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Retrospective farm scale spatial analysis of viticultural terroir fertility using a 70 y-aerial photograph time series, soil survey and very high resolution Pléiades and EM38 data

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In order to elaborate adequate and sustainable practices while better controlling harvest composition at farm scale, the detailed spatial assessment of terroir units is needed. Although such assessment is made in the present time, it reflects vine behaviour and soil quality according to cumulated past choices in vineyard management. In addition to demarcate homogeneous within-vineyard zones, there is a need, in cases where the winegrower starts up its activities, to retrace the behaviour of these zones in the past, so as to consolidate the diagnosis of vine fertility, and determine further adoption of new soil and vineyard management practices that are likely to favour a long-term preservation of quality production together with soil ecosystem functions. In this study we aimed at performing such historical and spatial tracing using a long term time-series of aerial survey images, in combination with a set of very high resolution data: resistivity EM38 measurements and very high resolution Pléiades satellite images.

This study was conducted over a 6 ha-farm mainly planted with rainfed black Grenache and Syrah varieties in the Southern Rhone Valley. In a previous study carried out at regional scale, soil landscape and potential terroir units had been characterized. A new field survey carried out in January 2015 considered a total of 98 topsoil sampling sites in addition to 14 soil pits, the horizons of which were described and sampled. Physico-chemical analyses were made for all soil samples, and for those horizons having the highest root development, additional analytical parameters such as copper, active lime and mineral nutrients contents were determined. Along with soil parameters, soil surface condition, vine biological parameters including vigour, presence of diseases, stock-unearthing were collected. A total of 25 aerial photographs in digitized format from the French National Institute of Geographic and Forest Information (IGN) were examined over the 1947-2010 period, of which 7 were retained for further rectification and processing (having either panchromatic, color and infrared emulsions). This dataset was used to retrace the landuse and planting history for each field. In order to assess actual vine vigour, NDVI was calculated from two atmospherically corrected Pléiades images (2.8 m-colour) acquired on 18 May 2014 and 28 July 2015 and clipped over the farm area. Moreover, within-field zones containing missing vines were isolated parameterizing the ENVI Feature Extraction[®] module for both the 0.7 m panchromatic band of the Pléiades image of July and 6 aerial photographs from 1972 to 2010. This enabled to demarcate those zones according to their frequency of missing and/or low vigour vines.

Actual soil organic carbon and copper contents and stock unearthing intensity appeared to be significantly correlated with past landuse, particularly forest or orchard dating back the 1940s. The temporal dataset exhibited a repeated spatial pattern of missing vines, despite several plantings and uprootings, in adequation with actual soil nutrient properties.