TERROIR ZONING IN APPELLATION CAMPO DE BORJA (NORTHEAST SPAIN): PRELIMINARY RESULTS

[1]Vicente GÓMEZ-MIGUEL, [1]Vicente SOTÉS, [1]Joaquín CÁMARA, [1]Álvaro MARTÍNEZ

[1]*Universidad Politécnica de Madrid; c/ Puerta de Hierro, 2; 28040-Madrid, Spain;*

vicente.gomez@.upm.es

Abstract

The components and methodology for characterization of the terroir have been described by Gómez-Miguel & Sotés (1993-2014, 2003) and Gómez-Miguel (2011) taking into account the full range of environmental factors (i.e: climate, lithology, vegetation, topography, soils, altitude, etc.), landscape variables (derived from photo-interpretation and a digital elevation model), and specific variables to the country's viticulture (i.e: size and distribution of the vineyards, varieties, phenology, productivity, quality, designation regulations, etc.).

This methodology describes: the integration of the resulting database in a Geographic Information System (GIS) that allows the spatial and statistical analysis of all variables; the parametric system of variable quantification; the selection of main endogenous and exogenous variables for terroir characterization; and the role of the all variables in the final results. The analysis has been carried out on over 4,5 million ha.

This paper presents the results (1:25.000) of a case studied in the Northeast Spain. The Campo de Borja region (DO Campo de Borja, Spain) expands on 65 240 ha and includes 6 815 ha (2012) of vineyards (figure 1). The observed distribution of vineyards in this county is correlated to the integrated landscape-terrain classification and productivity but does not depend on the total available area for cultivation. The results of the final study have general implications for terroir zoning in the region and define a set of methodological guidelines: a) definition of the set of variables that define the terroir b) definition of the Homogeneous Terroir Units (HTU); c) characterization of the homogeneous environmental terroir units; d) final zoning: integration of the HTU with the plant (variety and rootstock) and the product (must and wine).

This paper describes the role of the vegetation (figure 2A) and the climate (figure 2) as active factors upon the lithology (lithological groups, figure 4)) and the geomorphology (geophorms, drainage, altitude, slope, figure 5-8) as passive factors in the terroir configuration in the DO Campo de Borja (Spain).

Keywords: terroir, zoning, landscape, lithology, climate, soil, Geographic Information System, Campo de Borja, Spain

1 INTRODUCCIÓN

The DO Campo de Borja is located in the Northeast of the Spanish region Aragón, and it extends in the left bank of the Ebro River Basin over an area of 65 240 ha, of which 6 815 ha (2012) are under vines (figures 1A and 1B). There are three main geomorphologic units clearly differentiated which characterize the region: the area of influence of the Moncayo mountain, the connecting surfaces with valleys, and terraces of the Ebro River and its main major tributaries (figure 2C).

This paper describes the role of the vegetation (figure 2A) and the climate (figure 2B) as active factors upon the lithology (lithologic groups, figure 2D) and the geomorphology (geophorms), and the drainage (figure 2C), altitude (figure 1C), slope, as passive factors in the terroir configuration in the Apellation Campo de Borja (*Denominación de Origen Campo de Borja*, NW Spain; DO Campo de Borja).

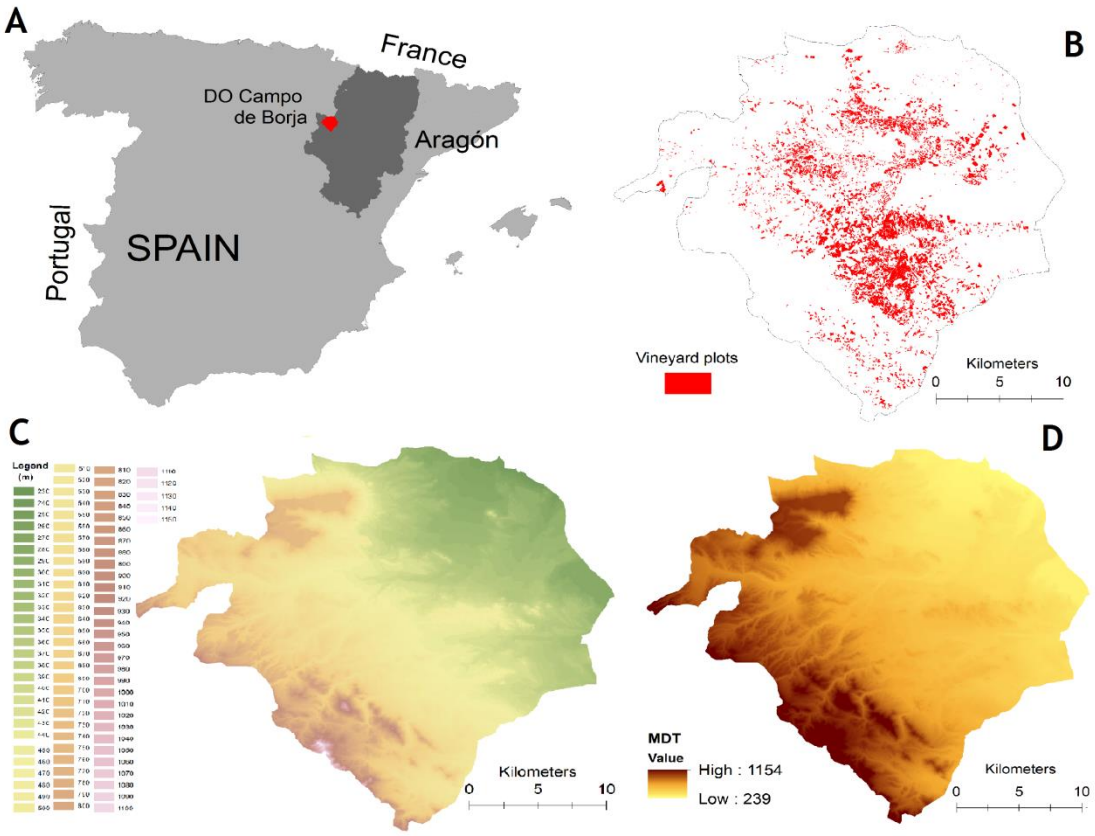

Figure 1. Localization (A), parcels distribution of vineyards (B), elevation contours (C) and Digital Terrain Model (D) in the DO Campo de Borja

2 MATERIALS AND METHODS

A debate quite persistent about the relationship between geology and wine quality remains in some studies . Our experience in analyzing over 4.5 million hectares, is that environment (climate, lithology, geomorphology, landscape and soils) is an important factor in wine quality.

Gómez-Miguel & Sotés (1993-2014, 2003) and Gómez-Miguel (2011) described the general methodology for terroir zoning and characterization that takes into account the specific conditions in Spain, such as land use, vineyard size and distribution, and occupation index of the designation regulations. The spatial scale of the analysis is 1:20.000, allowing adequate segregation of both geoforms and lithology analysis. Results will be published at 1:25.000.

The methodology is based on the integrated spatial analysis of environmental variables (i.e., climate, vegetation, geology and geomorphology, soils...), and variables specific to the country's viticulture (i.e., size and distribution of the vineyards, varieties, phenology, productivity, quality, designation regulations, etc.). The climatic study was carried out from a large number of quantitative variables such as temperature, precipitation, evapotranspiration, humidity and climatic balance, bio climatic and viticulture

indexes. Using multivariate analysis such as PCA, DFA, and cluster, the redundant variables were eliminated and only the variables with a high explanatory value were chosen. The mathematical models obtained allowed determining a map with the climatical viticultural zones. To evaluate the vigour of vine Normalized Difference Vegetation Index (NDVI, Rouse et al., 1973) was used. Criteria for the excluding were determined from vegetation maps (natural and potential vegetation). A digital terrain model allows the use of variables such as altitude and others more difficult to represent such as exposure and length and inclination of the slope. Variables related to lithology and geomorphology are evaluated from the respective maps obtained by airphotointerpretation (API), remote sensing and field work. The soil map (soil series, SSS, 1996, 1999; USDA, 2010) and viticultural and enological data are currently underway.

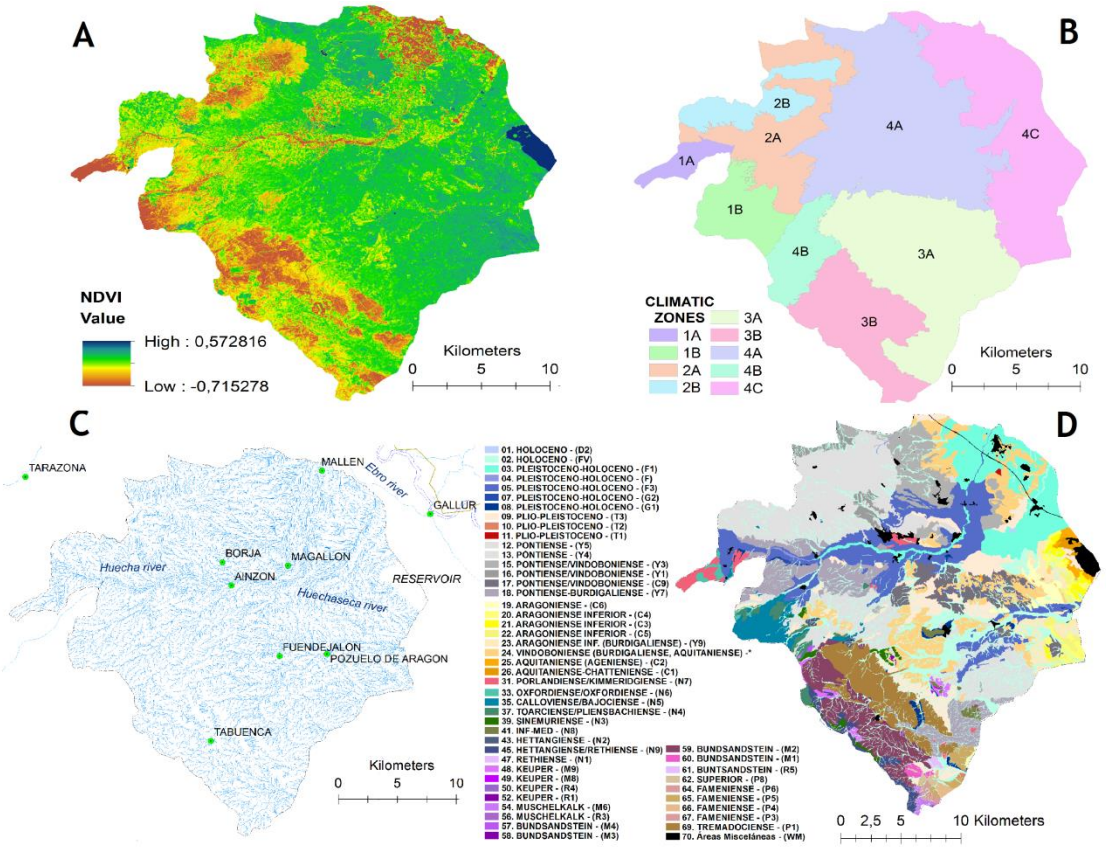

Figure 2. The Normalized Difference Vegetation Index, NDVI (A), the climatic zones (B), the drainage net (C) and the lithological groups (D) in the DO Campo de Borja

The result is a map with soil map units, which summarises the relationship among lithology units, geoforms and soil units. Then, the map units are evaluated according to a parametric system adapted to the ecological conditions for the vineyard. The resulting database is integrated in a geographic information system (GIS) that allows the spatial and statistical analysis of all variables and the results are presented in maps.

The validation of the results is carried out comparing the obtained results with the specific zone maps of distribution of vineyard and productions of grape and wine. Finally, the main influential variables are selected, quantified, and integrated, providing the basis for terroir characterization (zoning). The validation and the terroir units are not included in this paper.

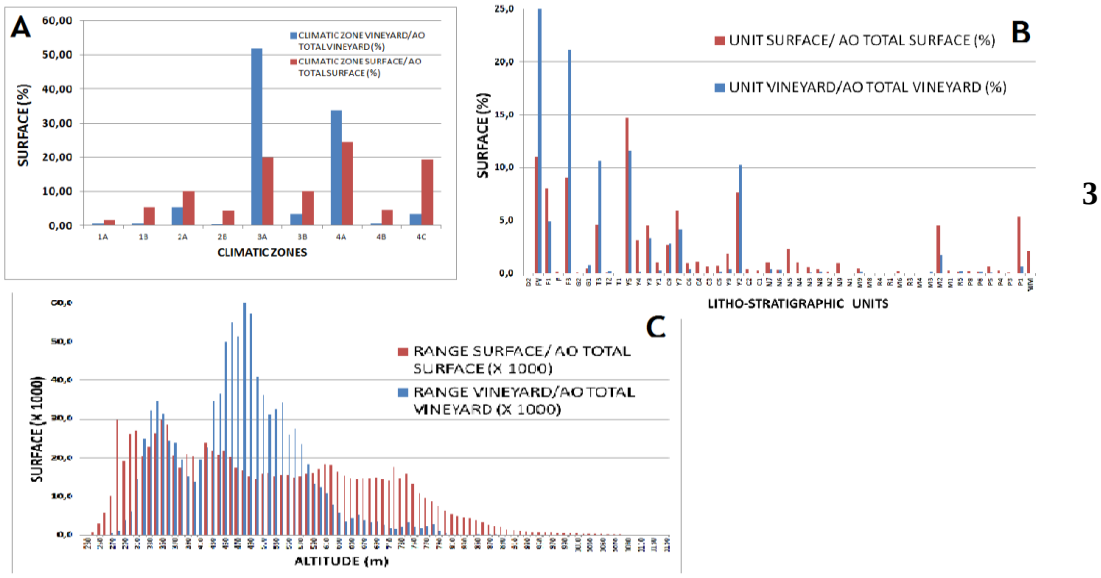

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Figure 3 Area (%) of climatic zones (A), lithological groups (B) and altitude areas (C)

RESULTS AND DISCUSION

The figure 2A shows the Normalized Difference Vegetation Index (NDVI) and climatic zones are included in Figure 2B: even visually observed a significant relationship. Two climatic zones (44.5% of the area of the region) represent 85.5% of the vineyard (figure 3A).

The influence of geology (lithology, stratigraphy, and geomorphology) in the relationship soil/grapevine is evaluated by aerial photointerpretation (API) and field work.

The geographic distribution of the API units of the DO Campo de Borja is derived from aerial photointerpretation. The legend consists of six digits that include lithology, geoforms, slope, erosion and others. The importance of such cartography is the fact that each of the units includes all attributes. For instance, the Campo de Borja vineyard remain under 610 m (Figures 1C and 3C): in the 310-610 m range 92,93 % (60,5 % of the region area).

The figure 2D shows the lithological groups and their distribution in the DO Campo de Borja. Only five zones (All Neogene materials, figure 3B) are of special relevance with 78.6 % of the vineyard (47 % of the region area).

This geographic information is validated with the cartography generated in polygons obtained by interpolation and topographic correction at predetermined intervals, and the results define uniform areas. The vineyard surface distribution has been considered before (Dioujev, 1973) but its use as validation index is not clear. Nevertheless, its use in global terms is justified since it is assumed that viticulturists select the most adequate growing areas, especially when the available area is large (Webster and Olivier, 1990), as in the case of DO Campo de Borja. In this area, there are some units clearly selected for vineyard, other units with mixed selection, and other units clearly disregarded for vineyards.

In the DO Campo de Borja, the vineyard distribution is in harmony with the cartographic units derived from our API analysis, with climate and lithology, and geomorphology parameters, and with the best qualified areas. The best polygons in our analysis present either a larger occupation index or more surface

of vineyard. In all cases, the percent area with vineyard is small since the total available surface is very large.

The results of the distribution of vineyard by environmental factors (climate, litho-geomorphologic and soil units) permit to establish criteria related to the optimal distribution and behaviour of the vineyard. Correct selection of the environmental groups allows further considerations related to soil characteristics correlations with wine production.

4 CONCLUSIONS

The results of the study have general implications for the terroir classification in Spain and define a set of methodological guidelines. The guidelines refer to (scale 1:25.000). :

- Definition and mapping of climatic zones. DO Campo de Borja has been divided into nine similar climate areas, where meteorological stations in the region are grouped
- Definition of the set of variables that define the landscape: characterization of the lithological and morphological components; homogenization of lithological units; cartography of the geological formations (Seventy units have been described and mapped, and only eighteen have vineyard); integration of a digital elevation model to derive altitude, orientation, exposure, and slope.
- The Definition of the Homogeneous Terroir Units (HTU), the selection of HTU and product characterization within the units and the final zoning (integration of HTU with the plant (variety and rootstock) and the must and the wine) are not included in this paper.

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5 REFERENCES

Dioujev P.K. (1973). Définition du milieu physique pour des vignobles typiques. Rapport Soviétique. Bulletin de l'O.I.V., 507, 377-385.

Gómez-Miguel, V. and V. Sotés. 1993-2014. Delimitación de zonas vitícolas en la DO Ribera de Duero (1992) en la DO Calificada Rioja (1995), en la DO Rueda (1998), en la DO Toro (1998), en la DO Bierzo (2002), en la DO Somontano (2004), en la DO Cigales (2009), en la DO Arribes (2012), en la RD Douro (2013) y en la DO Campo de Borja (2014-act). ETSIA. Universidad Politécnica de Madrid.

Gómez-Miguel V. and Sotés, V. (2003). Zonificación del terroir en España. In: M. Fregoni and D. Schuster (Eds). Terroir Zonazione Viticoltura. Phytoline, 187-226

Gómez-Miguel, V. 2011. Terroir. *In* J. Böhm (ed). Atlas das castas da Península Ibérica: história, terroir, ampelografia. Dinalivro, Lisboa, Portugal, 104-153

Rouse, J.W.J., R.H. Haas, J.A. Schell and D.W. Deering. 1973. Monitoring vegetation systems in the great plains with ERTS. Proceedings of the 3rd ERTS Symposium, NASA SP-351 1:309-17.

SSS. 1996. Soil Survey Laboratory Methods Manual. SSIR No. 42, v.3.0. United States Department of Agriculture

SSS. 1999. Soil Taxonomy. Second Edition. Agriculture handbook N1 436. Soil Survey Staff.

USDA. 2010. Keys to Soil Taxonomy. Soil Survey Staff. Natural Resources Conservation Service. Eleventh edition. Washington, D.C. 341 pp