The international Internet site of the geoviticulture MCC system

Le site Internet international du système CCM géoviticole

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Summary

The "Geoviticulture Multicriteria Climatic Classification (MCC) System" was developed to characterize the climate of the wine producing regions of the world. It is a method which determines three climatic indexes and uses them to classify a location. A worldwide database of these indexes in wine producing regions was created using this methodology and the System was made available as a web site (*http://www.cnpuv.embrapa.br/ccm*). The site presents general information about the Geoviticulture MCC System, describes the methodology, allows searches in the database and the calculation of climatic indexes. Searches may be worldwide or limited to a specific country, and search criteria allow limiting the class for each of the three indexes. Search results are presented as a table specifying location, index values, index classes and the source of the data used. In order to make it easier to visually identify locations with similar climate, an orthogonal color scheme was used for the three indexes. In tropical regions, where grapes may be harvested year-round, a separate index was included for each month of potential harvest. The site includes a reference list and, in some cases, PDF files with the complete papers. The site will be constantly updated as new data becomes available for insertion in the database. The web site is currently available in Portuguese, French and English, and its intention is to make the data available for whichever purpose users may need it.

Keywords: climate, database, viticulture

Introduction

Climate is an important element in viticulture in different regions of the world, influencing the characteristics of grapes and wines. Wine production in the world occurs in many types of climates. The Geoviticulture Multicriteria Climatic Classification (MCC) System was developed to improve the characterization of viticultural climate in the wine producing regions of the world.

The MCC System was described by TONIETTO (1999; 2007) and by TONIETTTO & CARBONNEAU (2004), and the methodology was used to generate a database of worldwide viticultural climates. However, data is of no value if it is not put to use. Therefore, in the interest of sharing information, an Internet website was created by Embrapa (EMBRAPA UVA E VINHO, 2007) to publish the MCC System and make the resulting viticultural climate database available for the international scientific community. Its intention is to make the data available for whichever purpose users may need it. The site may be accessed at the address *http://www.cnpuv.embrapa.br/ccm*. This paper describes the website, its use and plans for future developments.

Material and Methods

The site briefly describes the Geoviticulture MCC System, providing online access to a database of climatic indexes in wine producing regions of the world. The site was written in HTML and PHP, and the data is stored in a MySQL database. The web server uses Apache running on a Debian Linux Platform. The web site is currently available in Portuguese, French and English.

The main page of the site describes the MCC System and its objectives and provides links to the other pages. It also lists the institutions which currently participate in the MCC System and provides information on how other institutions may contribute to the database. The *Methodology* page describes the three climatic indexes (Heliothermal Index - HI, Cold Night Index - CI, and Dryness Index - DI) and how they are calculated. It also lists the six classes of HI (ranging from -3 to +3) and their

boundaries, as well as the four classes of CI and DI (ranging from -2 to +2). It also describes some important concepts of the MCC System. The *Bibliography* page lists the literature references related to the MCC System, providing, where copyrights permit, the full text in PDF for some of them.

The *Database* page allows the user to search the database of worldwide viticultural climatic indexes. Database search criteria allow displayed results to include all countries or be limited to one specific country. The search may also be limited or not to one of the six classes of HI, one of the four classes of CI or DI, or any combination of these search criteria. Results are displayed in alphabetical order and include country, viticultural region, meteorological station with latitude, longitude, altitude, HI value, CI value, DI value, HI class, CI class and DI class. Also included are the time period (years) used in determining the three indexes, during which climatic data was collected in each place, as well as a reference to the source from which the data was obtained.

In tropical regions, the seasons are not defined as rigidly as in a temperate climate, and grapes may be harvested throughout the year. In these places, the climatic indexes vary according to the time of harvest and a separate index was calculated for each month of potential harvest. The database entries relative to tropical places include these monthly indexes.

In order to make it easier to visually identify locations with similar viticultural climate according to the MCC System, an orthogonal color classification scheme within the RGB color space was used for the three indexes. HI varies along the red-cyan axis, with red as the highest heliothermal (above 3000) and cyan as the lowest (below 1500), with a white midpoint at 2100. CI varies along the blue-yellow axis, with yellow as the warmest nights (above 18°C) and blue as the coldest (below 12°C), with a white midpoint at 14°C. DI varies along the green-magenta axis, with green as the most humid (above +150 mm) and magenta as the driest (below -100 mm), with a white midpoint at +50 mm.

Colors are calculated for each of the three indexes according to the following equations:

$$\mathrm{HIc} = \begin{cases} 1 - e^{(3000 - HI)/600}/6 & \text{for } 3000 < HI \\ HI/3600 & \text{for } 2400 < HI \le 3000 \\ (HI - 1200)/1800 & \text{for } 1500 < HI \le 2400 \\ e^{(HI - 1500)/300}/6 & \text{for } HI \le 1500 \end{cases}$$

$$\mathrm{CIc} = \begin{cases} 1 - e^{(18 - CI)/4}/4 & \text{for } 18 < CI \\ (CI - 6)/16 & \text{for } 14 < CI \le 18 \\ (CI - 10)/8 & \text{for } 12 < CI \le 14 \\ e^{(CI - 12)/2}/4 & \text{for } CI \le 12 \end{cases}$$

$$\mathrm{DIc} = \begin{cases} 1 - e^{(150 - DI)/100}/4 & \text{for } 150 < DI \\ (DI + 150)/400 & \text{for } 50 < DI \le 150 \\ (DI + 250)/600 & \text{for } -100 < DI \le 50 \\ e^{(DI + 100)/150}/4 & \text{for } DI \le -100 \end{cases}$$

The resulting color values HIc, CIc and DIc have a range between 0 (cyan, blue and magenta, respectively) and 1 (red, yellow and green, respectively) with 0.5 being the white midpoint. Colors may be combined, with each climate resulting in a unique color.

The online *Calculations* page allows the user to calculate HI, CI and DI based on monthly climatic information supplied by the user about a viticultural region (mean, minimum and maximum temperatures, precipitation and potential evapotranspiration). It also determines the classes in which each of the three calculated indexes fall in, searches the database for locations with a similar viticultural climate and displays the list of these locations to the user.

Results and Discussion

The viticultural climate database includes, up to this date, over 20 countries and continues to grow. An example of database search results is shown in Figure 1, in which Brazil was selected as a search criteria. This example shows twelve entries for Petrolina (in the viticultural region of the São Francisco Valley), which is located in a tropical region, and has a viticultural climate with intra-annual variability, with a large variability in DI, characterizing a dry season and a wet season during the year. Also shown is the most important wine producing region of Brazil (Serra Gaúcha / Bento Gonçalves). The complete database of brazilian viticultural regions is being worked on and will be soon included in the database.

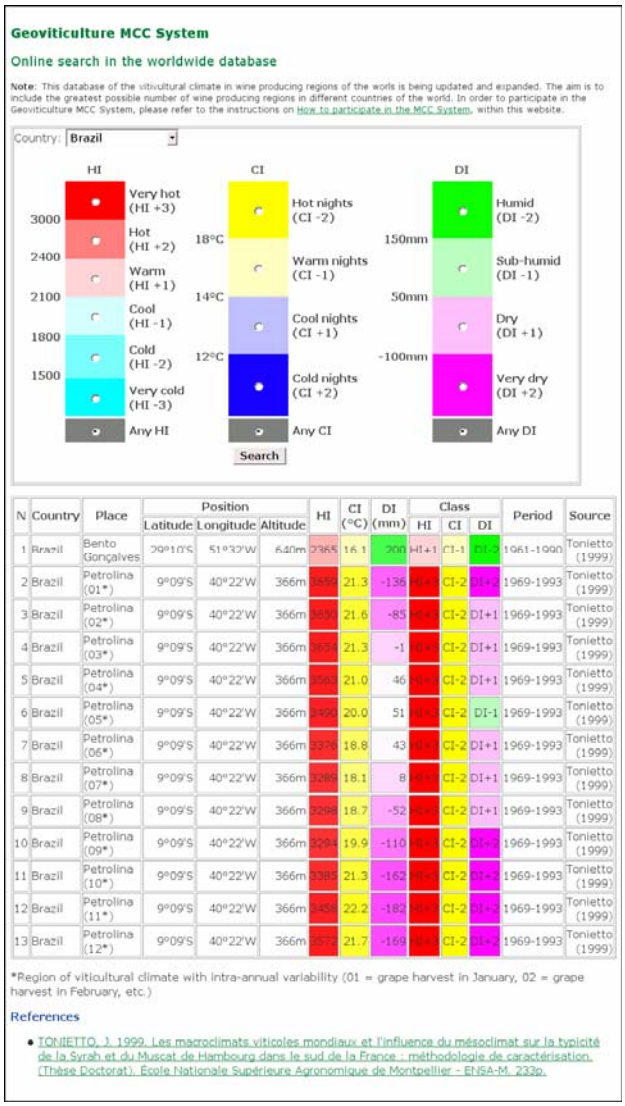
The database may be used to compare the climates of different locations, as well as to find locations with similar climates throughout the world.

An example of online viticultural climate index calculations (HI, CI and DI) is shown in Figure 2, which demonstrates how one may use the website to determine the class of viticultural climate in the location of his vineyards. User input is divided into three categories. In the *Identification* section are the names of the viticultural region, weather station and country. The *Geographic coordinates* include latitude, longitude, altitude and the list of years which compose the time series of climatic data used (should be at least 10 years; preferably 30). The most significant section for the calculations is *Monthly climatic data*, in which values should be entered for each of the months of April through September (in the Northern Hemisphere) or October through March (in the Southern Hemisphere). These data include the monthly average of the daily minimum temperatures (only for the last month), the monthly averages of the daily maximum and mean temperatures, and monthly total precipitation and evapotranspiration.

The results show a hypothetical location in the middle of the Atlantic Ocean with HI=2000 (class HI-1), CI=13°C (class CI+1) and DI=132mm (class DI-1), which is a viticultural climate similar to the French regions of Agen, Bordeaux and Cognac.

As global warming is becoming a reality, it is important to be able to predict its consequences in wine production. The MCC System may be used to simulate the effects of climate changes in viticultural climate indexes. The database may then be searched in order to find which locations in the world have a climate similar to the expected future conditions, which may give hints about the changes that may be expected in viticultural potential related with wine characteristics.

Future developments of the website include the possibility of storing climatic data for each specific harvest and to evaluate the range of the viticultural climate in a specific location. This also makes it possible to compare climatic conditions of one harvest with another in the same location and to better characterize vintage wines. This may also be used to compare the climate of one year in one location with the climate of another year in a different location. The evolution of the indexes along the different months of the vegetative cycle may also be included in the future. This information will permit an analysis of the evolution of the viticultural climate and improve the possibilities of comparing viticultural climates of different regions.



Geoviticulture MCC System

Online search in the worldwide database

Note: This database of the viticultural climate in wine producing regions of the worls is being updated and espanded. The aim is to include the greatest possible number of wine producing regions in different countries of the world. In order to participate in the Geoviticulture MCC System, please refer to the instructions on How to participate in the MCC System, within this website.

Country: Brazil

HI: Very hot (HI +3); Hot (HI +2); Warm (HI +1); Cool (HI -1); Cold (HI -2); Very cold (HI -3); Any HI

CI: Hot nights (CI -2); Warm nights (CI -1); Cool nights (CI +1); Cold nights (CI +2); Any CI

DI: Humid (DI -2); Sub-humid (DI -1); Dry (DI +1); Very dry (DI +2); Any DI

Search

N	Country	Place	Position			HI	CI (°C)	DI (mm)	Class			Period	Source
			Latitude	Longitude	Altitude				HI	CI	DI		
1	Brazil	Bento Gonçalves	29°10'S	51°32'W	640m	2365	16.1	200	HI+1	CI-1	DI-2	1961-1990	Tonietto (1999)
2	Brazil	Petrolina (01*)	9°09'S	40°22'W	366m	3859	21.3	-136	HI+2	CI-2	DI+2	1969-1993	Tonietto (1999)
3	Brazil	Petrolina (02*)	9°09'S	40°22'W	366m	3850	21.6	-85	HI+2	CI-2	DI+1	1969-1993	Tonietto (1999)
4	Brazil	Petrolina (03*)	9°09'S	40°22'W	366m	3653	21.3	-1	HI+2	CI-2	DI+1	1969-1993	Tonietto (1999)
5	Brazil	Petrolina (04*)	9°09'S	40°22'W	366m	3561	21.0	46	HI+2	CI-2	DI+1	1969-1993	Tonietto (1999)
6	Brazil	Petrolina (05*)	9°09'S	40°22'W	366m	3496	20.0	51	HI+2	CI-2	DI-1	1969-1993	Tonietto (1999)
7	Brazil	Petrolina (06*)	9°09'S	40°22'W	366m	3376	18.8	43	HI+2	CI-2	DI+1	1969-1993	Tonietto (1999)
8	Brazil	Petrolina (07*)	9°09'S	40°22'W	366m	3289	18.1	8	HI+2	CI-2	DI+1	1969-1993	Tonietto (1999)
9	Brazil	Petrolina (08*)	9°09'S	40°22'W	366m	3298	18.7	-52	HI+2	CI-2	DI+1	1969-1993	Tonietto (1999)
10	Brazil	Petrolina (09*)	9°09'S	40°22'W	366m	3294	19.9	-110	HI+2	CI-2	DI+2	1969-1993	Tonietto (1999)
11	Brazil	Petrolina (10*)	9°09'S	40°22'W	366m	3381	21.3	-162	HI+2	CI-2	DI+2	1969-1993	Tonietto (1999)
12	Brazil	Petrolina (11*)	9°09'S	40°22'W	366m	3458	22.2	-182	HI+2	CI-2	DI+2	1969-1993	Tonietto (1999)
13	Brazil	Petrolina (12*)	9°09'S	40°22'W	366m	3573	21.7	-169	HI+2	CI-2	DI+2	1969-1993	Tonietto (1999)

*Region of viticultural climate with intra-annual variability (01 = grape harvest in January, 02 = grape harvest in February, etc.)

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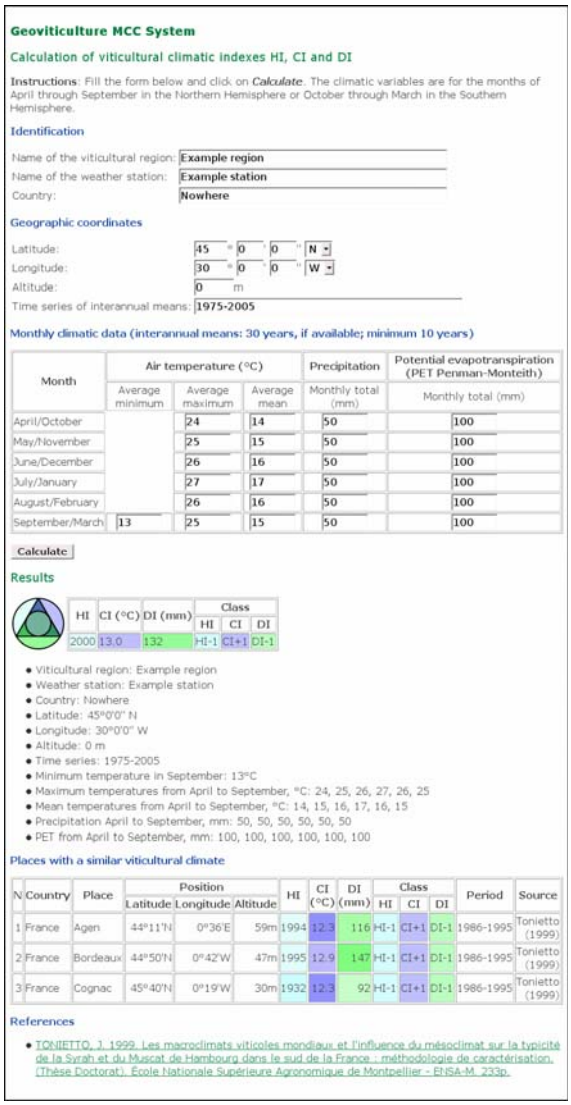
Figure 1 Output of a query to the worldwide viticultural climate database



Geoviticulture MCC System

Calculation of viticultural climatic indexes HI, CI and DI

Instructions: Fill the form below and click on *Calculate*. The climatic variables are for the months of April through September in the Northern Hemisphere or October through March in the Southern Hemisphere.

Identification

Name of the viticultural region: Example region
Name of the weather station: Example station
Country: Nowhere

Geographic coordinates

Latitude: 45 ° 0 ' 0 " N
Longitude: 30 ° 0 ' 0 " W
Altitude: 0 m
Time series of interannual means: 1975-2005

Monthly climatic data (interannual means: 30 years, if available; minimum 10 years)

Month	Air temperature (°C)			Precipitation	Potential evapotranspiration (PET Penman-Monteith)
	Average minimum	Average maximum	Average mean	Monthly total (mm)	Monthly total (mm)
April/October		24	14	50	100
May/November		25	15	50	100
June/December		26	16	50	100
July/January		27	17	50	100
August/February		26	16	50	100
September/March	13	25	15	50	100

Calculate

Results

HI	CI (°C)	DI (mm)	Class		
			HI	CI	DI
2000	13.0	132	HI-1	CI+1	DI-1

- Viticultural region: Example region
- Weather station: Example station
- Country: Nowhere
- Latitude: 45°0'0" N
- Longitude: 30°0'0" W
- Altitude: 0 m
- Time series: 1975-2005
- Minimum temperature in September: 13°C
- Maximum temperatures from April to September, °C: 24, 25, 26, 27, 26, 25
- Mean temperatures from April to September, °C: 14, 15, 16, 17, 16, 15
- Precipitation April to September, mm: 50, 50, 50, 50, 50, 50
- PET from April to September, mm: 100, 100, 100, 100, 100, 100

Places with a similar viticultural climate

N	Country	Place	Position			HI	CI (°C)	DI (mm)	Class			Period	Source
			Latitude	Longitude	Altitude				HI	CI	DI		
1	France	Agen	44°11'N	0°36'E	59m	1994	12.3	116	HI-1	CI+1	DI-1	1986-1995	Tonietto (1999)
2	France	Bordeaux	44°50'N	0°42'W	47m	1995	12.9	147	HI-1	CI+1	DI-1	1986-1995	Tonietto (1999)
3	France	Cognac	45°40'N	0°19'W	30m	1932	12.3	92	HI-1	CI+1	DI-1	1986-1995	Tonietto (1999)

References

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Figure 2 Calculation of viticultural climate indexes HI, CI and DI

Conclusions

Perspectives for the future are to increase the quality and to enrich the climatic database by including data from more countries and more wine producing regions. The site will be constantly updated as new data becomes available for insertion in the database. The collaboration of new and current partners is crucial to this effect. A CYTEd cooperation project of with 10 Ibero-American countries will increase the database, in the near future, in more than 150 new regions (SOTÉS and TONIETTO, 2004). It is our intention to translate the web site into other languages, with Spanish being the next target. New functionality is also being worked on, such as the estimation of the regional viticultural impact caused by climate change.

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