Vine growing description of Aeolian archipelago
Une description viticulturelle de l'archipel éolien

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Abstract

An agroclimatic description of Aeolian archipelago viticulture area (Me), Italy is presented. Aeolian archipelago is located off the northeastern coast of Sicily and it includes the islands of Alicudi, Filicudi, Salina, Panarea, Lipari, Stromboli and Vulcano. At present vine growing in this area accounts for about 160.0 ha, 96.0 of which at cv Malvasia di Lipari; the remaining 64.0 ha are dedicated to other varieties. The appellation Malvasia delle Lipari DOC includes sweet aromatic white wines, raisin wines and fortified wines from Malvasia di Lipari and Corinto Nero varieties. The appellation IGT Salina produces white, red, and rosé wines as well as monovarietal wines with the indication of the specific variety (Malvasia di Lipari, Catarratto bianco, Nerello mascalese, Ansonica, Nero d'Avola, Corinto nero, etc.).
The agroclimatic analysis concerned rainfalls, temperatures, vine specific bioclimatic indexes (Winkler, Huglin, Branas and Fregoni), ET0, and hydro-cultural consumptions. The agrometeorological data were provided by Sicilian Agrometeorological Information Service (SIAS) and by Regional Hydrographical Service (SI). The study allowed achieving an agroclimatic description of Aeolian archipelago, which is functional to the improvement of traceability and any kind of further study for territorial programming, as well as the evaluation of territorial aptitudes.

Keywords: GIS, bioclimatic indexes, grapevines, temperature, phenological phases.

Introduction

Climate has a heavy influence on vine vegetation and on grape quality. In fact, yields variation, efficient fertilization and fieldwork are often bound to metereological factors. The effects provoked by weather on vine vegetative and reproductive cycle show in different ways their dependence on the quantity and combinations of climatic components.
Climatic factors represent a basic part of the several inputs the vine needs to complete its vital cycle. Among the most influencing elements, temperature, hydrometeors and radiation are to be considered. The "quantity" of each climatic element necessary to vine plants varies through time and produces different effects interesting oenological targets, because each phase of vegeto-productive cycle benefits of certain climatic conditions. The effect that each climatic variable provokes on vine growth and production is very complex. Direct and diffuse radiation plays an important role on photosynthetic processes (McIntyre, G., 1982). In particular, as vines are heliophilous plants, they demand a great quantity of light. Rainfall proves to be very important for soil hydrological balance. Vine plants suffer humidity excess; when vine-growing regions see periods with reduced rainfall they do not bring negative consequences on grape quality. In fact, the deep root system allows vine growing also where rainfall is not superior to 250 mm per year, when adequately distributed through time.
In order to characterize the bio-climatic and oenological potential of a territory, some methodologies are today available, based on quality, thermal, hydrothermal and eliothermal indexes (Vaudour, 2005). These are often applied at macro-meso scale and therefore they seem generally not very suitable when climatic effects on vine bio-agronomic behaviour at farm scale are to be considered. Furthemore it is recognised that the performance of a genotype changes under environmental conditions owing to the interaction to the environment (Stefanini et. al., 2007).

The present work aimed to carry out a general climatic characterization of Aeolian archipelago, and a more detailed analysis on toposcale (example 1:10000) spatial distribution of the mentioned indexes as well. The latter is presented here by means of the elaborations of geo-topographical information in GIS environment achieved by using SIAS (Sicilian Agrometeorological Information Service) topoclimatic study of Sicily (Drago et al., 2005). These elaborations today are available just as partial results; the complete work in terms of methodology, operational maps and elaborated results, will be published within some months as a part of the Agrotopoclimatic Atlas of Sicily. The survey was carried out also with the aim to support the traceability of the viticulture production of this district which is an important area for today's agro-business.

Material and methods

General climatic characteristics

The archipelago of the Aeolian is located off the northeastern coast of Sicily at the latitude between 38°23' - 38' N and the longitude between 14°34' - 15°12' W. It includes the islands of Alicudi, Filicudi, Salina, Panarea, Lipari, Stromboli and Vulcano. The consistency of viticulture data in the archipelago were supplied by the Operative Unit 29 of the Agriculture and Forest Council Department of Sicilian Region.

In order to have a thirty-year meteorological dataset for temperature and rainfall so to correctly characterize the main general climatic aspects of Aeolian archipelago, this work presents some elaborations based on 1965-1994 dataset, available from Regional Hydrographical Service (SI) weather station (38°33'25" N, 14°52'17" W) located in Santa Marina Salina municipality (Salina island), 350 m a.s.l.: Peguy (1970) climatogram, monthly Thornthwaite-Mather (1955) soil water balance.

Further, an interesting elaboration based on data provided by Sicilian Agrometeorological Information Service (SIAS) weather station at Val di Chiesa (38°33'14" N, 14°49'29" W) in Leni municipality (Salina island), 315 m a.s.l., is presented, which is still characterized by short meteorological series, especially for temperature and rainfalls (start of data collection in 2002), but it proves very rich in terms of time resolution and meteorological variables data collection. This elaboration offers a comparison between monthly average potential evapotranspiration by applying the Penman-Monteith FAO method (Allen et al., 1998) for SIAS weather station (average 2002-2007) and the Thornthwaite (1955) methods for SI weather station (average 1965-1994).

Preliminary study of topoclimatic characterization

In this work topographical effects on temperature spatial distribution have been calculated using topoclimatic parameters obtained with the SIAS topoclimatic study (Drago et al., 2005). Besides, a measuring activity on field started in 2003 is still being carried out in seven sample areas characterized by topographical elements particularly interesting for the investigation. Thus, the survey carried out since 2003 on the spatial distribution structure of some meteorological fields related to territory topographical characteristics was supported by installing some electronic meteorological stations in every study area to hourly collect data in relation to the topographical elements being considered, such as air temperature and relative humidity, wind speed and direction, rainfall. The data analysis for the complete series allows us to verify the presence and the consistence of data spatial structures, related to topographical characteristics of the territory, especially aspect and topographical position. In particular, for the bottom valley sites minimum temperature values resulted always statistically lower than the average values for their corresponding study areas, while maximum temperature values resulted always higher than the average values for their corresponding study areas, especially in summer. As for the aspect influence on temperature, the survey confirmed that South exposition determines maximum temperature values significantly higher than the average values for each study area, while any significant effect has been noted on minimum daily values.

Topoclimatic characterization of the territory

Thanks to Salina SI thirty-year meteorological dataset, which is the only station today offering a long series functional to climatic elaborations on temperature and precipitations, and using topoclimatic parameters obtained with the field measuring activity mentioned above (2003 at present), the following toposcale maps were realized: "Winkler Index" (Winkler et al., 1962)., "Huglin Index"

(Huglin, 1983), "Hydro-thermal Branas Index" (Branas et al., 1946) and "Quality Fregoni Index" (Fregoni et. al., 2000). In particular, for maximum daily temperature toposcale factors based on elevation, aspect and slope were used; for minimum values toposcale factors based on elevation and topographical position were used.

It is important to underline overall the particular methodological approach here implemented and used in the toposcale data interpolation process. In fact this was not the case of a punctual elaboration (on weather station-point) followed by a spatial interpolation process using one of the different available methods (geo-statistical or others). Rather, the methodology applied does foresee first a topoclimatic interpolation in GIS environment to produce a single climatic base map (minimum temperature, maximum temperature, etc.), and then the use of the single climatic base maps to calculate the different indexes by specific algorithms exploiting the typical raster layer calculation tools in GIS environment.

This method presents two important advantages: it could be considered more immediate and robust to produce base climatic maps having a stronger relationship between geo-topographical characteristics and studied meteorological variable spatial distribution; climatic base maps could be used in every moment, to implement new indexes or to eventually correct or adapt themselves.

Bioclimatic characterization

Phenoclimatic indexes reflect the biological and cultural needs of vine allowing the characterization of its cultural area and to estimate new ones. Hence, vine success depends on the modality of its interaction with the rootstock, as answering at the pedoclimatic conditions. In the present study the data of Winkler index for beginning and end flowering, for beginning and end veraison, and the ripening for some vines (Malvasia di Lipari, Nero d'Avola and Ansonica or Insolia) of the Aeloian Archipelago, were obtained by GeReCa project (Policarpo et al. 2007). These data presented triennial averages (2005-2007) and standard deviation of the above-mentioned phenological phases.

Results and Discussion

Most of the vine growing area is located in the Salina island and split within its three municipalities, Malfa (73.8 ha), Leni (40.3 ha) and Santa Marina Salina (9.4 ha); Lipari follows with 36.7 ha (Table 1), at an altitude included between 0 and 400 m a.s.l.. The total viticulture surface amounts for about 160 ha, 50 ha of which are recorded to the DOC appellation and 27 ha to IGT appellation (Table 1). Besides, the 160 ha of vineyards also include 96 ha cultivated at Malvasia di Lipari; the remaining 64 ha are dedicated to other varieties (Table 2). The appellation Malvasia delle Lipari DOC includes sweet aromatic white wines, raisin wines and fortified wines from the Malvasia di Lipari and Corinto Nero varieties. The appellation IGT Salina produces white, red, and rosé wines as well as monovarietal wines with the indication of the specific variety (Ansonica, Nero d'Avola, Catarratto bianco, Corinto nero, Malvasia di Lipari, Nerello mascalese, etc.). The vine training systems adopted are spur cordon, gobelet, guyot and pergola (Table 3) used for white and black varieties in dry and wet vineyard.

General climatic characteristics

Aeolian archipelago is characterized by a Csa Köppen macro-climatic condition (the typical Mediterranean climate, with mild and quite rainy winters and hot dry summers) (Drago, 2002). The annual total rainfall average is about of 620 mm, while annual average temperature is about 18°C. The monthly distribution is shown in Fig. 1, by the typical Peguy climatogram: four spring-summer months are characterized by hot dry climate (from May to August); from October to April there is a temperate climate. The monthly variation of some Thornthwaite-Mather soil water balance parameters (Fig. 2) shows a long period of water deficit (difference between potential and effective evapotranspiration), from April to October. The comparison between potential evapotranspiration assessed by applying Penman-Monteith and Thornthwaite methods showed a similar pattern with some differences in ET0 value, at the beginning of the year the Penman-Monteith is higher then Thornthwaite while at the end of the year the Thornthwaite is higher then Penman-Monteith (Fig. 3).

Topoclimatic characterization of the territory

The maps presented in Figg. 4 and 5 highlight that in vine areas of Aeolian archipelago Winkler index presents values between 1800 and 2300, more then enought for the needs of the different phenological phases of Malvasia delle Lipari, Ansonica and Nero d'Avola (Table 4); other areas with an index value lower than 1800, mainly for Salina island, are not cultivated with vine essentially because of their high slope and consequently low accessibility. Huglin index varies from a minimum of 2200 to a maximum of 2600. The Hidro-thermal Branas index, varying from 1200 to 1400, determines a very low susceptibility to downy mildew attacks. Finally, Fregoni quality index varies between 250 and 400.
Today's most important bio-climatic indexes adopted in viticulture, Winkler and Huglin, valid enough to discriminate macroclimatic vine adaptability especially in relation to thermal regimes, where air temperature could represent the main limiting factor, have shown to be not very suitable for the complete exploration of the whole information characterizing the territorial elaborations obtained by the application of a high spatial resolution analysis methodology like the one presented in this work. In particular, a look at the standard classes division for Winkler index shows a clear trend to level differences between territories characterized by important pheno-climatic differences. And this is also true for Huglin index, even if in a lower measure.

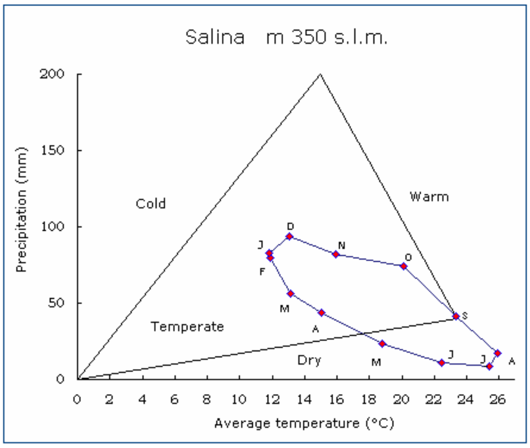

Figure 1 Peguy climatogram for Salina island (average 1965-1994).

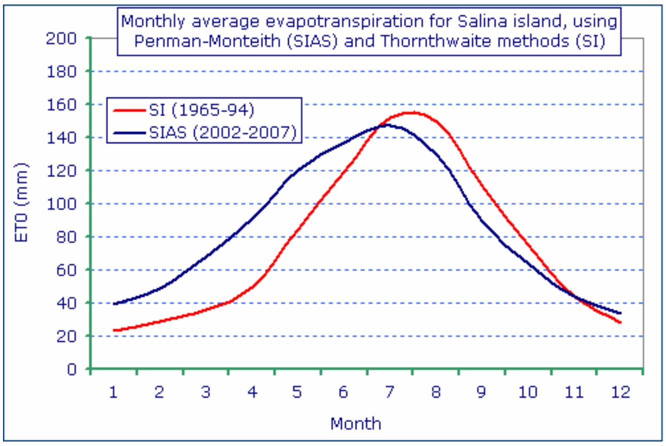

Figure 3 Potential (reference) evapotranspiration for Salina island estimated using two methods.

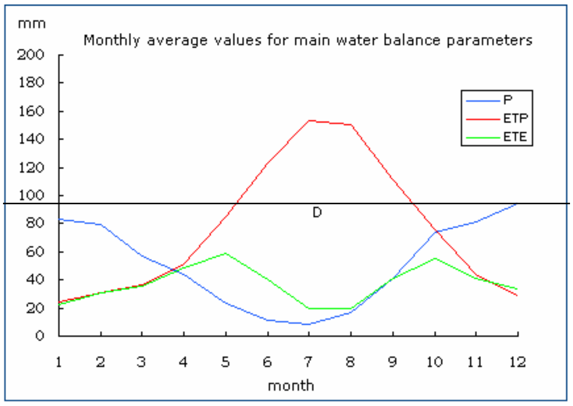

Figure 2 Thornthwaite-Mather main water balance parameters for Salina island (average 1965-1994). P=precipitation;ETP=potential evapotranspiration; ETE= effective evapotranspiration; D= deficit.

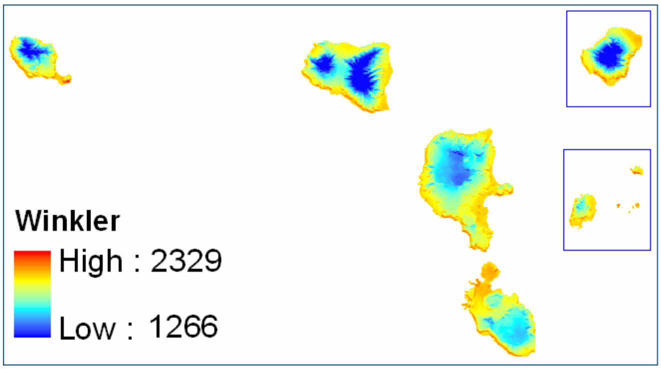

Figure 4 Winkler index for Aeolian archipelago.

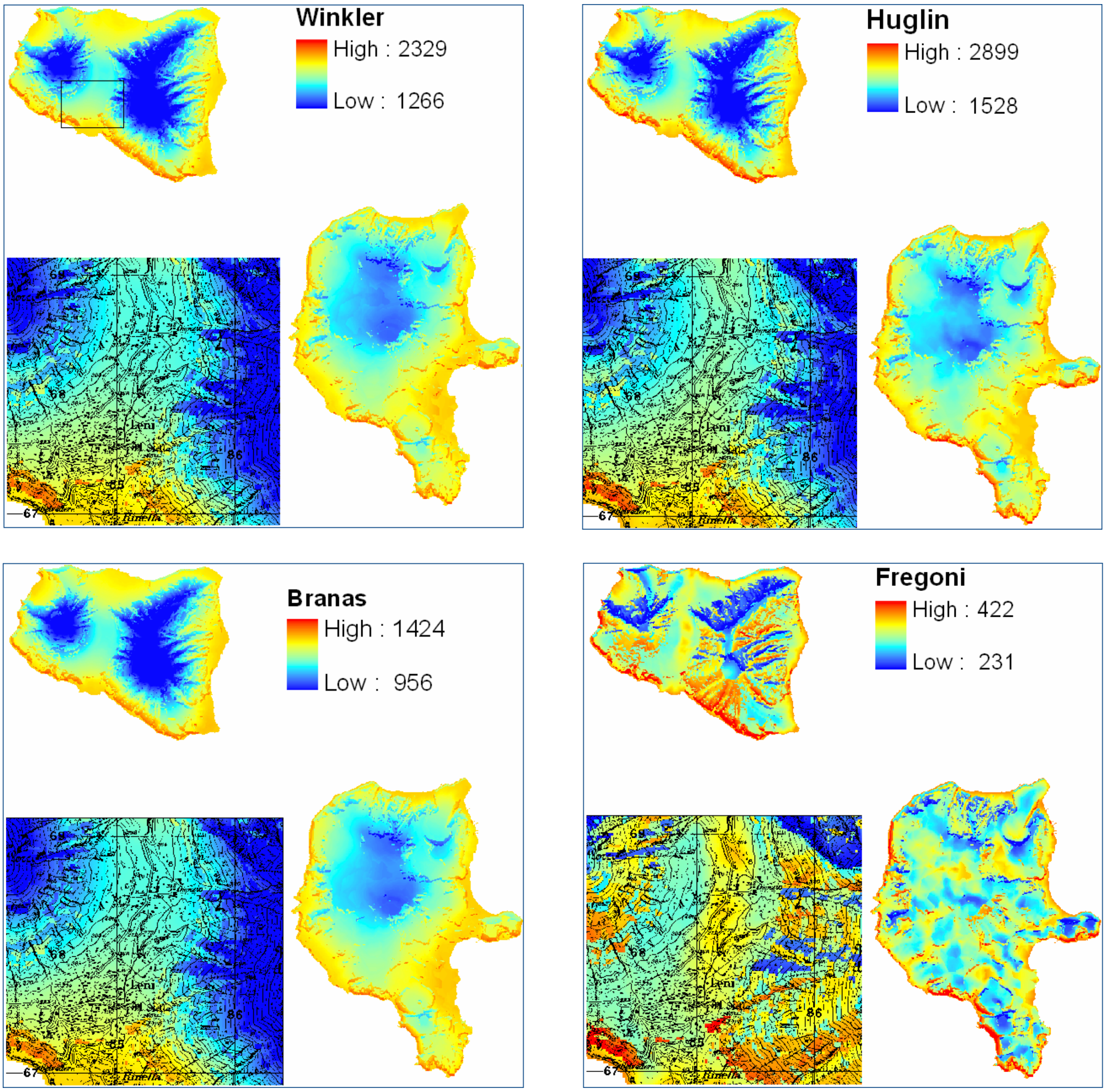

Figure 5 Winkler, Huglin, Branas and Fregoni indexes for Salina and Lipari islands. The panels present the indexes for an area of Salina on toposcale.

Municipality	Vineyard surface (Ha)	DOC appellation (Ha)	IGT appellation (Ha)	NO appellation (Ha)
S. Marina di Salina	9.4	2.5	0.5	6.4
Leni	40.3	11.2	5.0	24.1
Lipari	36.7	2.5	6.9	27.3
Malfa	73.9	33.8	14.6	25.5
Total	160.3	50.0	27.0	83.3

Table 1 Viticulture surface and its distribution in DOC and IGT appellation in the municipalities of Aeolian archipelago (2008).

Cultivar	Soil surface (Ha)
Malvasia di Lipari	95.7
Catarratto bianco	22.2
Other black grapes	14.3
Other white grapes	11.5
Nerello mascalese	9.2
Ansonica	3.2
Nero d'Avola	2.6
Corinto nero	1.6
Total	160.3

Table 2 Variety consistency in Aeolian archipelago (2008).

Training	Total (Ha)	White (Ha)	Black (Ha)	Dry (Ha)	Wet (Ha)
Gobelet	54.7	44.3	10.3	54.1	0.6
Spur Cordon	82.2	69.9	12.3	77.3	4.9
Guyot	21.1	17.1	4.0	21.1	0.0
Pergola	2.4	1.6	0.8	2.4	0.0
Total	160.3	132.9	27.4	154.8	5.5

Table 3 Training system used for white and black varieties in dry and wet vineyard (2008).

Cultivar	Start Flowering	End Flowering	Start Veraison	End Veraison	Maturation
Malvasia di Lipari	342.0 ± 11.6	437.6 ± 14.0	1080.8 ± 135.3	1332.8 ± 108.7	1422.1 ± 106.0
Ansonica	345.6 ± 13.6	441.0 ± 11.0	1335.8 ± 57.1	1462.6 ± 147.9	1510.5 ± 165.5
Nero d'Avola	340.7 ± 22.3	437.1 ± 37.4	1128.5 ± 61.0	1437.8 ± 31.1	1544.4 ± 19.9

Table 4 Triennal averages (2005-2007) of Winkler index during the phenological phases in some cultivars present in Aeolian archipelago (average ± standard deviation).

Conclusion

In the end, it could be said that nowadays' high spatial resolution map elaborations allow to represent territorial distribution of climatic elements and indexes with a detail until 1:10.000 scale or even more, namely at farm scale. Thus, it proves real the possibility to satisfy the need of a finer operational reclassification of the most used classical bioclimatic indexes, considering that the present classification have been thought and realized for macro and mesoscale applications. Further, this high spatial resolution map could allow to evidence the moving in altitude of the grapevine cultivated area and to know the aptitude of the territory so to support the study of territorial programming.

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