

# A spatial inventory of EU wine protected designation of origin to support decision making in a changing climate

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**Keywords:** adaptation, climate change, geographical indication, geospatial data

## Abstract

Wine products registered as Protected Designation of Origin (PDO) shape important values and are tied to closely defined geographic locations. To preserve the typicity of these wines, PDO wine production is strictly regulated, for instance by specifying allowed varieties or maximum yields. However, quality viticulture is increasingly under the pressure of climate change, which is altering the conditions of many winegrowing areas. Maintaining traditional wine products will therefore require the adoption of tailored adaptation strategies, which may include changes in legal regulations. To this end, it is necessary to have a comprehensive knowledge about wine PDO. With this study, we aim at presenting the preliminary results of a spatial inventory of European wine PDO that could support decision making in viticulture in the context of climate change. We analysed wine PDO legal documents and extracted relevant information useful for climate change adaptation. The output consists of a geographical dataset that identifies the boundaries of major European wine PDO and includes a set of legally binding regulations, such as the authorized vine varieties and planting density. This inventory will allow researchers to analyse the impacts of climate change on European wine PDO and support decision makers in developing tailored adaptation strategies.

## Introduction

Wines labelled as Protected Designations of Origin (PDO) are high quality products protected under a European Union (EU) quality scheme that recognize the physical and biological conditions of the place where they are made and the related production practices (Clark et al., 2017; European commission, 2022). 55% of the PDO recognized in Europe are related to wine products, and their regulatory documents include strict requirements regarding the cultivation and processing of grapes. To be labelled as a PDO product, a wine needs to be formally recognized by the European Commission. In this process, applicants must provide a set of specific documents that establish a direct link between the quality attributes of the product and its geographical origin (Marescotti et al., 2020). These documents are published online in the official EU indication register eAmbrosia, that represents the legal repository of all the geographical indications in the EU (European Commission, 2013).

Because of the strong relation between PDO wines and their cultivation area, as well as the conditions and production practices defined in their regulatory documents, these products are increasingly threatened by the consequences of climate change (Clark et al., 2017; OIV, 2010). For example, warmer climate conditions may affect the productivity of typical vine varieties that are the basis for the production of PDO wines (Fraga et al., 2016), and new climatic conditions might favour new diseases and pests harmful for traditionally established winegrowing regions (Caffarra et al., 2012). These changes may require the amendment of the documents that regulate the production and processing of PDO products. To thoroughly plan and develop specific adaptation strategies for PDO areas, it is therefore important to know their legal specifications (Clark et al., 2017; Neethling et al., 2017).

Here, we present an initial effort to collect and organize the regulatory information for major wine PDO in Europe. We show how it is possible to harmonize a set of regulatory information from the EU indications register eAmbrosia in a spatial inventory. This information is intended to be a support for the development of tailored adaptation strategies in PDO regions in the context of a changing climate.

## Materials and methods

We compiled the inventory over the period March 2021 – November 2021 using the EU geographical indication register eAmbrosia as a source (European Commission, 2022). We focused on major PDO recognized in the EU and the United Kingdom. The two steps for creating the inventory were:

(1) Spatialization of the PDO cultivation areas (Figure 1a, b). We georeferenced the areas using as a minimum mapping unit the local administrative units (LAU2), that correspond to the boundaries of municipalities (Eurostat, 2022).

(2) Selection and standardization of regulatory information (Table 1, 2). We extracted a set of selected information useful for adaptation purposes from the official documents available in the eAmbrosia portal. We collected only information that was available for all included PDO and could be standardized among them.

**Table 1.** Information included in the inventory and method used for standardization.

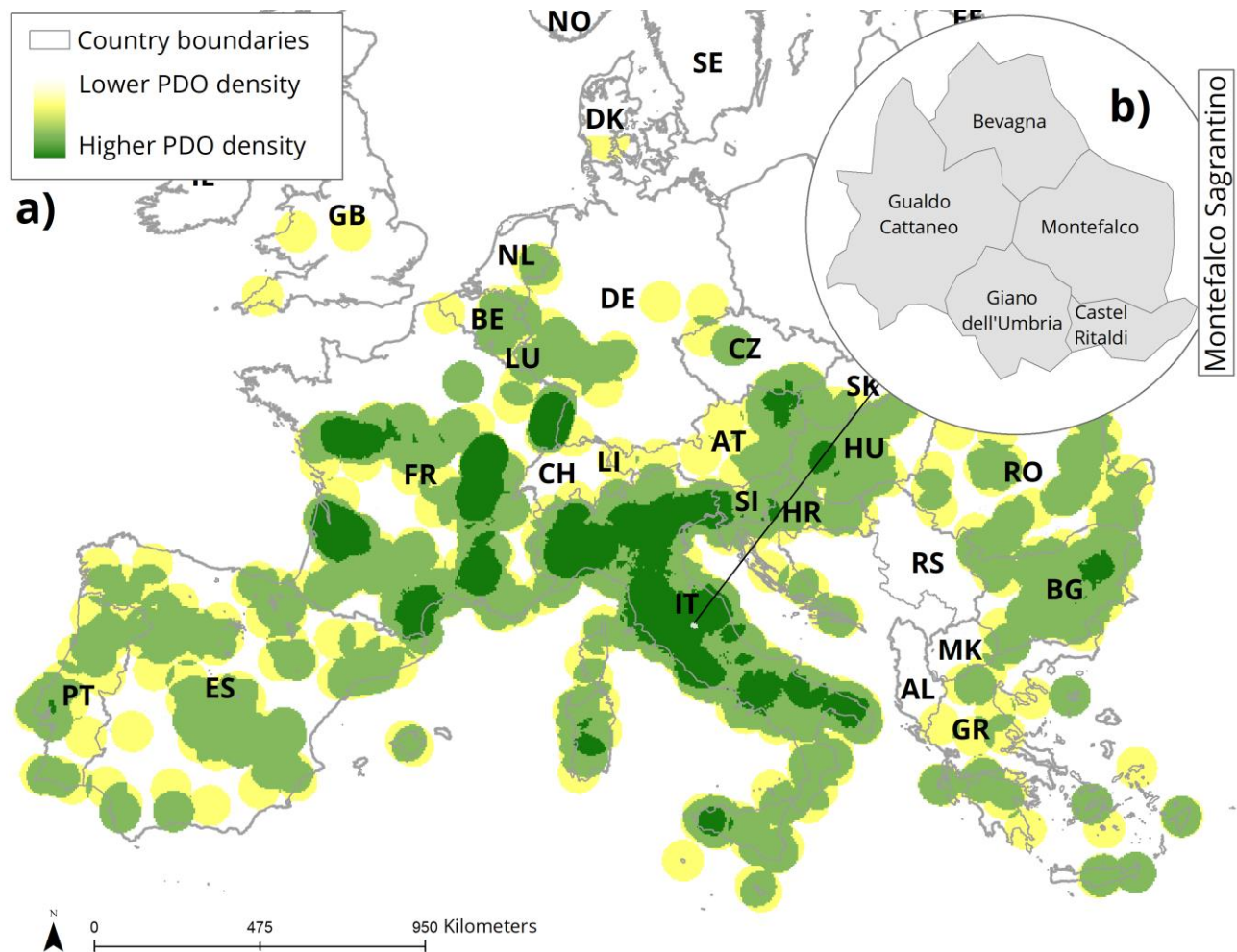
INFORMATION	METHOD
Country	The ISO 3166-1 code of the country where the wine PDO is located.
PDO identifier	The official id of the wine PDO as defined in eAmbrosia.
PDO name	The official name of the wine PDO as defined in eAmbrosia.
PDO registration date	The date of registration of the wine PDO.
Category of wine product	The wine product categories allowed in each PDO, following the definition of Regulation (EU) No 1308/2013 (European Commission, 2013).
Vine varieties	The list of the vine varieties allowed in the wine PDO, using the nomenclature adopted by the International Organization of Vine and Wine (OIV, 2013). If the varieties specified in the document are not included in the OIV list, they are listed in a separate field.
Yield	The maximum yield allowed in the PDO areas expressed in hl/ha or in kg/ha.
Planting density	The minimum planting density allowed in a PDO, expressed in number of vine stocks/ha.
Irrigation	The extent to which it is possible to use irrigation in the PDO (allowed/prohibited).
Presence of amendments	The presence or absence of changes in the original application documents of the PDO (yes/no).
Municipalities	The municipalities included in the wine PDO.
General information on the PDO	The link to the eAmbrosia page that include the regulatory documents about a wine PDO.

## Results and discussion

The results of our study consist in a preliminary database that includes the selected regulatory information for each of the major European wine PDO in Europe. Our first results show how the areas of high-quality wine production are distributed all over Europe, with a higher density in Italy and France (Figure 1a). Based on the extracted information, we can build a map for each PDO region, representing the municipalities included in the PDO (Figure 1b), and the whole set of related regulatory information (Table 2).

The gathered data can be organized in different ways based on the focus of the user. For instance, we structured it based on the characteristics of each PDO to have an overview on their main features, but the information from the inventory can also be organized based on the country where the PDO is located or the category of wine products. This allows the comparison of regulatory information and enables stakeholders to consider specific aspects of each PDO.

The preliminary version of our inventory is the first dataset that contains a set of regulatory information for wine PDO in Europe, collected to support the development of tailored strategies for climate change adaptation. This represents an important source of information for researchers and practitioners in the field of viticulture.



**Figure 1.** (a) density of the PDO areas in Europe. (b) example of spatialization for the PDO “Montefalco Sagrantino”. The density in (a) is calculated based on the localization of the centroid of each of the spatialized PDOs, with a search radius of 60km around each point. We included PDO localized in the United Kingdom as it was part of the EU until recently. The map in (b) was made using as a basis the boundaries from the European Statistical System (Eurostat, 2022) (ESS, © EuroGeographics for the administrative boundaries) at the LAU2 level.

**Table 2.** Example of the regulatory information collected in our inventory for the PDO region “Montefalco Sagrantino”.

Country	IT
PDO identifier	PDO-IT-A0833
PDO name	Montefalco Sagrantino
PDO registration date	31.12.1982
Category of wine product	Wine
Vine varieties	Sagrantino N
Yield	52 hl/ha; 8000 kg/ha
Planting density	4000 stocks/ha.
Irrigation	Allowed
Presence of amendments	No
Municipalities	IT_054004; IT_054008; IT_054021; IT_054022; IT_054030
General information on the PDO	<a href="https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/geographical-indications-register/details/EUGI00000005682">https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/geographical-indications-register/details/EUGI00000005682</a>

Codes in “Municipalities” field refer to the unique id of each LAU2 polygon from the European Statistical System (Eurostat, 2022).

Indeed, decision making related to adaptation in viticulture is a multi-faced and dynamic process that requires contextual knowledge about the area under analysis (Neethling et al., 2017). The information we gathered therefore has multiple applications. For example, crop modellers can use the gathered information to explore possible scenarios of adaptation based on the use of a new vine variety in a region (Fraga et al., 2016). Agronomists can suggest new wine growing strategies by comparing information about different PDO regions, and decision makers can compare this information to improve the conditions for high-quality wine production (Clark et al., 2017). All these processes will help to prioritize the selection of adaptation strategies available for the viticultural sector (Santos et al., 2020).

In the analyses for the construction of our inventory, we found that the regulatory information for wine PDO was highly heterogenous between areas located in different countries, with some countries, such as France or Italy, providing very detailed information. For example, in some cases yields were specified for each vine cultivar and wine product, or planting densities were defined based on the topographic characteristic of vineyards. For these countries, the inventory could therefore be expanded with more specific information and thus further increase our knowledge of the related PDO regions.

## Conclusion

Information on the regulation of PDO regions is fundamental to know the practices and processes allowed in each of these winegrowing areas and to plan future interventions. Here, we presented an initial effort to collect and harmonize the regulatory information for major wine PDO in Europe and create a detailed geospatial dataset. This inventory is intended to be a fundamental support for the development of adaptation strategies for wine PDO areas in the context of climate change.

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