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Spectroscopy as a diagnostic tool for urban soil

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Anthropogenic urban soil are the foundation of the urban green infrastructure, the green net quality is as good as each of its patches. In early days of pedology urban soil has been recognized with respect to contamination and the risks for human health but in study performed since the 70s, the importance of urban soil for the urban ecology became increasingly significant (Gómez-Baggethun and Barton 2013). Urban soils are highly disturbed land that was created by the process of urbanization. The dominant agent in the creation of urban soils is human activity which modifies the natural soil through mixing, filling or by contamination of land surfaces so as to create a layer of urban soil which can be more than 50 cm thick (Pavao-Zuckerman 2008).

The objective of this study is to determine the extent to which field spectroscopy methods can be used to extend the knowledge of urban soils features and components. The majority of the studies on urban soils concentrate on identifying and mapping of pollution mostly heavy metals. In this study a top-down analysis is developed – a simple and intuitive spectral feature for detecting the presence of minerals, organic matter and pollutants in mixed soil samples. The developed method uses spectral activity (SA) detection in a structured hierarchical approach to quickly and, more importantly, correctly identify dominant spectral features. The developed method is adopted by multiple in-production tools including continuum removal normalization, guided by polynomial generalization, and spectral-likelihood algorithms: orthogonal subspace projection (OSP) and iterative spectral mixture analysis (ISMA) were compared to feature likelihood methods (Li et al. 2014).

Results of the proposed top-down unmixing method suggest that the analysis is made very fast due to the simplified hierarchy which avoids the high-learning curve associated with unmixing algorithms showed that the most abundant components were coarse organic matter 12% followed by concrete dust, plastic crumbs, other man made materials, clay and other minerals.

The major part of the mineralogical composition was dominated by Montmorillonite and Kaolinite as is it expected to be in the Mount Carmel soils. Pyroxene and Olivine are also typical to the mineralogy of the Mount Carmel were there are several known magmatic eruption areas of Scoria and Basalt. There is a high frequency of Actinolite ($Ca_2(Mg,Fe)_5(Si_8O_{22})(OH)_2$), Amphibole family (2.5%) that is typical to metamorphic rocks that are not to be found in the Mount Carmel region. Some of the mineral found in the analysis is of marine origin like Syngenite ($K_2Ca(SO_4)_2(H_2O)$) and Blodite ($Na_2Mg(SO_4)_24(H_2O)$) as the area was created under the Mediterranean Sea and is still influence by it. None of the endmembers were detected only once, the lowest frequency was 4 times for Cyanide-Cadmium ($Cd(CN)_2$) and Andalusite (Al_2SiO_5).

The results of the soils pH, measured electrometrically and the particle size distribution, measured by Laser diffraction, indicate there is no big different between the samples particle size distribution and the pH values of the samples but they are not significantly different from the expected, except for the OM percentage which is significantly higher in most samples.

The suggested method was very effective for tracing the man-made substances, we could find concrete and asphalt, plastic and synthetic polymers after they were assimilated, broken down and decomposed into soil particles. By the top-down unmixing method we did not limit the substances we characterize and so we could detect unexpected materials and contaminants.

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