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Soil Pollution Index (SPI) for an Area of 10 Km Radius from the Proposed Carbon Black Manufacturing Unit at Pudi Village, Rambilli Mandal, and Visakhapatnam District.

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Abstract: ***The soil is a natural body composed of different layers of mineral constituents of varying thicknesses, which differ from their parent materials on the basis of morphological, physical, chemical and mineralogical characteristics. Soil which consists of broken rock particles that have been altered by chemical processes. It varies from its parent rock due to interactions between all the lithosphere, hydrosphere, atmosphere and biosphere, it is a mixture of mineral & organic constituents that are solid, gaseous and aqueous. Soil that is loosely packed, forming a soil structure filled with pore spaces.Soil is used in agriculture where it serves as the primary plant nutrient base but is shown to be hydrophonic and not essential for plant growth if the nutrients contained in the soil could be dissolved in solution.. This types of soils used in agriculture vary with respect to the species of plants that are cultivated.***

Index words: Mineral Constituents, Mineralogical Characteristics, Hydroponics, Soil Biota, Soil Contamination.

I. INTRODUCTION

Soil which is a vital part of the environment. As we know that the plants, animals, rocks and rivers were involved. Mainly mining and construction industries and it also involves in acidification, contamination, erosion or salination. By Applying various Bio-Fertilizers and manures we can reduce the chemical fertilizer and pesticides usage. Based on Biological methods also we can minimize the soil pollution. This is a reasonable solution and materials such as paper, some kinds of plastics and glass can be recycled. Increase in urbanization, agricultural activities, industrial activities, agriculture land causes land contamination. Main sources which causes pollution from many factories, industries or waste disposal activities, coal fired power plants, and other heavyindustries. Contamination of the soil at low levels is often capable of treating and assi milating the soil. As many waste treatment processes as treat ment capacity may exceed treatment, soil biota may be dam aged and soil function may be limited.

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II. DESCRIPTION OF STUDY AREA

a) Topography

The project site is located at pudi village, Rambilli Mandal and Vishakhapatnam district of Andhra Pradesh. The geographical intersection of proposed site is North latitude 17°31'11.17" and Longitude 82°59'58.26" East of 21m above the Mean Sea Level (msl). The major city which is near to the proposed carbon black Unit is Visakhapatnam at a distance of around 47 kms by road. The study area comprises mainly of rural area.

An area covering 10 kms radially, with the proposed site being the epicenter, has been selected for the soil collection. Continental Carbon India Limited (CCIL) is proposing to setting up +140000 MT per year as Phase- I, Followed by Phase – II & III of same capacity expansion +140000 MT. Each phase of the plant will also have 50 MW power plants. Plant will be located at Visakhapatnam, AP, and India. The plant design will be from continental Carbon, USA to produce all types of carbon black for various furnace grades and also recover full energy in the form of steam/power.

III. OBJECTIVE

1. Collecting of soil samples from the study area.
2. To study the trace elements concentration and to establish the soil pollution index in a study area.

IV. METHODOLOGY

Soil can be defined as "the upper layer of the crust of the ea rth to which most of the plants where they derive most of th eir supply of water as well as nutrients"The soil which is comprised of solids, water and air. The mineral soil contains about 50 percent solids of which about 90 percent is mineral water and 10 percent is organic matter. The remaining 50 percent consists of which consists variable amounts of water and there are six types of soil as depending upon their particle size in the soil is graded as sandy soil, silty soil , clay soil, loamy soil, peaty soil and chalky soil in these for ms.

A work as undertaken to establish soil pollution Index in and around 10 Km radius from the proposed carbon black manufacturing unit. The trace elements are measured for the period from June to September 2019. The methodology involved the following:

1. Selection of area for the study for development of soil pollution index.
2. Selection of sampling locations.
3. Sampling & Analysis.
4. Estimation of soil pollution index.

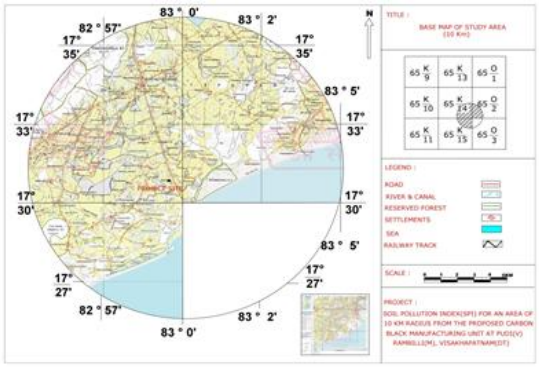

Figure 1: Base Map of Study Area

Visakhapatnam which is one of the leading industrial cities in India. We know that the heavy industries like Caltex oil refinery, Bharat heavy plates, Visakha steel plant, Coramandal fertilizers, Andhra Pradesh refractor y and pencils are present causing a major damage to nature. In spite of proper treatment there might be a chance of getting polluted with little amount of pollutants i.e; metals and trace elements.

TABLE 1: Selection of Sampling Locations

S. No	Sampling Location	Location Code	Direction w.r.t Plant site	Distance w.r.t Plant site (Kms)
1.	Plant Site	L1	Core	--
2.	Moturupalem	L2	W	1.7
3.	Narasapuram	L3	W	6.3
4.	Dibbapalem	L4	E	5.0
5.	Jogannapalem	L5	E	3.7
6.	Tallapalem	L6	E	1.3
7.	Pudi	L7	SW	1.0
8.	Chinnapudi	L8	SE	0.7
9.	Uddapalem	L9	N	0.8
10.	Kollivanipalem	L10	NW	0.8

a) Sampling and Chemical Analysis:

Soil Samples have been collected from the study area and the soil was thoroughly mixed for the analysis.

Atomic Absorption Spectrophotometer (AAS) is widelyUsed to track the presence of major elements and toxi c impurities lower than stated. Atomic Absorption Spectrophotometer have mainly 4 components :

- A Light Source (a hollow cathode lamp)
- An Atom Cell (Atomizer)
- A Monochromator
- A Detector, and Read out device

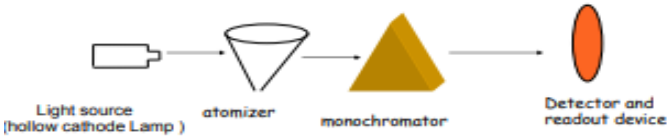

Figure 2 : Schematic Diagram of an atomic Absorption Spectrophotometer

20 Grams of soil will be digested with HNO_3 and HCl acids is known as Nitric Acid Digestion Method. The parameters chosen for calculation of soil pollution index were Lead, Zinc, Copper, Boron, Cadmium, Chromium, Cobalt, Manganese, and nickel. These trace elements were analyzed at Laboratories.

Soil pollution index :

The soil pollution index can be defined as a rating that reflec ts the composite influence of a number of parameters of soil quality on the overall soil quality,similar to air quality index, water quality index.

The SPI value runs from 0 to 40. The higher the SPI value the higher the pollution level. For example an SPI value of 10 represents “unpolluted”, while an SPI value over 40 represents “dangerously polluted”. If the SPI value is in between 10 to 20 represents “slightly polluted”.

$$D_i = C_i / S_i \times 100$$

Where, D_i = Soil pollution rating index of i th station , C_i = Concentration of the i th pollutant.

S_i = Soil quality critical value (or) standard of i th pollutant.

Soil pollution index is calculated by taking the geometric mean of Di for all the stations.

$$\textbf{Geometric mean} = \sqrt[N]{D1 \times D2 \times D3 \times D4 \ldots\ldots Dn}$$

D_i = Soil pollution rating index of i th station, N = Number of trace elements

Trace elements concentration in soil as lead-100, Zinc-70, Copper-60, Boron -5, Cadmium-3, Chromium-75, Cobalt-25, Manganese-1500, and Nickel-100.

b) Elements and their effects

Lead is a lustrous bluish white metal that causes damage to the ki dneys, brain damage.

Zinc is a lustrous bluish-white metal and causes damage to pancreas and arteriosclerosis.

Copper is reddish metal and causes liver kidney damage and even death.

Boron is non-metallic element and causes stomach, liver, kidneys and damage and eventually death.

Cadmiumis a silver white lustrous which causes diarrhea, b one fracture, immune system damage.is a lustrous, silver white and causes diarrhea, bone fracture, damage to immune system.

Chromium is lustrous and causes upset stomachs, respiratory problems, lung cancer.

Cobalt is a hard ferromagnetic, silver white and causes vision problems, heart problems.

Manganese is pinkish-grey and causes blood clotting, skin problems, birth defects.

Nickel is silvery-white and causes asthma, skin rashes.

V. RESULTS AND DISCUSSIONS

The classifications of the soil quality based on the rating of SPI are unpolluted, slightly polluted, moderately polluted, severely polluted and dangerously polluted. The quality parameters of soil samples considered for the calculation of SPI for Visakhapatnam industrial area were trace elements such as Lead, Zinc, Copper, Boron, Cadmium, Chromium, Cobalt, Manganese and nickel. The trace elements are measured for the period from June to September 2019. The soil pollution index for all the all sampling stations as calculated and which are given in below tables.

TABLE 2 : Trace elements concentration of soil quality in Visakhapatnam industrial area – (Sample 1)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.21	1.11	0.81	0.21	1.21	1.9	2.3	3	3.01	3.95
Zn	12.45	9.65	8.37	7.47	8.65	7.62	7.8	11.7	13.4	8.03
Cu	12.4	11.8	10.5	9.45	7.9	8.8	11.8	9.81	8.01	8.17
B	1.86	2.41	1.67	1.54	1.9	1.86	2.01	1.93	1.93	1.04
Cd	1.25	1.9	0.3	0.48	1.1	1	1.9	0.64	0.64	0.29
Mo	0.07	0.03	0.01	0.08	0.05	0.06	0.009	0.02	0.04	0.09
Cr	4.91	3.02	3.3	3.2	4.4	5.1	6.9	6.7	6.7	5.9
Co	0.4	0.74	0.22	0.37	0.98	0.83	1.1	0.54	0.54	0.82
Mn	11.7	10.2	8.32	9.67	8.9	7.6	7.42	8.03	8.03	7.85
Ni	0.22	0.17	0.09	0.12	0.29	0.35	0.25	0.29	0.29	0.23

TABLE 3: Trace elements concentration of soil quality in Visakhapatnam industrial area-(sample – 2)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.26	1.15	0.85	0.21	1.18	1.87	2.4	3.04	3.05	3.98
Zn	12.89	9.64	8.32	7.43	8.62	7.64	7.95	11.5	13.2	8.02
Cu	12.2	11.06	10.5	9.44	7.93	8.75	11.17	9.36	8.04	8.16
B	1.87	2.4	1.83	1.53	1.95	1.83	2.16	1.91	1.26	1.03
Cd	1.26	1.98	0.35	0.47	1.11	1.05	2.05	0.62	0.51	0.29
Mo	0.06	0.03	0.04	0.08	0.04	0.07	0.008	0.01	0.03	0.05
Cr	4.97	3.03	3.32	3.21	4.55	5.3	6.97	6.79	7.46	5.95
Co	0.15	0.75	0.22	0.36	0.95	1.15	1.05	0.59	0.95	0.78
Mn	11.5	10.2	8.36	9.69	8.08	7.44	7.41	8.08	8.69	7.56
Ni	0.23	0.17	0.05	0.13	0.31	0.32	0.24	0.31	0.35	0.26

TABLE 4: Trace elements concentration of soil quality in Visakhapatnam industrial area-(sample - 3)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.3	1.14	0.83	0.22	1.22	1.89	2.5	3.01	3.03	4
Zn	13.11	9.65	8.43	7.4	8.7	7.66	8.1	11.9	13.3	8.04
Cu	12.5	11.09	10.6	9.49	8	8.9	11.2	9.2	8	8.15
B	1.88	2.42	1.68	1.54	1.91	1.87	2.2	1.93	1.25	1.06
Cd	1.27	2	0.32	0.48	1.15	1.01	2.1	0.65	0.52	0.31
Mo	0.06	0.03	0.01	0.07	0.05	0.07	0.009	0.01	0.05	0.1
Cr	4.95	3.04	3.33	3.24	4.4	5.25	7	6.75	7.5	6
Co	0.04	0.76	0.24	0.37	1	1.1	0.5	0.93	0.84	0.47
Mn	11.9	10.3	8.34	9.7	9	7.6	7.45	8.05	8.7	7.75
Ni	0.24	0.17	0.07	0.14	0.3	0.41	0.25	0.31	0.37	0.25

TABLE 5: Trace elements concentration of soil quality in Visakhapatnam industrial area-(sample - 4)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.29	1.13	0.85	0.25	1.21	1.18	1.92	3.05	3.01	3.96
Zn	12.66	9.68	8.41	7.36	8.64	7.5	8.1	11.2	13.8	8.03
Cu	12.8	11.05	10.6	9.45	7.95	8.8	11.05	9.16	8.02	8.11
B	1.89	2.55	1.49	1.52	1.5	1.89	2.15	1.89	1.26	1.04
Cd	1.26	1.97	0.23	0.5	0.49	1.03	2.12	0.63	0.5	0.3
Mo	0.06	0.02	0.03	0.07	0.04	0.08	0.009	0.02	0.04	0.1
Cr	4.93	3.03	3.36	3.24	4.42	5.26	7	6.78	7.41	5.96
Co	0.29	0.75	0.23	0.36	0.1	1.02	0.5	0.91	0.88	0.57
Mn	11.9	10.4	8.36	9.66	8.99	7.57	7.39	8.09	8.66	7.77
Ni	0.23	0.16	0.08	0.13	0.3	0.38	0.24	0.3	0.35	0.24

TABLE 6: Trace elements concentration of soil quality in Visakhapatnam industrial area-(sample - 5)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.34	1.15	0.86	0.21	1.24	1.91	2.5	2.9	3.05	4.01
Zn	13	9.95	8.5	7.61	8.67	7.62	8.02	12.01	13.5	8.7
Cu	12.45	12.1	10.75	9.55	8.04	1.9	11.22	9.24	8.01	8.16
B	1.9	2.44	1.7	1.56	1.93	1.89	2	1.96	1.23	1.11
Cd	1.25	2.05	0.31	0.5	1.2	1.03	2	0.7	0.58	0.3
Mo	0.07	0.02	0.01	0.08	0.03	0.06	0.007	0.01	0.04	0.07
Cr	4.91	3.02	3.3	3.6	4.65	5	6.87	6.6	7.47	5.9
Co	0.38	0.72	0.26	0.4	0.98	1.4	0.55	0.98	0.82	0.48
Mn	11.7	10.2	8.31	9.67	8.85	7.5	7.4	8.35	8.72	7.9
Ni	0.2	0.15	0.07	0.16	0.35	0.35	0.29	0.33	0.35	0.23

TABLE 7: Trace elements concentration of soil quality in Visakhapatnam industrial area-(sample - 6)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.33	1.19	0.79	0.26	1.14	1.79	2.55	2.99	3.07	4.08
Zn	12.29	9.39	8.5	7.33	8.58	7.54	8.01	12.04	13	8.74
Cu	12.15	12.1	11.22	9.44	7.95	1.95	11	9.25	8.05	8.15
B	1.96	2.88	1.68	1.59	1.87	1.8	1.68	1.97	1.22	1.05
Cd	1.19	2.01	0.35	0.47	1.2	1.02	2.05	0.55	0.58	0.33
Mo	0.06	0.02	0.03	0.05	0.04	0.07	0.006	0.02	0.04	0.06
Cr	3.95	2.99	3.52	3.28	4.58	4.65	6.49	6.68	7.45	5.99
Co	0.29	0.72	0.26	0.45	0.94	1.38	0.43	0.95	0.88	0.48
Mn	11.35	10.11	8.11	8.37	8.81	7.55	7.41	8.35	8.79	7.66
Ni	0.3	0.09	0.02	0.04	0.3	0.29	0.28	0.34	0.36	0.25

TABLE 8: Trace elements concentration of soil quality in Visakhapatnam industrial area-(sample - 7)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.34	1.18	0.87	0.25	1.22	1.9	2.45	3	3.05	4.02
Zn	13.02	9.8	8.4	7.6	8.72	7.64	8	12	13.4	8.68
Cu	12.59	12	10.8	9.95	8.06	9.03	11.26	9.3	8.03	8.19
B	1.92	2.45	1.7	1.6	1.95	1.91	2.1	1.98	1.3	1.08
Cd	1.23	2.01	0.35	0.55	1.18	1.07	2	0.67	0.57	0.32
Mo	0.06	0.02	0.01	0.05	0.03	0.03	0.005	0.03	0.04	0.09
Cr	4.94	3	3.32	3.7	4.7	5.1	6.92	6.75	7.52	6.1
Co	0.32	0.73	0.25	0.42	0.75	1.35	0.6	0.96	0.8	0.46
Mn	11.45	10.19	8.33	9.65	8.89	7.8	7.42	8.3	8.75	7.85
Ni	0.22	0.19	0.08	0.12	0.41	0.4	0.3	0.29	0.32	0.2

TABLE 9: Trace elements concentration of soil quality in Visakhapatnam industrial area-(sample - 8)

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.33	1.19	0.88	0.25	1.29	1.99	2.48	3.05	3.02	4.08
Zn	13	9.62	8.46	7.64	8.64	7.68	8.07	12.08	13.8	8.66
Cu	12.56	12.06	10.89	9.98	8.09	9.05	11.12	9.45	8.01	8.2
B	1.99	2.46	1.58	1.69	1.95	1.97	2.18	1.79	1.27	1.1
Cd	1.23	2.06	0.36	0.54	1.14	1.08	1.98	0.67	0.59	0.36
Mo	0.06	0.02	0.03	0.05	0.03	0.02	0.004	0.02	0.05	0.09
Cr	4.98	3.12	3.69	3.79	4.35	5.18	6.98	6.57	7.5	6.16
Co	0.36	0.73	0.25	0.46	0.74	1.39	0.65	0.53	0.89	0.58
Mn	11.35	10	8.64	9.25	8.82	7.54	7.4	8.3	8.56	7.66
Ni	0.15	0.15	0.04	0.1	0.39	0.42	0.39	0.35	0.33	0.23

TABLE 10: Average of trace elements concentration of soil quality in Visakhapatnam industrial area.

ELEMENTS (µg/g)	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Pb	1.3	1	0.84	0.23	1.21	1.8	2.38	3	3.03	4.01
Zn	12.8	10.8	8.42	7.48	8.65	7.61	8	11.8	13.42	8.36
Cu	12.45	11.65	10.73	9.59	7.99	7.14	11.2	9.34	8.02	8.16
B	1.908	2.5	1.66	1.57	1.87	1.86	2.06	1.92	1.34	1.06
Cd	1.24	1.99	0.32	0.49	1.07	1.03	2.02	0.64	0.56	0.31
Mo	0.062	0.023	0.021	0.066	0.038	0.057	0.007	0.017	0.041	0.081
Cr	4.81	3.39	3.39	3.4	4.5	5.1	6.89	6.69	7.37	5.99
Co	0.27	0.23	0.23	0.39	0.8	1.2	0.67	0.79	0.82	0.58
Mn	11.6	8.33	8.34	9.45	8.79	7.5	7.41	8.19	8.6	7.75
Ni	0.22	0.06	0.06	0.11	0.33	0.36	0.28	0.315	0.34	0.23

Atomic absorption spectrum (BDL Level: Pb-0.05, Zn-0.005, Cu-0.001, B-0.05, Cd-0.002, Cr-0.01, Co-0.03, Mg-0.01, Ni-0.02).

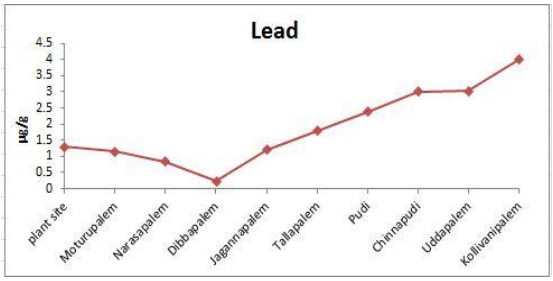

Figure 3: Overall Lead Concentrations present in the site locations representing in graph model

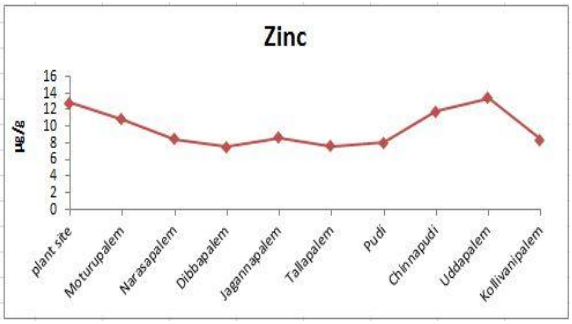

Figure 4: Overall Zinc Concentrations present in the site locations representing in graph model

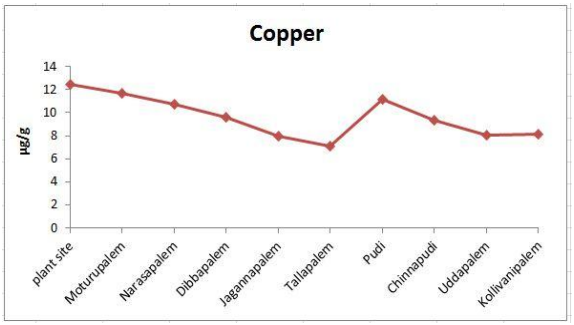

Figure 5: Overall Copper Concentrations present in the site locations representing in graph model

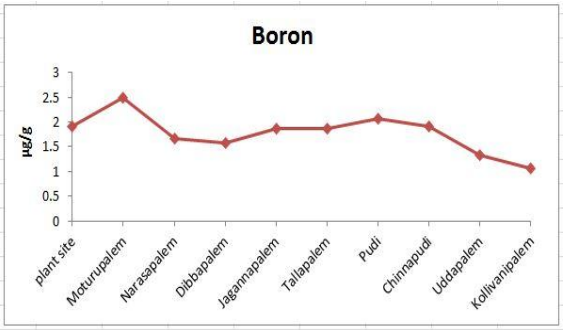

Figure 6: Overall Boron Concentrations present in the site locations representing in graph model

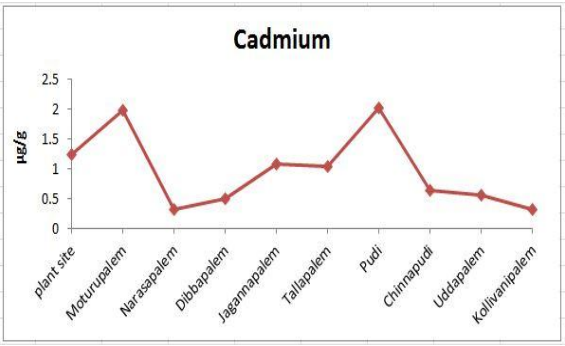

Figure 7 : Overall Cadmium Concentrations present in the site locations representing in graph model

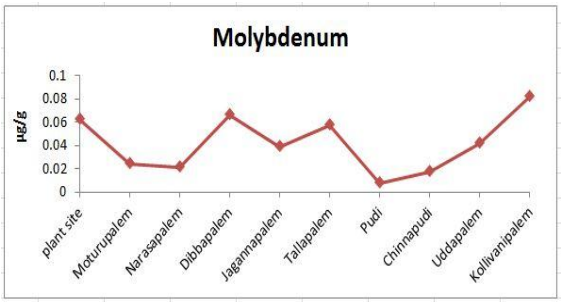

Figure 8: Overall Molybdenum Concentrations present in the site locations representing in graph model

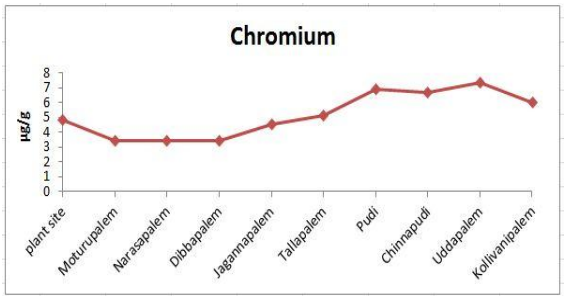

Figure 9: Overall Chromium Concentrations present in the site locations representing in graph model

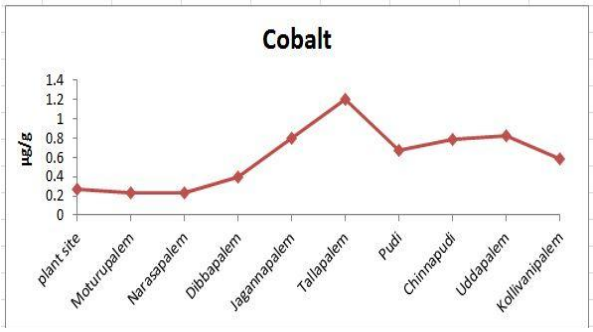

Figure 10: Overall Cobalt Concentrations present in the site locations representing in graph model

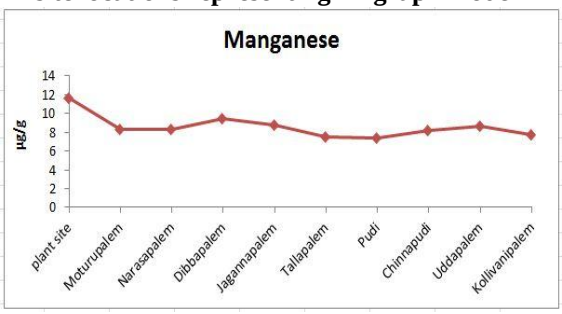

Figure 11: Overall Manganese Concentrations present in the site locations representing in graph model

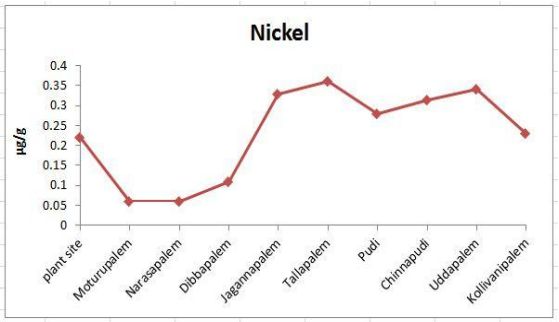

Figure 12: Overall Nickel Concentrations present in the site locations representing in graph model

TABLE 11: Soil Pollution Index (SPI) for the Visakhapatnam Industrial Area.

Site Locations	Soil Pollution Index
L1	4.42
L2	3.31
L3	2.49
L4	2.74
L5	4.24
L6	4.67
L7	4.19
L8	4.41
L9	4.67
L10	4.07
Average =	**3.92**

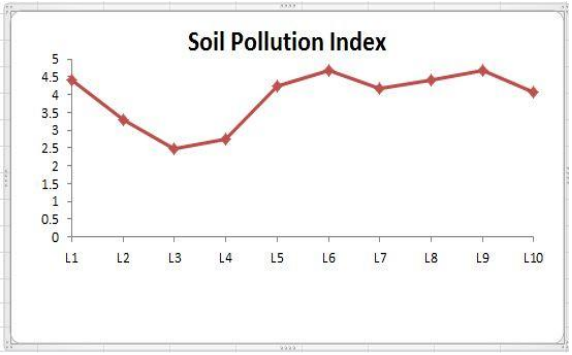

Figure 13 : Graph Indicating Soil Pollution index for the Site Locations

TABLE 12: Sample calculation of the soil pollution index for sampling station Visakhapatnam industrial area.

Trace Element(T_e)	Average Value(C_i)	Critical value (S_i)	Quality Rating (D_i)= $C_i / S_i * 100$	Geometric Mean (G.M)	Degree of Pollution
Lead	1.88	100	4.42		
Zinc	9.73	70	3.31		
Copper	9.62	60	2.49		
Boron	1.77	5	2.74		
Cadmium	0.96	3	4.24	3.92	UNPOLLUTED
Molybdenum	0.04	2	4.67		
Chromium	5.15	75	4.19		
Cobalt	0.59	25	4.41		
Manganese	8.58	1500	4.67		
Nickel	0.23	100	4.07		

Geometric Mean= $n\sqrt{D1 * D2 * D3 \ldots\ldots\ldots Dn}$

$= 10\sqrt{4.42 * 3.31 * 2.49 * \ldots * 4.07}$

= 3.92 .

In this table, 10 soil trace elements (T_e) the average values (Ci) of the first column are given in the s econd column. The third column shows in the critical values or standard values of soil (S_i) for these trace elements. The fourth column shows the quality rating (D_i). The fifth column shows the geometric mean of quality rating (D_i). While last column gives degree of pollution.

TABLE 13 : Atomic Absorption Concentration Ranges

Element	Wave Length nm	Flame Gases	Instrument Detection Level mg/l	Sensitivity Mg/l	Optimum Concentration Range Mg/l
Lead	283.3	A-Ac	0.05	0.5	1-20
Zinc	213.9	A-Ac	0.005	0.02	0.05-2
Copper	324.7	A-Ac	0.01	0.1	0.2-10
Boron	-	-	-	-	-
Cadmium	228.8	A-Ac	0.002	0.025	0.05-2
Molybdenum	313.3	N-Ac	0.1	0.5	1-20
Chromium	357.9	A-Ac	0.02	0.1	0.2-10
Cobalt	240.7	A-Ac	0.03	0.2	0.5-10
Manganese	279.5	A-Ac	0.01	0.05	0.01-10
Nickel	232.0	A-Ac	0.02	0.15	0.3-10

A-Ac = Air Acetylene; N-Ac = Nitrous Oxide – Acetylene;

VI. CONCLUSION

We had determined to study about soil pollution index, consecutively to know the level of trace elements in the soil. This study has shown that Soil pollution index may be used to know the amount of trace elements. This technique is to keep soil in good condition which is necessary for plants and biogeochemical cycles and to minimize the impacts on soil.

Average SPI of all the sites is **3.92** that indicate the soil is slightly/less polluted.

Overall the SPI ranged from 2.49- 4.67 for the selected 8 sites in Visakhapatnam with lowest value of 2.49 in sample site- L3 and highest value of 4.67 in sample site- L9.

From the final study it is concluded that the proposed site is **"UNPOLLUTED"** and the effect of trace elements are very **"LOW"**.

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