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WAVELET BASED ANALYSIS OF SOIL NUTRIENTS OF SURENDRANAGAR DISTRICT, GUJARAT, INDIA

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ABSTRACT

This paper presents the study of soil nutrition (Phosphorus (P), Potassium (K), Zinc (Zn), Iron (Fe), Sulfur (S), Manganese (Mn), Copper (Cu), Magnesium (Mg) and Calcium (Ca)), status of agricultural dirt of Surendranagar district, Gujarat, India through continuous wavelet transform (CWT). Under the soil health card program of Government of Gujarat, all soil samples were collected by trained farmers and brought for analysis to Soil Test laboratory. As the data is composite type, the calculation of wavelet variance derived from transform to facilitate the study based on dominant peak value and scale. The values of wavelet variance of macro and micro nutrients at dominant peak with scale and their respective contribution in percentage can provide scientific basis for monitoring and controlling the tillage management.

KEYWORDS: Soil Analysis, Wavelet Transform, Wavelet Variance, Surendranagar

INTRODUCTION

Soil is a naturally occurring porous medium that supports the growth of plant roots by retaining air, heat, water, and nutrients; and provides mechanical support to the plant. Soil provides a reservoir of nutrients required by crops and also for animals but not necessarily at optimum levels of immediate availability to plants. The purpose of soil analysis is to assess the adequacy, surplus or deficiency of available nutrients for crop growth and to monitor changes brought about by farming practices. For farming, nature, texture and chemical composition of the soil is extremely important. Balanced combination of all these can help in better crop. The composition of soil varies from region to region and requirement of the nutrients varies from crop to crop. So it is very essential to link the quality of soil with the requirement of the crop. If any deviation or lacunas found in ideal composition, it can be corrected by supplementing the deficient element to have better crop.

And this is where the analysis of soil becomes very important. A soil test is the analysis of soil sample to determine nutrient and contaminant content, composition and other characteristics, such as acidity or pH level. A soil test can determine fertility, or the expected growth potential of the soil, indicate nutrient deficiencies, potential toxicities from excessive fertility and inhibitions from the presence of non-essential trace minerals. Soil nutrients vary with depth and soil components change with time.

MATERIAL & METHODS

The sampling site is selected as all the ten tehsil places of Surendranagar district. The classification has been derived by secondary data sets of nutrition contempt under the soil testing laboratory. All the three tehsils are classified based on types of soils as medium black soil, sandy soil and Saline & Alkaline Soil. According to the pattern of soil the places are defined and classed as lane: 1, lane: 2 and lane: 3.

The entire district is classified as three zones (lane) with respect to the selection pattern as:

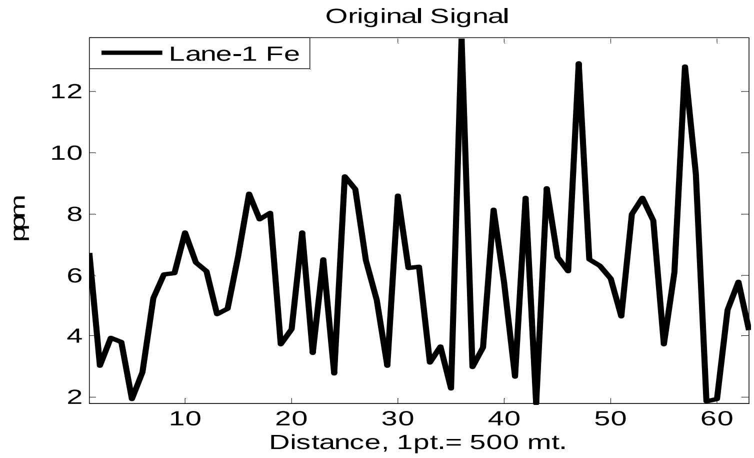
- The lane 1 which covers, Medium Black Soil under the various tehsil placesi.e.
  - Patdi: which covers Makhanpur, Haripur, Jarvala, Savlas, Bajana, Pipadi
  - Muli: which covers Raisangar, Jepar and
  - Chotila which have Morthala containing the part of Medium Black Soil.
- The lane 2 which covers Sandy Soil are defined as:
  - Halvad: which covers Chitrodi
  - Muli: Raisangar, Mahadevgadh, Bhavanigadh, Nalkhambha and Devpara
  - Sayala: which covers Adala and Ninama
- The lane 3 which covers Saline & Alkaline Soil are as:
  - Lakhtar: which covers Tanmaniya
  - Wadhvan: which covers Rajpar and Bakarthali
  - Muli: which covers Shekhpar, Gautamgadh, Khatadi, Chandreliya, Rampadra, Palasa, Khakharala, Vagadiya and Devpara
  - Chotila: which covers Thangadh and Rampara

All the ten tehsils of Surendranagar district is defined for 31 major villages which have been measured for distance of 500 mt., as and when the changes are required to be change the measuring scale of soil. The sample nutrition (macro and micro both) have been taken as samples. The data under consideration is composite signal type i.e. a mixture of periodic and aperiodic components. These type of pattern occurs may be due to the influence of several processes (e.g. climate change, weather disturbance, random use of fertilizers, crop pattern etc.) over the time. So it is difficult to get description of composite signals and identification of specific pattern. So heterogeneity in study area is studied by CWT for all three lanes. For this application Morlet wavelet is used. Morlet wavelet is nothing but a Sine wave multiplied by a Gaussian envelope.

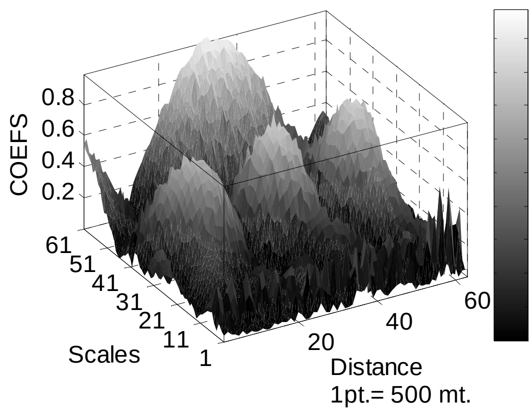
RESULTS AND DISCUSSIONS

For an example to illustrate type of information we get from CWT graphs and wavelet variance, with original signal for Phosphorous of lane-1 is shown in figure 1 (a – c), where the horizontal axis is for distance in meters. The greyish colour in CWT graphs indicates high coefficients of CWT at a particular frequency and location. The smaller coefficients are represented by black. The very high frequency components are located in the lower portion of the graphs in shades of black, indicating lower energies.

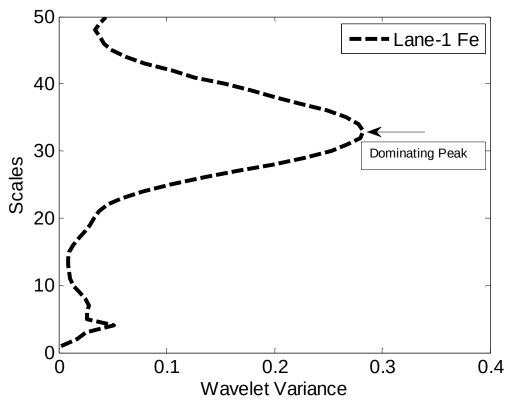
In CWT graphs y-axis corresponds to scales and z-axis to wavelet coefficients. The scale to scale analysis is suited to detect local features of aperiodic data. As the wavelet transform is a function of both scale and location, the interpretation of transform is difficult, so wavelet variance is the solution to facilitate analysis. Wavelet variance is simply



(a)



(b)



(c)

Figure 1: (A) Transect of Fe of Lane-1. The Vertical Axis Corresponds to Data Value, (B) CWT Presentation of Fe Lane & (C) Shows the Wavelet Variance of Fe Data in (A).The Horizontal Axis in (C) Corresponds to Wavelet Variance as a Function of Scale

The average of square of wavelet coefficients of a scale. Figure 2 (a – i) shows the wavelet variance of nutrients P, K, Zn, Fe, S, Mn, Cu, Mg and Ca. The horizontal axis in figure 2 corresponds to wavelet variance as a function of scale. The wavelet variance is proportional to the number and intensity of a feature of a given scale, a peak in the wavelet variance indicates presence of high number of low intensity values or low number of high intensity values. In studied data it is seen the dominant peak is directly proportional to number of data in a series. It is found from this study that the dominant peak is following a pattern, it is normally within the range:

Half the number of samples + 10% and half the number of samples + 20%.

In all parameters it is checked, where ever this range is not followed, heterogeneity is found. In some parameters along with dominant peak, small multiple peaks are also seen at lower scales, indicating variability and other characteristics

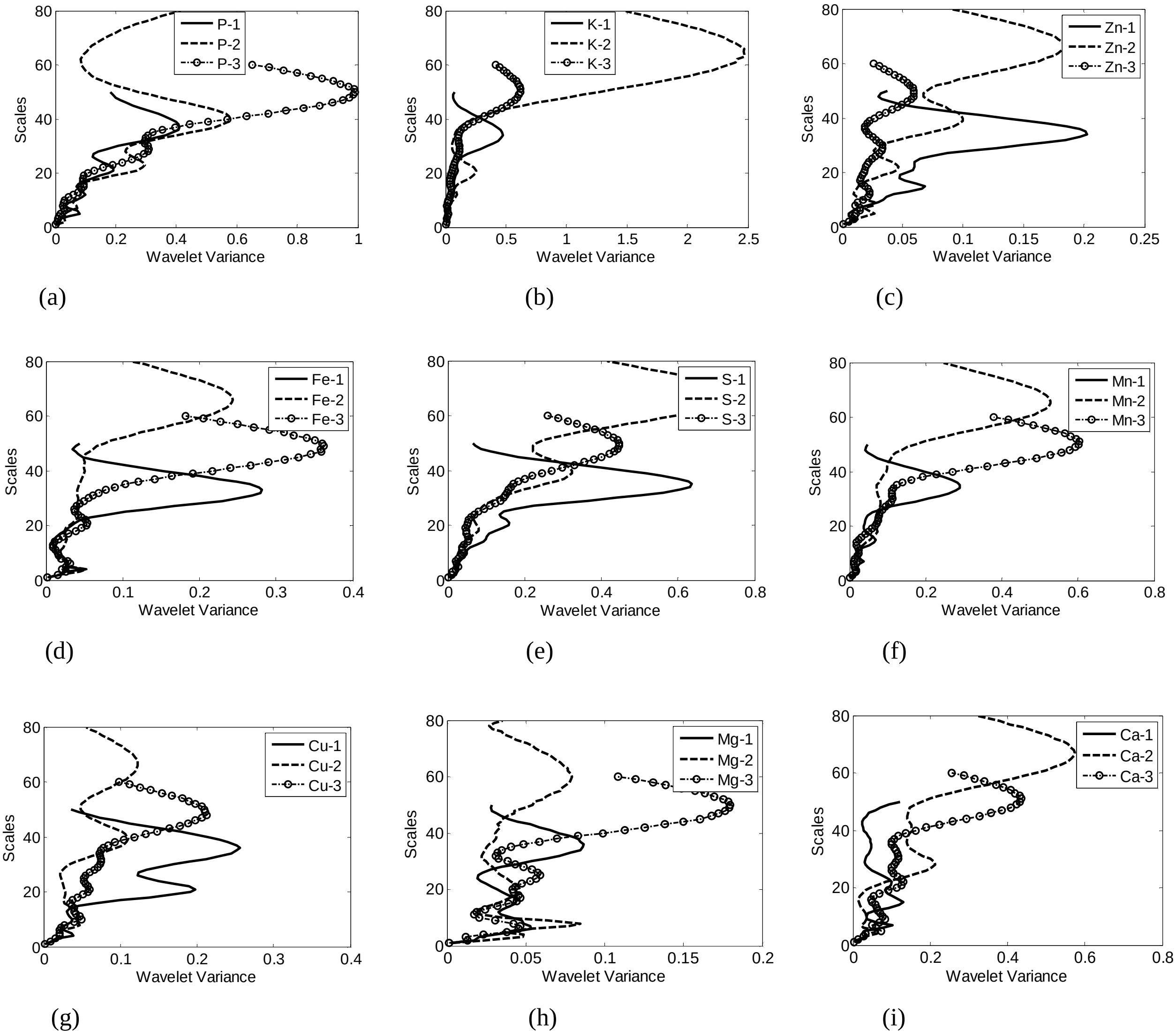


Figure 2: Shows The Wavelet Variance of P, K, Zn, Fe, S, Mn, Cu, Mg and Ca Data. the Horizontal Axis Corresponds to Wavelet Variance as a Function of Scale.

Table 1: Variance in Macro and Micro Nutrition

	Peak Scale	**Wavelet Variance Value**	**Weightage in %**	**Peak Scale**	**Wavelet Variance Value**	**Weightage in %**	**Peak Scale**	**Wavelet Variance Value**	**Weightage in %**
	Lane-1			Lane-2			Lane-3		
P	**37**	**0.41**	**14.8%**	**40**	**0.58**	**10.52%**	**50**	**0.99**	**25.3%**
K	**34**	**0.47**	**17%**	**64**	**2.47**	**44.82%**	**51**	**0.62**	**15.85%**
Zn	34	0.2	7.22%	66	0.18	3.26%	49	0.06	1.53%
Fe	33	0.28	10.1%	66	0.24	4.35%	49	0.36	10.2%
S	**35**	**0.64**	**23.1%**	**67**	**0.74**	**13.4%**	**50**	**0.45**	**12.8%**
Mn	34	0.29	10.46%	66	0.53	9.61%	51	0.6	17%
Cu	36	0.26	9.38%	66	0.12	2.17%	48	0.21	5.98%
Mg	36	0.09	3.24%	8 & 60	0.08 & 0.07	2.72%	50	0.18	5.12%
Ca	**15 & 7**	**0.13 & 0.1**	**8.3%**	**67**	**0.57**	**10.34%**	**51**	**0.44**	**12.5%**

Of studied area with low intensity. The values of wavelet variance of macro and micro nutrients at dominant peak with scale and their respective contribution in percentage is incorporated in table 1.

Table 1 and figure 2 reveal that

- In all three lanes P, K and S are dominating the sites.
- Ca is also a higher contributor but the multiple peaks shows not the entire site is under its influence but it is localized, as dominant peak in Lane-1 is not following the pattern and it means low intensity values are contributing more and giving rise to low scale multiple peaks.
- Mn in Lane-3 is having large variance.
- Zn, Fe and Cu are normal contributor. Cu is also showing multiple peaks at lower scale.
- It is very interesting to see though Magnesium is following the scale pattern, having multiples peaks in all lanes, in lane-2 values of both peaks are same, still total contribution is normal, it is a case of future study.

With scale we can get information of pattern, if any parameter is not following the pattern, we can predict variation in data due to some factors (like excess amount of fertilizers, weathering effect alter the values of particular nutrient, previous crop dependency, so one should change the next crop).

So from dominant peak we can get idea of whole distance area and with small peaks and multiple peaks district wise as well as village wise also can be predict.

Deviation from the general trend can be directly linked to random events and site conditions. In this study main event may be lack of knowledge of using fertilizers, quality of fertilizers, weather conditions etc.

CONCLUSIONS

With the help of scientific analysis of soil nutrients one can find out the shortfall of essential elements and can take corrective steps to have good crop.

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