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Spatial Variability of Surface Soil Analysis Using Hyperspectral Data

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ABSTRACT

The conventional strategies for soil classification are repetitive and they don't satisfy the quick necessities of spatial inconstancy.The present investigation features the utilization of hyperspectral remote sensing datasets for soil arrangement. The spectral hourglass strategy is exe- cuted for retrieve the 48 endmembers from EO-1 data. The USGS spectral library has been utilized for reference spectra of soil. The reference spectra is examined and utilized as a input spectra for Hyperion image classifica- tion. The Spectral Angle Mapper (SAM) technique is registered after spectral hourglass strategy for soil mapping. For approval of hyperspec- tral image information soil order, I have utilized landsat 4-5 information and arranged it in four classes where open area is identified with soil classification. The Deep Fine soil associated loamy soil, Deep silty soil , Deep loamy soil & Moderate salinity with associated loamy soil of surface soil types is identified, classified and mapped. The result of the present investigation is basic for computerized soil analysis and its mapping of heterogeneousregion.

Keywords: Soil Classification, HyperspectralRemote Sensing Datasets, Soil Properties, Endmembers,Spatial inconstancy,USGS Spectral Library,Spectral Hourglass, Spectral Angle Mapper,Heterogeneous Region.

I. INTRODUCTION

Soil is a characteristic principal asset and it is a blend of natural issue, minerals, gases, fluids, and life forms that together help of our life[1].Soil is a standout amongst the most essential assets and indispensable part of earth's basic zone. There are uncommon weights on soil because of urbanization,industrialization or from corruption; soils are lessening their quality that are unbalancing the agrarian practices and nourishment generation. Thus, soil quality and its administration with arranging are basic to save the soil with its quality for who and what is to come. [2].

Data of spatial and fleeting varieties of soil quality (soil properties) is required for different reasons for maintainable agriculture advancement and administration [3]. Soil mapping is a geological portrayal indicating assorted variety of soil types, distinguishing proof, arrangement of surface soil types[4]. In india, soils are heterogeneous in nature and it's examination what's more, forms are additionally many-sided for spatially and transiently variation [5], [6].

The spatio-fleeting variety in soils can not be satisfied by the conventional strategies. Soil examination and its mapping by research center strategies are too long and not monetarily proficient [7]. Hyperspectral Remote Sensing (HRS) datasets (imaging data) has provided fabulous data about earth surface materials for build up minute details of various materials on the earth surface [8].
Distinguishing proof, arrangement and mapping of surface soil composes through EO-1 datasets and

utilizing ENVI programming are helpful for better agribusiness and land settlement [9]. Hence, A vigorous attempt has been taken to characterize the surface soil in advanced routes by me.

To begin with of the all why Hyperspectral; not microwave or thermal wave remote sensing data has been used:

1. The unique normal for hyperspectral symbolism information have high phantom determination that is given a vast and persistent wavelength locale.
2. Every pixel is related with hundred of data information focuses that speak to the spectral signature of the materials inside the spatial zone of the pixel [10].

The outcome is a three-dimensional informational collection that has two axis, one give spatial data and one give spectral data (11). The high de- termination of hyperspectral symbolism information make it conceivable to distinguish the diverse materials at the world's surface.

In this study I have utilized multispectral dataset for confirmation of soil classification(Hyperion picture).I have classified the landsat Thematic Mapper (TM) image in four class Water, Agriculture, Settlement & Open Area.

Soil is a Medium for plant development & bio-materials generation where it take into consideration the transportation of water and supplements with the assistance of root to the steam and leaves.[12]

Information of soil grouping helps in expectation of soil conduct and Soil conduct helps in the estimating of soil execution for developing agricultural yields. With the assistance of advanced soil mapping we can get ready soil review maps of neighborhood soil orders for help of the ranchers to settle on choices about harvests to develop specifically regions.

The main objective of this study are :
Identification and classification of surface soil for spatio-temporal variation in soil and better agriculture ,help for land settlement pattern in district & an extra objective is to set the area organizations to work considering with computerized soil delineate their venture and apply this procedure to other locale too.

In light of the fact that soil assumes an essential part in the development of economy for any nation.

II. GEOGRAPHY OF STUDY AREA

The Allahabad locale of Uttar pradesh, is chosen as the study zone. The geological area of the study zone is arranged at 25 28' 22.9224" N latitude, 81 52'42.0852" E longitude . The aggregate size of the study zone is close around 82 Km2 which is heterogeneous in nature and encompassed by Rewa at South, Mirzapur at East and Pratapgarh at North and Kaushsmbi and chitrakoot at West [13]. The study site has a moist subtropical atmosphere which is arranged at a height of 90 meters over the ocean level. A yearly regular precipitation is close about of 981 mm with a yearly mean temperature is 18 C to 29 C.

In Allahabad mainly four types of soils are found: Deep Fine soil associated loamy soil Deep silty soil , Deep loamy soil & Moderate salinity with associated loamy soil. [14]

III. DATASETS USED

3.1. HYPERSPECTRAL DATA

3.1.1. EO-1 HYPERSPECTRAL IMAGE

The Hyperion information is acquired by utilizing USGS [15] on 21 April 2004, at 17:15 hrs. The Hyperion picture is GeoTIFF (level 1T) sort and it is geometrically and radiometrically redressed with band successive (BSQ)

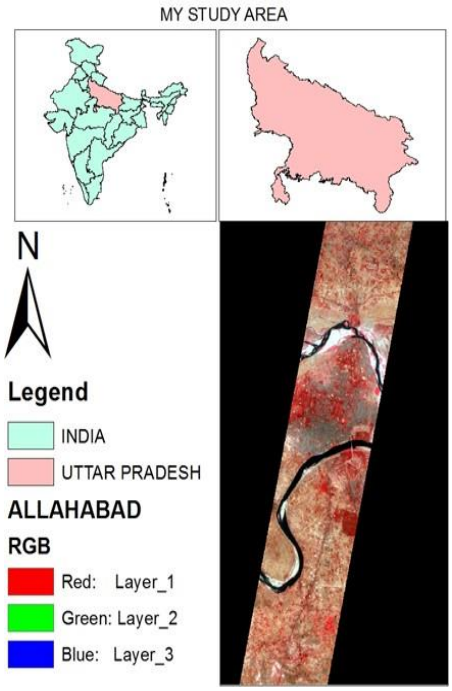

Figure 1. Geographical location of Study Area.

records having 0 to 9% cloud cover. The data has 242 bands groups with 10nm spectral resolution and 30m spatial resolution.

In the hyperspectral image, there are two infrared ranges exist. The 1st one is VNIR & 2nd is SWIR which having consist of 400-1000 nm spectral range & 900-2500 nm spectral range respectively.

In the hyperion image has 242 spectral band are exist, in which 1-70 bands related to VNIR and 71-242 bands related to SWIR [16], [17].

3.1.2. SPECTRUM ACQUISITION

The spectrum of different soil are found in USGS spectral library which is exist in ENVI also.[18]

3.2. MULTISPECTRAL DATA

The Multispectral data is obtained by using USGS[15] Landsat 4-5 The matic Mapper (TM) image (path 143, row 043) Level 2 from 29 April 2004.

Table 1. Landsat 4-5 Band Resolution.

	Landsat 4-5	Wavelength (micrometers)	Resolution (meters)
Thematic Mapper (TM)	Band 1	0.45-0.52	30
	Band 2	0.52-0.60	30
	Band 3	0.63-0.69	30
	Band 4	0.76-0.90	30
	Band 5	1.55-1.75	30
	Band 6	10.40-12.50	120* (30)
	Band 7	2.08-2.35	30

IV. METHODOLOGY

4.1. HYPERION DATASETS

For image analysis and data pre &post-processing the following methodology is performed by using ENVI 5.1.-

PRE-PROCESSING

1. Change the format of EO-1 image level 1T GeoTIFF to ENVI standard format using 'ENVI tools'.
2. Eliminate all uncalibrated bands.
3. Change the Digital Number (DN) of pixel to Radiance Value.
4. Atmospheric correction using QUAC algorithm with FCC image using R-51,G-30 & B-20 bands.

POST-PROCESSING

5. Dimensionality reduction by MNF using spectral hourglass.
6. Collect PPI(Pixel Purity Index) of image and use as a input for n-D Visualizers(48) spectrum.
7. The collected reflectance spectra will analyzed with the reference spectra which is obtained by using USGS spectral library.
8. Export the spectra which will match to reference spectra as a spectrum in .sli format.

CLASSIFICATION

9. Use the export spectra as a input for SAM supervised classification in ENVI.

ACCURACY

10. For check the accuracy of soil mapping,i have used LANDSAT image classified file.

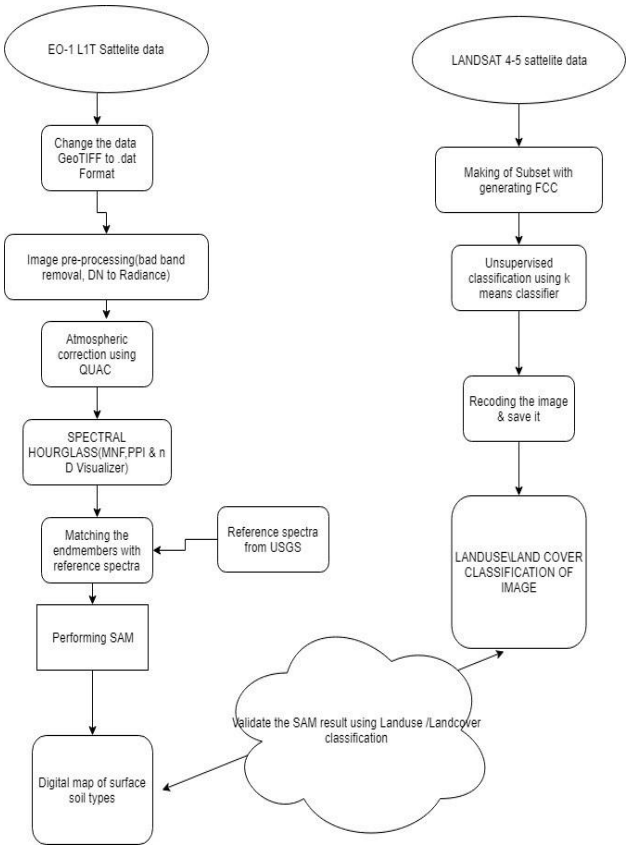

Figure 2. Workflow of Proposed Methodology.

4.1.1. CHANGE THE IMAGE FORMAT

For the processing of the image data in ENVI ,First the downloaded imageis changed the format from GeoTIFF to .data format. The using does it
of ENVI tools.

4.1.2. COMPLETE REMOVAL OF UNCALIBRATED BANDS

The hyperion picture having 242 groups among that groups 1-70 is in charge of VNIR area & band 71-242 in charge of SWIR locale of range. Groups No. 1-7, 58-70, 71-76 and 225-242 is uncalibrated groups. Thus, add up to 198 groups are aligned with VNIR and SWIR areas [19],[20].

In hyperion picture some water vapor bands is available like 120-132, 165- 182, 185-187 & 221-224 and after that disposed of from the pre-processing of the image [16], [17].

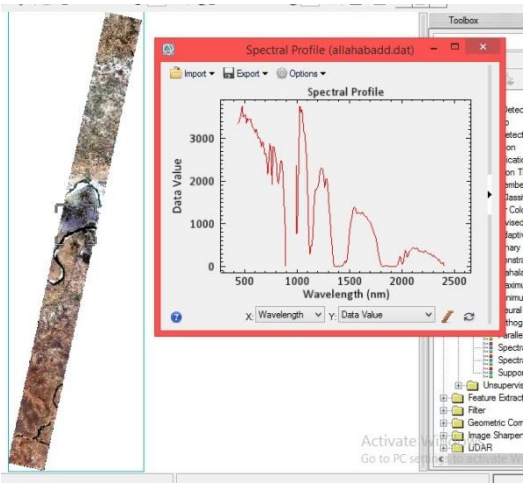

Figure 3. Spectrum of without processing EO-1 DATA.

Presently, The left 155 groups are valuable for pre-processing and these groups have attractive idea regarding the earth surface, which are utilized as the contribution for additional processing in ENVI.

4.1.3. DN VALUES OF PIXELS TO RADIANCE

The remaining 155 bands is used for radiometric calibration. In calibration i have followed these steps to perform radiometric calibration. From the Toolbox, Radiometric Correction is selected , Then an input file is selected , For computing radiance value, the bands is selected in the Spectral Subset. & then Click OK. [21]

4.1.4. ATMOSPHERIC CORRECTION USING QUick ALGORITHM

QUick Atmospheric Correction (QUAC) is a robotized climatic adjustment strategy in ENVI for recovering spectral reflectance from hyperspectral pictures [22].

The QUick algorithm performs without any help of data like latitude or longitude value. It convert the radiance values into reflectance values. [17]

4.1.5. PERFORM SPECTRAL HOURGLASS WIZARD Minimum Noise Fraction(MNF)

MNF has been utilized to separate the noise from the hyperion picture, and to diminish the image information in a specific measurement for target

Figure 4. Spectrum after atmospheric correction.

recognition in image processing. The beneficial bands of the MNF transformed data are known by two types of band.- Lower MNF bands have most of the information. & Higher MNF bands have most of the noise.

The MNF works to computing the normalized linear combinations of the original bands so that it can maximize the ratio of the signal to noise[23]. Pixel Purity Index(PPI) Pixel Purity Index is used to obtain the brightest (pure) pixels in hyper- spectral images.In it the result of MNF transformed data is taken as a input, and shown the result in forms of pure pixel spectrum.[24]n-D Visualizer The PPI raster is used as a input for extract the endmember spectrum [25]. The endmemberspectum are 48 no. of spectrum. Each spectrum show a different phenomenon present in the image data. After extaction of endmembers, all spectrum have matched with the reference spectra one by one. Then export the spectra which is correctly matched with reference spectra and save it as a spectrum in the format of .sli .

4.1.6. HYPERSPECTRAL IMAGE CLASSIFICATION USING SAM

SPECTRAL ANGLE MAPPER (SAM) is an supervised classificationmethod for comparing endmember spectrum to reference (known) spectrum in ENVI software. The SAM algorithm is working on the principle of "mea- surement of the spectral similarity between two spectra".[26].It determine the similarity by computing the spectral angle (in radian)between them andit treat both (known & unknown) spectrum as a vector[27].

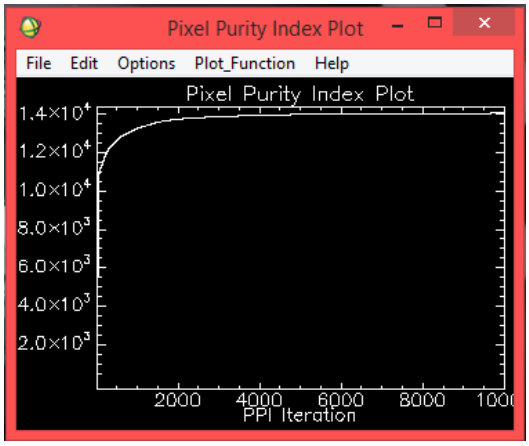

Figure 5. Pixel Purity Index.

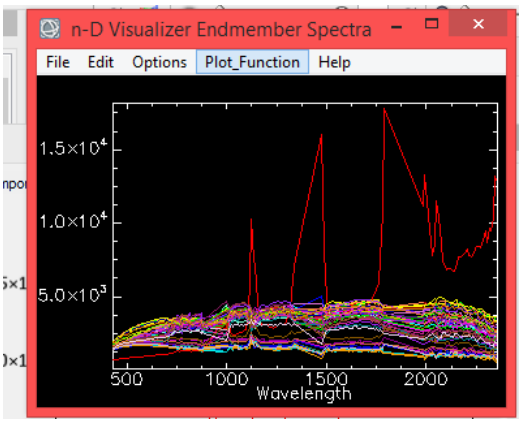

Figure 6. Endmembers.

4.2. LANDSAT DATASETS

For image classification the following methodology is performed by usingERDAS 2014.

1st of all the shape file of allahabad has been used for clipping and subset from the satellite images. Then the clipped images are then classified using unsupervised (K means) classification . After that the classified images have 50 classes ,then corrected the class and assigned proper name by the use of GOOGLE EARTH & finally assign name of every class give same colour to same type of class.

Hence, four class is assigned. WATER, TION, OPEN AREA.

V. RESULTS AND DISCUSSION

5.1. HYPERION DATA

5.1.1. IDENTIFICATION OF SOIL TYPE

Four soil classes are detected and classified on the basis of imaging re-flectance spectra. The soil classes are Deep Fine soil associated loamy soil , Deep silty soil , Deep loamy soil & Moderate salinity with associated loamy soil.

The spectrum of soil classes are recognised in a proper way considering of the spectral reflectance properties within the defined spectrum wavelength range.

Soil reflectance curve have more variation occurs and it depend on the various factors. Moisture content , soil texture ,surface roughness ,presence of iron oxide & presence of organic matter content. The every single above factor are variable, and interrelated with each other.[23], [24] Reflectance is lower if dampness content is available in soil. Dampness substance of soil is identified with the soil surface means it is coarse or fine soils. Inadequately depleted fine soils have low reflectance however coarse finished soils seem darker on the grounds that in the absense of water the soil demonstrates the turn around result .The rest of the elements that are likewise lessening of the soil reflectances are surface unpleasantness, nearness of organic matter & substance of iron oxide, at the visible region(400-700201 mm) of wavelengths.[28]

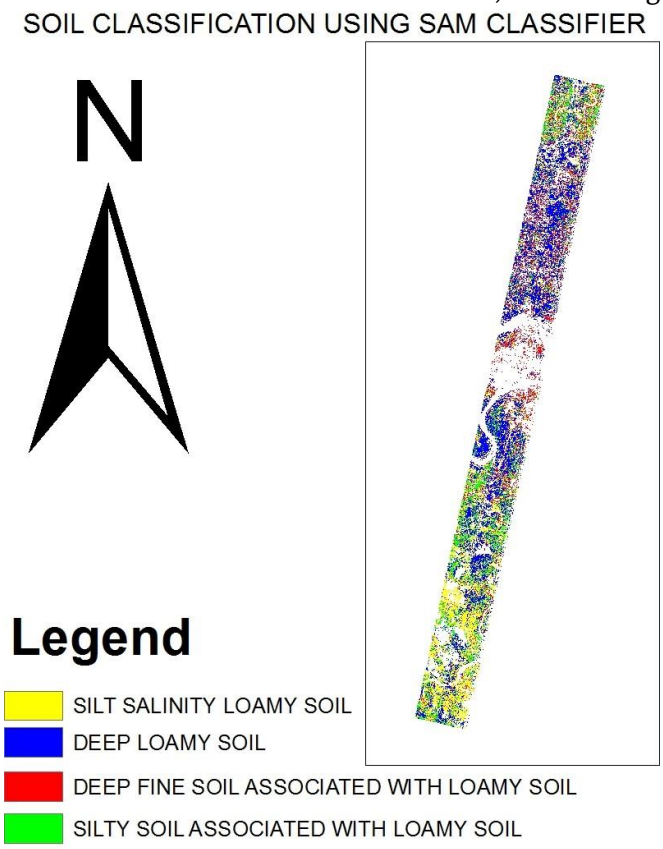

Figure 7. Classification Map of Surface Soils using SAM method.

5.1.2. The SAM Method Reports USING ENVI

The supervised SAM is fulfilled the demand of Hyperion image classifi-cation . The spectral-angle is kept 0.05 radian between each image spectra and reference spectra. Spectral endmembers(48) which are generated in n-D Visualizer processing for matching(corresponding in pattern) to the reference spectra of soil(derived by USGS spectral library). The digital mapping of surface soil types are mapped using SAM classifier. The classified soil map is shown

in Figure, there are most of the regions are shaded by the fine loamy soil followed by Deep silty soil , Deep loamy soil, Moderate salinity with associated loamy soil.

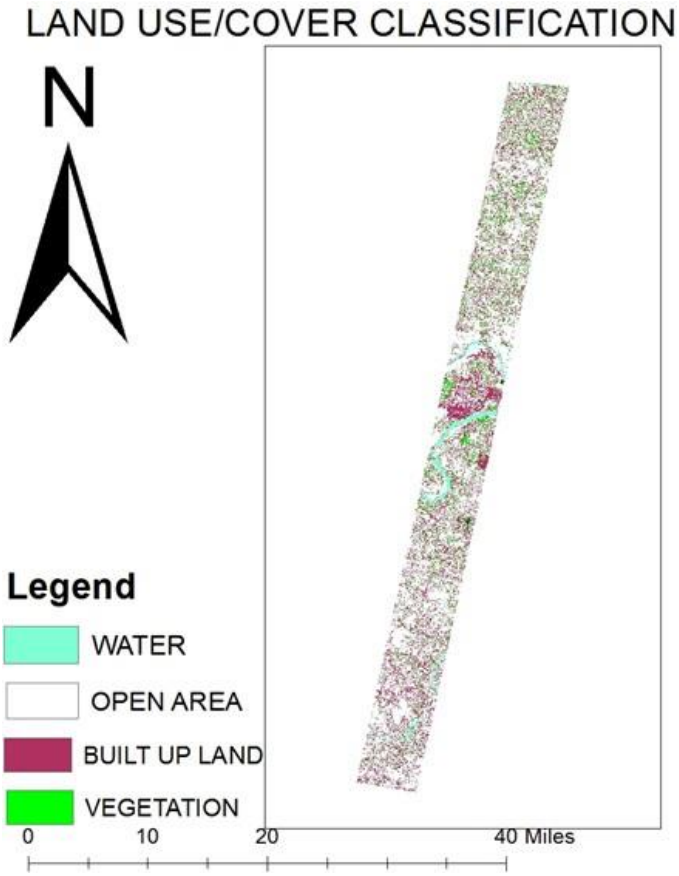

Figure 8

5.2. LAND USE LAND COVER IMAGE REPORT USING ERDAS

The classification of the satellite image utilizing K mean classifier into built up land,water,vegetation and open area are shown in the visual image of the allahabad territory, which is the essential affirmation of the entire territory pattern.

By reviewing the arranged picture, the open area in the city can be ef-fectively recognized.

5.3. VALIDATION OF SAM RESULT USING MULTISPECTRAL DATA

For the approval of ENVI result which is turned out by utilizing SAM classification, a multispectral image is grouped utilizing ERDAS software.As from the LANDSAT image , we can check the open area (no impervious territory) in the image which identifies with the EO-1 picture in form of soil mapping.I intend to state that wherever open area(landsat) is accessible ,there is no one but we can see the arranged soil(EO-1 SAM).

VI. CONCLUSION

The Hyperspectral Remote sensing carries on like a important device in ordering the surface soil with worthy outcomes. The USGS spectral library spectrum are utilized as a source of reference spectra for EO-1 image to mapping the surface soil . The principle donation of the study about is to get ready soil order display.

The consequence of the study is demonstrated that utilization of USGS library spectra have an awesome significance for SAM classification .The spectral

hourglass handling give great outcomes for endmember spectra of Hyperion picture information. Now reach the conclusion, the Hyperspectral remote sensing (SAM method) is appropriate for soil classification. The arranged advanced mapping of soil types can be utilized adequately in exactness in agriculture, settlement ar-ranging, administration and for various other applications.

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