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Heavy metal distribution in soil of Jaypee Cement Industrial Area 2012-13 of Rewa City, MP, India

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Abstract

The paper present on the heavy metal analysis of soil samples collected from ten different area of JP cement Industrial area of Rewa district, Madhya Pradesh state India. The variable parameters are correlated. Pre-monsoon and post monsoon variation in heavy metals parameters like Copper, Zinc, Iron, Manganese, Chromium, Nickel, lead, Cobalt etc. Were analysed for a period of year 2012-13. Were soil sample is indicated by JPIAS-1 to JP IAS-10. A great deal of increase in urbanization has resulted in soil contamination by heavy metals. This research aimed at identifying the adversely affected Jones due to this increase. Soil samples collected from fields and industrial area around Jaypee cement plant, duly analysed by AAS method .Revealed the fact that heavy metal contamination in the area is caused by anthropogenic activities.

Keywords: Heavy metals, soil analysis, industrial area, yearly parameters of soil Rewa, Madhya Pradesh.

Introduction

Cement industry is the life blood of the country's development playing a vital role all over the world in shaping its destines. In India to a large number of factories have been increasing by leaps and bounds with the result that the consumption and production of cements have scaled tremendous heights. This has produced a terrific impact on environmental imbalances producing air pollution hazards[1-3]. Soil is composed of mineral matters water, air, organic matter and living organism. The quantity of these components of the soil is variable as per the locality. Soil is the epicentre of living beings and future existence hence an adequate land management to maintain the quality of rural and urban soil is a must. The presences of different kinds of heavy metals such as Cd, Cu, Mn, Bi and Zn etc. in trace or in minimum level are naturally present in the soil but their enhanced level signals pollution hazards[4-6]. Heavy metal contamination adversely affects soil biological function including the size activity and diversity of soil microbial community. Soil microbes are highly sensitive to heavy metal contamination[7-9].

Materials and methods

Field surveys were conducted Heavy metals were assessed for the whole year during Pre-monsoon and Post monsoon season sessions 2012-2013. 10 contaminated sites were surveyed and soil samples were collected (by random sampling technique) in sterile polythene bags and carried to the laboratory. Soils were air dried, grinded and sieved through a sieve (2mm mesh size).

Micronutrient (Zinc, Copper, iron, Manganese) DTPA (Diethylenetriaminepentaacetic acid) extraction method[10] has been widely accepted for the simultaneous extraction of micronutrient cations viz. Zinc (Zn), copper (Cu). Iron (Fe) and manganese (Mn) in neutral and alkaline soils the content of these cations in the extract is determined on an Atomic Absorption Spectrophotometer (AAS) Determination of Heavy metal Nickel, Cadmium, Lead, Chromium and Cobalt[10].

The sample for metal analysis were digested using a mixture of $2cm^3$ of 60% percholric acid, $15cm^3$ of concentrated nitric acid and $1cm^3$ of concentrated sulphuric acid. The digested samples analyzed for the metals using Atomic Absorption Spectrophotometer (Perkin Elmer Model A Analyst 2002).

Results and discussion

Copper: Chlorophyll formation hinges upon copper besides being a segment of many enzymes. It is also essential for symbiotic nitrogen fixation. The soil samples in the study area contain copper in the range of 2.24 to 0.38PPM. Maximum concentration of metal was recorded in soil sample of Gadwa (JS-1) while minimum concentration was found in soil sample of Atrulli (JS-3) in pre monsoon season. The concentration of copper varied from 1.12 to 0.46PPM. Highest value of the metal was recorded in Chijjwar (JS-4) while minimum in soil sample of Maddhepur (JS-8) in post monsoon season. As the soils in the area are neutral to alkaline such abnormal values Cu emanate from a geogenic activity in the study area rather than any anthropogenic source. Except value of some soil samples, all value are within permissible limit set by Lindsay and Norvell, 1978 (0.2 to 1PPM). The statistical analysis showed that copper bears a significant positive correlation with Zn ($r = 0.396631$) while negative correlation with Fe, Mn, Cr and Ni during pre-monsoon season. Copper bears significant positive correlation

with Zn, Fe, Mn, (r=0.96, r=0.2252, r=0.3047 respectively) while negative correlation with Cr, Ni during post monsoon season.

Zinc: Zinc is involved in the enzyme system, particularly carbonic anhydrase and carboxylase. It is associated with Mn and Fe for the synthesis of chlorophyll. The soil samples in the study area possess Zinc ranging from 1.64 to 0.2PPM. Maximum concentration in soil sample of Chhijwar (JS-4) while minimum concentration in soil sample of Gadwa mine (JS2) during pre-monsoon season. The soil sample value ranged 1.12 to 0.68. Maximum concentration was found in soil sample of Chijjwar (JS-4) while minimum concentration was found in Maddhepur (JS-8). All soil samples are in permissible limit except some soil samples of zinc set by Lindsay and Norvell[10] (0.8 to 2ppm).

The available Zinc concentration may be less because of the formation of stable organic complexes with the solid state organic matter. The statistical analysis showed that Zinc does not show positive correlation with any parameters while negative correlation with Fe, Mn, Cr and Ni during pre-monsoon season. Zinc bears significant positive correlation with Fe, Mn, (r = 0.1938, r = 0.0.2361, respectively) while negative correlation with Cr, Ni during post monsoon season.

Iron: Iron is needed for energy transfer, plant enzyme function and photosynthesis. It is used by plant in some of its respiratory enzyme system, especially catalyse cytochrome and peroxidase. The concentration of soil sample varied in the range of 10.36 to 5.34PPM during pre-monsoon season. Maximum concentration was found in soil sample of Atrulli (JS-3) while minimum concentration in soil sample Jonhi (JS-5). The concentration of soil sample varied in the range of 7.601 to 1.139PPM during post monsoon season. Maximum concentration was found in soil sample of Gadwa (JS-1) while minimum concentration in soil sample of jonhi (JS-5). Except some soil samples the concentration of Iron in soil showed decreasing trends in post monsoon season as standard set by Lindsay and Norvell[10] (4.5 to 10ppm).

Iron deficiency is generally noticed in calcareous and alkaline soil. Most of the soil samples fall in alkaline medium. The statistical analysis showed that Iron bears a significant positive correlation with Mn (r=0.3013) while negative correlation with Cr and Ni during pre monsoon season. Copper bears significant positive correlation with Mn, Ni (r=0.8538, r=0.0028, respectively) while negative correlation with Cr, during post monsoon season.

Manganese: Mn is an essential factor in photosynthesis, nitrogen metabolism and respiration. It influences the uptake and utilization of other nutrients in the plants. The concentration of soil sample varies in the range of 7.60 to 1.139PPM during pre-monsoon season. Maximum concentration was found in soil sample of Gadhwa (JS-1) while minimum concentration in soil sample of jonhi (JS-5). The concentration of soil sample varied in the range of 8.165 to 1.824PPM during post monsoon season. Maximum concentration was found in soil sample of Gadwa (JS-1) and minimum concentration in soil sample of Navasta soya plant (JS-6). All these values are within the permissible limit set by Lindsay and Norvell[10] (5 to10ppm) except some soil samples having deficiency of Mn occurs in alkaline / highly acidic and organic soil. The statistical analysis showed that Mn bears a significant positive correlation with Cr (r=0.1627) whereas negative correlation with Ni during pre-monsoon season. Mn bears significant positive correlation with Ni (r=0.0472) while negative correlation with Cr, during post monsoon season.

Chromium: Not only Chromium (Cr) which is a grey, hard metal mosty found in the trivalent state in nature but also Hexavalent (chromium (VI)) compounds are found in small quantities. The concentration of soil sample varied in the range of 25.35 to 16.67PPM during pre-monsoon season. Maximum concentration was found in soil sample of Tiwni whereas minimum concentration in soil sample of Chijjwar. The concentration of chromium in soil sample varied in the range of 25.32 to 17.5PPM during post monsoon season. Maximum Concentration was found in soil sample of Maddhepur (JS-8) and minimum concentration in soil sample of chijjwar (JS-4). The concentration of chromium in all soil samples is within permissible limit. In the cement industry the linings of the rotaries possess chromium, which could be liberated by constant use to produce chromium in the soil samples. The statistical analysis showed that Cr bears a significant positive correlation with Ni (r=0.3387) during pre-monsoon season and also showed positive correlation with Ni (r=0.3387) during post monsoon season.

Nickel: Nickel is a mobile element, and its mobility is determined by the soil pH and its texture. The concentration of nickel in soil sample ranged from 25.7 to 10.2PPM in pre monsoon season. Maximum concentration was found in soil sample of Navasta soya plant (JS-6) whereas minimum concentration in soil sample of Chijjwar (JS-4).

The concentration of soil sample varied in the range of 25.56 to 11.3PPM during post monsoon season. Maximum concentration was found in soil sample of Navasta soya plant (JS-6) while minimum concentration in soil sample of chijjwar (JS-4). The concentrations of nickel in all soil samples are within permissible limit[11]. Elevated pH of soil limits phyto availability of Nickel. Examined soil samples are affected by dust which is rich in lime. The concentration of mobile nickel was found to be far below of the values regarded as toxic.

Cobalt, Lead and cadmium: Cobalt, Lead and Cadmium concentration in the soil samples of our study area does not come within the ambient of detection either because of either being absent or found to be immensely[12].

Table-1: Heavy Metals analysis of J.P. Nagar Industrial area soil during pre monsoon season 2012-13 [12].

Parameters	UNIT	JS 1	JS 2	JS 3	JS 4	JS 5	JS 6	JS 7	JS 8	JS 9	JS 10
Copper (Cu)	PPM	2.24	2.24	0.38	2.06	1.16	1.16	1.24	1.28	1.86	1.68
Zinc (Zn)	PPM	0.46	0.2	0.16	1.64	0.14	0.44	0.3	0.26	0.44	0.12
Iron (Fe)	PPM	9	6.32	10.36	6.84	5.34	6.28	7.48	9.56	6.2	5.96
Manganese (Mn)	PPM	1.56	1.66	1.88	1.32	1.72	1.5	1.96	1.72	1.32	1.84
Chromium (Cr)	PPM	18.2	17.5	19.6	15.78	20.6	21.40	20.56	25.32	24.53	23.54
Cadmium (Cd)	%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead (Pb)	%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickle (Ni)	PPM	19.2	16.2	15	10.2	17.2	25.69	16.9	15.6	18.6	16.4
Cobalt (Co)	(mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND= Non Detectable.

Table-2: Correlation coefficient of soil heavy metals parameters during pre-monsoon season 2012-13 [12].

	Cu	Zn	Fe	Mn	Cr	Ni
Cu	1					
Zn	0.3966	1				
Fe	-0.364	-0.079	1			
Mn	-0.553	-0.672	0.3013	1		
Cr	-0.304	-0.524	-0.007	0.1627	1	
Ni	-0.134	-0.442	-0.198	-0.062	0.3387	1

Table-3: Heavy metal analysis of J.P.Nagar industrial area soil post monsoon Season 2012-13 [12].

Parameters	Unit	JS 1	JS 2	JS 3	JS 4	JS 5	JS 6	JS 7	JS 8	JS 9	JS 10
Copper (Cu)	PPM	0.596	0.312	0.263	1.12	0.296	0.377	0.312	0.46	0.212	0.25
Zinc (Zn)	PPM	0.455	0.232	0.377	1.12	0.209	0.195	0.148	0.68	0.136	0.134
Iron (Fe)	PPM	7.601	2.952	5.179	4.16	1.139	3.114	2.379	3.16	4.13	5.15
Manganese (Mn)	PPM	8.165	1.553	4.01	3.15	1.963	1.824	2.073	2.16	2.43	2.56
Chromium (Cr)	PPM	19.5	18.6	20.6	16.67	21.7	21.42	21.46	24.31	25.35	22.53
Cadmium (Cd)	%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead (Pb)	%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickle (Ni)	PPM	20.5	16.3	16	11.3	18.6	25.56	17.8	16.5	20.6	17.35
Cobalt (Co)	(mg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = Non Detectable.

Table-4: Correlation coefficient of Soil parameters during post monsoon season 2012-13 [12].

	Cu	Zn	Fe	Mn	Cr	Ni
Cu	1					
Zn	0.91602	1				
Fe	0.22519	0.19376	1			
Mn	0.30469	0.23607	0.85376	1		
Cr	-0.6635	-0.503	-0.1781	-0.2848	1	
Ni	-0.5087	-0.6489	0.00277	0.04715	0.45069	1

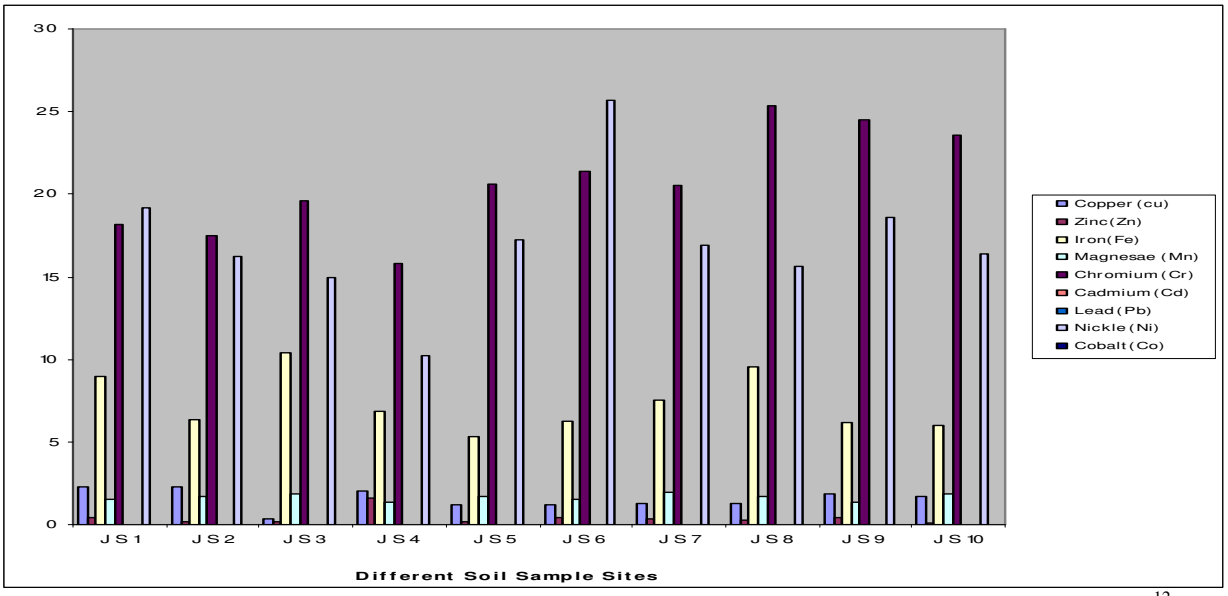

Figure-1: Heavy metal analysis of J.P. Nagar Industrial Area Soil during pre-monsoon season 2012-13 [12].

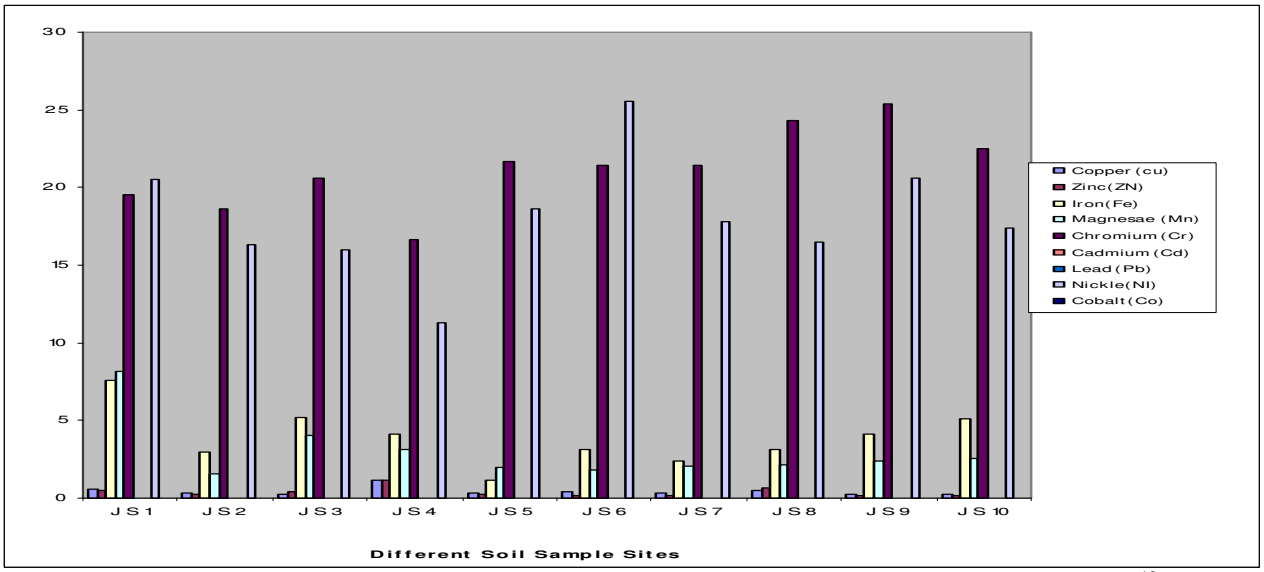

Figure-2: Heavy Metal Analysis of J.P.Nagar Industrial Area Soil Post monsoon season 2012-13 [12].

Conclusion

The different heavy metals are determine around Jaypee Nagar industrial area in comparatively different distance and direction in pre and post monsoon season session 2012-13. The concentration of copper in the study area is quite in tune with the limit set by Lindsay Norvell[10]; some abnormal values of Cu may be rooted in geogenic activities in the study area rather than any anthropogenic source[11]. The concentration of Zinc increases with increasing distance from the cement plant because soil around cement plant incorporated with cement dust that enhance pH and low organic carbon. Most of the soil sample in study area falls in alkaline medium so deficiency of iron generally noticed in calcareous and alkaline soil. The presence of Manganese in the soil samples of the study area is in keeping with the bound set by Lindsay Norvell[10], except some soil samples having deficiency of Mn occurs in high alkaline soil. The concentration of chromium in the soil samples of the study area understanding was found in conformity with the limit[11] except some samples have an increasing trend which is emerges out in the soil from the lining of the rotaries, which could be released by constant use. The concentration of nickel in soil sample of the study area is within permissible limit[11]. Elevated pH of soil samples limits phytoavailability of nickel. The heavy metal such as lead, cadmium and cobalt are not found in soil samples of study area indicates that toxicity of heavy metals in soil are in minimal position and soil are good condition for agricultural purpose. Result of most of the parameters of soil sample has concluded that the soil around Jaypee Nagar Industrial Area is less polluted and it is suitable for Agricultural purpose.

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