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Study of Spectral Reflectance Pattern of Red Soils under varying Moisture Conditions

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Abstract: Soil moisture is a critical process in the water cycle. In agricultural production, the spatial variability of soil moisture can be responsible for low or spatially variable crop yields, as soil moisture is required to make nutrients soluble for plant absorption. Soil moisture fluctuates both spatially and temporally due to factors such as soil type, soil horizon, and other site-specific geologic and climatic conditions. Traditional efforts to measure soil moisture have been principally restricted to in situ measurements. The spectral analysis is a fast and non-destructive method and has been used in many fields such as oil industry, food industry, Vegetative stress analysis, Forestry Analysis, Marine and Wetlands studies, Mineral identification, and Surface color measurement. Soils darken when wet with little apparent color change. This commonly observed phenomenon is an obvious and dominant characteristic of the reflectance of soils. Several explanations for the darkening have been suggested based on at least two, very distinct theoretical hypotheses. The spectral reflectance curve of bare soil is considerably less variable. The reflectance curve is affected by moisture content, soil texture, surface roughness, presence of iron oxide and organic matter. In the present study, the spectral reflectance of soil is found from the visible/near infrared spectra of sensitive spectral band was applied to develop a method for rapid detection of soil moisture content. From the study it has been studied how reflectance varies with respect to moisture content for red soil using Spectroradiometer. In this study, soil surface reflectance data in the visible and near–infrared regions were analyzed by spectroradiometer and it is observed that the reflectance is more when the soil is dry and the less reflectance is observed when the soil is highly wetted manually. The presence of the water ad the hydroxyl ions can be detected using the signatures. The presence of the iron oxide can also be identified using the spectral signatures of the soil.

Keywords: Hyper spectral, spectral analysis, red soils, Reflectance, Spectroradiometer

I. INTRODUCTION

Soil moisture is a critical process in the water cycle and its assessment is of paramount importance in forecasting changes in the water balance of a region (Salvucci et al., 2002). In agricultural production, the spatial variability of soil moisture can be responsible for low or spatially variable crop yields, as soil moisture is required to make nutrients soluble for plant absorption. Soil moisture fluctuates both spatially and temporally due to factors such as soil type, soil horizon, and other site-specific geologic and climatic conditions. Traditional efforts to measure soil moisture have been principally restricted to *in situ* measurements traditionally; soil moisture mapping has been accomplished through exhaustive point measurement, which can be cost prohibitive. Gravimetric measurements, while very reliable, are also very time and resource consuming. Several methods for measuring soil moisture with imbedded sensors, such as time and frequency domain reflectometers, have been developed. These sensors do not require quite as large an investment of time and facilities, and generate data that can be automatically logged. However, all of these methods suffer from some of the same disadvantages. *In situ* measurement can often be tedious, and it generally results in poor spatial resolution of soil moisture data. Depending on the topography of an area and the soil characteristics, soil moisture can be quite variable over the land surface. Thus, a method for determination of soil moisture without the necessity for exhaustive manual measurements would be beneficial in characterizing soil moisture within a given region or field. Remote sensing offers the potential for high–resolution, aggregated soil moisture mapping. Remote sensing measurements of the soil record the amount of radiation in a given wavelength reflected off of or emitted from the surface to the sensor. There are many factors that affect the resulting spectrum from the soil. The color of the soil influences its measured reflectance in the visible wavelengths. Soil texture also affects reflectance, as incoming radiation is scattered differently by coarse particles as compared to fine particles (Thomasson et al., 2001). In general, larger aggregate soil particles will have lower measured reflectance. For the same reason and because of shadowing effects, surface roughness, including the clods and machinery tracks that are especially prevalent in agricultural fields, also affects the measured reflectance from the soil surface (Matthias et al., 2000; King and Pradhan, 2001). Furthermore, surface crusting of soil tends to

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increase reflectance (Cipra et al., 1980; Baumgardner et al., 1985; Ben Dor et al., 2003). Because of the effects on soil color and texture, the mineral composition of the soil, including the soil organic matter content, also plays a role in the measured Soil moisture also affects the reflectance of the soil, although the manner in which it does so varies across the electromagnetic spectrum. Factors affecting soil reflectance are moisture content, soil texture (proportion of sand, silt and clay), surface roughness, presence of iron oxide and organic matter content. The presence of moisture in soil will decrease its reflectance -this effect is greatest in the water absorption bands at about 1.4, 1.9, 2.2 and 2.7 µm. Soil moisture content is strongly related to the soil texture. The reflectance of the soil in the field is taken using the spectroradiometer which ranges between 400nm to 1050nm.

II. LITERATURE REVIEW

Sophie Fabre *et.al* (2015) their study was to comparing between new methods to estimate the soil moisture content of bare soil from their spectral signatures in the reflective domain (0.4 - 2.5µm) with widely used spectral indices like Normalized soil moisture index (NSMI) and water index soil (WISOIL).Michael L. Whiting (2009) his study was on measuring surface water in soil and plant with light reflectance using hyper spectral full range imagery and field spectrometers. He realized that The relationship of the albedo lost to band depth, for the same mineral media, is nonlinear. By including water and mineral absorptions in the same fitting, the accuracy of the mineral abundance estimates are shown substantially improved. He created the soil sample with considerable thickness and used optic method of determining the water content measurement and Gravimetric (moisture holds from 4% to 8%) determination of water content in soil is the most common method. he mentioned The differences in soil color and tone due to variation in water, secondary clay mineral and organic matter content in aerial photography has been an early use in soil survey and other inventories.
A.L.Kaleita *et.al* (2005) their study was relationship between soil moisture content and soil surface reflectance. They minimize both the effect of time of day on the spectral data and the effect of drying time on the moisture data, every effort was made to perform the data collection within a consistent and minimal time frame. Data collections were limited to approximately a 2hr window.
David B. Lobell and Gregory P. Asner (2001) studied on moisture effects on soil reflectance and vegetation properties from remote sensing with shortwave radiation (400-2500 nm) were acquired in laboratory setting for four different soils at various moisture content. They used an equation in order to find the volumetric water content for each spectral measurement i,e;

$$\theta = \frac{m - m_\theta / \rho_w}{m_\theta / \rho_b}$$

θ = *Volumetric moisture content*, m = measured mass of soil sample

m_θ = Initial mass of the soil, ρ_w = Density of water, ρ_b = Bulk density,

The degree of saturation also considered in subsequent analysis and was calculated as the ratio of water volume/total soil pore volume:

$$s = \frac{\theta}{1 - \rho_b / \rho_p}$$

ρ_p = Particle density.

Finally they concluded reflectance decreased with increasing moisture for all soils, as demonstrated by the measured spectra, exhibiting a clearly non linear response that was well described by the exponential model.
E.L.Skidmore *et.al* (1975) their study was on evaluating surface soil water content by measuring reflectance. Source of infrared radiation, optic system, integrating sphere, detector etc. They examined radiation from an incandescent lamp was filtered with narrow band pass filter, chopped and allowed to strike the test surface, where it was either absorbed or reflected onto the surface of the integrating sphere. Distilled water was added to filter paper until it was nearly saturated. Then, reflectance of the wet filter paper was measured at 1.95 µm. After a slight amount of water had evaporated, reflectance was measured again. This process was repeated until most of the water had evaporated from the filter paper. They used filter paper for water content at 1.30, 1.45, 1.65, and 1.95µm. Finally they concluded that at lower water content soil properties strongly influenced soil reflectance at 1.95µm and drawn graph was linear trend. They measured the reflectance by reflectometer.
Recent research has suggested that reflectance in certain spectral bands have been correlated with soil properties and could provide inexpensive predictions of soil physical, chemical and biological properties (Ben Dor and Banin 1995; Reeves et al. 2000; Dunn et al. 2002; Daniel et al. 2004; Roy et al. 2006; Stamatiadis et al. 2005; Francis and Schepers 1997; Pocknee et al. 1996; Ehsani et al. 1999). As SOC increases, the soil appears darker, and vice versa (Fig. 1). This general observation formed the basis of the concept

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that electro-optical sensing of SOC might be feasible (Alexander 1969; Steinhardt and Franzmeier 1979; Hummel et al. 2001). Several researchers have tried to identify SOC using soil reflectance in the laboratory, and the result of their research has led to the development of high resolution spectral sensors. These sensors produce remotely sensed data that can provide ancillary information about the soil.

III. METHODS AND MATERIALS

Spectroradiometer an instrument for measurement of radiometric quantities in narrow wavelength intervals over a given spectral region. Spectra Vista Corporation proudly offers the SVC HR-512i. Here 512 indicate number of bands that are used in this instrument. This instrument combines the latest technology required to produce exceptional spectral data while capturing digital photographic, GPS and external sensor data. Hyper spectral hundreds to thousands number of spectral band and spectral resolution narrow, few nm, its capability detects and identifies solids and liquids. Measurements are easily acquired by one person by first setting up instrument parameters through the touch screen display and then initiating a measurement. Spectral resolution and low noise ensure that the collected data is of the highest quality and vice versa. Hyper spectral images provide each and every aspect that can be analyzed easily, spectral information to identify and distinguish between spectrally similar materials.
Hyper spectral imagery provides the potential for more accurate and detailed information extraction than is possible with other types of remotely sensed data. The domain of interest of such data covers a very large area of applications like target detection, pattern classification, material mapping and identification, defense and intelligence, forestry, water quality, Geology, Industrial, Environmental monitoring and Assessment, Agriculture. Spectroradiometer is basically emitting the light which has the properties such as electromagnetic radiation, light exists as photons displaying both wave and particle properties, discrete quanta of energy, energy inversely proportional to wavelength, measurements in 200nm-50µm range of EM spectrum. EMR interacts with objects in micro (voids, constituent particles) and macro levels (overall surface configuration and environmental context is most important). Red color for soil because of diffusion of iron in the form of iron oxide in the crystalline and metamorphic rocks and some time look like yellow when it is in the hydrated form. Red soils are found in Chhotangpur plateau Telangana, Nilgiris, Tamil Nadu, Karnataka, Andhra Pradesh and periphery areas of Deccan Plateau. These soils have been formed due to decomposition of underlying igneous rocks under heavy rainfall. Red soils are mostly cultivation of millets, Pulses, Tobacco etc. More sandy and less clayey poor in phosphorus, nitrogen, lime and rich in Iron, small amount of humus.

A. Sample Preparation and Spectra Acquisition

The experiment was conducted for red soil in disturbed condition and experiment carry out at different stages of moisture content dry to fully saturation by supplying artificial water. Numerous observations were obtained in order to get perfect spectral reflectance for that particular soil. The moisture content of the soil is measured by the soil moisture meter which gives the moisture content in terms of percentage (%). At known soil moisture content the reflectance of the soil is developed and the graph is plotted. By which the spectral signature at particular soil moisture is developed. Spectral reflectance is measured using the Spectroradiometer which ranges from 350-1050nm. The HR-512i is the instrument used to collect the spectra of the soil, which collects the reflectance values in 512 bands, which helps for the easy identification and differentiation of the different soils. In this instrument the typical scan acquisition time is <5 seconds. The reflectance of the soil at different soil moisture contents like 0.1%, 0.4%, 2.3%, 4.1%, 5.2%, 6.4%, 7.3%, 8.9% and 11.20%. is collected.

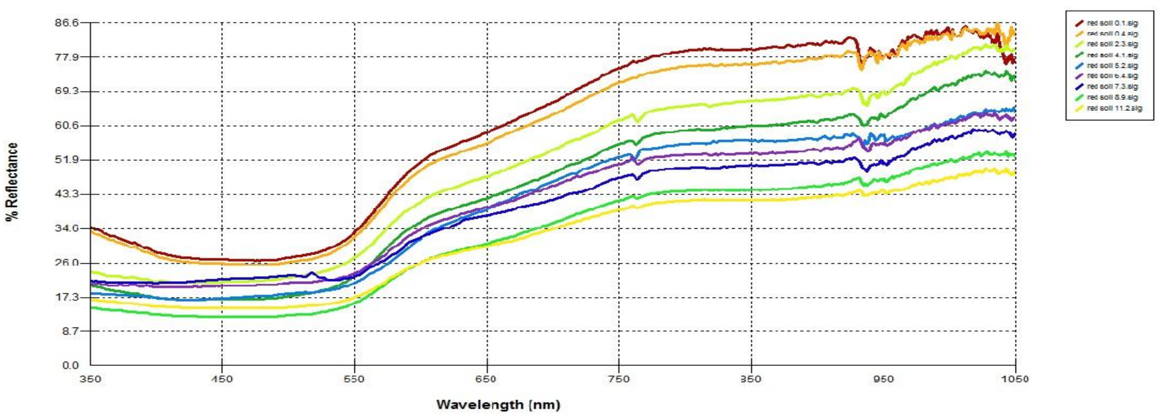
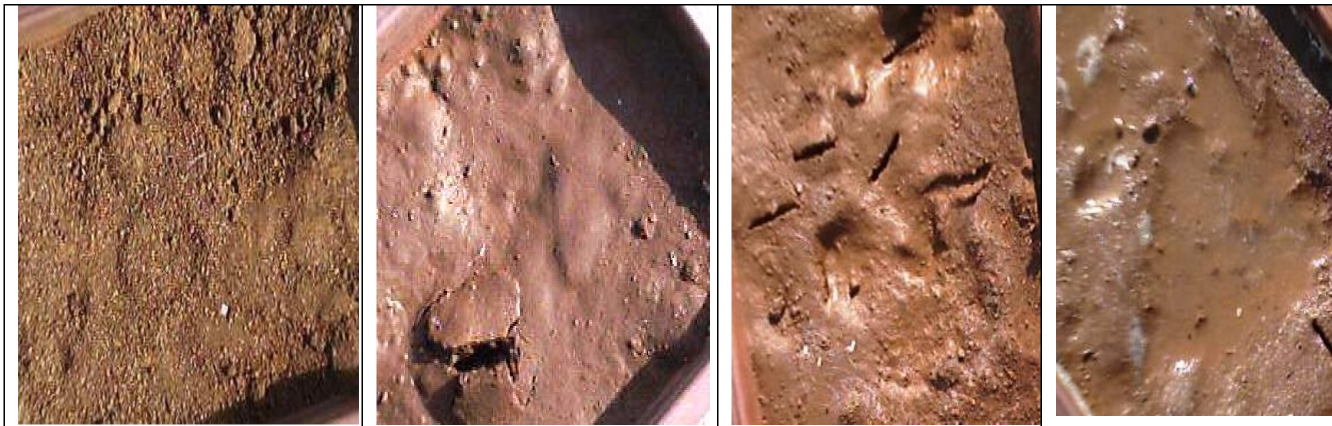


Fig 1. Graph indicating the reflectance at different soil moisture contents of red soil



Moisture content 0.1%	Moisture content 4.1%	Moisture content 7.3%	Moisture content 11.20%

Fig. 2 Red soil at different soil moisture contents.

IV. RESULTS AND DISCUSSIONS

The reflectance characteristics of Earth's surface features may be quantified by measuring the portion of incident energy that is reflected. Spectral reflectance drastically varies in water, vegetation, soil. We used spectroradiometer with wavelength of range is 350-1050nm. Maximum reflectance occurs at NIR wavelength as moisture increases overall reflectance of soil decrease. The increase in soil moisture will result in a particularly rapid decrease in reflectance due to water and hydroxyl absorption features at 900nm. The soil reflectance tends to increase with increase in wavelengths from 400-1000nm because of the presence of the iron oxide absorption at shorter wavelengths. Iron oxide gives rusty red coloration to soils by coating or staining individual soil particles. Iron oxide selectively reflects red light absorbs green light (600-700nm) and absorbs green light (500-600nm). In case of red soil the portion of spectral reflectance are changes (dips) at 760nm and 950nm which shows the presence of water, and the increase in reflectance after 400nm which indicates the iron oxide. And also shows a dip at 900nm which shows the absorption of hydroxyl ions. In this study, soil surface reflectance data in the visible and near–infrared regions were analyzed by spectroradiometer and it is observed that the reflectance is more when the soil is dry and the less reflectance is observed when the soil is highly moisture. The presence of the iron oxide is expected because of the increase in reflectance after 400nm.

REFERENCES

[1] Haubrock, S.; Chabrillat, S.; Lemmnitz, C.; Kaufmann, H. Surface soil moisture quantification models from reflectance data under field conditions.

[2] Bedidi, A., B. Cervelle, J. Madeira, and M. Pouget. 1992. Moisture effects on visible spectral characteristics of lateritic soil.

[3] Ben-Dor, E., & Banin, A. (1995). Near-infrared analysis as a rapid method to simultaneously evaluate several soil properties. Soil Science Society of America Journal, 59, 364–372

[4] Daniel, K. W., Tripathi, N. K., Honda, K., & Apisit, E. (2004). Analysis of VNIR (400–1100 nm) spectral signatures for estimation of soil organic matter in tropical soils of Thailand. International Journal of Remote Sensing, 25, 643–652. doi:10.1080/0143116031000139944.

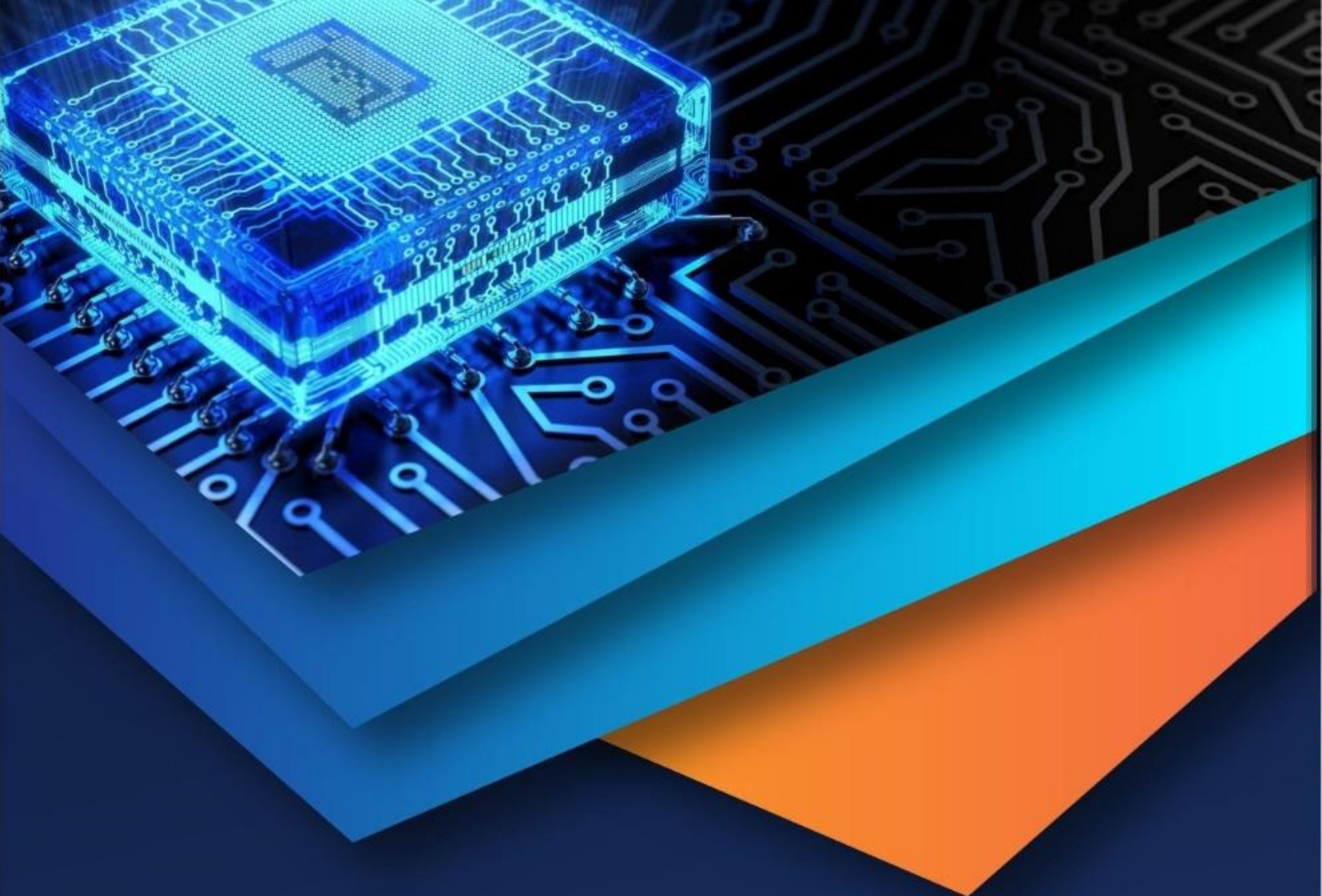
[5] Dunn, B. W., Beecher, H. G., Batten, G. D., & Ciavarella, S. (2002). The potential of near-infrared reflectance spectroscopy for soil analysis—a case study from the riverine plain of south-easternAustralia. Australian Journal of Experimental Agriculture, 42, 607–614. doi:10.1071/EA0117.

[6] Salvucci, G. D., Saleem, J. A., and R. Kaufmann, 2002, "Investigating Soil Moisture Feedbacks on Precipitation with Tests of Granger Causality," *Advances in Water Resources*, 25:1305–1312.

[7] Stamatiadis, S., Christofides, C., Tsadilas, C., Samaras, V., Schepers, J. S., & Francis, D. (2005). Groundsensor soil reflectance as related to soil properties and crop response in a cotton field. Precision Agriculture, 6, 399–411. doi:10.1007/s11119-005-2326-3.

[8] Alexander, J. D. (1969). A color chart for organic matter. Crops Soils, 21, 15–17.

[9] Steinhardt, G. C., & Franzmeier, D. P. (1979). Comparison of organic matter content with soil color for silt loam soils of Indiana. Communications in Soil Science and Plant Analysis, 10, 1271–1277. doi: 10.1080/00103627909366981.



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