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Studying soil properties using visible and near infrared spectral analysis

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This research is carried out inside the DIGISOIL Project, whose purposes are the integration and improvement of in situ and proximal measurement technologies, for the assessment of soil properties and soil degradation indicators, going form the sensing technologies to their integration and their application in digital soil mapping.
The study area is located in the Virginio river basin, about 30 km south of Firenze, in the Chianti area, where soils with agricultural suitability have a high economic value connected to the production of internationally famous wines and olive oils. The most common soil threats, such as erosion and landslide, may determine huge economic losses, which must be considered in farming management practices. This basin has a length of about 23 km for a basin area of around 60,3 Km2.
Geological formations outcropping in the area are Pliocene to Pleistocene marine and lacustrine sediments in beds with almost horizontal bedding. Vineyards, olive groves and annual crops are the main types of land use. A typical Mediterranean climate prevails with a dry summer followed by intense and sometimes prolonged rainfall in autumn, decreasing in winter.
In this study, three types of VNIR and SWIR techniques, operating at different scales and in different environments (laboratory spectroscopy, portable field spectroscopy) are integrated to rapidly quantify various soil characteristics, in order to acquire data for assessing the risk of occurrence for typically agricultural practice-related soil threats (swelling, compaction, erosion, landslides, organic matter decline, ect.) and to collect ground data in order to build up a spectral library to be used in image analysis from air-borne and satellite sensors.
Difficulties encountered in imaging spectroscopy, such as influence of measurements conditions, atmospheric attenuation, scene dependency and sampling representation are investigated and mathematical pre-treatments, using proper algorithms, are applied and tested. Data on detection limits of ground-based, airborne and satellite sensors are also provided. The problem of the influence of soil moisture and soil roughness on reflectance is also examined.
Spectral indexes, derived from absorption features, are related to laboratory results on clay minerals, carbonate and iron content, soil moisture and organic matter amount, in order to investigate the potential of hyperspectral sensors to estimate soil properties, using empirical prediction models.