Assessment of soil quality using magnetic susceptibility around NSL Sugars, Bhusnoor, Aland taluka, Kalaburagi, Karnataka, India.

Lingadevaru.M[1], Syed Hamim Jeelani[1*], Sharath Raj B[1], Siim Ots[2] and Bellaki.M.A[3]

1. School of Earth Sciences, Department of Geology, Central University of Karnataka, India
2. Department of Geology, University of Tartu, Tartu, Estonia.
3. ICR KrushiVignana Kendra, Kalaburagi, Karnataka.

Abstract

Industrialization is an index of modernization. The undesirable side effect of industrialization is environmental degradation. Besides municipal waste, the industrial waste contributes significantly to environmental deterioration. The large number of industries invariably discharges their waste products either in the form of effluents or solid waste to the natural ecosystems; as a result, the system gets contaminated and creates many health and environmental problems.

N.S.L Sugars-Bhusnoor Sugar Refining Mill, is located at 16°11′-17°45′N latitudes and 76°03′-77°30′E longitudes at Bhusnoor village, Aland taluka, Kalaburagi district, Karnataka, covering an area about 3 Km^2.The soil types in the Bhusnoor area of Aland taluk are deep black and medium black in colour and derived from basalts. The soil thickness of 0.5 to 3.6m and the infiltration rate is moderate to poor.

In the present study, an approach has been made to integrate the soil quality particularly Nitrogen and Potassium (NK) with slope, drainage and geomorphology to know the causative factors. The result indicates that the areas with slopes have relatively higher NK values.

Recently magnetic susceptibility (MS) maps are used as a proxy to estimate soil pollution. The magnetic minerals present in the soils may be either inherited from the parent rocks, form during pedogensis or may be stemmed from anthropogenic activities. Hence, the magnetic susceptibility is measured in grid pattern covering about 1.2 Km^2 and the prepared indicates state that MS values are higher in around the NSL sugars in the NE-SW direction. This indicates that the soil around the industry is polluted and higher values in NE-SW direction are due to wind direction. The values of Fe, Mn, Cu and Zn in the soils of the study area show correlation with MS values.

Key words: Magnetic Susceptibility, NSL Sugars, Soil Pollution, Causative factors

1. Introduction

Environmental Pollution caused by the industrial effluents/wastes is a global phenomenon. The very existence of life on the planet earth will be in danger, if suitable steps are not taken for abatement and control of environmental pollution.

Soil a significant factor affecting the efficiency of our planet's different biological systems. Soil is a blend of minerals, organic matter, gases, fluids and innumerable life forms that together help life on earth. Soils are indispensable for the presence of numerous types of life that have evolved on our planet. Soil itself is extremely perplexing. Soil is binding element in between organic matter and live organisms on the earth. Soil is a mode of crop production, producer and absorber of gases, mode of plant growth and home to the living. Soil is likewise a source material for building, medicine, artistry, and so forth.

The texture of soil alludes to the size of distribution of the mineral particles found in a representative sample of soil. Particles are ordinarily gathered into three principle classes: sand, silt and clay.

1.1 Study Area

The N.S.L Sugars-Bhusnoor Sugar Refining Mill, Government of Karnataka undertaking, established in 1988 is situated in Bhusnoor village in Aland taluk, Gulbarga district, nearest to Gangapur railway station at about 15km Fig 1. The taluk is located about 50km to the Kalaburagi. The sugarcane is used as raw material and the capacity of crushing (TCD) of sugarcane is 1250 tonnes per day. The sugar is normally produced in three forms 1. Refined sugar 2.Cane plantation double sulphitation direct consumption white sugar and 3. Raw sugar.

Raw materials and chemicals used in N.S.L sugar mills ltd are sugarcane, Bagasse-used as fuel for boilers, Molasses-to produce alcohol, spirits, and food flavouring, Tress mud-used for application in field, Sulphur, Milk of lime, calcium carbonate, phosphoric acid.

They produce generally the double sulphitation white sugar and raw sugar dependent on offer. The sugar beet is a beetroot variety with the most noteworthy sugar content, for which it is explicitly developed. Around 3,700,000 tons of sugar is made from sugar beet. The final molasses is a by-product in the sugar processes and contain lingering sugar (sucrose), glucose and fructose.

NSL Sugar Limited proposes to set up an incorporated eco-friendly 34MW limit cogeneration power project for decentralized generation of exportable surplus power, predominantly from sustainable sources of fuel. At present NSLSL has a sugar plant of limit of 1250TCD. The command area of the proposed sugar factory has incredible irrigation amenities, potential for supported cane supply to the sugar plant, molasses and biomass accessibility.

The cane area is extended up to about 110 kms and a major Amarja dam has been constructed across the river Amarja near kornahalli in Aland taluk which is about 5kms away from the factory site.

1.2 Geology and Soil type

The soil types in the Bhusnoor area of Aland taluk are deep black, medium black soil. The deep and medium black soil covers practically the entire area. Black soil has been resulted from basaltic rocks and contrasts in colour from medium to profound dark. Its thickness ranges from 0.5 to 3.6 m. Penetration rate of shallow, medium and black dark soil is moderate to poor. Geologically, the entire area comprises of greenish brown to black coloured basalts and the rocks highly weathered (Fig 2), the depth and intensity of weathering varied highly.

1.3 Use of magnetic susceptibility in soil quality assessment

The magnetic properties of the whole soil sample mirror the differed magnetic conduct of the scope of soil minerals present. Studies dealing with low field vulnerability state that ferromagnetic minerals alone decide bulk magnetic properties. The diamagnetic constituents of soils incorporate quartz, orthoclase, calcium carbonate, organic matter and water. In many soils these portions can be viewed simply as a dilutant, though for pure silica sands, pure limestones and ombrotrophic peats which are diamagnetic constituents will be magnetically important. Many soil minerals both essential and secondary are paramagnetic and soils which are iron rich yet poor in ferromagnetic minerals, paramagnetism will make a significant contribution to add up to susceptibility.

A few canted anti ferromagnetic minerals are available in soil. Of these, goethite is the most bounteous in very much drained soils made under mild conditions and hematite is increasingly prevalent in generally drier and all the more profoundly oxidized circumstances. Magnetite and maghaemite, ferromagnetic oxides are significant in the soil, however titanomagnetites and pyrrhotite are quite important in some lithologies. Magnetite will occur both as a primary mineral derived from igneous rocks and mainly basic igneous rocks. Maghaemite is a secondary soil mineral widespread in temperate minerals, it tends to be more abundant in highly weathered soils formed under tropical and subtropical conditions. It can occur as finely dispersed or concretions.

2. Review of literature

Environmental problems due to sugar industry in India examined by Grover and Grewal (1991), environmental contamination with metals through industrial wastes carried out by Alam and Mahbub (2007), environmental pollution caused by heavy metals is increasing along with the increase in the usage of chemicals in industry (Huget et al., 2009), water used in the industries creates a waste that has potential hazard for the environment because of the introduction of various contaminants such as heavy metals into soil (Azumi and Bichi, 2010), Magnetic enhancement in top soils was investigated by Orgeira et al., (2011), Maher, (1986), heavy metal and fly-ash pollution (Kapicka et al., 2000). Soil magnetic studies were carried out to determine the relationship between magnetic properties and parent rock lithology (Fialova et al., 2006; Shenggao, 2000).

Salehi et al., (2013) has assessed the relationship between magnetic susceptibility (MS) and heavy metals concentration in polluted soils of Lenjanate region and he said that MS can be used as a guideline to find contaminated urban area with high Fe and Cu values. Mariagrazia et al., (2006) have used MS measurements as proxy method to monitor soil pollution. These shows the relationships among MS values and heavy metal contamination level confirm that the magnetic properties of soil may be used as proxy variable for indicating the presence of pollutants. Mohamed et al., (2010) have used MS in assessment of anthropogenic impact in the urban environment and they said that heavy metals (such as Pb, Cu, Zn, Cd and Fe) contents of soils have more affinity to establish metallic bond with ferrous metals leading to enhancement of MS.

3. Materials and methods

The materials and methodology used for the study includes the collection of down profile soil samples from Bhusnoor region in Aland taluk and its magnetic susceptibility analysis using Magnetic susceptibility meter SM-30 Fig no 3. Analysis of data generated by the preparation of graphs, correlation of magnetic susceptibility values with physio-chemical parameters of soils and to arrive at conclusions.

3.1 Materials

Materials used for field work and analysis are wooden scrapper, soil sample bags, pick axe, name slip and permanent marker**,** GPS**,** Magnetic susceptibility meter SM-30**,** Electronic weight machine

3.2 Methodology

Sampling: It is a type of random sampling in and around the industry. Top surface soil has to be removed at first. Measure the magnetic susceptibility of the soil by using the meter SM-30. Dig the soil up to the depth of 20-30 cm by using a clean wooden scraper in a **"v"** shaped and take the sample from the side. Collect the samples on a soil sample bag and clearly label all the samples using name slip and permanent marker. Take the GPS reading of that location. Spread the collected soil samples on clean paper for 4 to 5 days for air drying and care should be taken for the samples to not get exposed to direct sunlight. Do not send wet samples to the laboratory. Take 100 gm. of collected soil to the laboratory for analysis.

Take the air dried soil sample and powder it by beating with wooden pestle. Mesh the ground sample over 2mm filter and transfer back the unsieved material for pounding again. Continue the process until pebbles, stones, organic residue etc. remain on it. Mix well the fine sieved material and store in a suitable soil sample bag with a label.

4. Results and discussion

4.1 Magnetic susceptibility

Since the 1980s, magnetic susceptibility measurements have been used in many different places to detect atmospheric pollution. The premise of distinguishing environmental contamination lies in the iron constituent of a few groups of pollution particles that gives them magnetic signs. The MS system is ideal for mapping heavily contaminated area around and downwind pollution sources. MS has been used as an economic and rapid measurement for mapping of heavy metal contamination.

Physico-chemical parameters of Soils in and around the N.S.L Sugar mill

Totally twenty-two samples collected representing the whole Bhusnoor and were analysed for eight physico-chemical constraints and the data is presented in the table.1. Pysico-chemical parameters were analysed by titrimetric method and the micronutrients were analysed by using AAS at the Dept. of soil science, ICAR Agriculture University, Gulbarga.

4.2 pH

The pH of a soil is an important physio-chemical property of soil. It influences the suitability of soil for a crop availability of nutrients microbial activity and physical property of the soil.

The pH of soil samples in the current work, is ranging from 6.31 to 8.45 (Avg. 7.87) and showing that the soil samples of the present investigation falls inside the Indian standard specification (6.5-8.5 pH). The pH of the soil shows high towards north and low towards south from the NSLsugars (Fig 4.1).

4.3 Electrical conductivity (EC)

The measurements of electrical conductivity are used in soil testing to estimate soil salinity. Soil generally differ in their salt content which affects their ability to grow crops. The soils containing an excess of soluble salts are saline. Excess salts interfere with water and nutrient uptake and in saline soils all crops may not grow successfully.

EC of the soils of the current study area ranges from 0.86 to 657.7 and the lowest EC varies in the southern part from the NSL and the highest values in the northern part towards the back side of the NSL sugars (Fig 4.2).

4.4 Available Nitrogen (N)

The available nitrogen in a soil represents a fraction of the total N absorbable by plants. Nitrogen is generally taken up in the NO3+ from under aerobic conditions and as NH4+ ions under anaerobic conditions of plant growth. Nevertheless, the sum of the NH4+-N & NH3- -N is generally smaller than the total N which becomes available to the plants during their growth.

In soils of the present study area, the existing nitrogen ranges between 112 to 1008 kg/ha. with an average of 577 kg/ha. Soils of the present study area shows low avilable N in the north-east part and high available N in the south-west and north- west part from the NSL sugars (Fig 4.3).

4.5 Available Potassium (K2O)

Accessible K in a soil is commonly the whole of water solvent and replaceable potassium. The reserve types of K in soils are the non-interchangeable K and the mineral K. As the interchangeable K of soils is evacuated through cropping or leaching, a portion of the reserve K results from weathering of feldspars and micas and become replaceable.

In the soils of the current study area accessible potassium varies between 1.68 to 742.56 ppm, with average of 206.44 ppm and the K value shows higher in the north-west direction and lowest in the north-east direction from the NSL sugars (Fig 4.4).

4.6 Zinc

In the study area, the amount of zinc ranges from 0.071 to 1.202 mg/l, (Avg. 0.61 mg/l), which shows lowest Zn value shows in north-west direction of the NSL sugars and highest Zn value shows towards south-west direction inside and outside the NSL and also in the north-west direction from the NSL sugars Fig 4.5.

4.7 Copper

In the area, the amount of copper ranges from 1.465 to 8.055 mg/l, (Avg. 3.18 mg/l). The highest value shows towards south-west and the lowest value shows towards west and north-west from the NSL sugars (Fig 4.6).

4.8 Iron

In the soils of the study area, the amount of iron ranges from 1.523 to 9.792 mg/l and average of 4.15 mg/l. The concentration is showing towards the north-west direction and the highest concentration is showing towards south-west direction (Fig 4.7).

4.9 Manganese

The manganese concentration in the soils of the present current area ranges from 0.933 to 9.9 mg/l with an average of 5.12 mg/l. the highest value shows in southern part and the lowest value shows in the north-west direction from the NSL sugars (Fig 4.8).

4.10 Magnetic Susceptibility

The average value of magnetic susceptibility (MS) for the study area was 5,31*10-3 SI. The lowest values were measured NW from the sugar factory (1,43*10-3 SI), while the highest values were in the close vicinity of the chimney (19,63*10-3 SI). In general, the whole sugar factory area and the close by dump sites have the highest Magnetic susceptibility values, being over 7*10-3 SI. The NE direction shows increased Magnetic susceptibility values, generally being over 5*10-3 SI. There are also high Magnetic susceptibility values in SW direction (over 6*10-3 SI), mostly due to basaltic host rock of the soil. Pollution from the village can also be seen at the cross-roads area (Fig 4.9)

5. Conclusion

Monitoring soil quality is also important since it is much cheaper to prevent soil contamination than it is to apply remedial measures to contaminated soil. The purpose of the present study is to assess the soil quality around NSL sugars in order to protect and improve long-term agricultural productivity and habitats of all organisms including people. We use soil characteristics as indicators of soil quality, but in the end, soil quality must be identified by how it performs its functions. In the present study an approach has been made to integrate the soil quality particularly NK with slope, drainage and geomorphology to know the causative factors as they are low in the soils of the present study. The result indicates that in areas with slopes have relatively high NK and covered by plantations. In summary, the low NK in the soils of farm land is due to excessive agriculture.

Recently magnetic susceptibility (MS) maps are used as proxy to soil pollution. The magnetic minerals present in the soils may be either inherited from the parent rocks, form during pedogensis or may be stem from anthropogenic activities. Hence, the magnetic susceptibility is measured in grid pattern covering about 1.2 Km^2 and the prepared indicates that MS valued are higher in around the NSL sugars in the NE-SW direction. This indicates that the soil around the industry is polluted and higher values in NE-SW direction are due to wind direction. The values of Fe, Mn, Cu and Zn in the soils of the present show correlation with MS values.

Figures and Tables

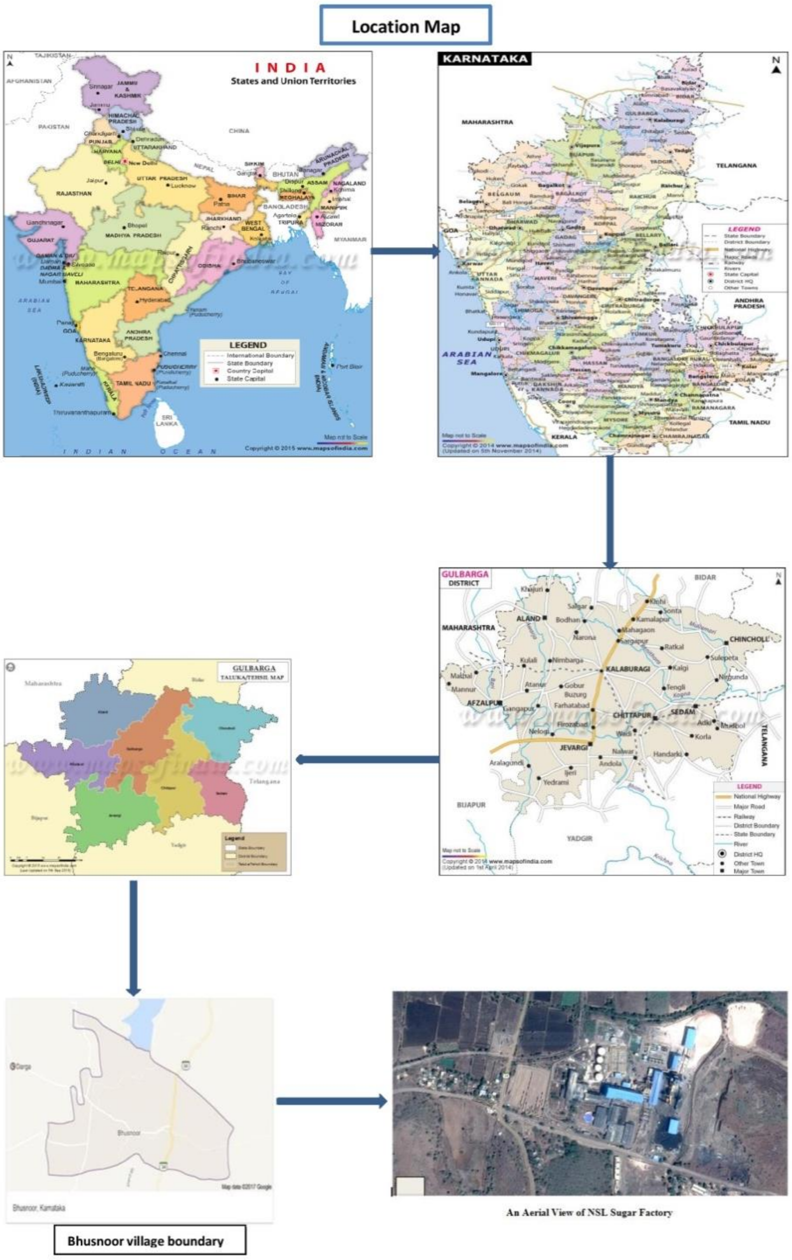

Fig 1: Location map of NSL sugars, Bhusnoor, Kalaburagi.

Fig 2 Field photo showing weathered basalt with very thin soil cover at NSL Sugars.

Fig 3: Magnetic susceptibility meter SM-30.

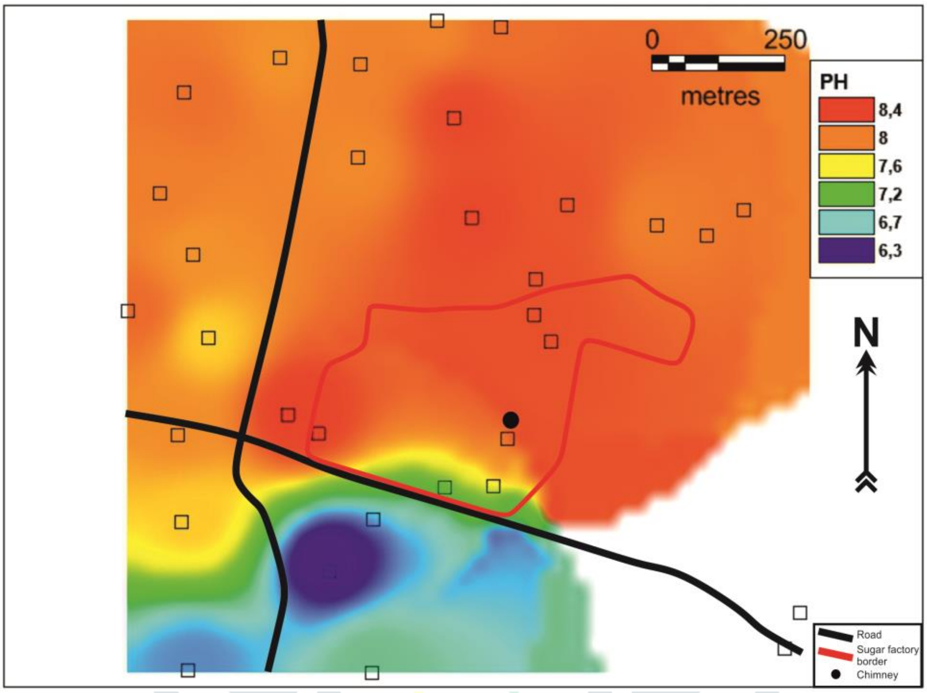

Fig 4.1 Map showing pH values in and around NSL sugars.

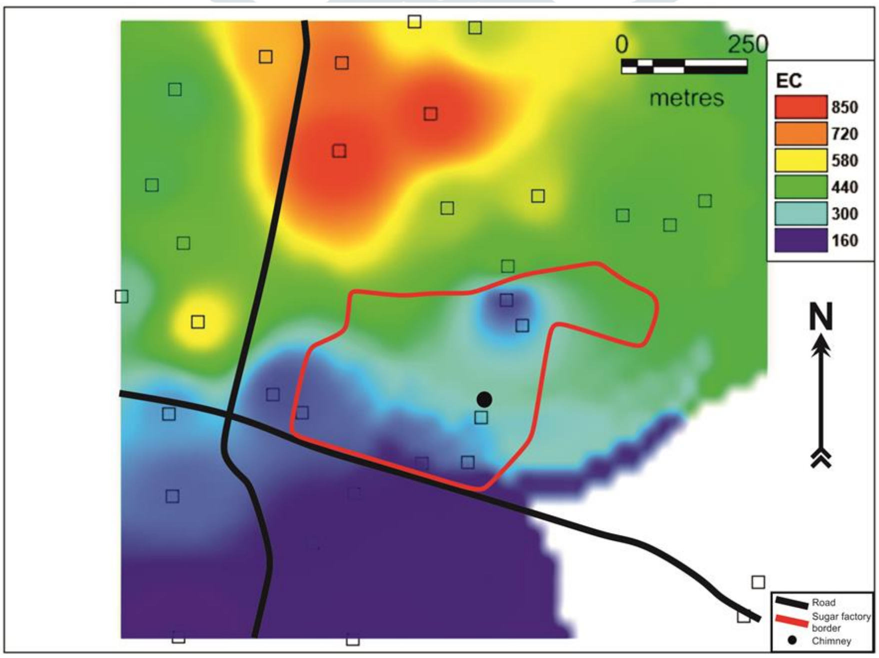

Fig 4.2 Map showing EC values in and around the NSL sugars.

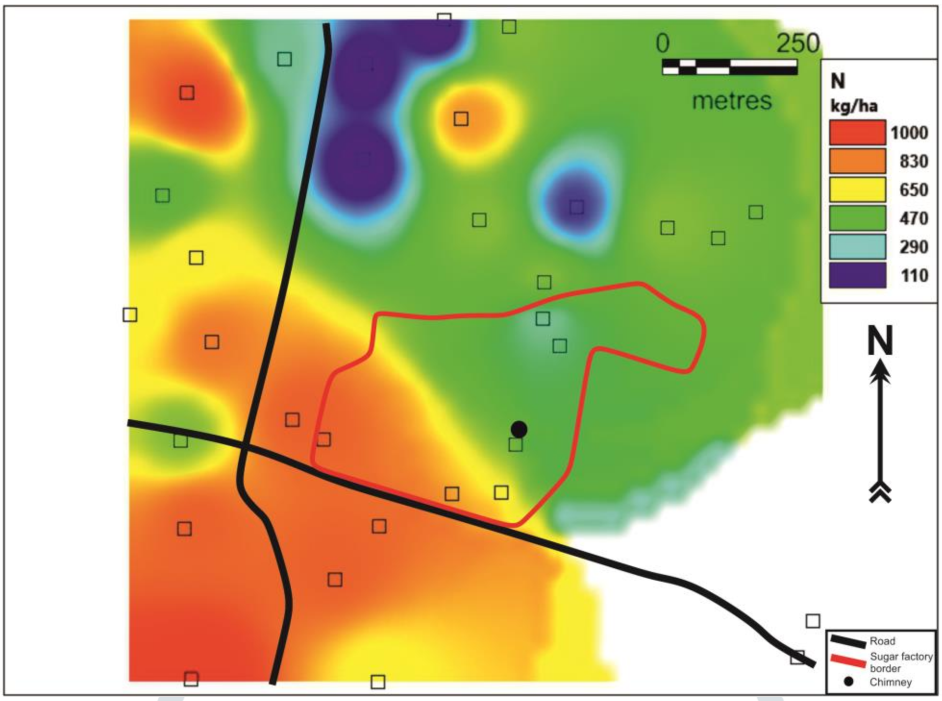

Fig 4.3 Map showing nitrogen values in and around NSL sugars.

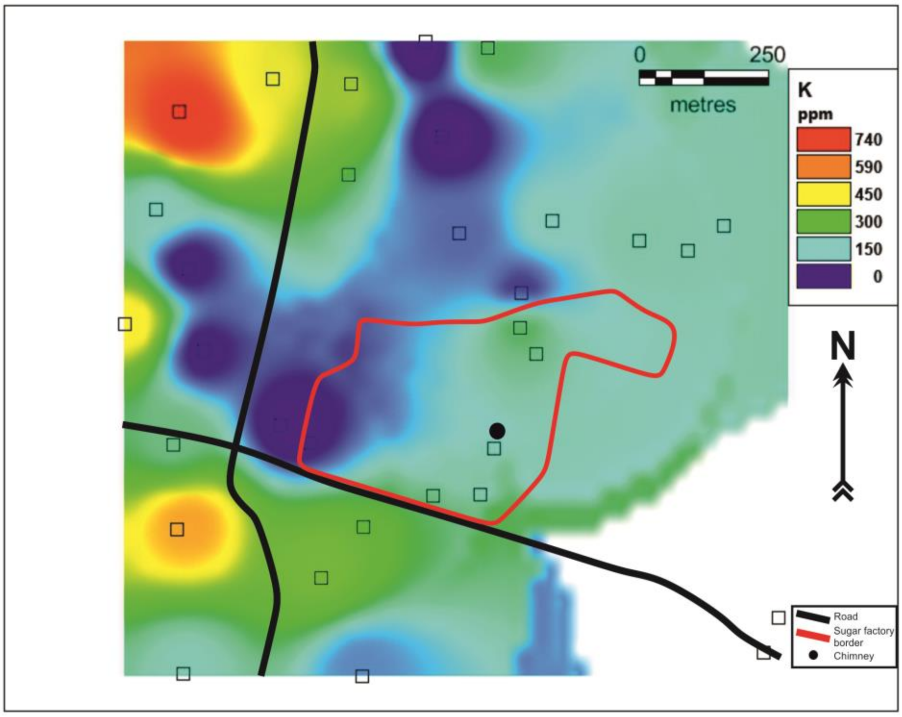

Fig 4.4 Map showing potassium values in and around NSL sugars.

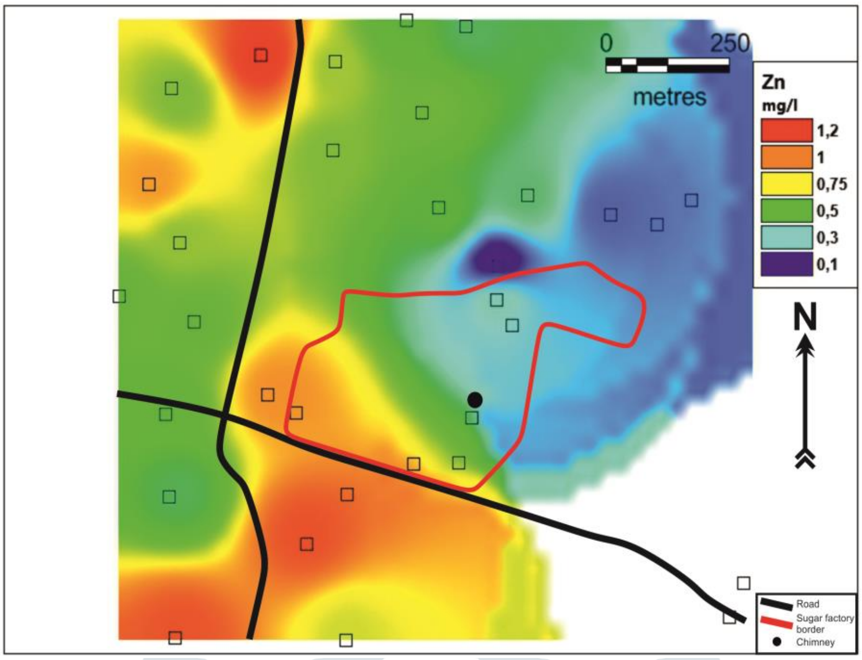

Fig 4.5 Map showing zinc values in and around the NSL sugars.

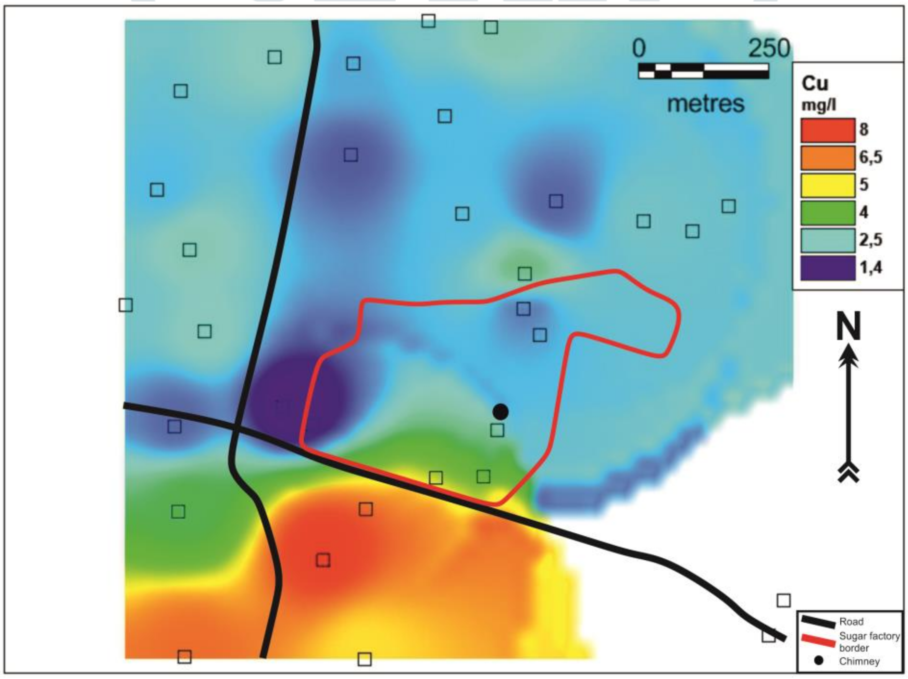

Fig 4.6 Map showing copper (cu) values in and around the NSL sugar.

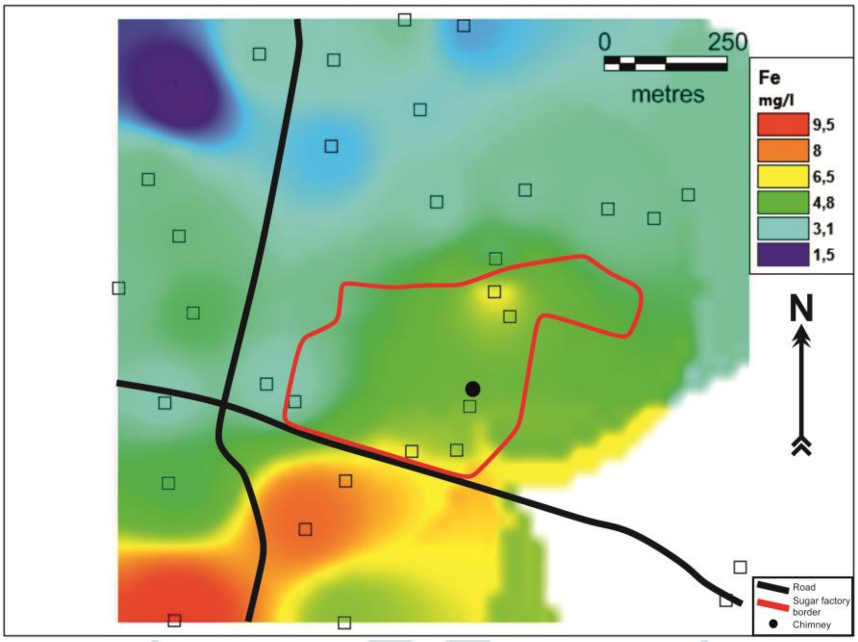

Fig 4.7 Map showing Fe values in and around the NSL sugars.

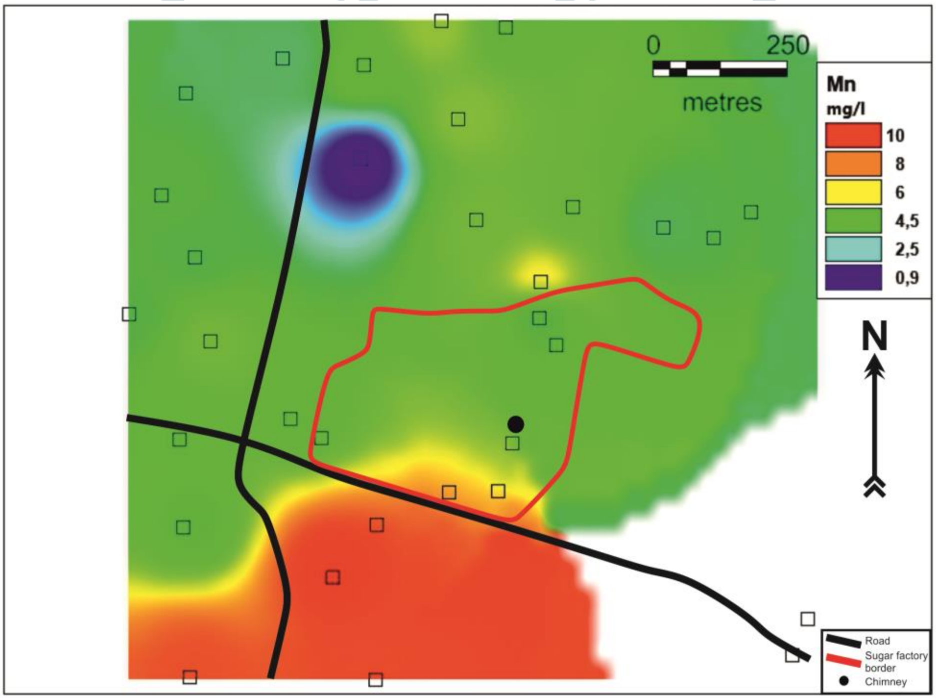

Fig 4.8 Map showing Mn values in and around NSL sugars.

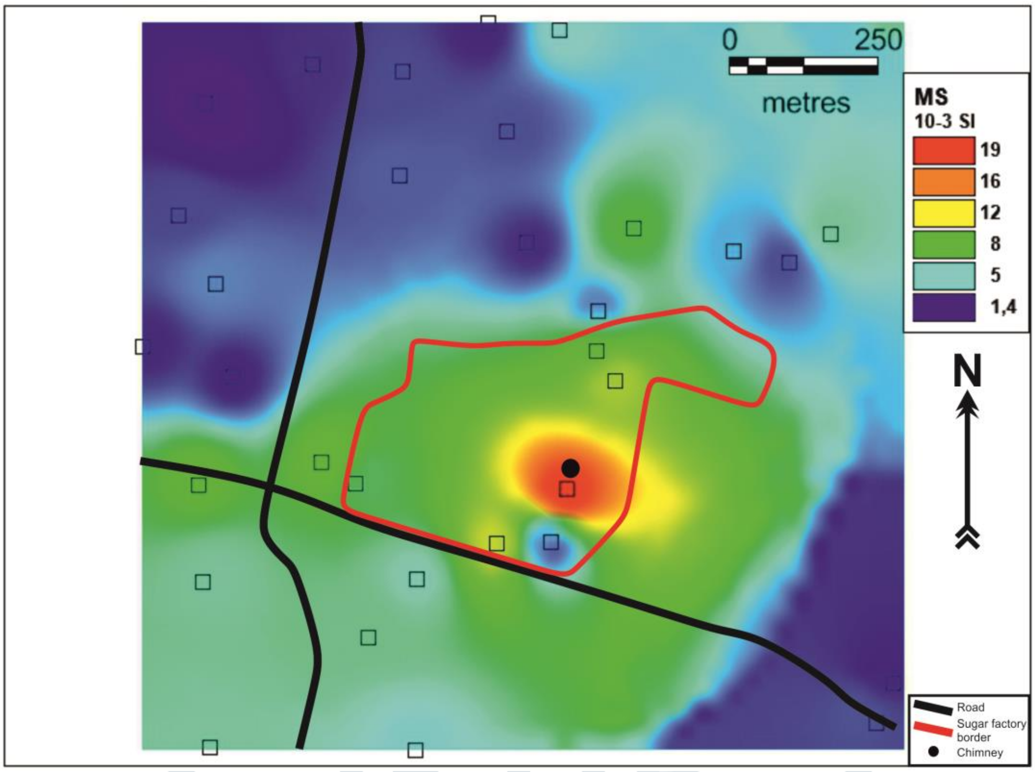

Fig 4.9 Magnetic susceptibility map of in and around the N.S.L sugar factory.

Table.1: magnetic susceptibility (MS) and physiochemical parameters of the soil samples of NSL sugars.

SAMPLE	MS	PH	EC	N (kg/ha)	K (ppm)	Zn (mg/l)	Cu (mg/l)	Fe (mg/l)	Mn (mg/l)
1	9.438	8.28	207.7	336	231.12	0.336	2.221	6.473	3.966
2	5.513								
3	6.25	6.31	192.2	896	355.92	1.105	8.055	8.537	9.9
4	4.943	6.87	175.7	672	94.08	0.714	5.757	5.76	9.403
5	5.838	6.58	162.8	1008	162.96	1.098	7.014	9.792	9.175
6	5.87	7.75	231.1	896	538.8	0.426	3.576	4.199	4.285
7	8.398	7.95	260.6	560	203.04	0.517	3.576	3.331	4.476
8	8.818	8.45	220.6	896	8.4	0.936	3.576	3.314	4.588
9	2.258	7.74	594.7	840	25.2	0.551	3.576	4.052	5.096
10	2.328	8.12	338.2	672	474.72	0.556	3.576	3.638	4.007
11	3.613	7.93	477.5	672	25.83	0.657	3.576	3.8	3.963
12	2.763	8.02	393.2	448	159.92	0.913	3.576	3.684	4.106
13	1.433	8.09	385.2	952	742.56	0.63	3.576	1.523	-
14	2.46	7.93	657.7	336	438.96	1.202	3.576	3.339	3.627
15	2.81	8	770.5	112	397.44	0.672	3.576	3.282	4.524
16	3.063	7.96	0.867	112	0	0.629	3.576	2.807	0.933
17	2.27	7.98	604.7	112	1.92	0.507	3.576	3.524	5.572
18	5.133	8.1	553.5	560	229.68	0.418	3.576	2.7	4.521
19	2.855	8.33	0.852	784	1.68	0.582	3.576	3.133	5.418
20	2.393	8.35	540.3	560	75.12	0.484	3.576	3.407	5.108
21	7.703	8.25	562.1	168	156.72	0.399	3.576	3.507	4.863
22	3.31	8.27	455.4	560	44.16	0.071	3.576	3.966	6.33

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