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# AGROCLIMATIC CHARACTERIZATION OF THE PORTUGUESE WINE DENOMINATIONS OF ORIGIN USING A COMPOUND INDEX

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## Abstract

**Aims:** This study aims to: (1) characterize the agroclimatic conditions of the Portuguese Denominations of Origin, using a compound index that combines thermal and soil water balance conditions and a high-resolution climatic dataset (~1 km spatial resolution); (2) categorize the main grapevine varieties as a function of this compound index.

**Methods and Results:** The 50 protected denominations of origin (DOs)/ sub-regions in mainland Portugal are considered in the analysis. The Huglin and dryness indices are computed based on a high-resolution dataset over mainland Portugal and for a baseline period (1981–2015). Principal component analysis is applied to the time-mean spatial patterns of the aforementioned bioclimatic indices and only over the planted vineyard cover areas in each region. This methodology enables the identification of a compound index that can be used to assess the agroclimatic conditions of a given DO / sub-region. Moreover, a set of 44 main grapevine varieties in Portugal is used for assessing their growth conditions. A categorization of these varieties in terms of their current agroclimatic growing conditions is also analyzed based on GIS methods.

**Conclusions:** The present study highlights a wide diversity of agroclimatic conditions in the Portuguese DOs. This heterogeneity contributes to a vast number of different terroirs in the country, which is an important added-value for the winemaking sector, particularly under the ongoing climate change. Furthermore, it is shown that the main grapevine varieties in Portugal are also growing in very different agroclimatic conditions, which enables their categorization based on their current growing bioclimatic conditions.

**Significance and Impact of the Study:** The results of this study are not only useful for a detailed characterization of the agroclimatic conditions of the Portuguese DO, where there is a considerable lack of meteorological observations, but are also of utmost relevance when planning climate change adaptation measures and risk reduction strategies in the Portuguese winemaking sector. The variety-specific information may also be very helpful for varietal selection, mostly because information of climatic suitability for most of the Portuguese grapevine varieties is still incipient.

**Keywords:** Denominations of Origin, Huglin Index, Dryness Index, Compound Index, bioclimatic zoning, Portugal

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**Aim:** This study aims to: (1) characterize the agroclimatic conditions of the Portuguese Denominations of Origin, using a compound index that combines thermal and soil water balance conditions and a high-resolution climatic dataset (~1 km); (2) categorize the main grapevine varieties as a function of this compound index.

**Methods and results:** The 50 protected denominations of origin (DOs)/ sub-regions in mainland Portugal are considered in the analysis. The Huglin (HI) and dryness (DI) indices are computed based on a high-resolution dataset for the period of 1981–2015. A principal component analysis is applied to the time-mean spatial patterns of the aforementioned bioclimatic indices and only over the planted vineyard cover areas in each region. This methodology enables the identification of a compound index that can be used to assess the agroclimatic conditions of a given DO / sub-region (Fig 1 & 2).

In addition, a set of 44 main grapevine varieties in Portugal is used for assessing their growth conditions. A categorization of these varieties in terms of their current agroclimatic growing conditions is also analyzed based on GIS methods (Fig 3).

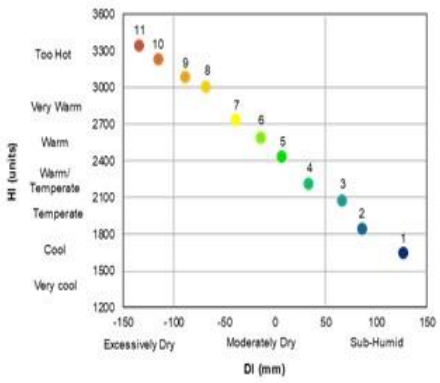



Figure 1. Scatterplot of the area-means of DI and HI for the different DI-HI combined bioclimatic classes (from 1 to 11). Area-means are computed only over vineyard areas.

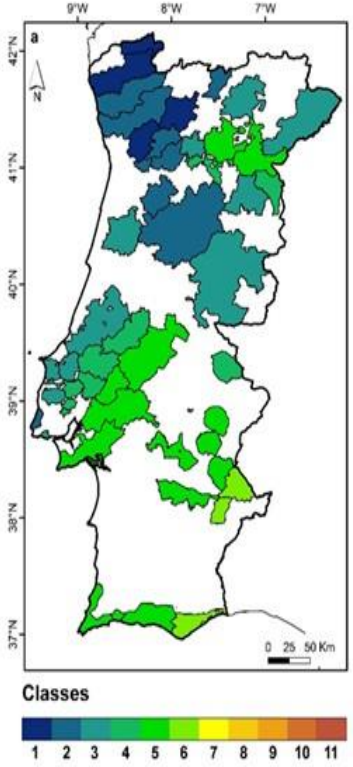
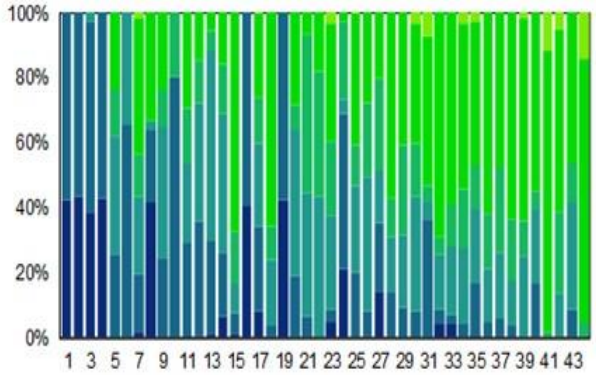



Figure 2. Map of the different DI-HI combined bioclimatic classes (from 1 to 11 according to the shading color scale) of the DOs and sub-regions over mainland Portugal for 1981–2015.



| | | |
|---|---|---|
| 1 - Espadeiro | 16 - Loureiro | 30 - Diagalves |
| 2 - Borraçal | 17 - Arinto | 31 - Alfrocheiro |
| 3 - Vinhão | 18 - Tinta Barroca | 32 - Rabigato |
| 4 - Azal | 19 - Trajadura | 33 - Viosinho |
| 5 - Gouveio | 20 - Bastardo | 34 - Trincadeira |
| 6 - Jaen | 21 - Tinta Miúda | 35 - Aragonez |
| 7 - Touriga Nacional | 22 - Vital | 36 - Touriga Franca |
| 8 - Alvarinho | 23 - Rabo de Ovelha | 37 - Malvasia Rei |
| 9 - Rufete | 24 - Avesso | 38 - Malvasia Preta |
| 10 - Encruzado | 25 - Tinta Carvalha | 39 - Síria |
| 11 - Malvasia Fina | 26 - Fernão Pires | 40 - Moscatel Graúdo |
| 12 - Bical | 27 - Tália | 41 - Antão Vaz |
| 13 - Baga | 28 - Moscatel Galego Branco | 42 - Castelão |
| 14 - Sercial | 29 - Alicante | 43 - Marufo |
| 15 - Tinto Cão | | 44 - Moreto |

Figure 3. Stacked relative bar charts (in %) for each grape variety and for the 11 classes for 1981–2015. Varieties are ranked from cooler/wetter to warmer/drier climates.

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