Geophysical Research Abstracts
Vol. 16, EGU2014-13621-1, 2014
EGU General Assembly 2014

Use of field and airborne advanced remote sensing data for the characterisation of surface erosional stages in agricultural semi-arid soils (central Spain) at various scales

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The interest in the use of non-invasive remote sensing methods such as visible-near infrared reflectance spectroscopy for the remote determination of mineralogical composition in soils and planetary surfaces has been demonstrated since the 1970s with the development of databases in the laboratory of minerals spectra. Nowadays, quantitative soil spectroscopy has been shown to be a powerful tool for the identification and prediction of soil properties, and has been used in many soil science applications. With the upcoming launch of the next generation of hyperspectral satellite systems such as the German EnMAP (Environmental Mapping) satellite in 2017, new potential toward the quantitative analyses of chemical and physical soil attributes of the Earth's soil surface composition based on reflectance spectroscopy will be opened. In particular, in arid and semi-arid agricultural regions sensitive to soil erosion processes, the analyses of the spatial distribution of combined varying surface soil properties based on advanced hyperspectral methodology could be used to infer erosion and deposition stages in selected areas, although it was never thoroughly demonstrated. To fully utilize the potential of this technology for the assessment of surface soil erosional stages, new adapted approaches have to be developed, providing the context for this study.

This research focuses on a semi-arid, agricultural area in Central Spain near Toledo and Madrid, in which airborne hyperspectral and LiDAR data have been obtained. The study area is under the influence of a Mediterranean climate with extended agricultural rainfed uses on mostly evolved soils. There, soil erosion features can be observed that are representative for areas throughout Southern Europe. Such erosion features are associated with different soil horizons and rock outcrops with contrasted physical and chemical characteristic. They are exposed at the surface as a consequence of human induced soil erosion which is derived mainly from tillage practices. The identification of these contrasting soil surface layers based on the optical properties of different soil components is a major goal of this study. The optical analysis is accompanied by a geomorphological assessment of the spatial distribution of defined soil erosion and depositional stages. Morphometric variables derived from a digital terrain model based on the acquired LIDAR data are related to topographical features and associated with local soil erosion models that exist for the study area.

In this paper we present preliminary results at various scales from field and remote sensing analyses over selected test sites chosen as representative of the main soil types in the area, and of the main erosion and depositional stages that could be observed. Results show that the identification and mapping of different soil horizons linked to soil erosion and depositional stages as well as slope and curvature analyses can be achieved based on the spectroscopy data and on the LIDAR data, respectively. Therefore, the spatial mapping of the soil erosion and depositional stages are consistent with the soil erosion models implemented for southern agricultural areas.