ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 5, March 2018

Spatial Variation and an Investigation on Soil Quality in the vicinity of Industrial Area in Ranipet, Vellore

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Abstract: An increase in heavy metal pollution in the soils of Ranipet due to intense industrialization and urbanization has become a serious environmental problem. In the current study, the Ranipet Industrial Area was assessed for its Soil quality status. The region hosts several industrial facilities which are the main source for hazardous wastes which include tannery, paint, plastic, metal, wood, automotive supply industry, machinery, and chemicals. In the present study 10 samples are collected from Industries around Ranipet. The soil samples were collected at a depth of 10 – 15 cm near Industries such as KH groups, Malladi Drugs and Pharmaceuticals, SVIS labs and Iconium Leather works ltd., etc. The testing was conducted to determine the Concentration of Heavy Metals in the soil. The results were compared with the WHO limits to check whether the samples are in the prescribed limits. The soil sample has shown that the Cr ranges from 0.21-3127.85 mg/l, Cr(VI) ranges from 0-224.19 mg/l, Cd ranges from 0.13-2.93 mg/l, Pb ranges from 26.85-383.56 mg/l, Zn ranges from 36.85-465.4 mg/l, Fe ranges from 1.72-117.2 mg/l, Ni ranges from 3.257-199.39. Spreading of hazardous wastes from industrial facilities in the study area via rain or wind is the main source of soil pollution. Hence, the soil is affected by Industrial effluents. Which may leads to ground water contamination and degrade soil quality in selected zone.

Keywords: Heavy metals, Soil contamination, Hazardous wastes, Ranipet Industrial area.

I. INTRODUCTION

With rapid development in industrialization, soil contamination has become a serious problem in many countries. Contamination and negative impact on the quality of air, water, and soil by population growth, rapid urbanization, and industrial activities have been stated by several works. Among the most significant soil contaminants resulting from population growth, rapid urbanization, and industrial activities, heavy metals are of prime importance due to their long-term toxicity effect.

Several studies have shown that metals such as Pb, Fe, Cd, Cr, Zn, Ni amongst others are responsible for certain diseases that have lethal effect on man, animal and plants. According to WHO, 20 million children worldwide suffer from pollution which has become critical. The most common environmental pollution in the world are heavy metals. Sludge disposal in land are potentially serious source of pollution of the environment, especially when located very close to the water bodies and operated haphazardly. The high pollution potential of these sites is due to the fact that they usually contain almost all types of pollutants from their source community. The contaminants can leach out through the soil, contaminating the soil itself, surface water and ground water.

Ranipet is one of the regions intensely affected by soil contamination of industrial origin. This is one of the largest industrial region in the world and it is the only Indian city to hit the top 10 dirtiest and polluted industrial cities in the world. The contamination has affected the health, resources and livelihood of thousands, the BI report said. Therefore, monitoring of this change and determination of contamination in soils has gained importance. Heavy metal contents in the soils of Ranipet industrial area, their contamination levels, and pollution sources has not been investigated. Therefore, the aim of this work is to examine the heavy metal concentration in the soils of Ranipet and compare them with WHO limits.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

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II. MATERIALS AND METHODS

A. *The study area - Ranipet*

The present studies have been chosen the Ranipet industrial area for analysing the soil quality. Most of the industries are leather industries and chemical industries. The Ranipet town is located at 12 56□ northern latitude and 79.20□ eastern longitude and is 93 km west of Chennai. It is geographically 25 km away in the north east of Vellore, the district headquarters of Vellore district. Ranipet has been selected by the SIDCO & SIPCOT to establish the estates/complexes, since it is situated at a distance of 3.5 km from river Palar and adjoining Chennai - Bangalore road (NH-4). It ranks 1st in polluted industrial cities in India and top 10 in polluted industrial cities in the world.

B. *Soil Sample Collection*

Soil samples were collected in Ranipet Industrial area. In order to evaluate the impact on soil contamination due to industrial activities, totally ten soil samples were collected near industries, In addition, soil samples were collected at a depth of 10-15 cm from top surface. Use of metal tools was avoided and a plastic spatula was used for sample collection. All the samples are labeled properly for the of sources in thick quality polythene bags and brought to the laboratory for further analysis.

Fig.1 Ranipet Sampling Map

C. *Soil Sample Preparation, Processing and Storage*

The collected soil samples were dried in room and then dried in sun light for 4 hrs and then it is sieved to < 150 micron through a stainless steel sieve. Then the soil samples were further homogenized with the help of mortar and pestle and preserved in clean polythene cover for further use.

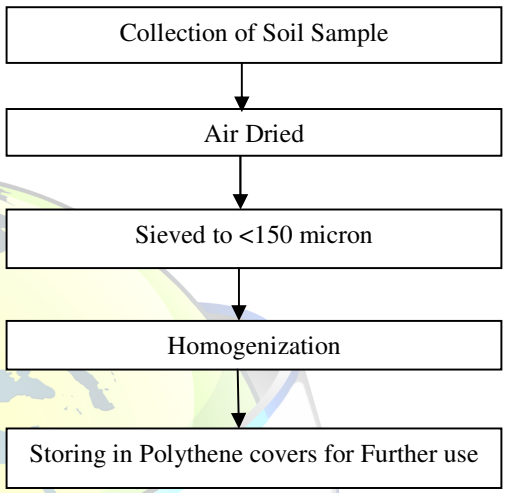

Fig.2 PREPARATION OF SOIL SAMPLE

D. *Physio-Chemical Analysis*

S.NO	PARAMETER	METHOD
1	Moisture Content	Oven Drying method
2	Organic Carbon Content	Walkey and Black method
3	Bulk Density	Gravimetric method
4	Particle Density	Pycnometer method
5	Percent Pore Space	Imbibition method
6	pH	pH meter
7	Electrical Conductivity	Conductivity meter
8	Alkalinity	Volumetric Method
9	Chlorides	Volumetric Method
10	Sulphates	Gravimetric method
11	Nitrite	Spectrometric Method
12	Nitrate	Spectrometric Method
13	Fluoride	Spectrometric Method
14	Sodium	Flame photometer
15	Potassium	Flame photometer
16	Nitrogen	Kelplus Distyl - EMS

Fig.3 Methods of testing

E. *Digesion of soil*

The samples were first air dried, then placed in electric oven at a temperature of 40 °C approximately for 60 minutes. They were then homogenized which was previously ground and sieved through IS sieves of stainless steel 150 μm mesh. A 0.1g sample is weighed out and transferred to reaction vessel. A 0.1g sample is weighed out and transferred to reaction vessel. 2.0 ml of

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concentrated nitric acid and 5.0 ml of concentrated hydrochloric acid were then added to each vessel. concentrated hydrochloric acid were then added to each vessel. Vessels then placed in the rotor and the rotor is microwave at the given instrument condition. At the end of the microwave program, the vessels were allowed to cool for a minimum of 25 minutes before removing them from the microwave system. The vessels were carefully uncapped and the digests were filtered through Whatman No. 41 filter paper (or equivalent) and the filtrate was collected in a 100-mL volumetric flask, the volume was adjusted to 100 ml with 0.5% HNO and were sealed and brought to the laboratory to know the heavy metal concentration by AAS analysis.

F. Heavy Metal Analysis

The of selected trace metals in all soil i.e. Iron, Zinc, Chromium, Lead, Cadmium and Nickel were analysed using Atomic Absorption Spectrophotometer (VARIAN GTA-120, AA240). Prior to analysis, the samples were diluted with 2% 1N nitric acid solution.

III. RESULTS AND DISCUSSION

Physical parameters of soil sample

The physical parameters of the samples have been determined from different locations in Ranipet Industrial area. The Testing was conducted to analyze the soil samples.

Samples	Moisture Content	Organic Carbon Content	Bulk Density	Particle Density	Percent Pore Space
1	22.67	0.42	1.82	2.11	0.23
2	16.62	0.29	2.62	2.53	0.3
3	11.79	0.54	2.77	2.51	0.36
4	19.6	0.48	2.17	2.03	0.31
5	10.29	0.47	2.09	1.92	0.21
6	9.41	0.6	1.62	1.45	0.29
7	12.83	0.36	2.43	2.23	2.23
8	24.79	0.61	1.94	1.68	0.27
9	8.65	0.33	1.42	1.37	0.23
10	20.12	0.55	1.74	1.62	0.26

A. Moisture Content

The mean moisture content in the soil is 15.67% ranging from 8.65 to 24.79% Moisture content (MC) was found to be significantly low about 8.65% in the indra industry area when compared with other areas. Moisture content is high in thirumalai chemicals industry area which is about 24.79%. The moisture content can range from 10-15% as per WHO limits.

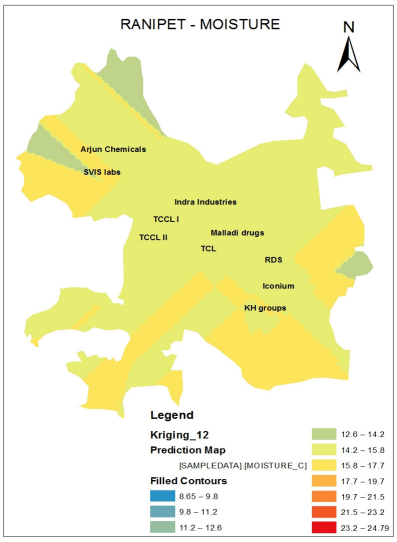

Fig.4 Moisture Content

B. Organic Carbon Content

The mean organic carbon content in the soil is 0.46% ranging from 0.29 to 0.61. Organic carbon was noted to be acceptable limit indicated by the IS code for the soil obtained from industrial area The high levels of organic matter present at the dump sites were attributable to the use of the sites for dumping municipal wastes. Organic matter is a reservoir of essential and non-essential mineral elements for plant growth and development, hence increased organic matter content may lead to increased soil productivity.

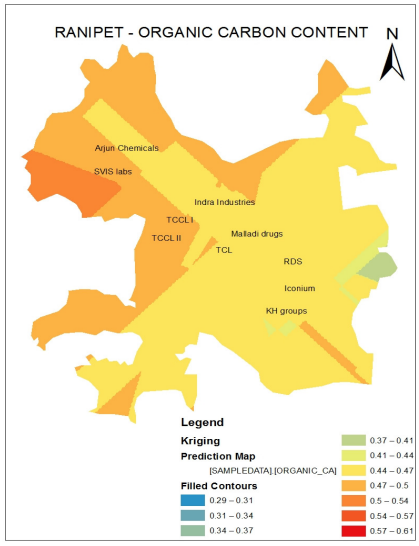

Fig.5 Organic Carbon Content

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ISSN 2394-3785 (Online)
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International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
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C. Bulk Density

The Bulk density in Ranipet industrial area soil varies from 1.42 to 2.77 g/cc. The mean of bulk density is 2.06g/cc. Lower bulk density is a positive productivity indicator in a clayey soil as it helps in easing root penetration and therefore also will encourage downward movement of water through old root channels.

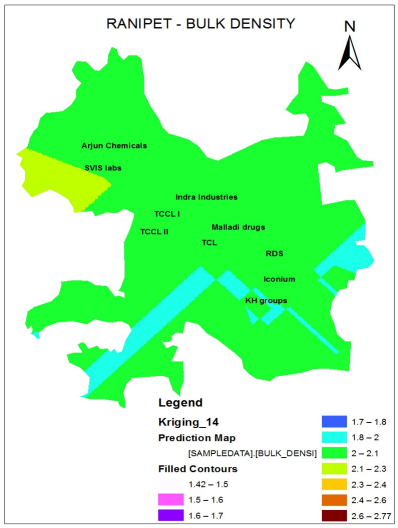

Fig.6 Bulk Density

D. Particle Density

The particle density in Ranipet industrial area soil ranges from 1.37 to 2.53 g/cc. The mean is 1.94 g/cc. Particle density is higher in iconium leather works, Arjun chemicals and Malladi drugs & Pharmaceuticals of 2.53, 2.51 and 2.23 respectively.

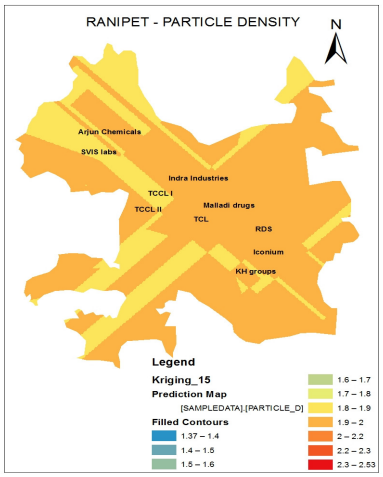

Fig.7 Particle Density

E. Percent Pore Space

The percent pore space of soil ranges from 0.21 to 0.36. the mean of porosity is 0.27. the mean of porosity is less that than permissible limit Soil total porosity measurements follow a reverse trend reflecting bulk density. Greater total porosity measurement were recorded in Arjun chemicals and Malladi drugs & Pharmaceuticals.

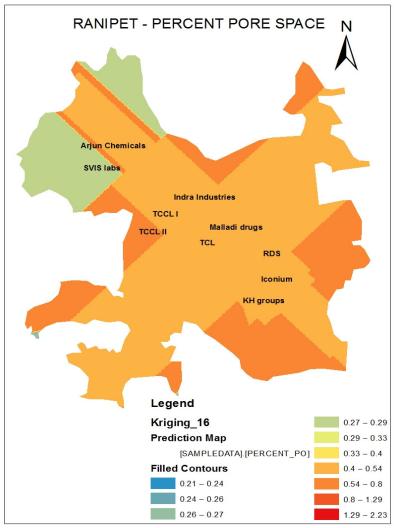

Fig.8 Percent Pore Space

Chemical parameters of soil sample

Totally 11 chemical parameters are analysed such as pH, Chlorides, Nitrates, Nitrite, Sodium, Potassium etc., The testing is done by different methods i.e Gravimetric method, Volumetric Method, Spectrometric Method and Flame photometer etc.,

From these methods chemical parameters are known of the soil sample and the values are compared with WHO limits to know the level of contamination

Samples	pH	EC	Cl^-	Alkalinity	So_4^{2-}	F^-
1	9.65	8400	34	928	531	2.0
2	7.53	366	34	308	90	2.0
3	7.81	4400	182	176	179	1.3
4	8.72	427	26	512	585	2.2
5	7.71	495	56	208	120	1.6
6	7.38	370	36	208	88	1.9
7	9.24	3400	116	496	98	1.4
8	7.1	499	26	240	71	1.2
9	5.46	492	38	144	45	1.4
10	7.51	478	24	304	246	2.1

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
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Samples	No_2	No_3	Na	K	N
1	22	0.1	169	4	21.28
2	41	0.2	7.6	2.2	12.32
3	0	0.2	60.6	4.9	11.2
4	10	0.1	13.7	4.3	8.96
5	9	0.2	12.2	1.7	0
6	20	0	10.4	12.6	11.2
7	11	0.2	60.4	3.3	7.84
8	16	0.2	1.9	1.9	0
9	23	0.3	5.9	2.7	10.08
10	9	0.2	12.2	12.2	6.72

F. pH

pH is one of the important factor of the soil. In the study area pH varies from 5.46 to 9.65. The mean is 7.81. The increase in pH in the industrial area may be due to the high organic matter content which tends to buffer the soil by preventing excessive pH changes due to the release of exchangeable cations during mineralization of organic matter. The increased pH in the industrial area is a positive productivity indicator in an acidic tropical soil where low pH limits uptake of nutrient elements.

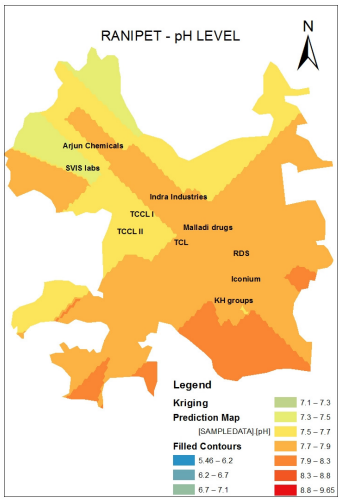

Fig.9 pH

G. Electrical Conductivity

Electrical conductivity of the soil near the industrial areas was ranging from 366 to 8400. The mean EC content in the sol is 1932.7. Comparing the electrical conductivity of industrial soil KH groups has highest electrical conductivity. When compared to other industries.

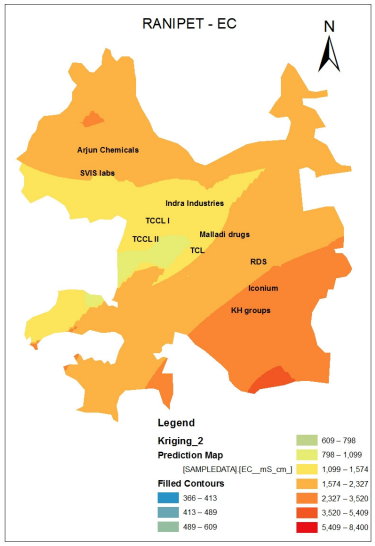

Fig.10 Electrical conductivity

H. Chlorides

Inorganic ions were the key elements essential for the growth of crops. Amount of inorganic ions such as chlorides, sulphates and nitrogen present in the dumped area varied significantly with the soil of non-dumped area. They were not exceeded the acceptable limit of WHO limits. The chloride concentration in the Ranpet Industrial Areas Ranges from 24 to 182. The mean Chloride content in Ranipet industrial soil is 57.2

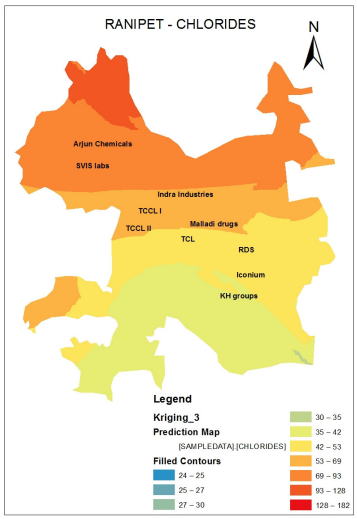

Fig.11 chlorides

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ISSN 2394-3785 (Online)
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I. Alkalinity

Alkalinity of the soil near the industrial areas was found to be 144 to 928 mg/l and the mean Alkalinity in soil is 352. The alkalinity of the soil is very low in Indra industries which is 144mg/l and in KH groups the alkalinity is high when compared to other industries.

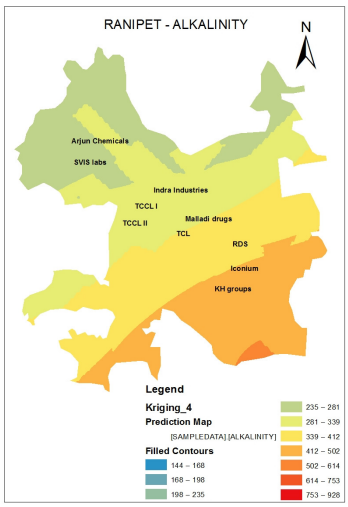

Fig.12 Alkalinity

J. Fluoride

Fluoride concentration is high in all industrial areas which is above the acceptable limits. The fluoride value ranges from 1.2 to 2.2 mg/l. the fluoride concentration is high in TCCL 1 which is 2.2 mg/l and low in TCL which is 1.2 mg/l. the acceptable limit of fluoride is 1.0mg/l.

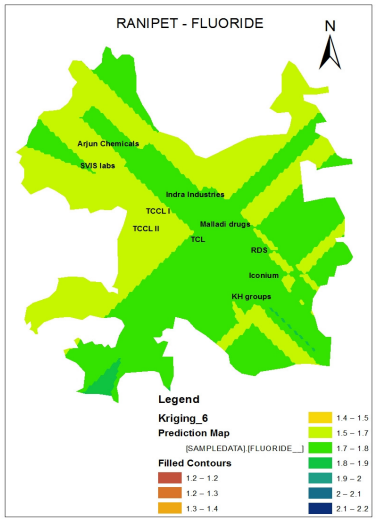

Fig.13 Fluoride

K. Sulphate

Sulphates was noted to be acceptable limit indicated by the WHO for the soil obtained from industrial area. The Sulphate concentration is soil ranges from 71 to 585 mg/l and mean of sulphate is 157.3 mg/l.

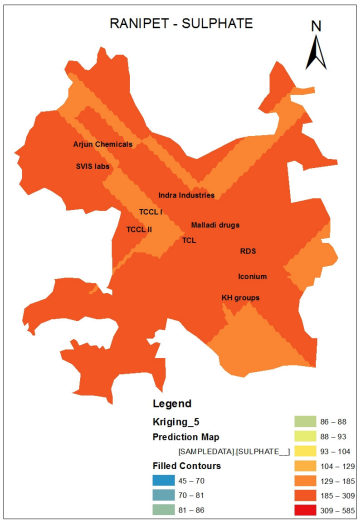

Fig.14 Sulphate

L. Nitrate

Nitrate is slightly high in most of the industrial soils. The Nitrate concentration ranges from 0 to 41 mg/l and mean of nitrate in soil is 16.1 mg/l. The acceptable limit of nitrate in soil is 10mg/l. The concentration of nitrate is very high in Iconium Leather Works.

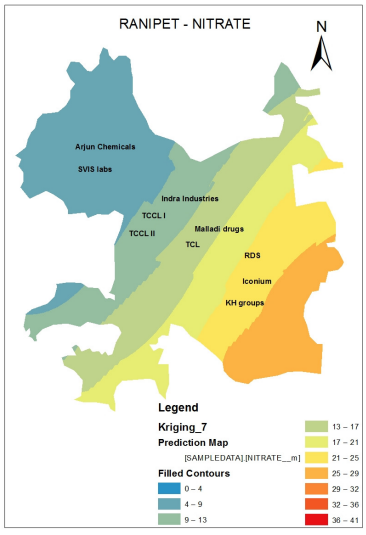

Fig.15 Nitrate

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International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
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M. Nitrite

Nitrite concentration is low in all industrial areas which is lower than 1mg/l. The concentration of nitrite ranges from nil to 0.3mg/l. The mean of nitrite content in soil is 0.17. The nitrite concentration is nil in Ranipet dumping sites and 0.3mg/l in Indra industries.

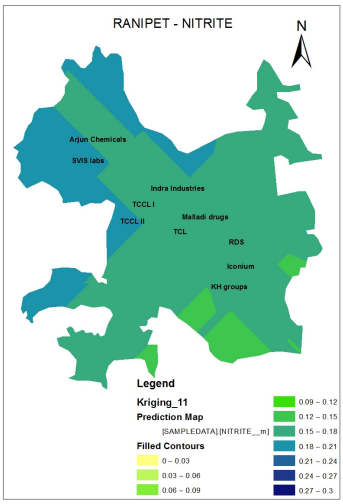

Fig.16 Nitrite

N. Sodium

The acceptable limit for sodium is less than 250ml/l. Sodium content ranges from 1.9 to 169 mg/l in Industrial soils. And the mean sodium concentration is 35.42 mg/l. The sodium concentration is high in chemical industries when compared to leather industries.

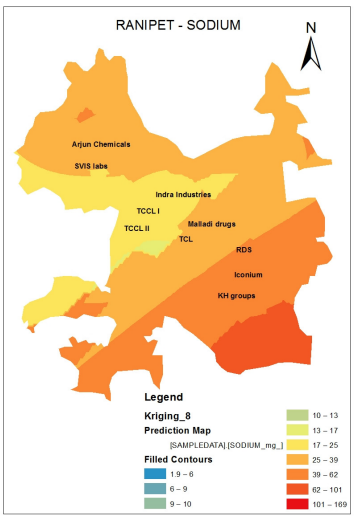

Fig.17 sodium

O. Potassium

Potassium concentration varies from 1.9 to 12.6 mg/l. The mean sodium concentration is 4.9 mg/l. Sodium concentration is high in Ranipet dumping site and SVIS labs. Massive crop production in agricultural field depletes soils of potassium and agricultural fertilizers can consume 95% of global potassium chemical production.

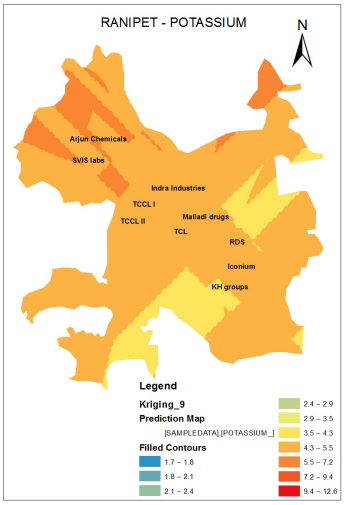

Fig.18 Potassium

P. Nitrogen

The Nitrogen concentration in soil is high in KH groups which is 21.28 and the Nitrogen is nil in TCCL 2 and in TCL industrial areas. The concentration of nitrogen is less than or equal to the acceptable limits.

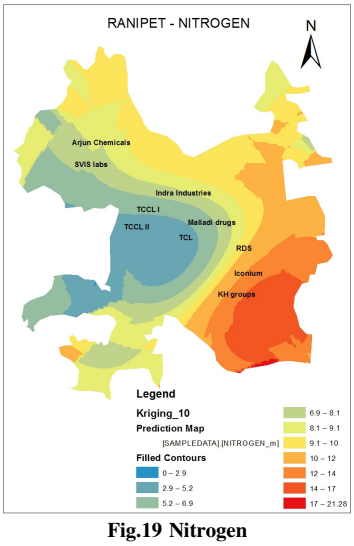

Fig.19 Nitrogen

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ISSN 2394-3785 (Online)
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Heavy metal concentration of soil samples

From the Atomic Absorbtion Spectrophotometer (AAS) selected heavy metal concentration results of soil samples shows the total concentrations of heavy metals. The concentration of heavy metals is high in Ranipet Industrial soils. Most of the elements have a wide range of variation of several magnitudes. This is evident for Cr, whose concentration vary from 0.21 to 3127.85 mg/l with significantly higher mean of 526.03 mg/l. Similarly variability was found between Fe, Pb, Zn and Ni.

S	Cr	CR(VI)	Fe	Pb	Zn	Ni	Cd
1	86.16	29.88	5.2	36.31	107.37	37.85	0.97
2	138.06	52.04	4.98	46.68	157.23	54.343	0.88
3	0.73	0	4.72	50.24	47.48	32.561	0.42
4	3127.85	224.19	37.18	76.46	126.41	23.164	0.89
5	1891.64	147.62	15.64	44.27	102.36	20.213	0.67
6	0.21	0	1.72	26.85	42.95	3.257	0.13
7	1.06	0	9.6	56.64	53.78	13.706	0.79
8	5.07	0	4.48	80.03	36.85	19.046	0.91
9	0.91	0	117.2	383.56	465.4	199.39	2.93
10	13.63	5.2	9.84	49.85	126.72	10.365	1.26

Q. Chromium

Cr concentrations in the Chemical industrial area are lower than in the Tannery industrial areas. The lowest and highest concentrations of Cr are 0.21 and 3127.85 mg/l respectively. The mean Chromium concentration is about 526.03. This difference may be explained by the fact that the two regions have different types of industries. The Cr content of topsoil is known to increase due to pollution from various sources of which the main ones are several industrial wastes and municipal sewage sludge.

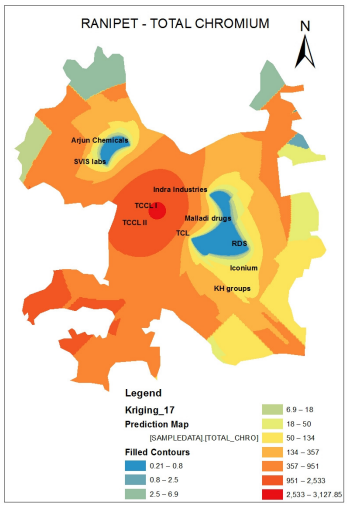

Fig.20 Chromium

R. Hexavalent Chromium

Hexavalent chromium (Cr(VI)) refers to the chemical compounds that contain the element chromium in +6 oxidation state (thus Hexavalent) Virtually all chromium ore is processed via Hexavalent Chromium, Specificallythe sail sodium dichromate. Cr(VI) are highly found near Chromium Factories such as TCCL and other Leather industries. The mean hexavalent content in Ranipet Industrial soils is 45.89 mg/l ranging from 0 to 224.19 mg/l.

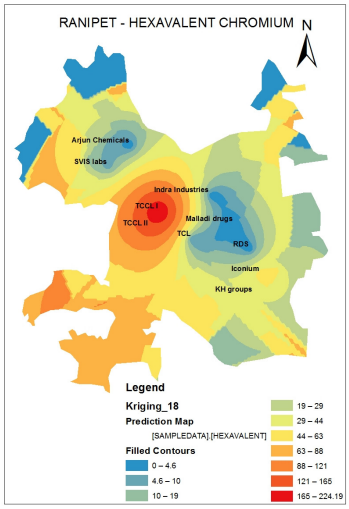

Fig.21 Hexavalent Chromium

S. Zinc

Zinc is a transition metal with the following characteristics: period 4, group IIB, atomic number 30, atomic mass 65.4, density 7.14 g cm−3, melting point 419.5◦C, and boiling point 906◦C. Zinc occurs naturally in soil (about 70mg kg−1 in crustal rocks), but Zn concentrations are rising unnaturally, due to anthropogenic additions. Most Zn is added during industrial activities, such as mining, coal, and waste combustion and steel processing. Many foodstuffs contain certain concentrations of Zn. Drinking water also contains certain amounts of Zn, which may be higher when it is stored in metal tanks. Industrial sources or toxic waste sites may cause the concentrations of Zn in drinking water to reach levels that can cause health problems.

The anthropogenic sources of Zn are related to the nonferric metal industry and agricultural practice. The minimum Zn conc in Ranipet soil is 36.85 mg/l and maximum of 465.40 mg/l ranging from 36.85 to 465.40 with mean of 126.64 mg/l.

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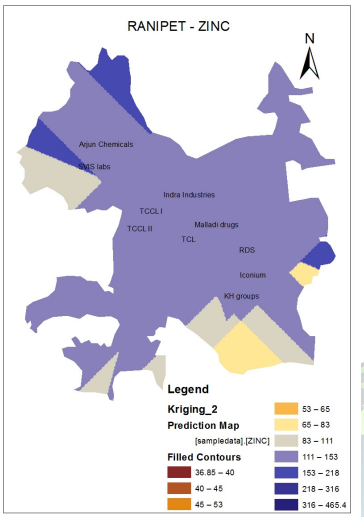

Fig.22 Zinc

T. Iron

The mean iron content in soil is 21.05 mg/l ranging from 1.72 to 117.2 mg/l. Iron concentration in uncontaminated soil is ranging from 1.72 to 4.98 mg/l. High Fe concentration in Ranipet industrial soils is due to industrial activities. Significant anthropogenic sources of Fe are related to metallurgical and machinery industries.

There are growing environmental concern about Fe as being one of the toxic metals, which exhibits adverse effect on plan, animal and Soil. The high Fe concentration on Ranipet industrial soil is due to metallurgical industrial activities.

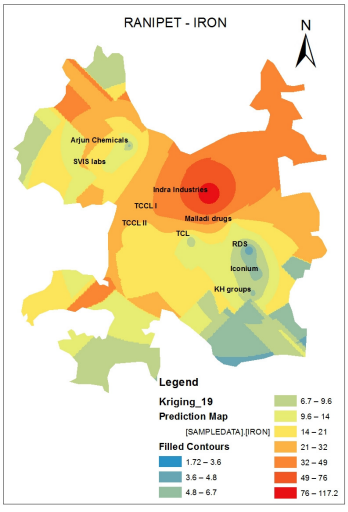

Fig.23 Iron

U. Lead

Lead contamination in soils is seriously emphasized in recent years since this metal is very toxic for humans and animals. Lead enters the human or animal metabolism either via food chain or by intake of soil dust. Lead concentration in Ranipet soils are between 26.85 to 383.56 mg/l with an average of 85.08

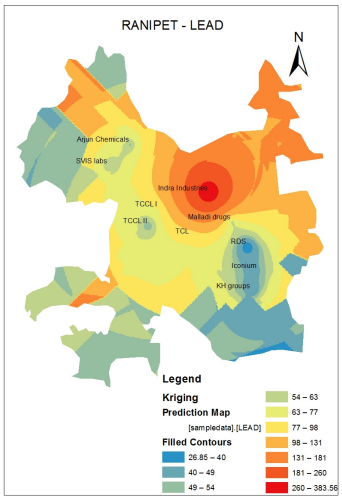

Fig.24 Lead

V. Cadmium

Cadmium is located at the end of the second row of transition elements with atomic number 48, atomic weight 112.4, density 8.65 g cm−3, melting point 320.9◦C, and boiling point 765◦C. Together with Hg and Pb, Cd is one of the *big three* heavy metal poisons and is not known for any essential biological function. In its compounds, Cd occurs as the divalent Cd(II) ion. Cadmium is directly below Zn in the periodic table and has a chemical similarity to that of Zn, an essentialmicronutrient for plants and animals. This may account in part for Cd's toxicity; because Zn being an essential trace element, its substitution by Cd may cause the malfunctioning of metabolic processes. The most significant use of Cd is in Ni/Cd batteries, as rechargeable or secondary power sources exhibiting high output, long life, low maintenance, and high tolerance to physical and electrical stress. Cadmium concentration in top soil is attributed to metal smelting, sewage waters and the use of phosphate fertilizers. The Cd concentration in Ranipet soil ranges from 0.13 to 2.93 mg/l. High cadmium concentration is found in Indra industries.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
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International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 5, March 2018

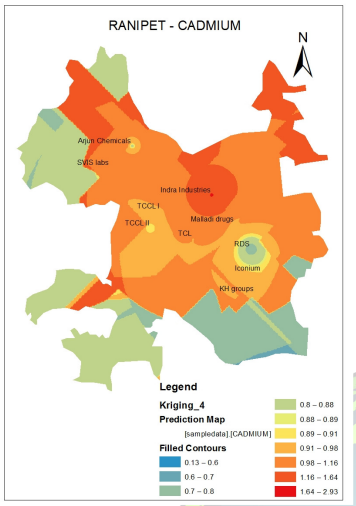

Fig.25 Cadmium

W. Nickel

The mean nickel concentration is found to be 41.38 mg/l and ranging from 3.257 to 199.39 mg/l. Nickel concentration is less only in Ranipet dumping site and high in Indra Industries.

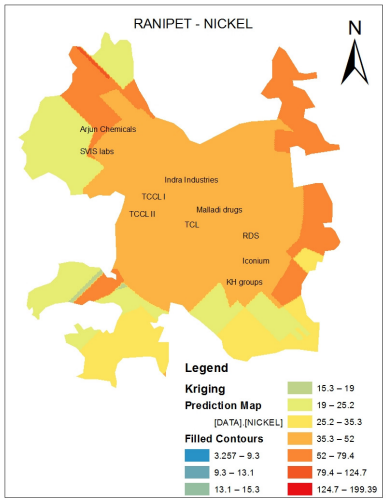

Fig.26 Nickel

IV. CONCLUSION

Soil is an important constituent of human biosphere. Any harmful change to occurring in this environment seriously affects human life and life quality. The most adverse effect of heavy metals is that they can be introduced into the food chain and threaten human health. Agricultural products growing on soils with high metal concentrations are represented by metal accumulations at levels harmful to human and animal health and bioenvironment. The Ranipet industrial zone has been extremely contaminated for many years because of unrestrained disposal of hazardous wastes from industrial facilities and exhaust gasses. As a result of the index of geoaccumulation, enrichment factor, contamination degree, and integrated pollution index applications, very high Cr, Cd, Pb, Zn, Fe and Ni concentrations were found in the soils of the Ranipet industrial area. In addition, these soils are also slightly contaminated by Physio-Chemical parameters. These element concentrations can be introduced into the food chain via soil and may be a serious threat for human and animal health. These metals with high concentrations in the Ranipet soils may be mixed with groundwater by leaching

High concentrations of Cr, Cr(VI), Pb, Zn, Ni, Cd, and Fe in soils around the industry facilities originate from an anthropogenic source which is associated with unrestrained solid and fluid wastes of industry. Based on environmental health criteria the Ranipet area needs a remediation. Remediation techniques such as Reverse Osmosis, Ion Exchange, Chemical Precipitation, Chemical Coagulation and phytoremediation can be used to mitigate pollution.

REFERENCES

[1] Gülten Yaylalı-Abanuz (2011) "Heavy Metal Contamination of Surface Soil around Gebze Industrial Area, Turkey".
[2] Mahmut coskun, Eiliv Steinnes, Marina Viladimirovna (2005) "Heavy Metal Pollution of Surface Soil in the Thrace Region, Turkey".
[3] Manoj kumar tiwari (2015) "An Analytical Study of Heavy Metal Concentration in Soil of an Industrial Region of Chhattisgarh, Central India".
[4] B.U.Kale (2016) has studies "Analysis Of Physico-Chemical Properties and Heavy Metal Concentration in Soil Sample Collected From Industrial Area Jalna, Maharashtra, India.
[5] A. K. Krishna (2005)"Soil Contamination Due to Heavy Metals from an Industrial Area of Surat, Gujarat, Western India".
[6] X.D. Li, C. Poon, P.S. Liu, "Heavy metal contamination of urban soils and street dusts in Hong Kong".
[7] T.B. Chen, Y.M. Zheng, M. Lei, Z.Ch. Huang, H.T. Wu, H. Chen, K.K. Fan, K. Yu, X. Wu,Q.Z. Tian, "Assessment of heavy metal pollution in surface soils of urban parks in Beijing, China".
[8] B. Wei, L. Yang, "A review of heavy metal contaminations in urban soils, urban road dusts and agricultural soils from China".
[9] P. Quevauviller, R.Lavigne, L. Cortez, "Impact of industrial and mine drainage wastes on the heavy metal distribution in the drainage basin and estuary of the Sado River, Portugal".

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[10] Chen TB, Zheng YM, Lei M, Huang ZCh, Wu HT, Chen H, Fan KK, Yu K, Wu X, Tian QZ (2005) "Assessment of heavy metal pollution in surface soils of urban parks in Beijing, China".
[11] Gong M, Wu L, Bi XY, Ren LM, Wang L, Ma Z, Bao Z, Li Z (2010) "Assessing heavy-metal contamination and sources by GIS-based approach and multivariate analysis of urban–rural topsoils in Wuhan, central China".
[12] Krishna, A.K., & Govil, P.K. (2004). Heavy metal contamination in soil around pali Industrial area, Rajasthan, India.
[13] Huisman, D.J., Vermeulen, F.J.H., Basker,J., Veldkamp,a., Kroonenberg, S.B., & Klaver, G.T., (1997). Agerlogical interpretation of heavy metals concentration in soils and sediments in Southern Netherlands.
[14] H. Lim, J. Lee, H. Chon, M. Sager, Heavy metal contamination and health risk assessment in the vicinity of the abandoned Songcheon Au–Ag mine in Korea.
[15] Rajesh Kumar Sharmaa, Madhoolika Agrawal, (2005) "Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India".
[16] E. Steinnes, R.O. Allen, H.M. Petersen, J.P. Rambaek, P. Varskog, "Evidence of large scale heavy metal contamination of natural surface soils in Norway".
[17] Y. Sun, Q. Zhou, X. Xie, R. Liu, "Spatial, sources and risk assessment of heavy metal contamination of urban soils in typical regions of Shenyang, China".
[18] R.K. Sharma, M. Agrawal, F. Marshall, "Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India"
[19] R. Uminska, "Assessment of hazardous levels of trace elements to health in contaminated soils of Poland".
[20] Alper Baba and Gulbin Gurdal, 2006, Concentrations of heavy metals in fly ash from CAN coal combustion thermal power plant
[21] Carlson C. L. and Adriano D. C., 1993, Environmental impacts of coal combustion residues
[22] Gabriel R. Kassenga and Stephen E. Mbuligwe, 2009, Impacts of a Solid Waste Disposal Site on Soil, Surface Water and Groundwater Quality in Dar es Salaam City, Tanzania
[23] Muraka I. P. et al., 1987, Solid waste disposal and reuse in the United States
[24] Zeng-Yei Hseu et al., 2002, Digestion methods For Total Heavy Metals in Sediments and Soils, Water, Air, And Soil Pollution
[25] Brus, D. J., Gruijter, J. J., Walvoort, D. J. J., De Vries, F., Bronswijk, J. J. B., Romkens, P. F. A. M. and De Vries, W.: 2002, 'Mapping the probability of exceeding critical thresholds for cadmium concentrations in soils in the Netherlands
[26] Ansari, A.A., Singh, I.B., & Tobschall, H.J. (1999). Status of anthropogenically induced metal pollution in the Kanpurunnao industrial region of Ganga plain, India.
[27] Arantzazu, U., Vega, M & Angul, R. (2000). Deriving ecological risk based soil quality values in the Barque Country.
[28] Alloway, B.J. (ed) (1995). Heavy Metals in Soils (pp. 22-151) Glasgow: Scotland Blackie Academic and professional Publishers.
[29] Bob Wilson, Brennan Lang & Brian pyatt, F. (2005). The dispersion of heavy metals in the vicinity of Britannia Minc, British Columbia, Canada.
[30] Chang, L.W. (1996).Toxicology of Metals, In: F.L. Boca Raton (Ed.), CRC Lewis Publications.
[31] Nigin, Guvene, Omar, Alagha & Gurdal, Tencel. (2004). Investigation of soil multi-element composition in Antalya, Turkey.
[32] Larocque, A.C.L., & Rasmussen, P.E. (1998). An over view of trace metals in the environment: mobilization to remediation.