Estimation of Lead and Nickel Contamination using VNIR Spectroradiometer

[1]Bharti S. Pawar, [2]Dr. R.R.Deshmukh, [3]Pratiksha P.Shete
[1]PG student, [2]Professor, [3]PG student
[1]Department of Computer Science & Information Technology,
[1]Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (MS), India.

Abstract : Naturally in soil different heavy metals, petroleum substances, polynuclear, pesticides, etc. are present in soil within their limits. If their presence in soil cross the limit then they become a polluted which is harmful for human health and also for plant. Soil pollution is happens because of human made activity, which interfere in nature activity. Traditional method for to analyse heavy metal in soil is time consuming and costly. ASD Fieldspec-4 with spectral resolution 350-2500 nm gives useful option to traditional method. It is convenient, accurate and rapid method to analyse heavy metal in soil.

Keywords: **- Heavy Metal, ASD Fieldspec4 Spectroradiometer, PLSR, PCR, Vis-NIR spectroscopy.**

I. INTRODUCTION

Earth is surrounded by natural things like soil, water and air. Consequently, soil is made by combination of different components, like organic matter, liquids, minerals, gases and countless organisms [1][2].Soil is made up of unconsolidated material thin layer of surface on the earth. Soil analysis is done to determine potential toxicities from excessive fertility and also to extract physiochemical and biological elements chemically from the soil and measured from the soil samples which are essential for "plant growth". Soil contamination includes various heavy metals like Lead, Nickel, Arsenic, Zink, Copper, Cobalt, Magnesium.

Lead and nickel denoted by symbol Pb and Ni respectively. Lead and nickel are naturally occurs in soil. But their extend content in soil get harmful to human health as well as it has impact on crop also. Lead in the body is distributed in brain, liver, kidney and bones. It store in teeth and bone, where it accumulate over a time. Lead is a cumulative toxicant that affects multiple body systems and is particularly harmful to young children. Above 300ppm level of soil, most of the risk is from lead contamination [3].

The main source of nickel is industrial waste water, the stacks of large furnaces used to make alloys, power plants and trash incinerators. Nickel is so strongly attached to dust and soil particles. Common harmful effect of nickel in human body is allergic reaction.

Hyperspectral technology can obtain continuous soil spectrum, which responds to the combined actions of various soil chemicals and physical factors. Coupled with calibration techniques, hyperspectral technology has been developed to predict distinctive soil properties.

II. BASICS OF REMOTE SENSING

Hyperspectral remote sensing is used to obtained information about object or areas, without physical contact with object or areas. Remote sensing scan the object by electromagnetic radiation(light)[4]. Hyperspectral remote sensing analysis physical composition, biological composition and various objects[5].

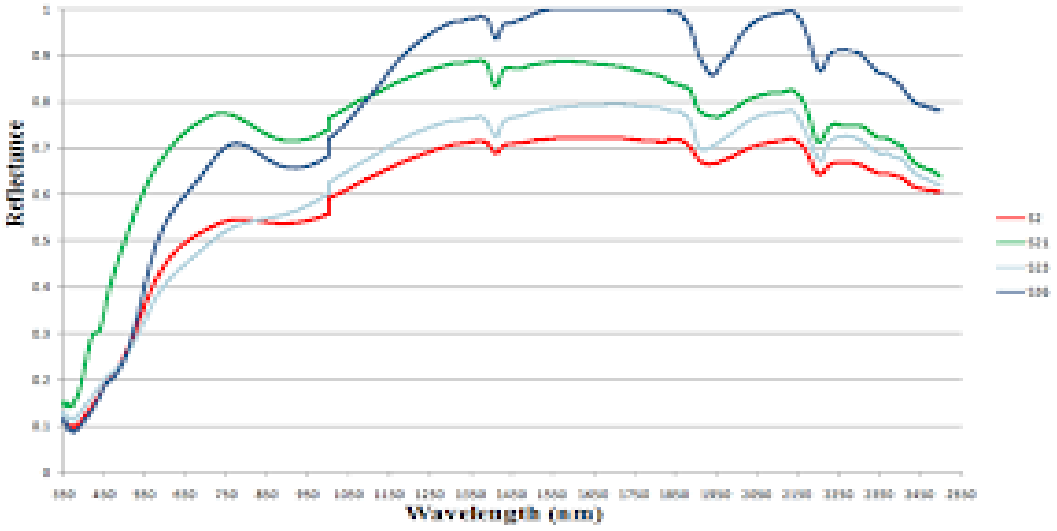

Fig 1.1 Heavy metal contamination in soil[6].

III. RELATED WORK

VNIR spectroscopy is useful alternative method to traditional method for analysis of heavy metal contamination in soil.

Golayeh Yousefi & Mehdi Homaee & Ali Akbar Norouzi from Tehran 14115-336, Iran. They investigated heavy metals Ni and Cu had significantly negative correlation with spectral reflectance in the entire VNIR range. They have results demonstrate that VNIR reflectance spectroscopy method has a high potential for detection and estimation of heavy metals in soil.[7]

Thomson Kemper and Stefan Sommer student from Joint Research Centre of the European Commission, Institute for Environment and Sustainability, Soil and Waste Unit, T.P. 262, I21020 Ispra (Va), Italy have done research on Estimation of heavy metal in soil after a mining accident using reflectance spectroscopy (Fieldspec 2). In these study they used multiple linear regression analysis (MLR) and an artificial neural network (ANN) approach. They got same result by MLR and ANN.[8]

Shamsoddini, S. Raval, R. Taplin from Australian Centre for Sustainable Mining Practices, School of Mining Engineering, University of New South Wales, Sydney, NSW 2152, Australia completed work on Spectroscopic analysis of soil metal contamination around a derelict mine site in the blue mountains, australia.[9] They work on diagnostic characteristics of the original reflectance and models derived from first and second derivatives of the reflectance data. They got the result that the models derived from the first derivative of the reflectance data gives more accurate result than the models derived from the second derivative of the reflectance data.

J Kobza work on problem due to heavy metal pollution on soil and plant[10]. Analytical procedure is used for soil samples. They found that Cd,Pb,Ni in forestland higher than agricultural land. 0.05 mol/l EDTA extraction method suitable to find out heavy metal concentration.

Antoine Stevens work on Laboratory, Field and Airborne Spectroscopy for Monitoring Organic Carbon Content in Agricultural Soils[11]. They found that in estimation of

greenhouse emission fluxes in Soil Organic Carbon (SOC) content was often used by the temporal evolution. They used VNIR Spectroscopy in option to chemical analysis process. In result of these technique it reduce the sampling processing time, more samples are analysed within time budget and time conditions.

Fei Wang works on Concentration estimation of heavy metal in soil from typical sewage irrigation area using reflectance spectroscopy[12]. They evaluate the feasibility of rapid concentration estimation of heavy metals(Cr,Cu,Ni,Pb,Zn,As,Cd and Hg) based on VNIR technique. They found that SMLR model using first derivative data is the best prediction method to predict the contents of heavy metal and the order of enrichment levels in soil was Cd>Cu>Pb>As>Ni>Zn>Cr>Hg.

The toxicity level of heavy metal determines the how soil used for agriculture is contaminated[13].

IV. METHOD

Toxic element concentration in soil can be measured by traditional method in laboratory. But for more sampling and scientific analysis technique requires more time and it is expensive. Reflectance spectroscopy is the best option to traditional method to analyse toxic element concentration in soil.

Several methods are previously used for reflectance spectral data pre-processing. Previously used method gives appropriate result to analyse contamination of heavy metal in soil.

First Derivative:

First derivative is the common method for signal pre-treatment applied on spectral data. To resolving peak overlap, eliminate constant between sample first derivative is applied.

Partial Least Square Regression:

partial square regression technique is used for prediction model. For many and highly collinear factor partial square regression technique is used. According to their relevance for predicting the dependent variables, partial square regression technique orders the principle components.

When sets of independent variable values are correlated rather than orthogonal then the PLSR are much more stable.

V. RESULTS AND DISCUSSION

The remote sensing technology has more no. of application in various industries which is depends on agriculture. The excess content of lead and nickel causes various effects on human body and also soil infertility which reduce crop yield. With the help of spectral data the excess content of lead and nickel can be easily determine. Various pre-processing techniques gives good result for determining heavy metal contamination. Previously PLSR method mostly used and gives good results for predicting heavy metal contamination in soil.

VI. ACKNOWLEDGMENT

This work is supported by Department of Science and Technology under the Funds for Infrastructure under Science and Technology (DST-FIST) with sanction no. SR/FST/ETI-340/2013 to Department of Computer Science and Information Technology, Dr. Babasaheb

Ambedkar Marathwada University, Aurangabad, Maharashtra, India. The authors would like to thank Department and University Authorities for providing the infrastructure and necessary support for carrying out the research.

REFERENCES

[1] Dong et al., "Study on quantitative retrieval of soil nutrients," IEEE International Geoscience and Remote Sensing Symposium, Vancouver, BC, 2011, pp.3330-3333. doi: 10.1109/IGARSS.2011.6049997,2011.

[2] Elfaki, J. , Gafer, M. , Sulieman, M. and Ali, M. "Comparison and Evaluation of Two Analytical Methods for Cation Exchange Capacity and Exchangeable Sodium Percentage of Five Soil Types in Central Sudan." Open Journal of Soil Science, 5, 311-318.doi:10.4236/ojss.2015.512029,2015.

[3] https://conservancy.umn.edu/handle/11299/93998 accessed on 20 Nov. 2018.

[4] Steven M. de jong, Freek D.van der meer and G.P.W.Clevers "Basics of Remote Sensing" Remote Sensing Image Analysis: Including the Spatial Domain, pp:1–15. © Springer 2007.

[5]M.K. Maid, R.R. Deshmukh "Hyperspectral Analysis of Wheat Leaf Rust (WLR) Disease: A Review" JCSE International Journal of Computer Sciences and Engineering, Volume-6, Issue-1, E-ISSN: 2347-2693, 2018.

[6] A. Shamsoddini, S. Raval , R. Taplin "Spectroscopic analysis of soil metal contamination around a derelict mine site in the blue mountains, australia" ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume II-7, 2014.

[7] Golayeh Yousefi & Mehdi Homaee & Ali Akbar Norouzi, "Estimating soil heavy metals concentration at large scale using visible and near-infrared reflectance spectroscopy", Environ Monit Assess (2018) 190:513, # Springer Nature Switzerland AG 2018.

[8] Thomas Kemper*, and Stefan Sommer Joint Research Centre of the European Commission, Institute for Environment and Sustainability, Soil and Waste Unit, T.P. 262, I21020 Ispra (Va), Italy , "Estimate of Heavy Metal Contamination in Soils after a Mining Accident Using Reflectance Spectroscopy", Environ. Sci. Technol., 2002, 36 (12), pp 2742– 2747 Publication Date (Web): May 10, 2002.

[9] Shamsoddini, A.; Raval, S.; Taplin, R.," Spectroscopic analysis of soil metal contamination around a derelict mine site in the blue mountains, australia." ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences, pp.75-79, Volume II-7, 2014.

[10] J Kobza, Soil Science and Conservation Research Institute Bratislava, Regional Workplace Banská Bystrica, Slovakia, "Soil and plant pollution by potentially toxic elements in Slovakia",PLANT SOIL ENVIRON, pp.243-248,2005.

[11] Antonie Stevens a,BAS van Wesemael a,Harm Bartholomeus b,Damien Rosilon c,Bernard Tychon c and Eyal Ben –Dor ,"Laboratory Field an Airborne spectroscopy for monitoring organic carbon content in agricultural soils", Geoderma,pp. 143-144, 12 Dec 2007.

[12] Fei Wang, Chunfang Li, Jining Wang, Wentao Cao, Quanyuan Wu "Concentration estimation of heavy metal in soils from typical sewage irrigation area of Shandong Province, China using reflectance spectroscopy" @Springer-Verlag Berlin Heidelberg : 16883-16892. DOI:10.1007/s11356-017-9224-x, Jul 2017.

[13] Vaibhav N. Lokhande, Dr. Ratnadeep R. Deshmukh "Monitoring Arsenic Contamination in Agriculture Soil using Spectroradiometer", DOI:10.15680/IJIRSET.0504185, PP:5508-5513,2016.