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Review on Analysis and Classification Techniques of Soil Study in Remote Sensing and Geographic Information System

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Abstract

As we seen past few decennary, the various changes in land use has substantiated by earth's surface. Global environmental changes are currently modifying key ecosystem services that soils provide. Because of these conditions monitoring tools are needed for preserving a sustainable ecological status and developing soil conservation at local, regional and global level. In this research Remote Sensing has presented a tremendous conceivable role in soil characteristics retrieving. Various methodologies have been arranged for the evaluation of soil parameters, based on distinct remote sensing sensors and classification techniques. Remote Sensing is emerging research field in agriculture for soil analysis. Indian economy is based on agriculture, agriculture is a source of income for most of the population in India. Now a day's Agriculture production are decreases because of cheap yield prediction. Many factors are affects yield prediction like soil, rain, fertilizers. Soil quality is important to increase agriculture productivity .The Hyper spectral tools helps to improve soil quality and also to resolve the soil characteristics like carbon, nitrogen, phosphorus, Potassium, pH, CEC, Silt, Clay, Sand over the wavelength 350-2500nm. In this paper a review is done for various soil analysis & classification techniques.

Keywords: Agriculture, Spectroradiometer, VIS/NIR, MIR, PLSR, PCA, RMSE.

1. INTRODUCTION

Remote Sensing is widely used area in research. Remote sensing is nothing but to extract the information about an object without any physical contact with it. Sensors are used to record the physical properties .Remote Sensing is emerging research field in agriculture soil analysis**.** Standard approaches of averaging soil properties are consistently composite, excessive, and prolonged .For this purpose elementary and cost effective soil testing techniques are needed in the laboratory and in the field for both assessment and management of soil quality[1][2].For any special purpose soil classification one basic requirement is that the soil is must be classified in terms of their properties such as Chemical ,Physical, Biological [3].They quantify the organic and inorganic C for to reduce the atmospheric Co2 levels [4] .They investigate the some chemical properties such as Ca, Mg, Fe, Mn and K for monitoring the environmental process [5] .It is the interaction of how the validation is required for different soil characterization [6].They investigate the characterization of some decomposition characteristics which is important for sound management for soils as well as livestock .Transformation of reflectance could also be correlated with chemical properties[7][8].They analyze and measure the some content of Nitrogen and Organic matter in soil characteristics [9][10].Spectral arrangement for organic C and Nitrogen was better for the fOM fraction than for soil[11]. They retrieve laboratory pretending data for all profiles sampled., for the preservation & valuated of global environment desires the evolution of some innovative new methodologies which is used to estimate the spatial & temporal variability of soil characteristics[12].They estimates the soil chemical properties and combine these predictions with geographic information system[13].Using Soil chemical and physical laboratory analysis are possible to gain understanding of the soil and assessment of its quality and function and examine the quantitative determination of Total Carbon and Total Nitrogen in soil[14][15].They investigate the methods for measurement of Carbon in soil at the regional global scale[16][17].They analyze the quantitative model to predict the nutrition element content in soil[18]. They describe development of a diffuse reflectance spectral library from a legacy soil sample. They discuss some important factors which are helps to build the spectral library and they also explain how to collect sampled, how to handled it , prepared ,after that where to stored it , how to scanned and the what kind of reference analytical procedures used for it [19].They develop heuristic scheme as a tool which helps to assess the definition and diagnostic screening of soil condition for agricultural and environmental management for current and future purpose[20].They established the soil spectral library to determine the state of soil and also to solve the

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degradation problem[55].They investigate the salt affected soil characteristics like pH, ECe , Na+, Ca2+ + Mg2+, Cl− and SAR. The awareness about the Remote Sensing is necessary for better perceptive of the subject and its comprehensiveness, and also for future development, particularly for the welfare of human society. The development of GIS is Geographic Information System which consists of three words, viz. Geographic, Information and System. It is a tool used to evaluate, operates and anticipate geographic information of an object [56].

2. FIELD SPEC SPECTRORADIOMETER

The world's early convenient Spectroradiometer constructed in 1990, the initial version of the ASD Field Spec was on the market in 1993**.** Field spec Spectroradiometer is used to gather soil samples for soil examination. The instrument has a spectral range of 350 to 2500 nm and a resolution from 3 nm (at 700 nm) to 10 nm (at 1400 and 2100 nm) as a result of its three pointers. Data experiment interval is 1.4 nm (350-1000nm) @ 350-1000 nm and 2 nm (1000-2500nm) @ 1000- 2500 nm. The total number of 2151 data points per spectrum using a Field Spec, Field Spec Pro and Field Spec FR Spectroradiometer (Analytical Spectral Devices Inc., Boulder, Colorado, USA).It needed air-dry soil samples and halogen lamp light source is retained encompassed it. Reflectance records, though the samples with constant angle at length from sensor and after 3-5 subsequent readings, each average of ten succeeding reflectance spectra. The sample can be rotated 90 and 360 degrees and placed on Petri plates. Here It's Got 24 articles used Spectroradiometer with 350-2500nm spectral range . It can see in Table 3.1, the spectral reflectance of soil samples was measured in VNIR and SWIR region. Its required input is 1.5m permanent fiber optic cable and it having 25 degree, 8 degree and 1 degree Field Of View. Fiber optic cable is extensible and it can change. It is a very formable instrument. We can carry it, collect spectrum and save it on laptop through it. It can use in lab and on the field. It desires same attachments like pistol grip tripod, lamp, reference panels, backpack, battery, AC power supply and laptop. The laptop is have need communicate to instrument through Ethernet wired interface or Wi-Fi Ethernet interface. It has a few software like RS3, View Spec Pro, Indico Pro and third party software. RS3 software is used for data acquisition RS3 software file is saved as .asd extension. We can set 25 degrees, 8 degree and 1 degree Field Of View. View Spec Pro software is used for data resolution, and also useful for process data .It has a few tools like reflectance, absolute reflectance, log 1/ T, log 1/ R, 1st and 2nd derivative, and parabolic improvement and so on. It can export .asd file into the ASCII code (text file) [43-53].

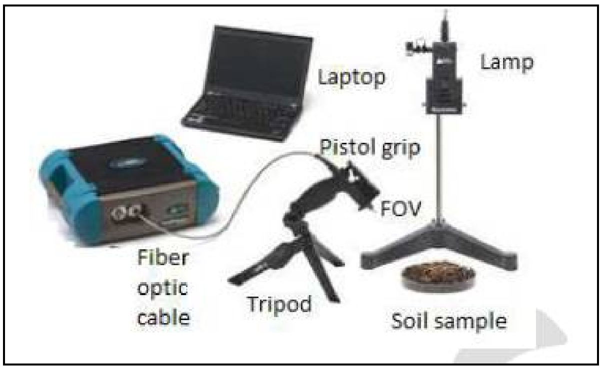

Figure 1: Working of FieldSpectroradiometer

3. LITERATURE SURVEY

The review is done for soil characteristics study using Remote Sensing and GIS .In this paper we studied the reference work since from 2000 to 2016.Here the literature we have done in three sections .Section 1 dealing with Hyper spectral tools used for soil analysis and classification. In Section 2 we studied the Soil Characteristics, Preprocessing, and its Classification and Statistical techniques for agriculture sector and also in section 3 mostly used preprocessing and analysis techniques are studied.

3.1 Hyper spectral Tools

The term Hyper spectral used in Remote Sensing with other terms such as Spectroscopy, Spectrometry, Spectroradiometery and sometimes Ultra spectral. It has been a provocation to find ultimate convenient technique for studying soil property definitely and at the same time shortening the time and effort involve in the field sampling and laboratory analysis. Hyper spectral data are present in extensive size ,extending of week overtones and essential vibrational bands ,have been very crucial for its direct interpretation .So multi-various investigation is required for denotative clarification of soil parameters from hyper spectral reflectance data .Hyper spectral remote sensing produce an plenty of spectral information, which recommend a probable technique for evaluating soil properties Compared with traditional laboratory techniques. Hyper spectral techniques are more rapid and less costly. This review focuses on soil properties analysis using hyper spectral tools such as NIR, Mid-IR, Field Spec, Lab Spec, Spectroradiometer, Spectrophotometer, Diffuse Reflectance Spectroscopy. When we have going through the literature survey we get various hyper spectral tools which are available for soil study. Those tools are presented in this paper in below Table 3.1.The table contains Hyper spectral tools, its ranges and reference id.

Table 3.1: Hyper spectral tools with its ranges

Hyper spectral Tool	Range	Reference Id
NIRS	400-2498 nm, 1100-2500nm	[1]
Field Photometer Spectroradiometer	400-1050 nm 400-1100nm	[2]
NIRS	1300-2500nm	[3]
NIR, mid- IR	1100-2498nm 4000-400 cm-1(2500-25,000)nm	[4]
Field Spec II Spectrometer	0.4-2.5 nm	[5]
FieldSpec Pro FR-VNIR Specroradiomter	350-2500nm	[6]
Field Spec Spectroradiometer 4	350-2500 nm	[7]
Fourier transform infrared Photoacoustic Spectroscopy (MIR spectrum)	400-4000 cm-1	[8]
Photoacoustic spectroscopy	(400-4000 cm-1)	[9]
FieldSpec Pro FR	350-2500nm	[10][38][53]
NIR(FieldSpecTM FR spectroradiometer)	1000-2500nm	[11] [21]
NIRS(FieldSpecTM FR spectroradiometer)	350-2500nm	[12]
Fieldspec Pro FR VNIR spectroradiometer	350-2500	[13]
NIRS	350-2500nm	[14][36]
BioRadFTS175(MIR Spectrum),VIS/NIR/MIR	1200-20,000nm, 350-2500nm	[15]
FTS -700 Spectrometer(Mid-IR,NIR)	1100-2500nm	[16]
FieldSpec Pro Spectroradiomter	400-2500nm	[17]
NIRS	700-2500nm	[18]
Tensor 37 FT-IR spectrometer	400-4000 cm-1	[20]
MIR	2500-25000nm (400-4000 cm-1)	[22]
NIR/SWIR	350-2500nm	[23]
ATR, photoacoustic spectroscopy	800-1200 cm-1, 600-2000 cm-1	[24]
(FT-NIR) spectrophotometer	12000 to 3800 cm-1.	[25]
NIR spectroscopy	920-1718nm	[26]
VNIR Spectroscopy	400-950nm	[27]
VNIR	450-2470nm	[28]
Field Spectrometer	350-2500nm	[29]
IRIS (Infrared Intelligent Spectroradiometer)sensor)	(400–2,500 nm	[30]
FieldSpec Pro Spectroradiometer	350-2500nm	[31]
FieldSpec Pro hyperspectral sensor(VNIR)	350-2500nm	[32]
ASTER(VIS/NIR)	350-2500nm	[33]
VIS/NIR	2000-2300nm	[34]
VIS/NIR (Spectrophotometer(Tech5,Germany)	350-2500nm	[35]

NIR/MIR	(13500 to ~4000 cm-1), (4000-450 cm-1)	[37]
NIR,MIR	1000-2500nm 2500-25000nm	[39]
NIRS Spectrophotometer	400-2500nm	[40]
ASD HandHeld FieldSpec Spectroradiometer	400 to 1,000 nm	[40]
field spectrometer With3S-HeD Assembly	350-2500nm	[41]
VIS/NIR	400-2500nm	[42]
LabSpec 2500	350-2500nm	[44][45]
Vis/NIR Spectroscopy	1650-2500nm	[47]
FieldSpec Spectroradiometer	350-2500nm	[48]
FieldSpec® Pro FR spectroradiometer	350–2500 nm	[49][55]
LabSpec ®2500 spectrophotometer	350-2500nm	[46][50][51][52]
VIS/SWIR	350-2500nm	[54]

3.2 Soil Statistical and Classification Techniques

The number of various calibration techniques is accessible and have been tested when describing measured spectra to measured values of soil properties .The preference of calibration technique will depend on the application of the data .The most common techniques which are used in this such as PLSR, PCR. Various pre-processing transformation have been enforced in several studies to revolution soil spectral data ,remove noise ,emphasize features .Pre-processing conversions of spectral data constituent an important step in multivarious calibrations and have been shown to improve the accuracy of prognosis models .In table 3.2 we present various statistical and classification techniques which are studied by various authors for soil study in Remote Sensing .In this section we present the literature according to Author and year , soil physical , chemical properties , preprocessing techniques ,classification and statistical methods for soil study . Which we review during literature survey.

Table3.2: Soil Characteristics, Preprocessing, its Classification and Statistical methods

Author and Year	Soil attributes	Preprocessing	Classification	Statistical method
Cheng-Wen Chang,2000 [1]	C, N, CEC, CLAY, pH, TEXTURE, MOISTURE, Sand	Log 1/R, 1st derivatives	PLSR	Mean , SD,RPD, RMSECV,r^2
K. Daniel, N.K.Tripathi, K.Honda, E.Apisit,2001 [2]	SOM(soil organic matter)	Log1/R	SRCA	Cross validation ,Efficiency index ,R^2

Cheng-Wen Chang,2001b **[3]**	C,N, biomass C,CEC,Clay,Silt,Sand,pH-H2O,pH-CaCl2,Ca,Cu,,Fe,K,Mg,Mn,Zn,P,Ca,Na,K	Log1/R,1st Derivatives	PCR	Mean, Min, Max,SD,RPD,RMSECV, r^2
Mccarity G. W, MimmoT.V,Reeves V.B,Follet R.F,Kimble J.M,GallettiG .C, **2002c** **[4]**	Carbon	1 st and 2 nd Derivatives, Mean,Centering,VarianceScaling,Multiplicative Scatter Correction	PLSR	RD,RMSD
Thomas Udelhoven, **Christoph Emmerling** **&Thomas Jarmer,2003** **[5]**	Ca,Mg,Fe,Mn.K	1 st Derivatives SavitzkyGolay Filter Vecor Normalization,Min ,Max Normalization,Convex Hull Computation	PLSR	Mean,SD, r^2 cv ,RMSE cv
David J. Brown, **Ross S. Bricklemyer, Perry R. Miller,2005** **[6]**	Organic C ,Inorganic C	1 st Derivatives	PLSR,PCA	SEP,SECV,RPD,MSD,SB, LC,NU,RMSD
Ramdas D. Gore, Reena H. Chaudhari, **and Bharti W. Gawali,2016** **[7]**	,Carbon,Nitrogen, Phosphorus Sand.silt,clay,Moisture Content	1st derivative, 2nd derivative, savitzky-Golay method, Multiplicative scatter correction (MSC) and Standard normal Variate (SNV)	LDA	Mean
C. Dua, **R. Linker,** **A.Shaviv** **[8]**	Clay ,Calcium carbonate content, organic matter, hygroscopic water content	1 s Derivatives SavitzkyGolayFilter, Smoothing ,Normalization	PCA,PNN	-
Du Changwen, Raphael Linker, **And Avi Shaviv,2010** **[9]**	Clay,Caco3,OM	2nd Derivatives Savitzke-y Golay Filter	PLS	RMS, R^2
He Y,Song HY,Pereira AG, **Gomezah,2005**	N,OM	Log 1/R ,1 st Derivatives,MSC	PLSR,PCA,	RMSECV,SEP

[10]				
K.D. Shepherd, B. Vanlauwe, C.N. Gachengo & C.A. Palm,spr2005 [11]	C,N	1 st Derivatives Savitzky-GolayFilters,Smoothing,Normalization	PLS,MLR,	RMSE,r^2,RER,SD,SE,
Patrick Kiiti Mutuo_, Keith D. Shepherd, Alain Albrecht, Georg Cadisch,2005 [12]	SOC,N	1st Derivatives SavitzkyGolay Filter	PLSR	R^2,RMSE,Bias,Mean,CV
David J. Browna, Keith D. Shepherdb, Markus G. Walsh, M. Dewayne Maysc, Thomas G. Reinsch,2005 [13]	pH,SOC,IC,Fed,CEC,Clay,Sand	1st derivatives, XRD	PLSR, BRT, PCA	Kappa coefficient, Cross-Validation, MSD, RMSD, Bias, SB, NU, LC,
Yong He and Haiyan Song,2006 [14]	N,P,K,OM,pH	Log1/R	PCA,PLS	R,SEC,RMSEC,SECV,RPSECV,bias
R.A. Viscarra Rossela,T, D.J.J. Walvoortb, A.B. McBratneya, L.J. Janikc, J.O. Skjemstad,2005 [15]	pH,LR,OC,CEC,Clay,Silt,Sand,P,EC,AI,K	-	PLSR1,PCR,RMSE	RMSE,R^2,Mean,SD,Cross validation
Beáta E. Madari James B. Reeves , Pedro L.O.A. Machado , Cleber M. Guimarães , Eleno Torres , Gregory W. McCarty,2006d [16]	C,N,Clay,Silt,Sand	1s Derivatives	PLSR	Mean,SD,R^2,Min,Max,Cova, RMSD
Joel B. SankeyDavid J. BrownMelisa L. Bernard Rick L. Lawrence,2008 [17]	Clay,SOC ,IC	1st Derivatives	PLSR,BRT,CART, LM,GLS,GNLS	RMSD,Bias,MSD,SB,NU, LC,SEP
Ronald J. Gehl · CharlesW. Rice,2006 [18]	SOC	-	PLSR,PCR,MLR	r^2,SEC,SEP,RPD
Wanq.L,Lin QZ,	N,P,K	-	PLSR,SMLR	-

Jia D,Shi HS, **Haunq XH,2007** **[19]**				
Raphael A Viscarra Rossel, Alex B Mcbratney, **Inakwu O. A. Odeh,2007** **[20]**	OC, CEC, Clay, TC, Ca,TN, Sand, Mg, pH, K, TP, Silt, ESP, NH4, Na, P, EC, NO3-N	1st & 2nd derivatives, SNV, Savitzky-Golay filter	PLSR,PCA	RMSE, ME, SDE, RPD,Mahalonobis statistic
Alex O. Awiti , Markus G. Walsh a , Keith D. Shepherd , Jenesio Kinyamario ,2007 **[21]**	SOC,ECEC,pH,K,TN,Mn, Mg,Ca,Zn,Fe,Mn	1st Derivatives ,first order SavitzkyGolay Filter ,MSC	PLSR,PCR	RMSEC,RMSEP,Mean,SE r^2
Changwen Du, **Jianmin Zhou,2008** **[22]**	C,N,P,K,S,Ca,Clay,Water. microbes	Normalization,Smoothing ,Baseline Correction,1 st Derivatives SavitzkyGolay	PCR,PLSR,ANN,Backpropogatiolalg,PCA,Beer Lambert Law,	RMSE,ME,CV
Zhuo Luo, **Liu Yaolin,** **Wu Jian,** **Wang Jing,2008** **[23]**	SOM	Log 1/R 1 st Derivatives	PLSR	Mean,SD,SE,Min,Max,VAR,Median,RMSECV,RPD
Raphael Linker,2008 **[24]**	Clay,CaCo3,OMC	1st and 2nd Derivatives Savitzky-GolayFilter,Normalization	Winner-Takes-All,NN,Wavelet Decomposition	CV
R. Zornoza, **C. Guerrero,** **J. Mataix-Solera, K.M. Scow, V. Arcenegui,** **and** **J. Mataix-** **Beneyto,2008c** **[25]**	EC,CEC,SOC,Ca,Mg,Na, K,Na,WHC,MbCBSR,MBC,PLFA	1st and 2nd Derivatives Linear offset subtraction, Straight line subtraction, Multiplicative scatter correction, Vector normalization	PLSR,PCA	RPD,RMSECV,r^2,Cross Validation
Hak-Jin Kim, **Kenneth A. Sudduth,and**	N,P,K	-	FFT,PLSR,SMLR	RMSE,SEP

John W. Hummel,2009 [26]				
Aichi H, Fouad Y, Walter C, Rossel R,2009 [27]	OCC	-	PLSR	RMSE,RPD,Cross Validation
Ren HY, Zhuanq DF, Qiu DS, Pan JJ,2009c [28]	OC,As,Fe	1 st and 2nd Derivatives Savitzky-Golay Filter ,Baseline Correction MSC,SNV,CR	PCR,PLSR	RMSEP,Cross Validation,R^2
Jian Wu, Yaolin Liu , Dan Chen, Jing Wang,209 [29]	Nitrogen	Log(1/R) ,1 st Derivatives	Linear Regression	Correlation Coefficient
José A. M. Demattê , Peterson R. Fiorio and Suzana R. Araújo,2010 [30]	OM,CE C,SC,V,m, Silt,Sand ,Clay	-	NDVI,MLR	RMSE,R^2
Henrique Bellinaso José Alexandre Melo Demattê; Suzana Araújo Romeiro 2010 [31]	Fe_2O_3, Sand, Clay, Silt, Organic matter and Opaque minerals.	-	PCA	-
A. Volkan Bilgili , H.M. van Es , F. Akbas , A. Durak , W.D. Hively,2010 [32]	CaCo3,SOM,Ca,K,Mg,Na ,CEC,pH,EC,Clay,Silt,San d	1st Derivatives SavitzkyGolayFilter, Smoothing	PLSR,MARS	RER,RPD,RMSEP,R^2,G CV,Mean,Min,Max,SD
Luiz Eduardo Vicente , Carlos Roberto de Souza Filho,2011 [33]	Iiron-rich soils, Iron-poor soils, Sandy soils, Kaolinite-rich soils, Montmorillonite-rich soils, and ANPV	-	MTMF,PCA	XRD,MNF,R^2

Kusumo,Bambang HariHedley,Mike J.Hedley, Carolyn B.Tuohy,Mike P,2011d [34]	Carbon, Nitrogen	Log 1/R 1st Derivatives	PLSR	RPD,RMSECV,r^2
Haiqing Yang, Boyan Kuang, Abdul M.Mauazen,2011 [35]	Sandy, Clay, Loam clay, Semi clay	Smoothing ,MA,MSC,SNV,DT, BC and Derivatives(Ist and IInd)	PCA	Min, max, mean, SD
Yufeng Ge, J.Alex Thomasson,2011 [36]	Textures, OC,IC , Macro- and Micro-nutrients, Moisture content, CEC,EC , pH, and Iron	1stDerivatives,Savitzky, GolaySmoothing, mean, Median Filtering	PCR,PLSR,MLR	BRT
Gordon Rajendram and Kyle Devey,2011 [37]	TN,TC,SOM	-	PLS	RER,RPD,SEL,IQR,SD,RMSE
Huseyin Senol, Mesut Akgul, Metin Mujdeci and Levent Basayigit,2012 [38]	Clay,Silt,Sand,FieldCapacity,Wilting Point	Smoothin,1stDerivatives and 2nd Derivatives(Savitzky-Golay)Filters,MSC, SNV	PLSR	Mean,Min,Max,SD,RMSEC,R^2 Regression Coefficient,Regression Equation
A.V. Bilgili , W.D. Hively , H. van Es , J.Reeves , L.Gaston [39]	pH, Organic C,Clay,Sand , Silt, AI, Fe	DWT	PLSR,MLR, DWT(Haar,Db1,Db6)	RMSEP,R^2,
Sonia Gannouni , Noamen Rebai, Saadi Abdeljaoued, 2012 [40]	Pb, Zn, Mn, Fe, Cd,Cu, Cr ,Ni. The pH and EC	1st Derivatives	PLSR,PCA	Mean,Min,Max,SD,RMSE ,PIV,R^2
Stephan Gmur , Daniel Vogt, Darlene Zabowski and L. Monika Moskal,2012 [41]	N,C,C,OM	1st Derivatives	CART,ENVI	R^2,RE,CVE,
Zelikman. E, Carmina.	SM,HW,SC,SSA	1st and 2nd	PLSR	RMSE,SEP,SNR,MNF,SR

E,2013 [42]		Derivatives Savitzky –Golay filter		,R(Correlation Coefficient),R^2
Johanna Wetterlind, Bo Stenberg, Raphael A Viscarra Rossel,2013 [43]	Clay,SOC	Log1/R	PLS,MLR,ANN.MARS,PCR	RMSE,RPD,Biaas,SDE
Francesca Garfagnoli , Gianluca Martelloni ,Andrea Ciampalini ,Luca Innocenti ,Sandro Moretti (2013) [44]		-	MATLAB, PLSR,CR	-
Michaela Kastanek,2013 [45]	SOC	Log1/R,1st Derivatives SavitzkyGoly Filter	PLS1	RSQ,RMSECV,SEP,RPD
Dan Shiley,2013 [46]	CARBON	Log1/R	PLSR,ANN,SVM	RSQ,SECV,SEP,RPD
Donald Campbell, Daniel Shiley and Brian Curtiss,2013 [47]	CEC	Lof1/R	PLS1(PLSR)	RSQ,SECV,RPD,SEP
Mohammed Z. Quraishi, Abdul M. Mouazen,2013 [48]	BD,PR,MC,OMC,CLC	-	ANN,MLP,PBDS,BFGS	RMSE,R^2,RPD,SD
A. Gholizadeh , M. S. M. Amin , L. Borůvka , M. M. Saberioon (2014) [49]	Bulk density ,Moisture content ,Clay,Silt and Sand	1st Derivatives SavitzkyGolay Filter	SMLR	R^2
Shuo Li , Wenjun Ji , Songchao Chen , Jie Peng , Yin Zhou and Zhou Shi,2015 [50]	TN	1st Derivatives	PLSR,LWR,SVMDA, kernel-based learning Algorithm	RPD,R^2Cohen's kappa coefficient,Mean,Min,Max, SD,CV

A. Cambou, R. Cardinael, Ernest Kouakoua, Manon Villeneuve, C. Durand,Bernard Barth_es,2015 [51]	SOC	1st Derivatives,Log1/R	PLSR	RPD,SEP,R^2,Mean,SD,Bias,Min,MaxSECV
Offer Rozenstein,Tarin Paz-Kagan, Christoph Salbach, and Arnon Karnieli,2015 [52]	Sand ,Silt,Clay,SOM,pH,EC,N	Averaging, Centering, smoothing, standardization, normalization,1st and 2nd derivatives	PLS-DA,RF	MSC,GLSW,PPT,SGS,SNV
A. Gholizadeh, L. Borůvka, and M. M. Saberioon,2015 [53]	Cu,Mn,Cd,Zn.Fe,Pb,As	Savitzky –Golay Smoothing,1st and 2nd Derivatives	PLSR,SVMR,	Mean,Min,Max,SD,CV,RMSEP,RPD,R^2
Bruno Seilera, Mathias Kneubühlera , BettinaWolfgrammb , Klaus I. Itten [54]	C ,N, Organic C, pH, $CaCO_3$, P, Ca, Mg , K, Clay, Silt and Sand.	Derivative with a Savitzky-Golay filter	MLR,CART,PCR	R^2,RMSEP,Min,Mean,Max,SD
D. Curcioa , G. Ciraolob , F. D'Asaroa , M. Minacapilli,2013 [55]	Clay, Sand, Silt	CR	PLSR	RMSE,RMSD,MAD,R^2

4. TECHNIQUES FOR PREPROCESSING AND SOIL ANALYSIS

Preprocessing techniques are used to separate any extraneous information which cannot be managed properly by the modeling techniques. In this paper we address some of the most common Preprocessing and classification techniques. These techniques are present in below.

4.1 Derivatives.

In Table 3.2 1st and 2nd Derivatives widely used for pre-processing of soil samples. It is measures of the slope of the spectral curve at every point. The slope of the curve is not affected by baseline offsets in the spectral signature. It is an effective method for removing baseline offsets. It also used to accounting for solar angles and viewing geometry [19][20][21][22][23][24].

4.2 Baseline

It is two transformations. One is offset and another is linear baseline correction. Offset is variable to subtract to all selected variables. The result of offset baseline is minimum value is set and the rest is positive values. Linear baseline is the slope of baseline into the horizontal baseline. It is to point out two variables which will define the new baseline [21][27].

4.3 Partial Least Squares Regression

One of the largest prominent approach multivariate techniques for spectral arrangement and forecasting. It takes the dependent variables into account. It is able to handle data with substantial transparency and noise likewise position in which the number of variables remarkably passes the number of available samples. Where PLS components noted as components are chosen to enlarge both explanation of the independent variables and correlation to the dependent variables [22-34][37].

Regression analysis further including multiple regression analysis (MLR), Principal component regression (PCR). MLR are used pre-processing measures (matrix transformation for independent and response variables) to scale down the dimensionality of the hyper spectral data [30][36] [38][42].

4.5 Principal Component Analysis

Principal component analysis (PCA) was used to scale down the dimensionality of the data beyond much deficiency of information. The PCA scores were used in classifiers based either on the Euclidean and Mahalanobis metrics, or on probabilistic neural networks. Further used to reduce an interchange interrelationship and abstract noise. It is also recycled to Data Perception, Data Reduction , Noise Contraction , Data coordination [31][33][35].

4.5 Smoothing

It is used for removing noise from the data set and allowing important patterns of in the data set. Data smoothing can do in a different ways like moving average, Savitzky-Golay filter and Gaussian filtering. Savitzky-Golay filter is better than the simply averaging data points is to perform a least squares fits polynomial data set to successive curve segment and then replace the first values with further regular variations. The Savitzky - Golay filter is continually used to remove spectral noise picks when chemical information can keep it [32-36]. Root mean square error of prediction (RMSEP) was used for validating the prediction ability of constructed models [32][38].

5. CONCLUSION

The aim of this article is to review an explain use of Remote Sensing and its different techniques which helps in Agriculture. Remote Sensing is new research area in agriculture. As agriculture is a soil-based industry. After doing the literature survey we recognize that hyper spectral imaging tools such as Field Spec 4 Spectroradiometer is widely used in Agriculture for assessing the Soil quality and soil characteristics. For doing the literature survey this paper dealing with the various hyper spectral imaging tools available in remote sensing for soil study such as Field Spec 4, LabSpec, Spectrophotometer etc which are presented in Section 1(Table3.1), Section 2(Table3.2) deals with soil characteristics, various Statistical and Classification techniques which is used by various authors at regional, national or international level. And section 3 contains different preprocessing and analysis techniques used for soil study in agriculture sector. The techniques such as Root Mean Square Error (RMSE) ,Residual Prediction Deviation(RPD),Standard Error Of Prediction(SEP), Standard Deviation (SD) and classification Methods like Partial Least Square Regression(PLSR),Principal Component Analysis(PCA),Multiple Regression Analysis (MLR),Principle Component Regression (PCR) for getting the information from soil characteristics .When these different techniques of Remote Sensing are applied to an agricultural soil profile, it may improve decision making about the right use of fertilizers , to knowing the amount of nutrients level and also efficiency of nutrients from characteristics of soil (Physical, Chemical, Biological) etc. So that soil fertility and soil productivity as well as Agriculture productivity can be increased.

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