FEASR

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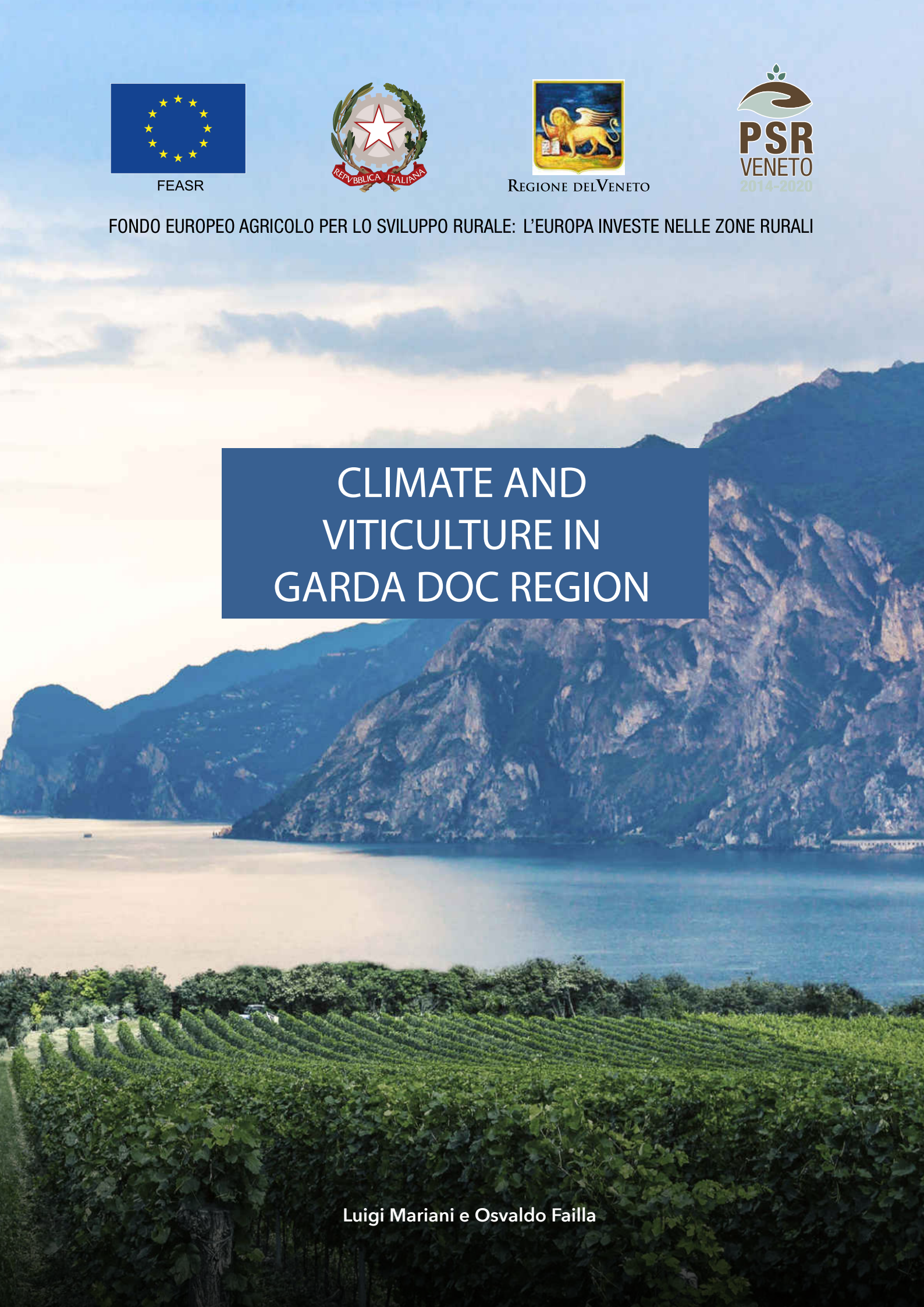
FONDO EUROPEO AGRICOLO PER LO SVILUPPO RURALE: L'EUROPA INVESTE NELLE ZONE RURALI



CLIMATE AND VITICULTURE IN GARDA DOC REGION

Luigi Mariani e Osvaldo Failla

AGROCLIMATE-BASED SUITABILITY MODEL

Viticulture has existed in the Garda region for millennia, creating a truly unique production area from both a viticultural and oenological perspective. To properly characterise the current status and prospects of this wine region, the Garda DOC Consortium intends to promote a series of research initiatives that will describe the pedoclimatic and viticultural and oenological aspects. Of these initiatives, the first to be launched and that is now coming to a close is the agroclimatic study, which examined the link between the climate and the qualitative characteristics of white and red Garda wines. The study was conducted by the professors Osvaldo Failla and Luigi Mariani from the University of Milan and the Agricultural History Museum of Lombardy, whose affiliations highlight their focus on both the present day and the historical roots of the suitability of viticulture.

THE UNIQUENESS OF GARDA'S MESOCLIMATE

The agroclimatic study began by considering the unique mesoclimatic and topoclimatic conditions, which were investigated using a historical series of meteorological data covering the period 1951 to 2021. Garda's mesoclimate can be described by taking the Mediterranean climate as a reference: mild and rainy in winter (over 70% of the annual precipitation falls in the six months from October to March), dry and not excessively hot in summer and with modest daily and annual temperature ranges. The Garda region benefits from precipitation that is relatively well distributed throughout the year, with two peaks (one in spring and the other in autumn) and one main rainfall minimum in winter and another secondary one in summer. It should be noted that the summer rainfall in the Garda region is too abundant to be able to qualify the region as having a Mediterranean climate in the strict sense; nevertheless, the Mediterranean characteristics are significant as a result of the extent of the lake surface (Lake Garda, formerly known as Benacus, has the biggest surface area of the large Italian pre-Alpine lakes: 370 km2, compared with 212 km2 for Lake Maggiore, 145 km2 for Lake Como and 61 km2 for Lake Iseo) and the fact that it is one of the most southerly large pre-Alpine lakes, the one closest to the sea and at the lowest altitude (65 m above sea level, compared to 163 m for Lake Maggiore, 185 m for Lake Iseo and 199 m for Lake Como).
Another Mediterranean element is the low frequency of fog, which is rare at the northern end of the lake (3 days per year on average in Riva del Garda) and gradually becomes more frequent moving south, with around 40 days in Salò, and is most frequent on the southern shore (Desenzano), where there Is a more significant penetration of cold air from the plain. Garda's Mediterranean nature is also evident by applying Pavari's phytoclimatic classification (De Philippis, 1937), according to which the Garda region is in the Lauretum cold subzone (annual average temperature between 12°C and 17°C, average temperature of the coldest month around 3°C and absolute minimum values no lower than -9°C), which, among other things, enables the region to accommodate extensive olive groves.
The topoclimate accounts for the considerable effect of the hills and mountains on the climate, an effect that originates from the combined action of altitude, exposure, slope and

position of the various areas under vine. The annual average temperatures fall by 0.5°C on average for every 100 m of increase in altitude, although inversion phenomena occur periodically that are typical of anticyclonic circulation patterns and characterised by the fact that the temperature increases with the altitude rather than decreasing. In terms of exposure, the south-facing areas are the most thermally favoured, followed by those facing west, then those facing east and, lastly, those facing north. The favourable effects of the exposure are modulated by the slope, which influences the angle of incidence of the sun's rays by altering the amount of energy accumulated per unit area. Lastly, the position means that the slopes of the hills and mountains benefit from a milder and more uniform climate than the plains and valley bottoms, which are exposed to the night-time accumulation of cold air flowing downwards from the mountain ranges.
Besides mesoclimate and topoclimate, there is also microclimate, which accounts for the effects caused by the vine canopy and the fact of whether the soil is covered with grass. Microclimate is thus substantially influenced by agronomic choices (training system, pruning, agronomic management of the soil), hence, for example, a cluster or trunk that is shaded by leaves reaches significantly lower
temperatures than those observed by the same parts of the grape vine in full sunlight and the effects of frosts depend on the height of the shoots established by the training system. Agronomists have been aware of the effects of mesoclimate, topoclimate and microclimate on vine cultivation for millennia, to the extent that treatises by the Roman agronomists Virgil and Columella talk about it, also citing the Carthaginian Mago, one of the greatest agronomists of antiquity, whose works have unfortunately been lost.

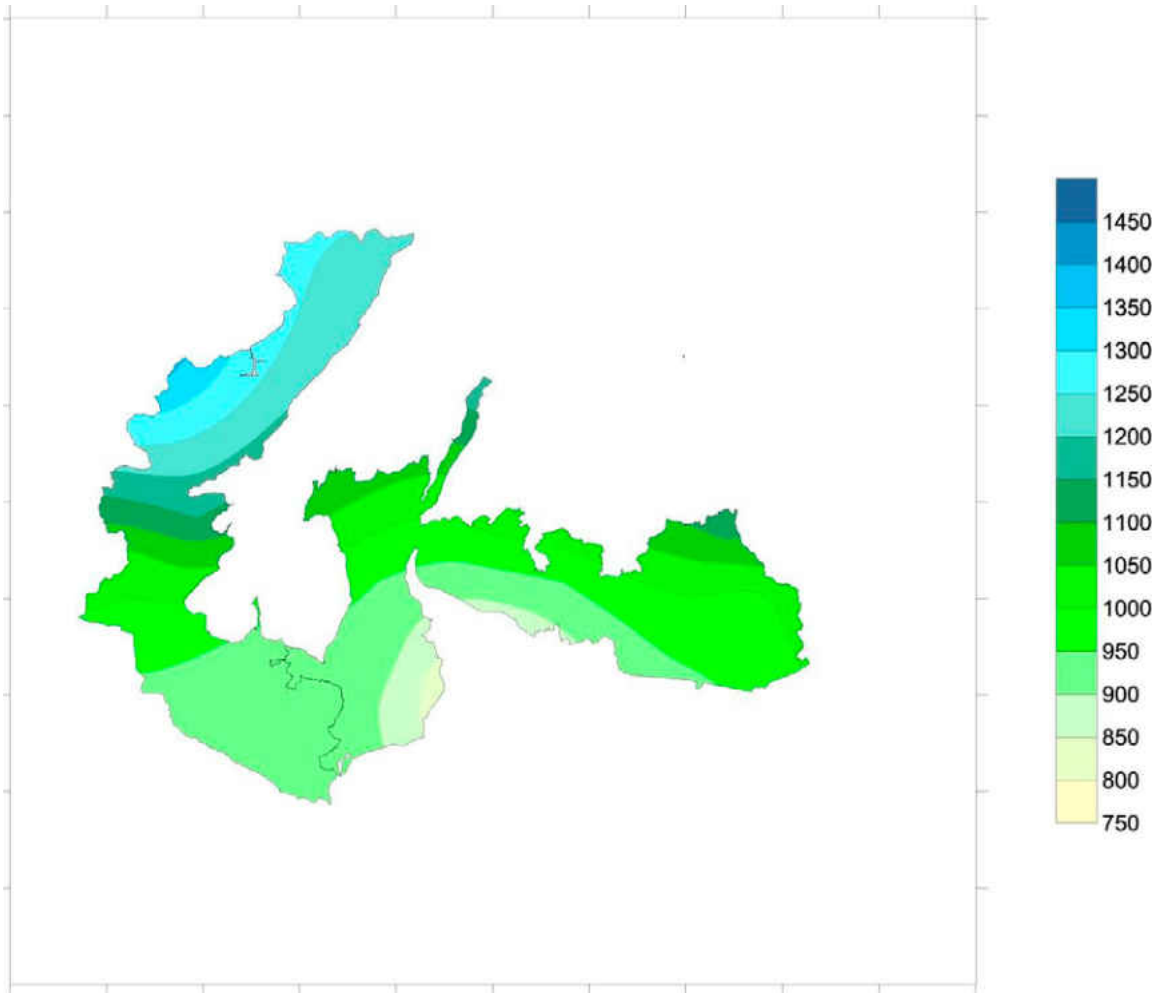


Figure 1 – Map of the annual average precipitation in millimetres for the period 2001-2020.

THE AGROCLIMATIC ANALYSIS OF THE GARDA DOC AREA

The agroclimatic indicators selected have made it possible to describe the region subdivided into unit cells measuring 50 x 50 m (0.25 ha). The resources and limitations that the climate imposes on the viticulture have been described for each unit cell.
Briefly reviewing the results achieved, it is, firstly, noted that the analysis of radiation resources expressed as PAR (photosynthetically active radiation) has shown an abundance of these resources, except for the areas that are less favoured due to unfavourable exposure and/or orographic horizon.
The precipitation values for the DOC area range between 800 and 1350 mm (Figure 1), with maximums in the Upper Garda area in the province of Brescia (Alto Garda bresciano), and minimums in the area south-east of the lake. The abundance of average precipitation contributions in the autumn-spring period is connected with good rainfall in the summer period, mainly attributable to storm phenomena. The storms provide water supplies that are irregular and often subject to significant runoff phenomena, rendering the rainwater only partially usable by the vines. The water reserves of the soil that can be exploited by the vines are dependent on rainfall as well as on losses due to evapotranspiration, runoff and deep infiltration, factors that are also associated with the establishment of water stress conditions. The frequency of such conditions was analysed for the Garda DOC area, obtaining an average number of days subject to stress ranging from 5-10 days per year in Upper Garda to 50-55 days in the south-western part of the DOC area. The map in Figure 2 illustrates the normal days of post-veraison stress for mid-late maturing varieties.
In terms of thermal resources, the analysis of the Winkler and Huglin indices reveals values very favourable to vine cultivation in a large part of the region. In particular, the Huglin index (Figure 3) has values between 800 and 3000, while the Winkler index has values between 400 and 2600. The lowest values for both indices are observed along the hills and mountains of the western Upper Garda area in the province of Brescia, while the highest values are along the south-western lakeshore and in some valley bottoms in the Lessini Mountains.

FROM AGROCLIMATIC RESOURCES TO SUITABILITY MODEL

The suitability model was defined by describing the effects of the thermal resources and limitations on the ripening profiles of white and red varieties. The suitability model considers in particular:
- the effects of thermal resources on sugar accumulation and acidity degradation dynamics (technological ripeness) as well as, for red varieties, the phenolic ripeness dynamics in terms of anthocyanin accumulation and evolution of tannins in the grape skins and seeds;
- the potential aromatic profiles of the wines according to the most common olfactory descriptors.

Five zones are thus identified, illustrated in the map in Figure 4, the legend for which is shown in Table
1. The map shows the absence of abrupt transitions between the western area inside the lake basin and the eastern part outside the basin itself. The similarity between the two sub-areas lies both in the homogeneity of the thermal, precipitation and radiation resources and in the breeze circulations that contain relative humidity, limiting fungal diseases while promoting the evapotranspiration process which is essential for thermoregulation and the intake of carbon dioxide from the air and other nutrients (sulphur, phosphorus, potassium, etc.) from the soil.

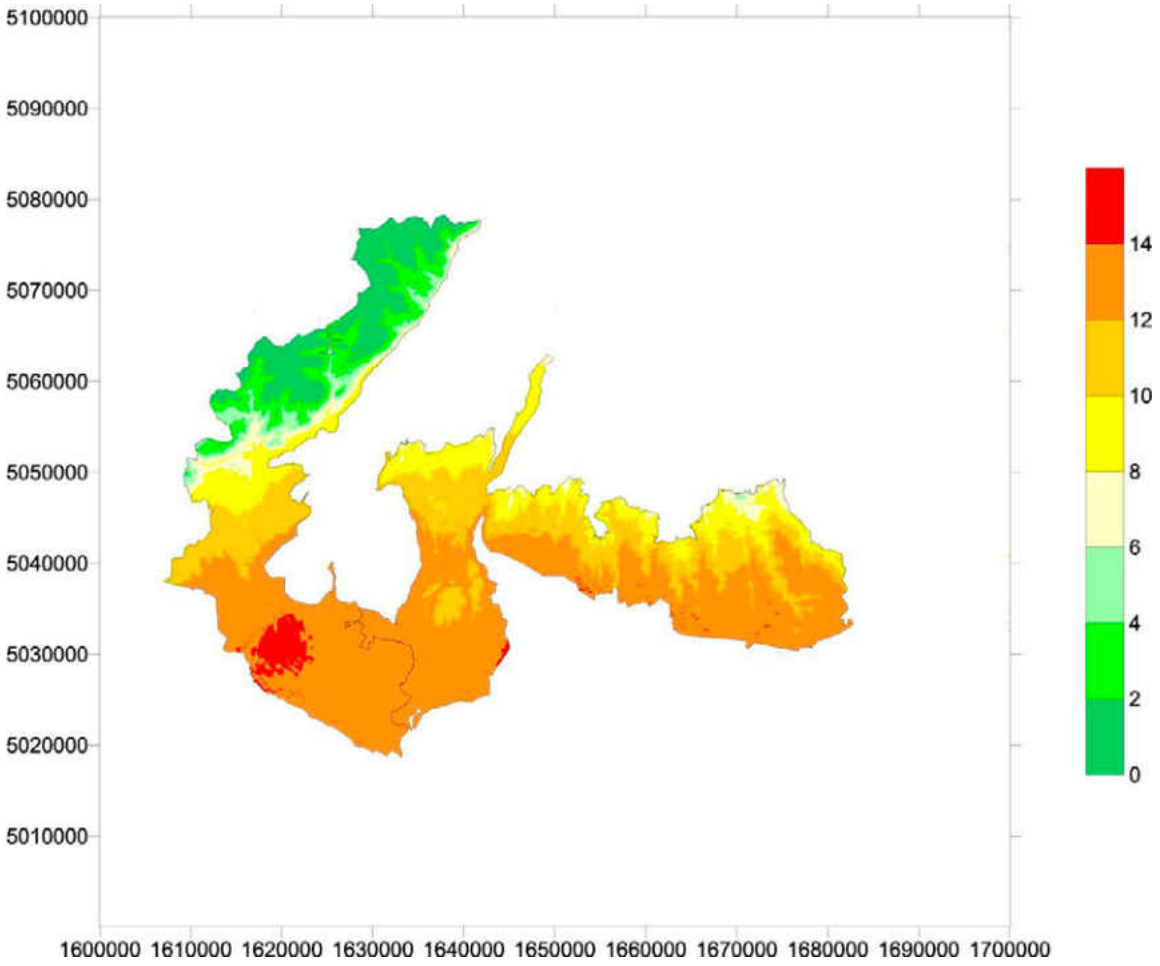


Figure 2 – Map of the post-veraison water stress expressed as normal days of stress and referring to mid-late maturing varieties (average for the period 2001-2020).

GARDA: AN APPELLATION FOR ENHANCING VARIETAL WINES

If correctly interpreted by producers, the five agroclimatic subzones of the Garda DOC appellation make it possible to produce varietal wines in different styles, wines that are particularly capable of enhancing the winemaking capacities of the single varieties. Specifically, zones 1 and 2 – characterised by the highest thermal resources that generate, more or less intensely, favourable summer stress – are most suitable for mid-late maturing varieties to produce structured, long-lived wines with a complex, mature aromatic profile; zone 3, on the other hand, can provide the best balance between alcohol and acidity, as well as an aromatic profile with a full spectrum of fresh, spiced and ripe aromas at the same time. Zones 4 and 5, meanwhile, are most suitable for early varieties and the production of fresh, floral and fruity wines and sparkling wines.

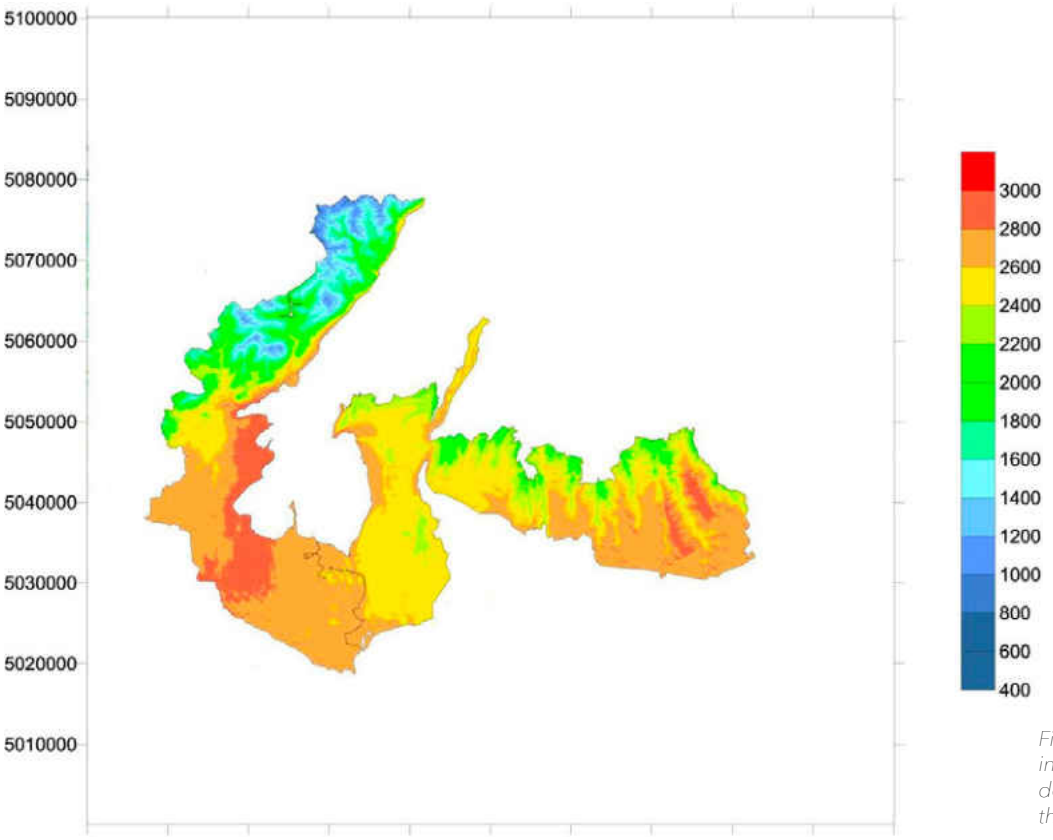


Figure 3 - Map of the average Huglin index for the period 2001-2020, describing the thermal resources for the area.

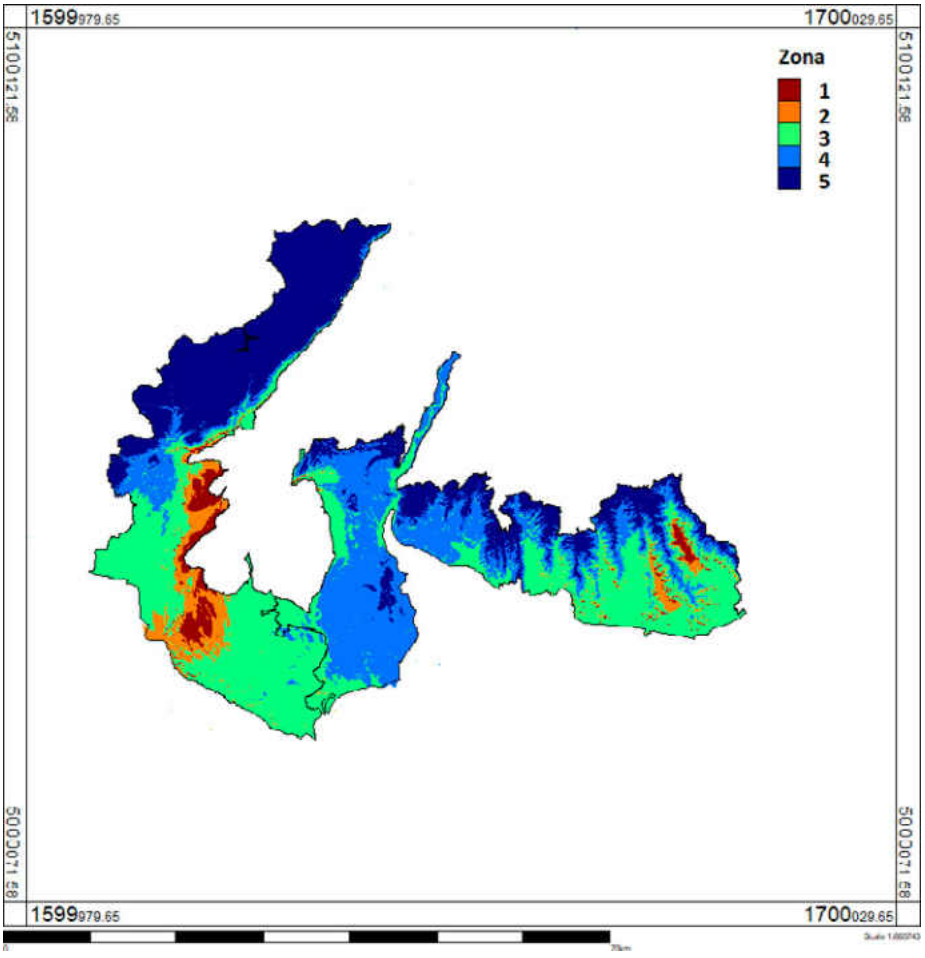


Figure 4 - Suitability map for red and white grapes. The region is subdivided into 5 zones based on the criteria defined in Table 1.

Table 1 – Legend for the map in Figure 4. For each ripening profile descriptor, the number of + is proportional to the expected intensity based on the thermal resources.

Red varieties

Class	Thermal resources (HI)	Heat stress (hrs/yr)	Expected ripening profiles			
			Technical	Phenolic	Aromatic (notes expected in the wine)	
1	> 2800	> 700	sugar accumulation +++++ titratable acidity ++	anthocyanin accumulation ++ tannicity +++++ grape seed maturity ++	jam +++ phenolic +++ red fruit +	spiced + floral + vegetal ++
2		< 700	sugar accumulation +++++ titratable acidity ++	anthocyanin accumulation +++ tannicity +++ grape seed maturity +++	jam ++ phenolic +++ red fruit +++	spiced + floral + vegetal +
3	2600–2800		sugar accumulation +++ titratable acidity +++	anthocyanin accumulation +++++ tannicity ++ grape seed maturity +++++	jam + phenolic + red fruit +++	spiced +++ floral +++ vegetal +
4	2400–2600		sugar accumulation ++ titratable acidity ++++	anthocyanin accumulation ++++ tannicity ++ grape seed maturity +++	jam + phenolic + red fruit ++	spiced +++ floral +++ vegetal +++
5	< 2400		sugar accumulation ++ titratable acidity +++++	anthocyanin accumulation ++ tannicity +++++ grape seed maturity ++	jam + phenolic + red fruit +	spiced ++ floral +++ vegetal +++

White varieties

Class	Thermal resources (HI)	Heat stress (annual hours)	Expected ripening profiles		
			Technical	Aromatic (notes expected in the wine)	
1	> 2800	> 700	sugar accumulation +++++ titratable acidity ++	fruity +++++ floral + aromatic herbs +	citrusy +++ balsamic ++ vegetal ++
2		< 700	sugar accumulation +++++ titratable acidity ++	fruity +++++ floral + aromatic herbs +	citrusy +++ balsamic ++ vegetal +
3	2600–2800		sugar accumulation +++ titratable acidity +++	spiced +++ floral +++ aromatic herbs ++++	citrusy ++ balsamic + vegetal +
4	2400–2600		sugar accumulation ++ titratable acidity ++++	fruity ++ floral +++ aromatic herbs +++	citrusy + balsamic +++ vegetal +++
5	< 2400		sugar accumulation ++ titratable acidity +++++	fruity + floral ++++ aromatic herbs ++	citrusy + balsamic + vegetal +++

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GARDA DOC

CUSTOZA

CONSORZIO DI TUTELA CHIARETTO E BARDOLINO

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