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Investigating the Potential of Spectral Bands in the Detection of Heavy Metals in Soil

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Abstract : Ongoing monitoring of soil contamination by heavy metals is critical for ecosystem stability and environmental protection, and food security. The conventional methods of determining these soil contaminants are time-consuming and costly. Spectroscopy in the visible near-infrared (VNIR) - short wave infrared (SWIR) region is a rapid, non-destructive, noninvasive, and cost-effective method for assessment of soil heavy metals concentration by studying the spectral properties of soil constituents. The aim of this study is to derive spectral bands and important ranges that are sensitive to heavy metals and can be used to estimate the concentration of these soil contaminants. In other words, the change in the spectral properties of spectrally active constituents of soil can lead to the accurate identification and estimation of the concentration of these compounds in soil. For this purpose, 325 soil samples were collected, and their spectral reflectance curves were evaluated at a range of 350-2500 nm. After spectral preprocessing operations, the partial least-squares regression (PLSR) model was fitted on spectral data to predict the concentration of Cu and Ni. Based on the results, the spectral range of Cu- sensitive spectra were 480, 580-610, 1370, 1425, 1850, 1920, 2145, and 2200 nm, and Ni-sensitive ranges were 543, 655, 761, 1003, 1271, 1415, 1903, 2199 nm. Finally, the results of this study indicated that the spectral data contains a lot of information that can be applied to identify the soil properties, such as the concentration of heavy metals, with more detail.

Keywords : heavy metals, spectroscopy, spectral bands, PLS regression
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