VITICULTURAL ZONING IN D.O.C. RIBEIRO (GALICIA, NW SPAIN)

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Key words: mesoclimates, geographic information systems, digital terrain model, traditional varieties, viticultural climatic characterization.

Summary
The 'Ribeiro' is the most historically renowned Denomination of Origin (D.O.) in Galicia and includes some 3,200 hectares. This region is situated in the central part of the river Miño valley in northwest Spain and has a temperate maritime climate corresponding to Winkler´s II zone. Although there are very productive varieties of vines e.g. Palomino or Garnacha, these have been recently substituted by more traditional varieties better suited to the production of higher quality wines.
In the following article, we identify prevailing mesoclimates, in this particular vine growing and wine producing area and characterize the most suitable conditions for these varieties concerned. In order to distinguish among mesoclimates, data provided by seven new automatic meteorological stations during 2003 was utilized. In addition to this, the wine-producing cooperative commercialising over 60% of the production in the area concerned, facilitated details corresponding to Brix degrees when grapes harvested entered the cellars. These data on Potential Alcohol Content (PAC) were introduced into a geographic information system (GIS) for integration with a Digital Terrain Model (DTM) in order to obtain a zonification where mention of the identified mesoclimates present appear together with the most suitable areas for the traditional varieties.

Résumé
L'AOC Ribeiro est la plus ancienne de Galice (NO de l'Espagne), avec une aire de production potentielle de 3.200 ha. Situé dans la région centrale de la vallée du Miño, le Ribeiro a un climat de tipe maritime tempéré qui se correspond avec la zone climatique II de Winkler. Bien que prédominent des variétés très productives (Palomino, Grenache), aujourd'hui beaucoup de vignerons sont en train de substituer ces cépages, au profit des variétés anciennes plus adaptées à la production des vins de qualité.
Le but de ce travail est caractériser les méso climats présents dans cette région viticole et aussi, identifier les endroits les plus favorables pour ces cépages anciens.
Nous disposons des données météorologiques fournies par sept nouvelles stations automatiques au cours de l'année 2003. Pour l'étude viticole, la cave coopérative qui commercialise plus du 60% des vins produits dans la région nous a proportionné les données relatives au degré alcoolique des raisins du millésime 2003. En préliminaire, toutes les données recueillies ont été intégrées à un système d'information géographique (SIG), pour générer la base cartographique du zonage. En ajoutant les données concernant la maturité des vignobles (degré alcoolique) avec un modèle numérique du terrain (MNT), nous avons raffiné le zonage méso climatique initial. De plus, cela nous permit d'identifier les zones mieux adaptées aux exigences des variétés traditionnelles.

Mot-clés: variétés anciennes, méso climats, SIG, modèle numérique du terrain (MNT), variétés traditionnelles, zonage climatique pour le vignoble.

Introduction

The Ribeiro DO fills more than 2.700 hectares in southern Galicia (NW Spain), spreading southwest from the outskirts of Ourense along the Miño valley to the outskirts of Melgaço on the Portuguese frontier (Figure 1). In this area, the vines yield annually approximately 18000 tons of grapes which produce 13,5 millions litres of wine (85% white wine) in about 100 usually quite small wine cellars.
Having been created in 1945, this area is the most historic DO in Galicia and is at present undergoing improvements in selection of varieties. One of the main changes is the substitution of widely grown varieties (e.g. Palomino and Garnacha) which had been introduced during a crisis of mildew and philosera in the second half of the ninetieth century (Huetz, 1967) for others utilised long before and which have greater potential yield in the production of quality wines. Today, although the varieties actually most extended are Palomino (representing about 66%) and Garnacha (14%) many vine growers are substituting these for other varieties such as Treixadura (9.5 %) and Torrontés (7.5 %) and even mainly including such minor varieties such as Loureira, Albariño and Lado.
The success of this restructuring depends greatly on phenology and the demands of each variety as well as the specific characteristics of the different mesoclimates prevailing in the zone. This is because we are dealing with an area where variations in altitude and orientation favour the appearance of specific local climates which are ultimately those decisive in the maturity potential of each variety.
The objectives of this study are to identify the conditions of altitude and orientation most favourable for the different varieties and also the limits where maturity problems arise.
In order to identify these limits, we had data from the PAC (potential alcohol content) of more than 5500 grape batches corresponding to 6.9 millions kilos processed by the biggest wine cellar in the zone. Although this information is of limited value to inform on the maturity stage (Gladstones, 1992; Martinez, 2001), it does have the value of quantity (it represents more than 37% of the total production in the DO) and its extensity since this cellar buys grapes proceeding from the entire Ribeiro DO.
We hypothesised that integrating the corresponding data from the different batches, vine growers and varieties in a DTM in which the vines appeared with their respective altitudes and orientations, we could then construct a GIS capable of identifying the most suitable topographic conditions for maturity of each variety and the limits from which maturity problems begin to arise.

Materials and methods

Materials

Meteorological data corresponding to 2003 was obtained from seven meteorological stations which the regional government has in this zone and which have been active since 2000. The data corresponding to the PAC of more than 5500 batches of grapes were submitted by the Ribeiro Wine Cooperative which in this period processed more than 6.9 millions of kilograms of 12 different varieties although in the present study only the figures of three varieties considered to be of greater importance in the programs of restructuring were considered (Palomino, Treixadura and Torrontés). The DTM was acquired from the Spanish National Geographic Institute and has a 200 metres pixel resolution whereas the land use map was provided by the Spanish Ministry of Agriculture.

Methods

The meteorological data were submitted to a simple statistic treatment before elaborating a similitude matrix among the different stations consulted in the statistics package SPSS.12© to establish similarities and differences among the different stations. The same program was employed to quantify the relationships between the data corresponding to PAC, altitude, and orientation in each wine growing area.
The integration of the different data corresponding to the vineyards where the grapes had been selected was carried out utilizing GIS Geomedia 5.1 (Intergraph©) under Registered Research Laboratory Agreement number RRLES6103. This software package allowed us to relate the corresponding values of PAC and variety with the topographic variables provided by the MDT.

Results and discussion

Table 1 shows some of the main characteristics of the climate of the zone such as mean annual temperature, temperature during the growing period, precipitation from January to October, precipitation during the growing period, and the values corresponding to the Winkler index (Winkler *et al.*, 1984) for the stations situated in the Ribeiro DO or proximities during 2003.
The statistical treatment and a dendogram (Figure 2) generated from the similitude matrix constructed from the data corresponding to the selected weather stations during 2003 allowed the identification of three climatic zones (mesoclimates) (Figure 3): the zone corresponding to Ribeiro of Arnoia, the rainiest; the Avia valley, the coldest, and the sector corresponding to the Ribeiro of Ourense which is the warmest and driest. These results confirm the character of climatic transitional zone which an author had previously attributed to this vine-growing DO (Yglesias, 1983).
Analysis of the data corresponding to the PAC of the three selected varieties revealed in the first place that the main variety (Palomino) had considerable problems during maturity during the 2003 campaign. According to this, the reintroduction of minority varieties Treixadura and Torrontés appears to be successful due to considerably better maturity.
In figure 4, it can be seen that the Palomino variety is hardly affected by orientation as only those vineyards with NE orientation are clearly seen to be less adequate in relation to maturity. In any case, in the better-attended vineyards, the highest PAC values always corresponded to vineyards orientated towards the SE, S and SW. It was also found that the maturity of this variety is hardly sensitive to elevation until reaching three hundred meters.
In Figure 5, of the three varieties, Treixadura can be seen to present higher average PAC values and is also more sensitive to sun exposure preferring S, SE and SW orientations except in specific cases where vineyards orientated to the West and Northwest can also produce high PAC values. This variety doesn't show sensitivity to altitude as long as the vines are not cultivated at more than 225 m, apart from which they show many maturity problems.
In Figure 6, Torrontés has the peculiarity of being able to mature adequately in N and NW orientations which are quite frequent in the vineyards of the area under study. With appropriate cultivation Torrontés can have very high PAC values in SE and SW orientations and, similar to Treixadura, shares maturity problems in altitudes over 225 m.

Conclusions

The PAC was employed as a reference in the evaluation of the adaptation of the three varieties of white wine vines dominating in the DO Ribeiro. It was found that the majority variety, Palomino, attained lower PAC values than the other two varieties although having in advantage a relative indifference to orientation and altitude. In contrast, of the three varieties, Treixadura is the one that reaches the highest PAC values although demonstrating an evident preference for S, SE and SW orientations. But on the other hand, begins to show maturity problems over 225 m altitude. Similarly, Torrontés shows maturity problems from the same height but, in contrast, is able to reach satisfactory maturity in north and northwest orientations which were little suitable for Treixadura.
To sum up, the integration of meteorological data and the corresponding PAC values together with the help of a GIS permitted the identification of three distinct mesoclimates within the Ribeiro DO and the characterization of the topographic conditions most suitable for the maturity of the three most representative white wine varieties (Palomino, Treixadura, Torrontés).

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List of tables and figures

Tables and figures.

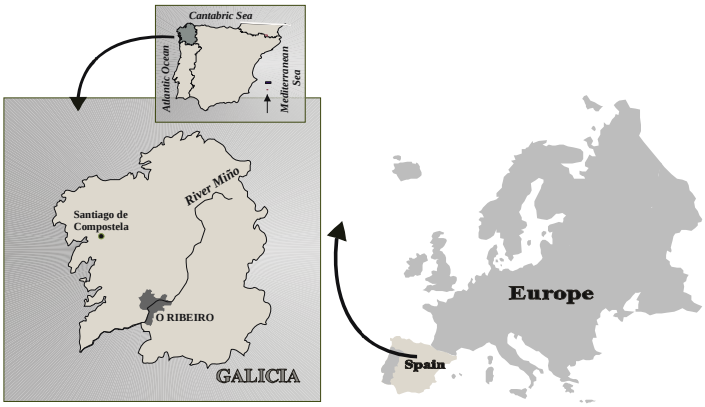

Figure 1. Location of Ribeiro DO.

Table 1. Weather characteristics for year 2003 in Ribeiro DO.

Station	Alt	Mat	Mtap	Pjo	Pap	Et
Arbo	180	15,0	18,3	1246	414	1516
Arnoia	120	14,1	18,7	1122	391	1593
Quinza	108	13,6	17,1	1130	406	1478
Leiro	110	13,6	18,2	1170	349	1501
Prado	145	14,3	19,0	962	286	1643
Barbantes	120	13,8	18,3	817	228	1523
Ourense	143	15,6	20,4	679	204	1901

Alt: altitude above sea level in meters; Mat: mean annual temperature (ºC); Mtap: sum of effective temperatures (Tª>10 ºC); Pjo: rainfall from January to October (mm); Pap: rainfall in mm from April to September (mm);

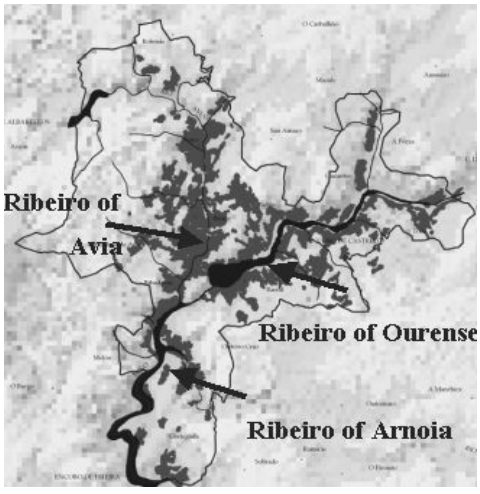

Figure 2. Areas of intense vineyard cultivation and location of the three distinct mesoclimates in the Ribeiro DO.

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   C A S O       0         5         10        15        20        25
Label       Num  +---------+---------+---------+---------+---------+

Quinza        3   ⇩✖⇩⇩⇩⇘
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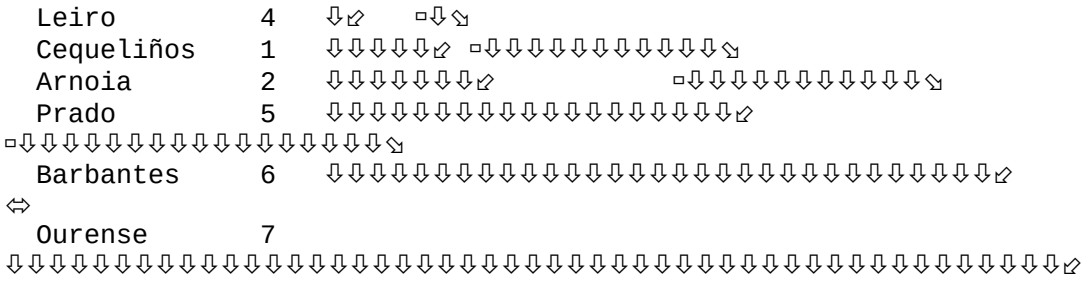

Figure 3. This Dendogram shows the distinction of the Ribeiro of Avia (Quinza and Leiro coldest stations) and the Ribeiro of Miño (the others). Within the Ribeiro of Miño, Cequelinos and Arnoia are the rainiest whereas the rest are warmest and driest.

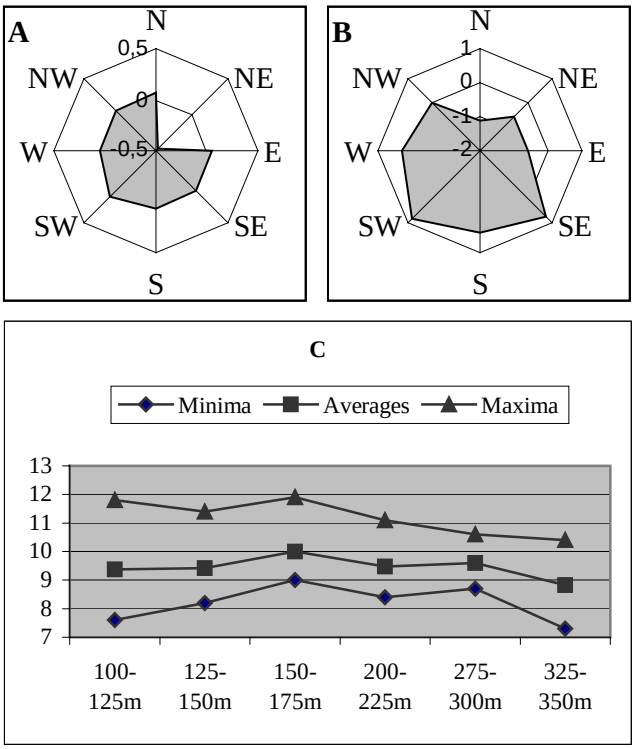

Figure 4. Results for Palomino vine variety. A. Difference with average PAC. B. Difference with average of PAC maxima. C. PAC with Altitude Relationship

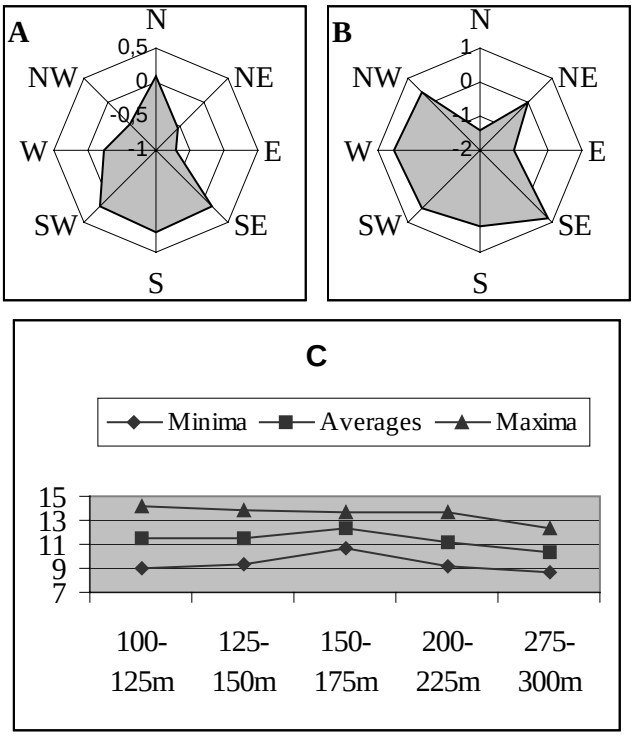

Figure 5. Results for Treixadura vine variety. A. Difference with average PAC. B. Difference with average of PAC maxima. C. PAC with Altitude Relationship.

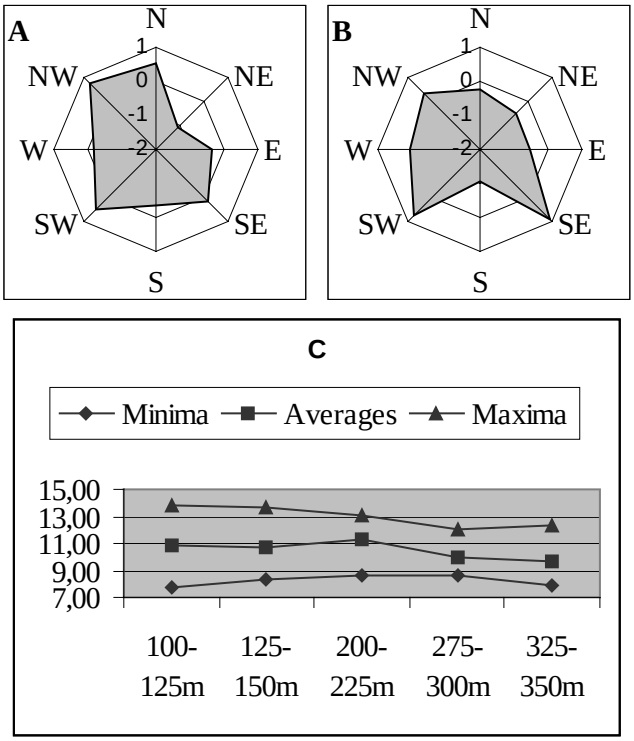

Figure 6. Results for Torrontés vine variety. A. Difference with average PAC. B. Difference with average of PAC maxima. C. PAC with Altitude Relationship.