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Soil Surface Reflectance as a Tool to Estimate Water Infiltration Rate from UAV Platforms

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Soil is an essential component in the environment and is vital for food security. It provides ecosystem services, filters water, supplies nutrients to plants, provides us with food, stores carbon, regulates greenhouse gases emissions and it affects our climate. Traditional soil survey methodologies are complicated, expensive, and time-consuming. Visible and infrared spectroscopy can effectively characterize soil properties. Spectral measurements are rapid, precise and inexpensive. The spectra contain information about soil properties, which comprises minerals, organic compounds, and water. Today, several Soil Spectral Libraries (SSLs) are being created worldwide because these datasets have a notable potential to be used as training datasets for machine learning methods that will benefit precision agriculture activity for better management of food production. Nonetheless, as SSL's are created under laboratory conditions it is not clear if it can be used to infer field conditions in situ and/or from the sky. Thus, study the relationship between RS, field spectroscopy and the laboratory measurements of soil is very important. Accordingly, this study postulates that traditional SSLs don't simulate the real spectral signatures in the field that both, satellite and airborne sensors measure as well, because they are affected by factors that are not an integral part of the soil, such as: moisture, litter, human and animal activity, plow, grass, dung, waste, etc... However, under laboratory conditions, these factors are usually removed for the preparation of SSLs. Thus, given the several SSLs available, it is necessary to evaluate the protocols that were used in these SSLs. The objective of this study is to evaluate the gap between field and laboratory spectral measurements through the analysis of the performance of spectral based models. This procedure combined two soil spectral libraries that contain 114 samples that were measured in the laboratory as well as in the field. The nature of the dataset is

varied, because these samples were collected from six different fields in three countries of the Mediterranean basin: Israel, Greece and Italy. Moreover, 63 samples are mainly sandy and 51 are mainly clayey. In order to obtain optimal spectral measurements in the field, we used a new optical apparatus that simulates the sun's radiation. Next, we generated PLSR models to estimate one of the most important hydrological parameters namely “infiltration rate” that control the runoff stage, soil erosion and water storage in the soil profile. This property is strongly affected by the surface characteristics. Finally, the field based spectral model was adapted to an UAV hyperspectral sensor in order to estimate the infiltration rate from the sky. The results were successfully validated in field, and we concluded that for the estimation of the infiltration rate, SSLs must be created using surface reflectance in field because laboratory protocols can be detrimental for the performance of the dataset in question.