



## **Multidate remote sensing approaches for digital zoning of terroirs at regional scales: case studies revisited and perspectives**

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Geospatial technologies prove more and more useful for characterizing terroirs and this, not only at the within-field scale: amongst innovating technologies revolutionizing approaches for digitally zoning viticultural areas, be they managed by individual or cooperative grape growers, or even unions of grape growers, multispectral satellite remote sensing data have been used for 15 years already at either regional or whole-vineyard scale, starting from single date-studies to multi-temporal processings. Regional remotely-sensed approaches for terroir mapping mostly use multispectral satellite images in conjunction with a set of ancillary morphometric and/or geomorphological and/or legacy soil data and time series data on grape/wine quality and climate.

Two prominent case-studies of regional terroir mapping using SPOT satellite images with medium spatial resolution (20 m) were carried out in the Southern Rhone Valley (Côtes-du-Rhône controlled Appellation of origin) in Southern France and in the Stellenbosch-Paarl region (including 5 Wine of Origin wards: Simonsberg–Stellenbosch, Simonsberg–Paarl, Jonkershoek Valley, Banghoek and Papegaaiberg and portions of two further wards, namely, Franschoek and Devon Valley) in the South Western Cape of South Africa. In addition to emphasizing their usefulness for operational land management, our objective was to develop, compare and discuss both approaches in terms of formalization, spatial data handling and processing, sampling design, validation procedures and/or availability of uncertainty information.

Both approaches essentially relied on supervised image classifiers based on the selection of reference training areas. For the Southern Rhone valley, viticultural terroirs were validated using an external sample of 91 vineyards planted with Grenache Noir and Syrah for which grape composition was available over a large 17 years-period: the validation procedure highlighted a strong vintage effect for each specific terroir. The output map was appropriate at the scale of cooperative wineries and the scale of the union of grapegrowers. For the Stellenbosch-Paarl region, 55 Sauvignon Blanc vineyards previously characterized in terms of grape/vine/wine quality in several earlier studies were used to introduce expert knowledge as a basis for bootstrapped regression tree calculations, which enabled uncertainty assessment of final map results.

Further perspectives related to the spatial monitoring of vine phenology according to the output terroir units and the possible characterization of both within/between terroir spatio-temporal variability of vegetative growth were initiated for the Southern Rhone terroirs considering a SPOT4-Take Five satellite time series acquired from February to June 2013 in the framework of the SPOT4-Take Five program of the French Space Agency (CNES).