CHARACTERIZATION OF SALT - AFFECTED SOILS USING HYPERSPECTRAL REMOTE SENSING DATA – A CASE STUDY OF MATHURA DISTRICT, UTTAR PRADESH, INDIA

Gautam Ghosh[a], S.K.Saha [a], Suresh Kumar [a]*
[a]Indian Institute of Remote Sensing, Dehradun - 248001

ABSTRACT

Soil salinity / alkalinity development is one of the major land degradation problem affecting sustainable agricultural productivity in irrigated areas of arid and semi arid regions of the world. The characterization and mapping of salt affected soils is difficult as the salt concentration may vary substantially over short distances. Various broadband multi-spectral satellite data and spectral indices have been used to delineate and characterize salt-affected soils but very few studies have been carried out using satellite hyperspectral / narrowband spectral data and indices which have high potential in characterizing salt-affected soils.

The objectives of this study are – (i) to evaluate the usefulness and sensitivity of hyperspectral satellite data (Hyperion) derived spectral indices in characterizing degree of soil salinity with respect to variation of soil salinity sensitive physio-chemical characteristics of the soil; and (ii) to compare the narrow band field spectra and Hyperion derived spectra using spectral similarity measures. The study area was an intensive irrigated agricultural area of part of Mathura District, Uttar Pradesh in northern India.

The Hyperion data of 15th May, 2007 was first atmospherically corrected using ENVI's "FLAASH" atmospheric correction model. The mean spectral reflectance value (3x3 pixels) for each of the ground soil sampling points in all the 148 bands of Hyperion satellite data were extracted. Soil salinity / alkalinity sensitive physio-chemical properties of the soil such as Electrical Conductivity (EC), pH, Electrical Conductivity of Saturated Extract (ECe), ESP (Exchangeable Sodium %) and SAR (Sodium Adsorption Ratio) were estimated in the laboratory for the collected surface soil samples. Based on correlation analysis between the mean spectral

reflectance value and soil salinity parameters, sensitive bands were selected for computation of soil salinity sensitive narrowband spectral indices viz. Salinity index (SI), Brightness index (BI), Normalized Differential Salinity Index (NDSI), Combined Spectral Response Index (COSRI) and Coloration index (CI). Stepwise Discriminant Analysis (SDA) and regression analysis were carried out for the data of narrowband spectral indices and soil salinity parameters for finding out highly soil salinity sensitive narrowband spectral indices as well as for development of suitable empirical models for prediction of spatial soil salinity in the study area. Field soil spectra of samples i.e. normal, salt-affected and waterlogged soil were generated using a portable ASD FieldSpecPro Spectrometer. Spectral Angle Mapper (SAM) and Normalized Euclidean Distance (NED) techniques were used for analyzing spectral similarity between field spectra and Hyperion derived spectra of the soils.

It may be concluded that hyperspectral narrowband spectral indices with wavelength of 436.99 nm, 548.93nm, and 630.32 nm used in computing SI and BI index can be successfully employed to study the degree of salinity in the study area. The spectral angle is insensitive to changes in brightness, whereas the normalized values of ED that is NED takes into account the brightness difference between the two vectors, thus giving a better estimate of spectral similarity. The Normalized Euclidean distance (NED) derived from the Euclidean distance between the reference spectra and image spectra, has performed better than other measures currently in use. Given the reduction in computation time, NED constitutes an attractive measure to be used in spectra matching.

KEYWORDS

Hyperspectral, sensitive bands, spectral indices, electrical conductivity, electric conductivity in saturation extract, exchangeable sodium percentage and sodium absorption ratio, spectral angle mapper and Normalized Euclidean Distance.

BIBLIOGRAPHY

[1] Farifteh and Meer, “Spectral characteristics of salt-affected soils; Impact on Imaging Spectroscopy”, 4th workshop on Imaging Spectroscopy, Warsaw, April 27-29, 2005.

[2] J.Farifteh and Meer, “Similarity measures for spectral discrimination of salt-affected soils”, International Journal of Remote Sensing, Vol.28, no 23, 5273-5293, Dec 2007.