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Potential of SENTINEL-2 images for predicting common topsoil properties over Temperate and Mediterranean agroecosystems

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This study aimed at exploring the potential of SENTINEL-2 (S2A) multispectral satellite images for predicting several topsoil properties in two contrasted environments: a temperate region marked by intensive annual crop cultivation and soils derived from either loess or colluvium and/or marine limestone or chalk for one part (Versailles Plain, 221 km^2), and a Mediterranean region marked by vineyard cultivation and soils derived from either lacustrine limestone, calcareous sandstones, colluvium, or alluvial deposits (La Peyne catchment, 48 km^2) for the other part. Two S2A images (acquired in mid-March 2016 over each site) were atmospherically corrected. Then NDVI was computed and thresholded (0.35) in order to extract bare soils. Prediction models of soil properties based on partial least squares regressions (PLSR) were built from S2A spectra of 72 and 143 sampling locations in the Versailles Plain and La Peyne catchment, respectively. Ten soil properties were investigated in both regions: pH, cation exchange capacity (CEC), five texture fractions (clay, coarse silt, fine silt, coarse sand and fine sand), iron, calcium carbonate and soil organic carbon (SOC) in the tilled horizon. Predictive abilities were studied according to R_cv^2 and ratio of performance to deviation (RPD). Intermediate to near intermediate performances of prediction (R_cv^2 and RPD between 0.28-0.70 and 1.19-1.85 respectively) were obtained for 6 topsoil properties: clay, iron, SOC, CEC, pH, coarse silt. In the Versailles Plain, 5 out of these properties could be predicted (by decreasing performance, CEC, SOC, pH, clay, coarse silt), while there were 4 predictable properties for La Peyne catchment (Iron, clay, CEC, coarse silt). The amount in coarse fragment content appeared to impact prediction error for iron content over La Peyne, while it influenced prediction error for SOC content over the Versailles Plain along with calcium carbonate content. A spatial structure of the estimated soil properties for bare soils pixels was highlighted, which promises further improvements in spatial prediction models for these properties.

This work was carried out in the framework of both the TOSCA-CES “Cartographie Numérique des sols” and the PLEIADES-CO projects of the French Space Agency (CNES).