SOIL QUALITY ASSESSMENT AROUND MAGNESITE MINES AND SALEM TOWNSHIP USING GIS TECHNIQUES

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ABSTRACT
Salem is one of the major places of magnesite deposits. Mining of magnesite in various places have been going on for manufacturing of refractory bricks. The low grade waste magnesite ores are dumped on some places around the mines and due to the mining of magnesite and storage of rejected ore in the area may seen to be a causative factor for contamination of soil and ground water quality. In view of this, a detailed investigation to assess soil and ground water quality in salem area has been carried out. Fifteen soil samples were collected in different locations around the magnesite mines and cultivable land. The chemical parameters for soil namely pH, EC, N, P, K, Fe, Mn, Zn, Cu were analyzed by adopting standard procedure. The quality of soil parameter is evaluated in considering suitability of soil for agriculture purpose. The pH of soil exceeds 7.5 in all observation points that indicating alkaline nature of soil. The poor N, P, K values and low soil nutrients (Fe, Mn, Zn, Cu) are due to contamination of mining deposition into the soil. The N, P, K value of soil in most of places is found to be lower than standard values. It indicates the contamination of some certain chemicals elements through leaching of magnesite waste. In some places heavy metal namely Cu, Zn in the soil are found to be slightly higher indicating the waste residue from the mine places leached into the soil. The soil quality index map has been prepared using GIS techniques for the study area and its presented in the paper.

KEYWORDS: *Magnesite, Soil Quality index, Ground Water Quality Index*

I. INTRODUCTION

Heavy metals affect all groups of organisms and ecosystem processes, including microbial activities. These metals which are not biodegradable are accumulated in living organisms. Though some of the metals like Cu, Fe, Mn, Ni and Zn are essential as micronutrients for life processes in plants and microorganisms, many other metals like Cd, Cr and Pb are proved detrimental beyond a certain limit. The heavy metal pollution of urban soils and mining soils poses serious health implication especially to crops grown in the surrounding sites. The deadlier diseases like edema of eyelids, tumor, congestion of nasal mucous membranes and pharynx, stuffiness of the head and gastrointestinal, muscular, reproductive, neurological and genetic malfunctions caused by some of these heavy metals have been documented.
Assessing the problems caused by contaminated soils typically involves soil chemistry as well as laboratory and field studies to fully assess the extent and significance of any adverse environment effects. Therefore, assessment of these metals is important for safety assessment of physicochemical and metal properties of waste dumps of magnesite and bauxite, as well as it is essential to know about the possibilities of remediation process on that soil. Salem is chosen as the study area. Magnesite is being mined from three large and several small mines located in Salem. This paper includes the map of the study area, the methodology involved in the study of different parameters and finally the results are presented.

II. STUDY AREA

Salem in Tamil Nadu, is the hub of basic refractory industry in the country. Magnesite, the chief raw material for basic refractories as well as calcined Magnesia, is being mined from three large and several small mines located in Salem. The ultramafic complex of Salem spreads over an area of 30 km^2 and is known as the Chalk Hills region. It is the repository of both refractory and non-refractory grades of magnesite. The deposits occupy numerous N-S trending small and moderately high hillocks (ranging in height from 5m to 70m from the mean ground surface). In addition to magnesite, dunite, one of the host rocks of mineralization, is also being mined. The study area map is shown in figure 1.

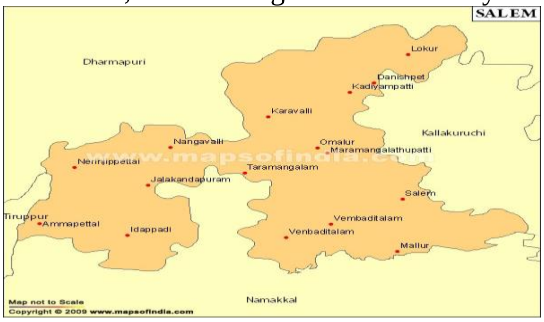

Figure 1. Study Area Map

The average temperatures range from 37ºC to – 43ºC and the average rainfall for the district is 972.3mm. Topography of the study area contains generally plain land and undulating terrain only. Occasionally there are some ridges and valleys. Predominantly soil groups in the study area belong to Blackcotton, Gravel and mixture of clay loamy soil. Occasionally some of the places the mixture of sandy clay is found to be distributed.

III. GEOGRAPHIC INFORMATION SYSTEM

A geographic information system (GIS) integrates hardware and software data for capturing, managing analyzing, and displaying all forms of geographically referenced information. Modern GIS technologies use digital information, for which various digitized data creation methods are used. The most common method of data creation is digitization, where a hard copy map or survey plan is transferred into a digital medium through the use of a CAD program, and geo-referencing capabilities. GIS uses spatio-temporal (space-time) location as the key index variable for all other information. The key is the location and / or extent in space-time. Any variable that can be located spatially and increasingly also temporally can be referenced using GIS.

IV. DATA COLLECTION

In the study area fifteen observation points for soil sample collection were identified with respect to the distribution of magnesite mines. The soil samples were collected from those observation points and analyzed as per standard procedure. The soil samples were collected around the mines at depth of 15-20cm. The map of the study area showing the sampling stations is shown in figure 2.

By using a handheld global positioning system instruments (GPS) of 10m accuracy, the ground co-ordinates of soil sampling points were collected. The ground co-ordinates data of ground soil were used to prepare location map of sampling observation points. The sampling station co-ordinates were given in the table 1.

Figure 2. Soil Sampling Stations

Table 1. Soil Sampling Station Coordinates

No	LOCATION	CO-ORDINATES	No	LOCATION	CO-ORDINATES
S1	Adivaram	78º8'35"E;11º41'45"N	S9	Mungilpadi	78º6'18"E;11º44'15"N
S2	Ayyamperumalpatti	78º5'30"E; 11º40'58"N	S10	Muniyappankovil	78º10'48"E;11º43'58"N
S3	Chettichavadi	78º9'09E;11º43'48"N	S11	Pasuvakkal	78º9'15"E;11º43'02"N
S4	Karuppur	78º4'35"E;11º43'27"N	S12	Rettipatti	78º6'12"E;11º42'14"N
S5	Kollapatti(pudur)	78º3'20"E;11º43'50"N	S13	Sengaradu	78º7'43"E;11º44'38"N
S6	Kundur	78º3'08"E;11º43'25"N	S14	Vellakalpatti	78º6'57"E;11º41'47"N
S7	Mallamoopanpatti	78º5'28"E;11º41'23"N	S15	Vinayagampatti	78º11'13"E;11º43'25"N
S8	Mettupatti	78º5'42"E;11º43'18"N			

V. METHODOLOGY

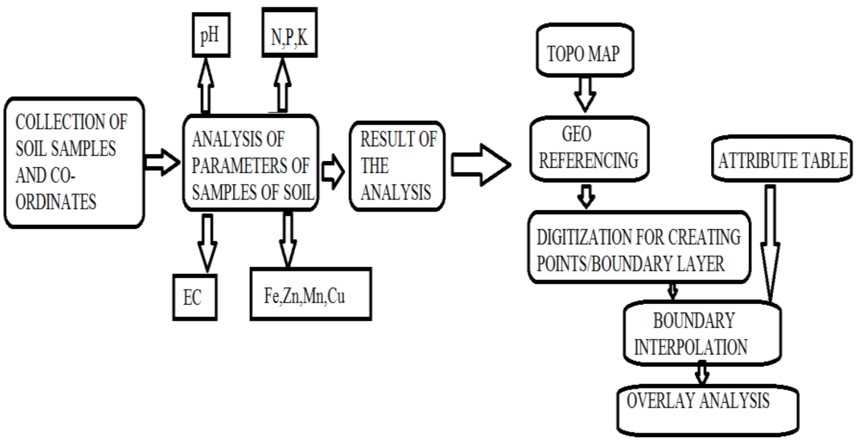

Figure 3. Methodology of the study

The methodology adopted for the study is shown in figure 3. For the determination of quality of soil samples the chemical parameters such as N, P, K, pH, Electrical Conductivity, Fe, Zn, Mn, Cu were determined by adopting standard methods.

VI. Results And Discussion

The impact of magnesite mines activities on soil resources has been investigated by making interpretation of physic-chemical parameter of soil through the quality index map by GIS techniques. The 15 soil samples were collected in the study are as per standard procedure given by BIS. The various parameter of the soils namely N, P, K, pH, Fe, Cu, Zn, Mn have been analyzed.

6.1. Interpretation of Physico-chemical Parameters

The quality of soil parameter is evaluated in considering suitability of soil for agriculture purpose. Mostly the quality of soil is found to be suitable for agriculture purpose except at five places, where the N, P, K values are very less. The pH of soil exceeds 7.5 in all observation points which indicate the alkaline nature of soil. The poor N, P, K values and low soil nutrients (Fe, Mn, Zn, Cu) are due to the contamination of mining deposition into the soil. The graphical comparison of the soil parameters is shown in figure 4.

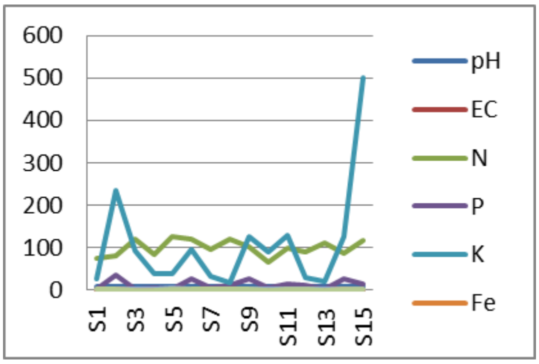

Figure 4. Comparison of Soil Parameters

6.2. Preparation of Soil Quality Map

Thematic layers of the soil of the study area for various chemical parameters namely N, P, K, pH, EC, Fe, Zn, Mn, Cu has been prepared for soil spatial distribution. The spatial distribution of pH in soil (figure 5) reveals that all samples fall under alkaline condition. The spatial distribution of electrical conductivity in soil (figure 6) reveals that all samples fall under low level of conductance. The spatial distribution of nitrogen in soil (figure 7) reveals that, 5 samples fall under medium level of nitrogen presents and remaining 10 samples are fall under low level of nitrogen. The spatial distribution of phosphorus in soil (figure 9) reveals that, 7 samples are fall under low level of phosphorus, 3 samples are fall under medium level of phosphorus presents and remaining 5 samples are fall under high level of phosphorus. The spatial distribution of potassium in soil (figure 8) reveals that, 3 samples fall under low level of potassium, 3 samples fall under medium level of potassium presents and remaining 9 samples are fall under high level of potassium. The spatial distribution of iron in soil (figure 10) reveals that all samples are fall under low level of iron. The spatial distribution of manganese in soil (figure 11) reveals that, 12 samples are fall under low level of manganese presents and remaining 3 samples are fall under high level of manganese.

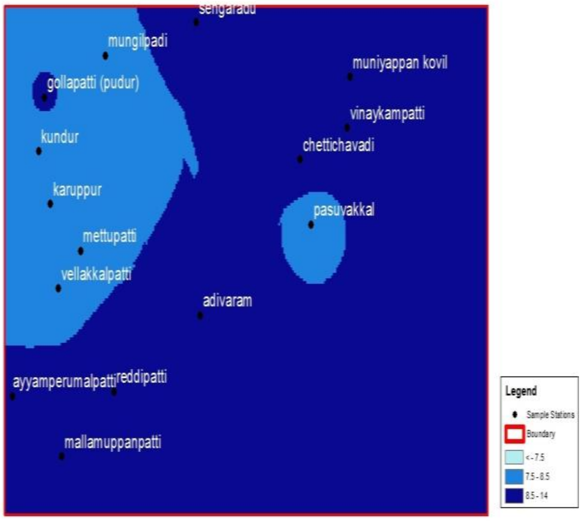

Figure 5. Spatial Distribution of pH in soil

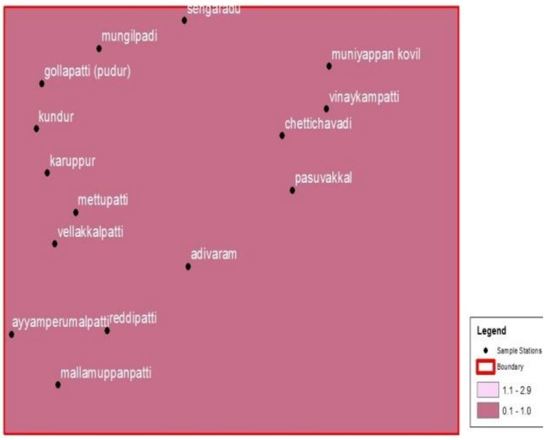

Figure 6. Spatial Distribution of EC in soil

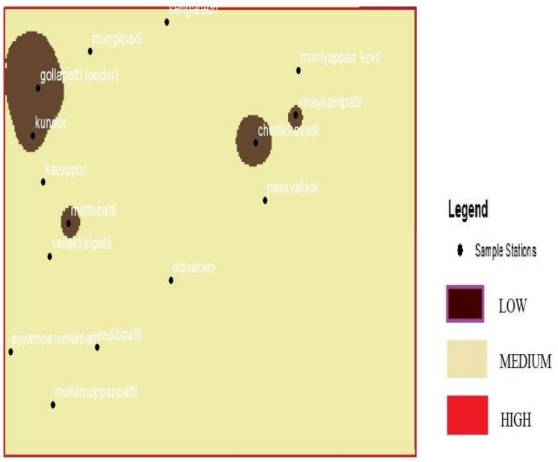

Figure 7. Spatial Distribution of Nitrogen in soil

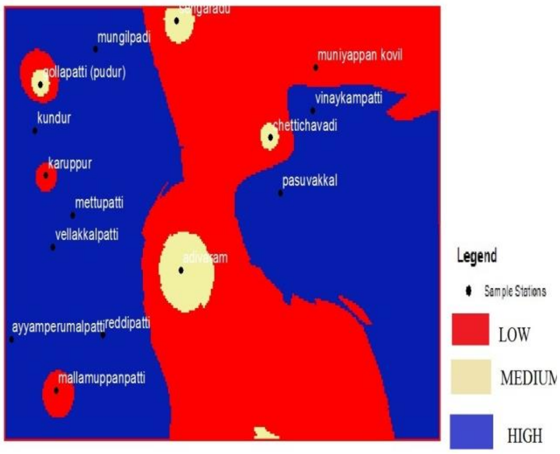

Figure 8. Spatial Distribution of Phosphorus in soil

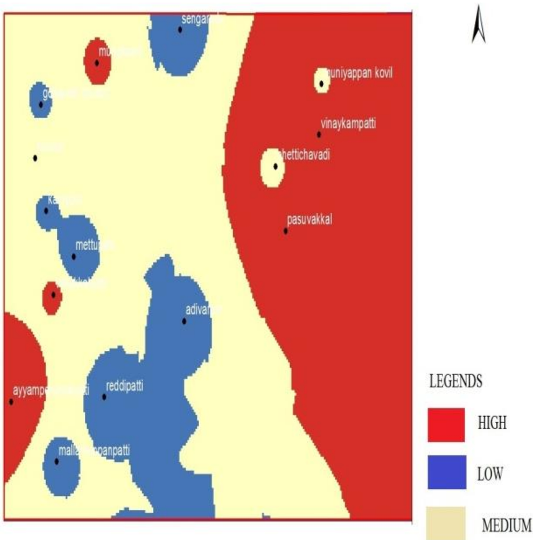

Figure 9. Spatial Distribution of Potassium in soil

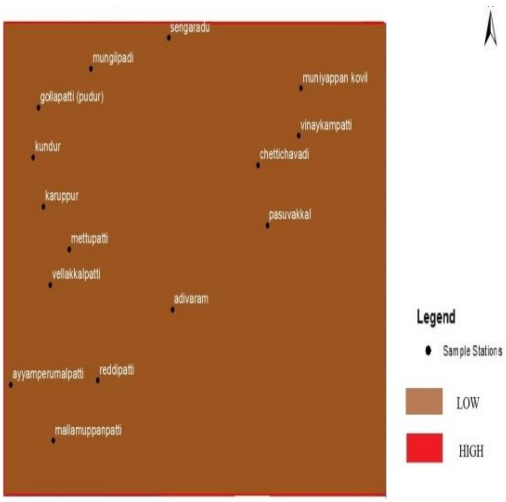

Figure 10. Spatial Distribution of Iron in soil

The spatial distribution of zinc in soil (figure 12) reveals that, 14 samples are fall under low level of zinc presents and remaining one sample is fall under high level of zinc. The spatial distribution of copper (figure 13) in soil reveals that, 9 samples are fall under low level of copper presents and remaining 6 samples are fall under high level of copper.

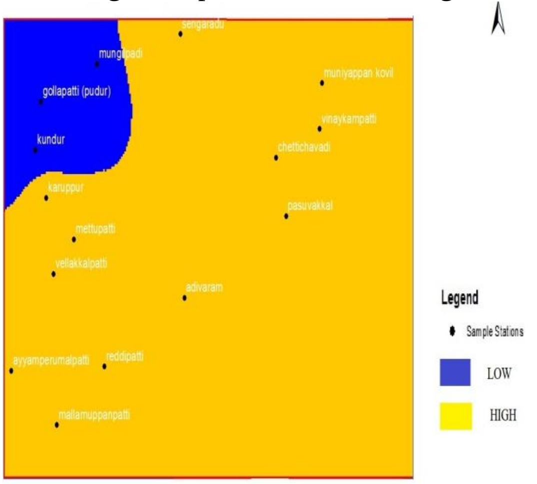

Figure 11. Spatial Distribution of Manganese in soil

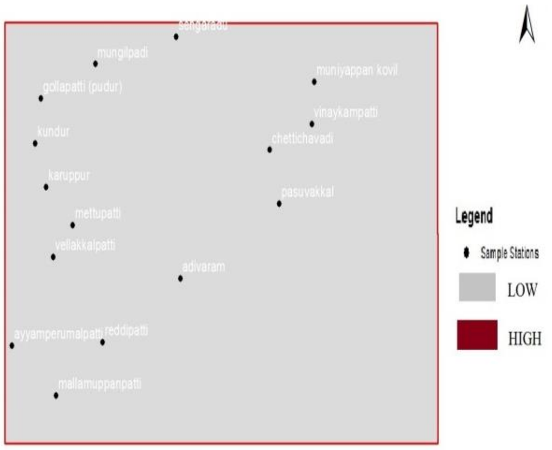

Figure 12. Spatial Distribution of Zinc in soil

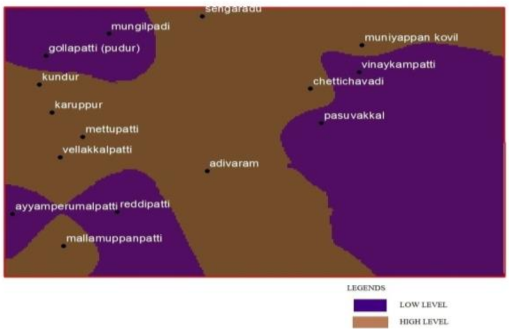

Figure 13: Spatial Distribution of Copper in Soil

VII. CONCLUSION

The evaluation of soil quality around Magnesite mines in Salem has been done. 15 soil samples are collected around Magnesite mines and chemical parameter pH, Electrical conductivity, N, P, K, Fe, Zn, N, Cu were evaluated. For all chemical parameter of soil of the study area, spatial distribution has been drawn using GIS technique. The interpretation of spatial diagram reveals that in some of the areas around the Magnesite mines, the chemical parameter N, P, K, are found to be lower than the standard value. Which attribute due to the leaching of low grade waste magnesite ore dumped along the mines site, however the heavy metals Zn,Cu,Mn in the soil of study area are found to be slightly high in some of the places are magnesite mines and which may be due to residue of waste magnesite contaminated with soil.

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