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The use of a hydrological physically based model to evaluate the vine adaptability to future climate: the case study of a Protected Designation of Origin area (DOC and DOCG) of Southern Italy

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The quality of grape and wine is variety-specific and depends significantly on the pedoclimatic conditions, thus from the terroir characteristics. In viticulture the concept of terroir is known to be very complex. At present some changes are occurring in the studies of terroir. Their spatial analysis is improving by means of studies that account for the spatial distribution of solar radiation and of bioclimatic indexes. Moreover, simulation models are used to study the water flow in the soil-plant-atmosphere system in order to determine the water balance of vines as a function of i) soil physical properties, ii) climatic regime and iii) agro-ecosystems characteristics.
The future climate evolution may endanger not only yield production (IPCC, 2007), but also its quality. The effects on quality may be relevant for grape production, since they can affect the sustainability of the cultivation of grape varieties in the areas where they are currently grown.
This study addresses this question by evaluating the adaptive capacity of grape's cultivars in a 20000 ha viticultural area in the "Valle Telesina" (Campania Region, Southern Italy). This area has a long tradition in the production of high quality wines (DOC and DOCG) and it is characterized by a complex geomorphology with a large variability of soils and micro-climate.
Two climate scenarios were considered: "past" (1961-1990) and "future" (2021-2050), the latter constructed applying statistical downscaling to GCMs scenarios. For each climate scenario the moisture regime of the soils of the study area was calculated by means of a simulation model of the soil-water-atmosphere system (SWAP). The hydrological model SWAP was applied to the representative soils of the entire area (47 soil units); the soil hydraulic properties were estimated (by means of pedo-transfer function HYPRES) and measured.
Upper boundary conditions were derived from the climate scenarios. Unit gradient in soil water potential was set as lower boundary condition. Crop-specific input data and model parameters were estimated on the basis of scientific literature and assumed to be generically representative of the species.
Synthetic indicators of the regimes (e.g. crop evapotranspiration deficit - CWSI, available soil water content, soil temperature) were calculated and compared with thermal and water requirements of a set of grape varieties, including the ones currently cultivated in the area.
As a result of the comparison, most varieties resulted adaptable to the future climate. For some cultivars (i.e. Catalanesca) a significant increase of suitable area is foreseen; in other cases (i.e. Aglianico and Falanghina) a slight reduction will occur. Moreover for the most important varieties actually cultivated (e.g. Aglianico, Falanghina, etc.) an analysis on the expected spatial migration due to the climate change was performed.
Finally, an analysis of CWSI during different crop phenological stages was performed for both climate periods . The time course of the moisture regime in different soils was thus described; this analysis allowed to identify the soils where the water regime can positively affect grape (and wine) quality .
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