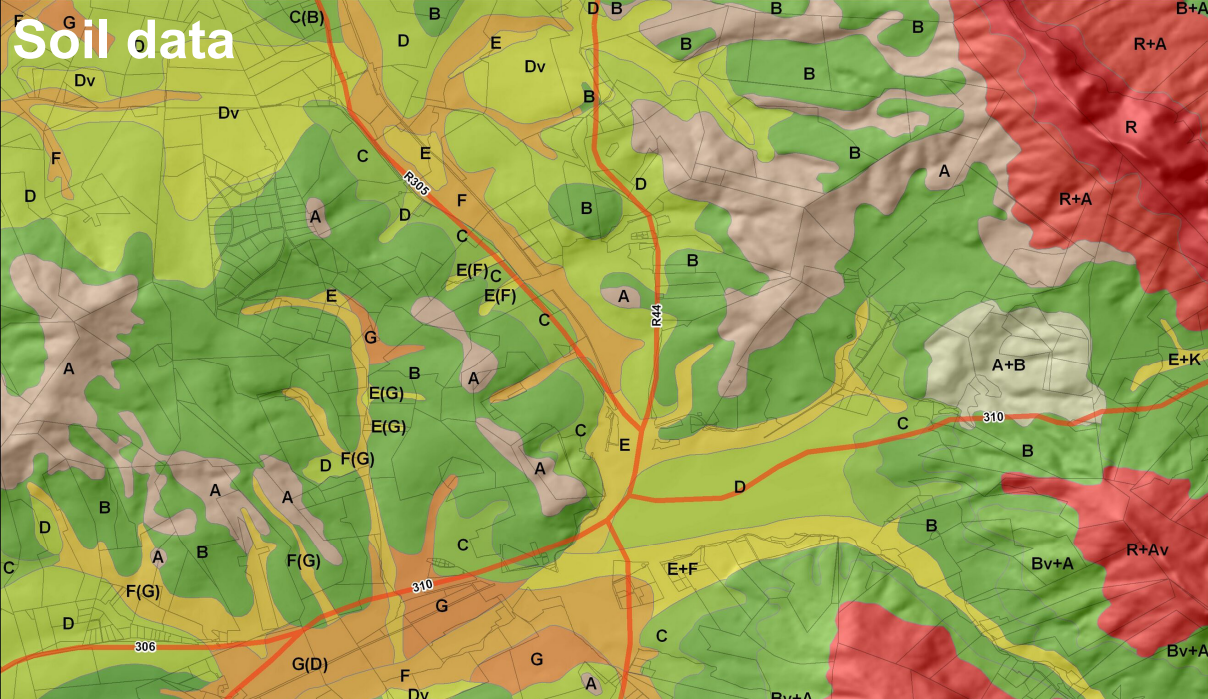


Weather stations



CLOSE

Soil data



Legenda

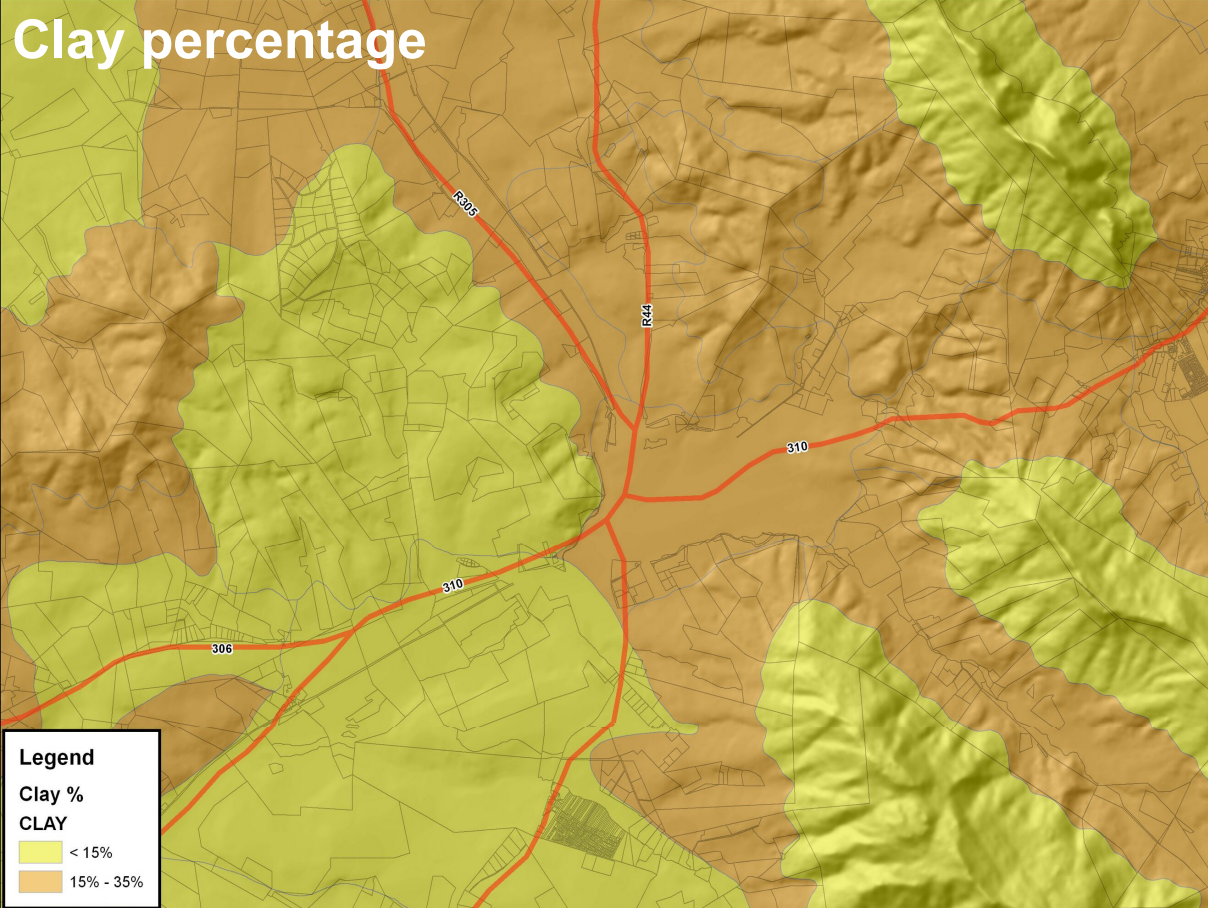
Stellenbosch soils

<ul style="list-style-type: none"> AGS, Vlak-residuele gronde (Blak dupleks en alluviale leemgronde) A-E, Vlak-residuele gronde + Rood en geel apoksele gronde A-Bv, Vlak-residuele gronde + Vlak rooi en geel apoksele gronde A, Vlak residuele gronde A+Dv, Ower-vlak residuele gronde + Vlak nat dupleks gronde Av, Oros-vlak residuele gronde BAv, Rooi en geel apoksele gronde (Vlak residuele gronde) B+A, Rooi en geel apoksele gronde + Vlak residuele gronde B+Av, Rooi en geel apoksele gronde + Koppingsgronde E, Rooi en geel apoksele gronde Bk, Koppingsgronde Bv+A, Vlak rooi en geel apoksele gronde + Vlak residuele gronde Bv, Vlak rooi en geel apoksele gronde 	<ul style="list-style-type: none"> CBv, Oros-dupleks gronde (Rooi en geel apoksele gronde) Cv, Oros dupleks gronde + Vlak residuele gronde C, Oros dupleks gronde Cv+K, Koppingsgronde D, Vlak oros dupleks gronde Dv, Vlak oros nat dupleks gronde (Blak dupleks en alluviale leemgronde) Dv+D, Matig-dep nat dupleks gronde + Oros dupleks gronde Dv+J, Matig-dep nat dupleks gronde + Nat platteweg gronde D, Matig-dep nat dupleks gronde Dv+Dv, Vlak nat dupleks gronde + Vlak oros dupleks gronde Dv+E, Vlak nat dupleks gronde + Goed-gedreweerde dep alluviale sande D, Vlak nat dupleks gronde EPF, Goed-gedreweerde dep alluviale sande (Blak dupleks en alluviale leemgronde) EGS, Goed-gedreweerde dep alluviale sande (Blak dupleks en alluviale leemgronde) 	<ul style="list-style-type: none"> E+H, Goed-gedreweerde dep alluviale sande + Rooi en geel apoksele gronde E+H, Goed-gedreweerde dep alluviale sande + Oros-gedreweerde alluviale gronde E+K, Goed-gedreweerde dep alluviale sande + Koppingsgronde E, Goed-gedreweerde dep alluviale sande Fv, Goed-gedreweerde alluviale gronde (Blak dupleks en alluviale leemgronde) F+G, Swak-gedreweerde alluviale gronde + Blak dupleks en alluviale leemgronde F, Swak-gedreweerde alluviale gronde + Koppingsgronde F, Swak-gedreweerde alluviale gronde Gv, Blak dupleks en alluviale leemgronde (Matig-dep nat dupleks gronde) G+Dv, Blak dupleks en alluviale leemgronde + Vlak nat dupleks gronde Gv+H, Blak dupleks en alluviale leemgronde + Nat oros sande G, Blak dupleks en alluviale leemgronde Gv, Vlak brak dupleks en alluviale leemgronde H+G, Oros-dep sande + Blak dupleks en alluviale leemgronde 	<ul style="list-style-type: none"> H, Oros-dep sande Hv, Vlak oros sande op rits of kalkriet L, Swak brak Koppingsgronde J, Nat platteweg gronde K, Koppingsgronde Kv, Rooi en alluviale gronde + Vlak residuele gronde Rv, Rooi en alluviale gronde + Oros-vlak residuele gronde R, Rooi en alluviale gronde STEDELIK UITSWAAKING VAER WATER
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CLOSE



Clay percentage



Legend

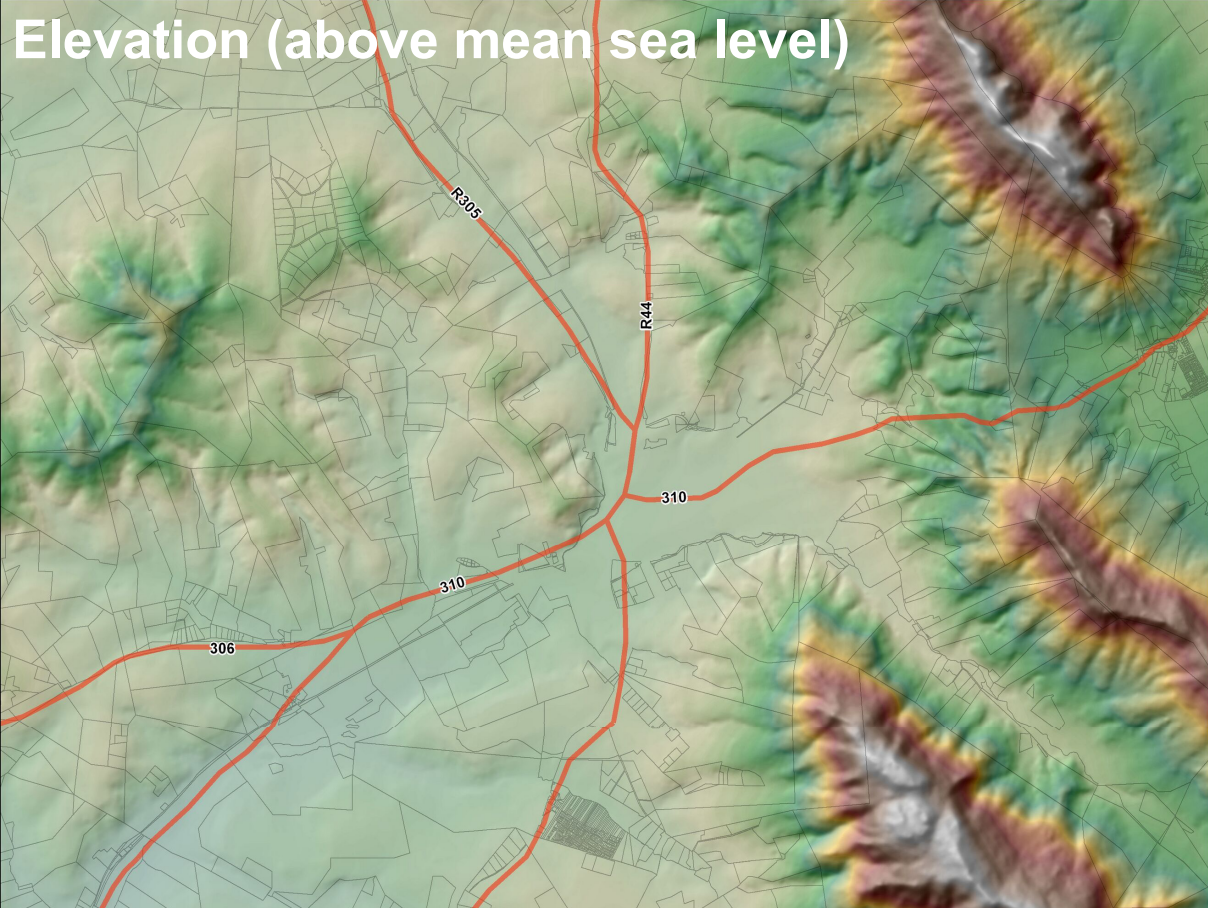
Clay %

CLAY

- < 15%
- 15% - 35%

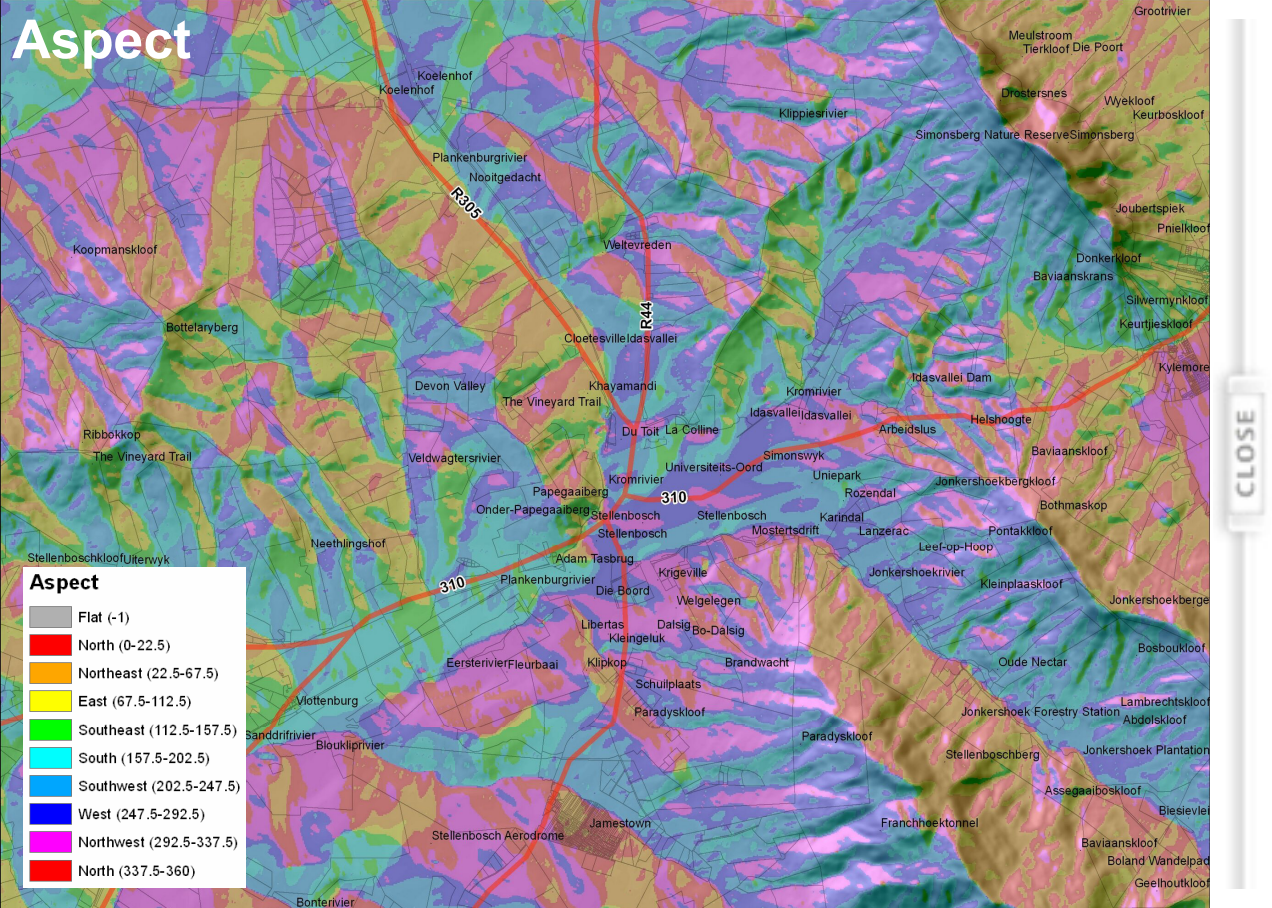
CLOSE

Elevation (above mean sea level)



CLOSE

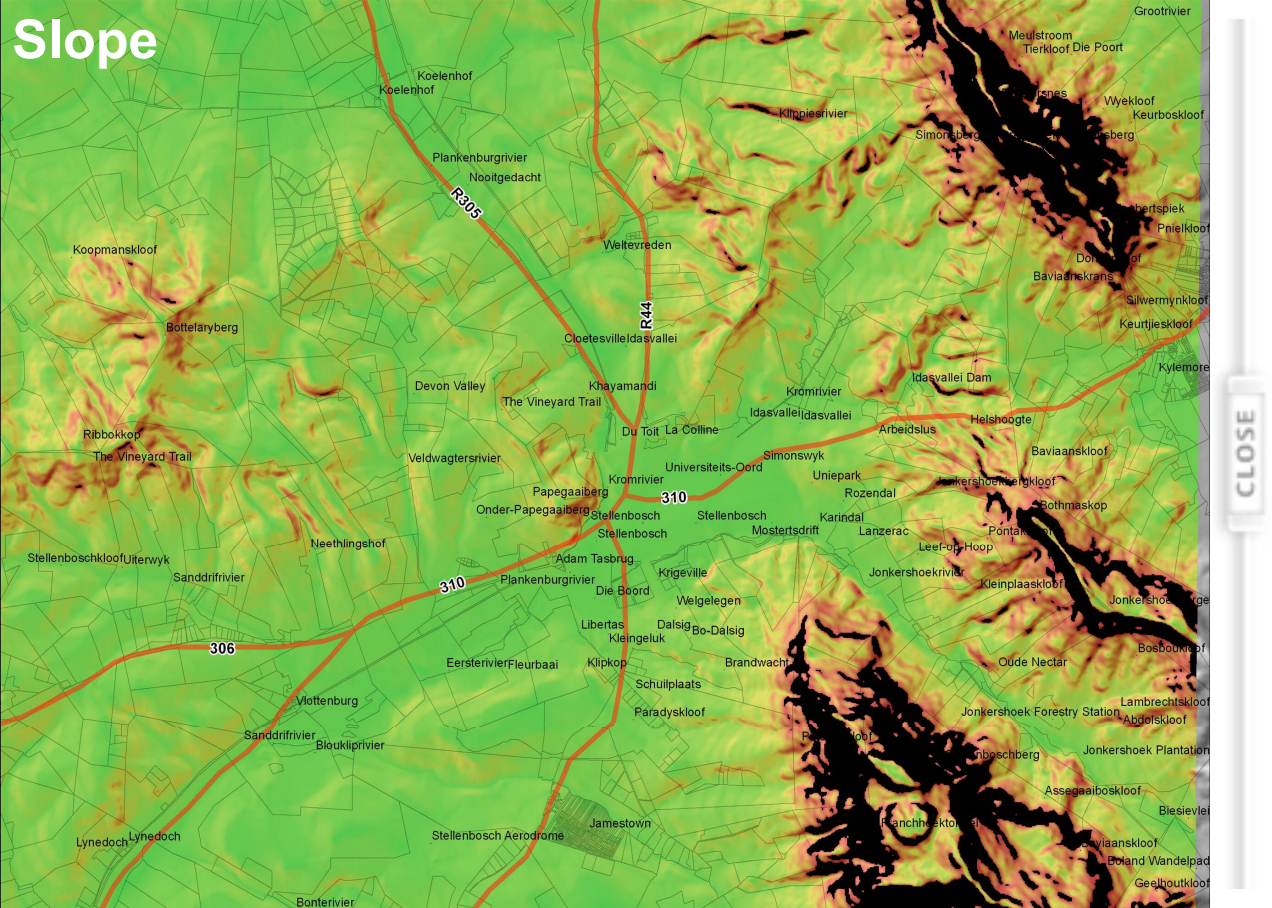
Aspect



Aspect	
Grey	Flat (-1)
Red	North (0-22.5)
Orange	Northeast (22.5-67.5)
Yellow	East (67.5-112.5)
Light Green	Southeast (112.5-157.5)
Cyan	South (157.5-202.5)
Blue	Southwest (202.5-247.5)
Dark Blue	West (247.5-292.5)
Magenta	Northwest (292.5-337.5)
Dark Red	North (337.5-360)

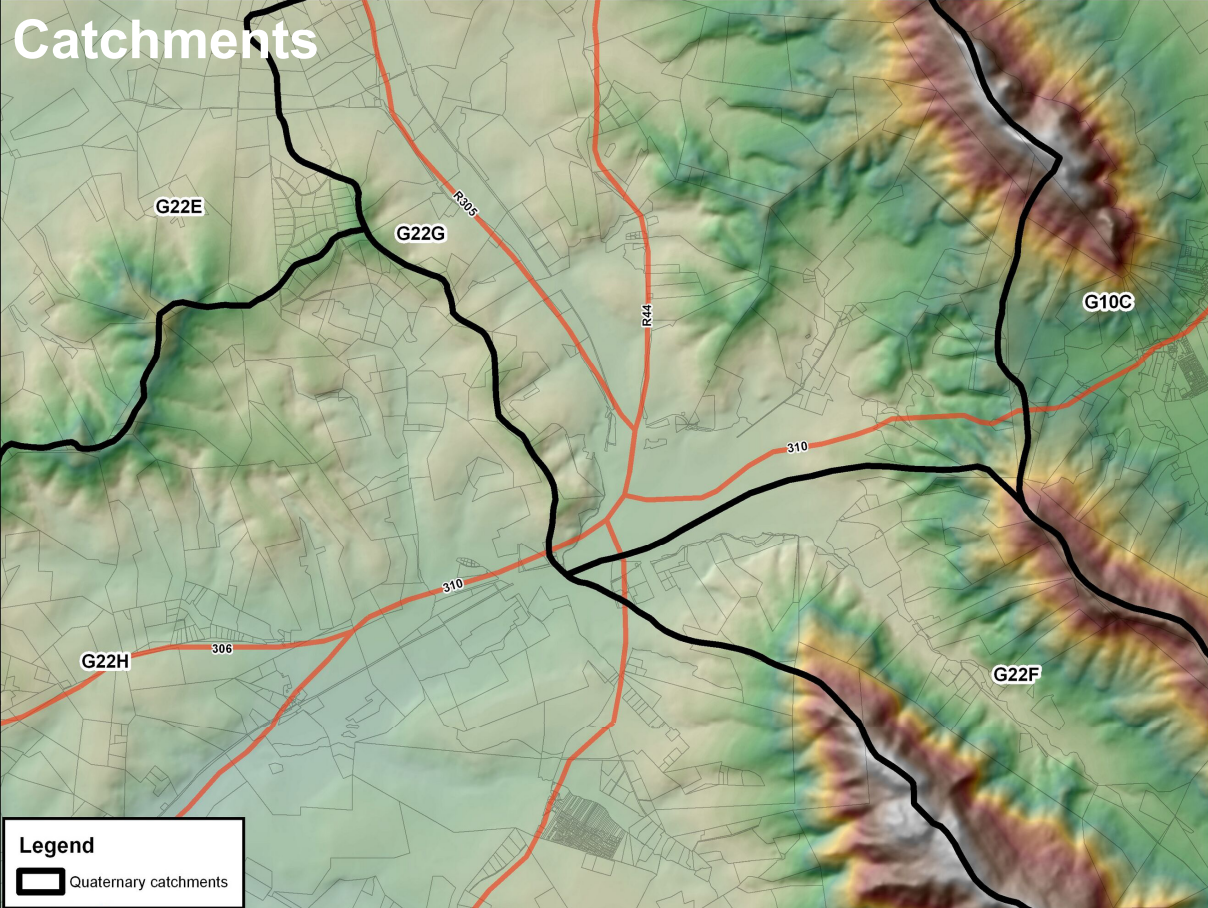
CLOSE

Slope



CLOSE

Catchments



G22E

G22G

G10C

G22H

G22F

R305


R44

310

310

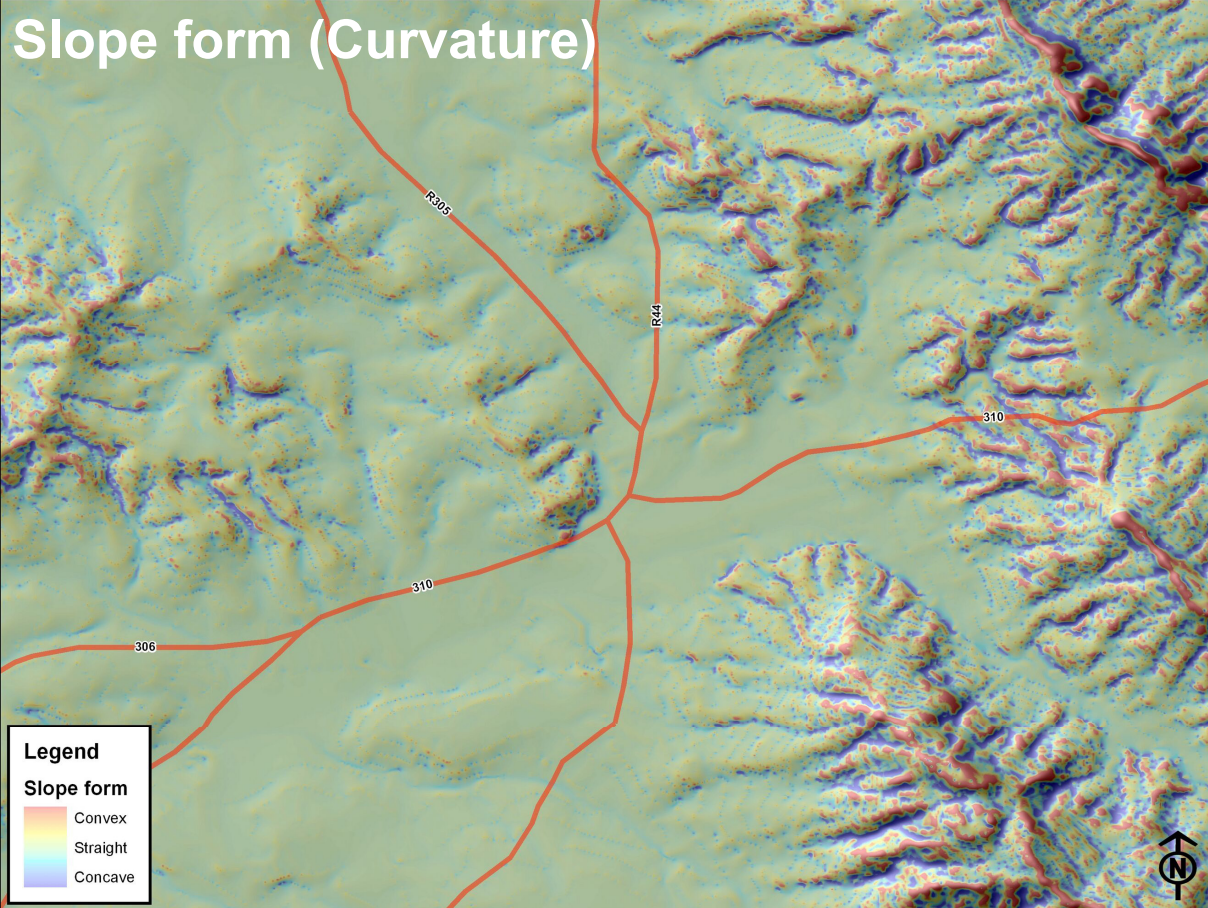
306

Legend

 Quaternary catchments

CLOSE

Slope form (Curvature)



Legend

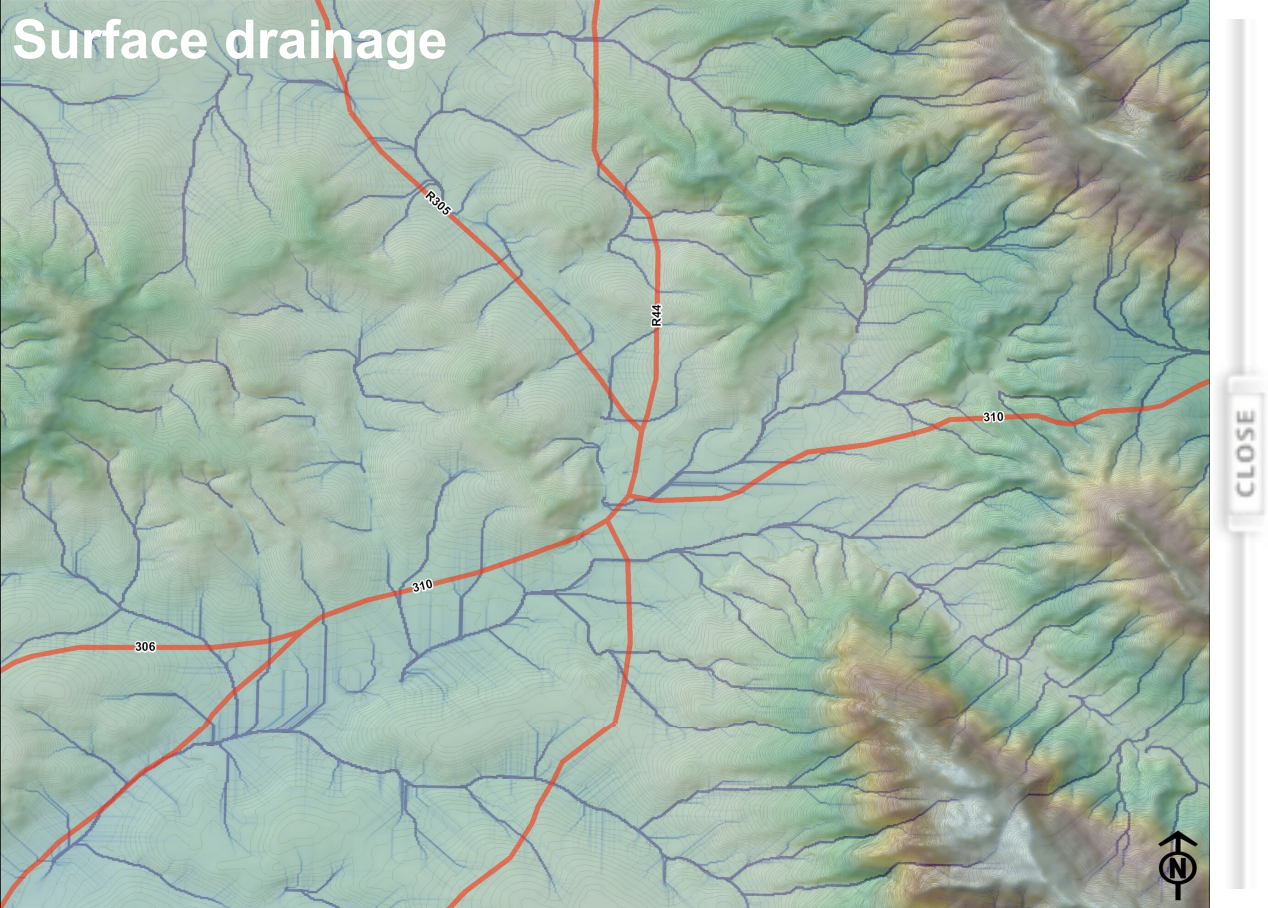
Slope form

- Convex
- Straight
- Concave

CLOSE



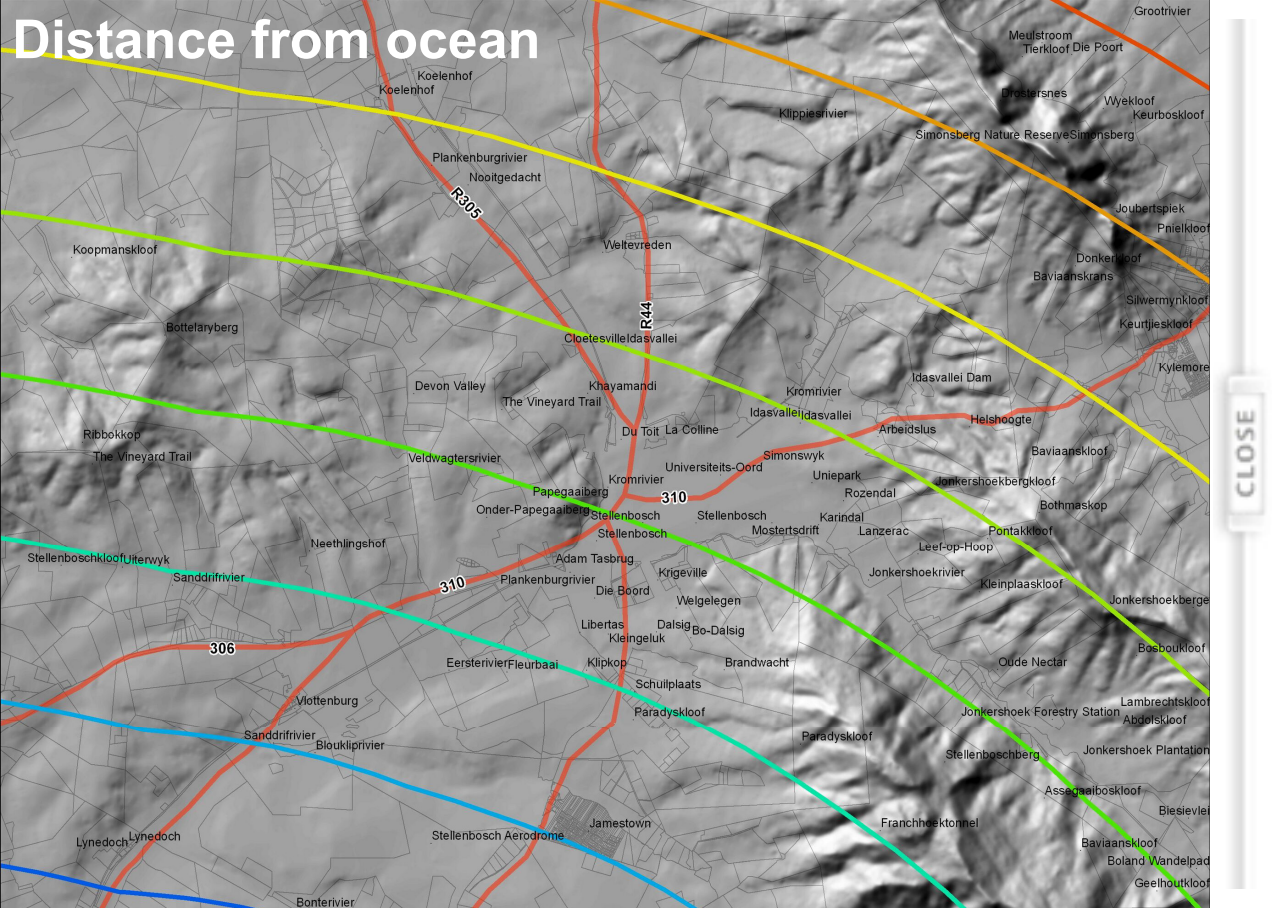
Surface drainage



CLOSE



Distance from ocean



CLOSE

Best site for Sauvignon blanc (with a vegetative character)

Temperature

Ave Feb temp 18 -19.9°

Reclass_solar radiation

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

Layer weight

40%

Elevation

Reclass_Elevation

- 0 <100 and >550m
- 5 100-150m
- 6 150-200m
- 7 200-250m
- 8 250-300m
- 9 300-350m
- 10 350-550m

Layer weight

20%

Fertile soil

>12% clay

Reclass_clay%

- 0 <15%
- 1 15-35%

Layer weight

10%

Slope

5 - 30°

Reclass_slope°

- 0 <5 and >30°
- 1 5-30°

Layer weight

15%

Aspect

South

Reclass_Aspect

- 0 N/NE/NW
- 3 E/W
- 8 SE/SW
- 10 South

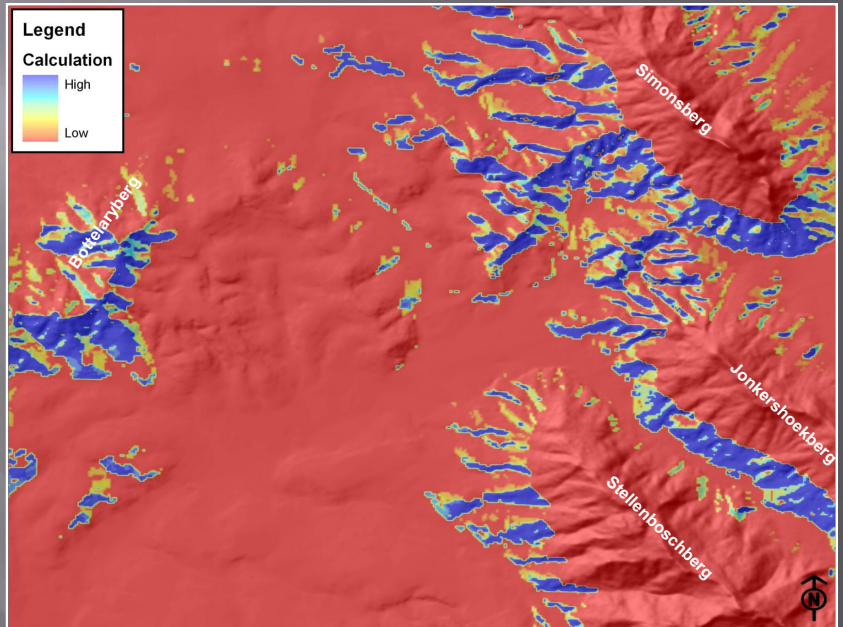
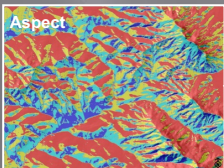
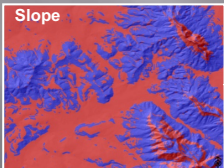
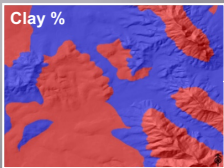
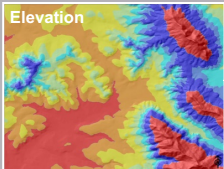
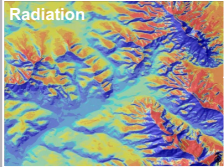
Layer weight

15%

Raster calculator (radiation*elevation*clay*slope*aspect)

Single potential layer

Potential sites for Sauvignon blanc using multi-variable spatial modeling



CLOSE

Conclusion

- ▣ Spatial modeling is a powerful tool where different entities can be compared based on its spatial location
- ▣ For a more accurate model one needs:
 - scientist to identify the individual terroir elements and its potential range and weight for each cultivar, that contributes to wine typicity
 - accurate, high resolution base data
 - to integrate all relevant data into the equation



CLOSE

THANK YOU

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