International Journal of Interdisciplinary Innovative Research & Development (IJIIRD)
ISSN: 2456-236X
Vol. 01 Issue 01 | 2016

Study of Physiochemical impact of Industries & mining of Chandrapur (M.S.) on soil

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ABSTRACT

Chandrapur Industrial area is one of the best Industrial area in Vidarbha region and is the major coalfield of Maharashtra State. It spans a total area of 70.23 hectares. Chandrapur city has 86 industrial units at present which include chemical, auxiliary and engineering services industries. Beside this, Chandrapur city and surrounding area is rich in minerals and coal and include 26 coal mines of WCL, cement plants, paper industry, lime mining and steel plants. In addition, it has STPS having capacity of producing 2340 MW electricity. Soil is foundation for ecosystem and primary source of nutrient for the biota. Soil degradation occurs due to human activities, urban and industrial development. In degraded soil, microorganism is no longer able to perform their normal processes of cycling nutrient which badly affect to fertility of soil. In view of these observations, during present work, soil quality analysis of 5 locations from Chandrapur city was carried out to assess the quality of soil. All soil sampling locations at Chandrapur and surrounding areas were found affected and contaminated due to various industrial activities carried out around Chandrapur city. The other impacts associated with mining include loss of natural vegetation and soil erosion. Hence, conscious steps are required to be taken for ensuring the city's environmental sustainability.

Keywords: ***Coalfield, soil quality, Pollution, Impact of Industries, Impact of mining***

1. INTRODUCTION

Environment is the natural condition which exists around us. It is sum total of biotic and abiotic factors that potentially influence the character of the natural setting, the climate, water, soil, rocks, minerals, landform, flora and fauna. It operates as interacting system of physical, biological and cultural elements. Different components of environment are interlinked and interdependent. It operates as interacting system of physical, biological and cultural elements. Different components of environment are interlinked and interdependent. The physical elements determine the variability of dispersion of habitat, opportunities and limitations. The biological elements collectively operate to maintain energy flow through food chain, while cultural elements find expression in varied man made features mainly based on using natural resources. The progress has placed extraordinary stress on the environment and accelerated the age old afflictions and depletion of environmental quality. A soil is an ecosystem containing thousands of micro organisms competing for organic matter and nutrient within and on the surface of the soil. The enormous range of organism and their diversity balance produced a stable and flexible ecosystem. Soil is foundation for ecosystem and primary source of nutrient for the biota. Soil degradation occurs due to human activities, urban and industrial development. In degraded soil, microorganism are no longer able to perform their normal processes of cycling nutrient, assimilating organic waste and maintaining soil structure.[123] In extreme cases, plant growth on the surface of the soil can die off, causing the soil to erode and ecosystem to become severely degraded. Soil pollution is nothing but the degradation of the earth's land surface through misuse of the soil by poor agricultural practices, mineral exploitation, industrial waste dumping, and indiscriminate disposal of urban waste. Muncipal solid waste is the solid wastes sent by households, business, and municipalities to local landfills and other waste-disposal facilities. According to Environmental Protection Agency (EPA),[1] although municipal wastes are the most obvious, additional solid wastes accumulate from mining, industrial production, and agriculture are far greater in many instances and are more difficult to dispose off and shows greater environmental hazards . The most common and convenient method of disposing of municipal solid wastes is the sanitary landfill but the open dump is found the common method used for disposal of solid waste which attracted populations of rodents and other pests and often emitted hideous odors; many time it spread over large soil area and it make surrounding soil unfertile. Sanitary landfills should provide better aesthetic control and avoid soil pollution. The microbial status of the soil is highly dependent on factors such as temperature, available moisture, nutrient levels, toxic elements, conductivity and pH. The survival and development of microorganism depend to a large extent on the physical and chemical properties of the soil. Physico-chemical parameters play important role in deciding the land use pattern and reclamation techniques.[2] The microbial status of the soil is highly dependent on factors such as temperature, available moisture, nutrient levels, toxic elements, conductivity and pH. The survival and development of microorganism depend to a large extent on the physical and chemical properties of the soil. The percent distribution of gravel, sand silt and clay in the soil helps to ascertain the possibility of working of

various mechanical instruments and also help to evaluate moisture potential of soil.[3] Hence in present work Physiochemical analysis of 48 soil samples fpor parameters pH, Conductivity, Alkalinity, chloride, nitrate phosphate, sodium, potassium, calcium etc in different seasons is carried out.

Table: 1 Different Codes for Locations of water and soil

Source	Padoli area soil	Tadali area soil	Urjanagar area soil	Datada area soil
Code	PS1 - PS4	TS1 - TS4	US1- US4	DS1- DS4

Soil sampling: For soil sampling, following methods [4] were adopted to get a representative sample. For each sampling sites, five sub-samples from four corners and one center of a grid by quartering method were used to prepare one composite sample at each location. About 1kg of sub-sample upto depth of 6 inch was collected. This is considered to be the most reactive zone of soil from the point of view of fertility. After collection, all such sub-samples were kept on a clean polythene sheet and mixed thoroughly. Then two opposite corners were retained by rejecting the remaining two. These two parts were mixed thoroughly and again two opposite corners were retained. The process was repeated till the final retained sample was about 1 kg for subsequent analysis. Collected soil samples were air dried under shade. Direct drying of soil samples under high temperature or directly under sun light was avoided as this might bring about major changes in soil properties. Then all the soil samples were grinded and passed through 2 mm sieve, the samples were stored in clean and dry polyethylene containers. 50 g air dried soil sample was mixed with 250 ml distilled water to prepare a suspension (1:5 dilutions). After 24 hours the suspension was filtered through Whatman filter paper number 42. This clear solution was used to determine various physico-chemical parameters like pH, Conductivity, TDS, Total Hardness, Chloride, Nitrate , Sulphate, Calcium, Magnesium, Sodium, Potassium.
The values of all the parameters also determined for over burden sample PS4 and Statistical data is summarized in Tables 2 and 3.

2. RESULT AND DISCUSSION

1. Evaluation of soil quality of farms of Padoli area, Chandrapur. Duration: August 2010 - August 2012: Statistical analysis of soil samples showing minimum, maximum and mean and standard deviation are given in Table 4.17. During the tenure of investigation pH ranged from 7.2 - 8.1 with a mean of 7.6. Fluoride, total alkalinity, total hardness, total dissolved solids, chloride, nitrate, phosphate, sodium, potassium, calcium and magnesium ranged from 1.2 - 3.1, 335 - 650, 223 - 493, 893 - 1507, 52.4 - 148.6, 87.4 -158.7, 7.0 - 44.8, 88.9 - 258.8, 1.8 - 27.7, 72.4 - 162.8, and 13.0 - 207.5 ppm with corresponding mean values of 2.3, 512, 359, 1132, 359.8, 117.4, 20.4, 142.3, 12.2, 112.5 and 38.8 ppm respectively.
The values of standard deviation for most of the parameters as shown in Table 1. are higher. The higher values may due to the fact that 28 samples were collected during August 2010 - August 2012 from 4 different farms of Padoli (Chandrapur MIDC area) of Chandrapur city as shown in Table 2. It also indicates that the contaminants in all the 4 sources are distributed unevenly due to variations in industrial and domestic activities.
Variations of some parameters seems to be affected and contaminated due to presence of various industries like MOI, pharmaceutical, cement product industries etc., situated in this area, different industrial and domestic activities running nearby and heavy transportation. No regular trend has been found in the values of parameters studied due to presence of different industries, industrial activities and large number of different coal handling activities like presence of coal station, transportation of coal, heavy vehicle traffic and presence of dumping station of solid waste from city and coal ash.

Table 2. Statistical analysis for all soil samples at Tadali area Chandrapur From Aug.10-Aug.12.

SN	Parameters	Padoli Area				Tadali Area			
		Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.
1	pH	7.2	8.0	7.6	0.2	6.7	8.0	7.4	0.3
2	Conductivity	914	1523	1175	164	770	1267	979	125.2
3	TDS	892	1507	1132	173.2	679	1146	922	123.2
4	Total Alkalinity	335	650	512	71.7	154	536	373	104.3
5	Total Hardness	223	493	360	79.7	125	559	423	106.3
6	Chlorides	52.4	148.6	113.0	26.1	54	142	102	19.9
7	Flouride	1.2	3.1	2.3	0.6	1.7	3.3	2.5	0.5
8	Nitrate	87.4	158.7	117.4	18.7	51.5	172.0	104.0	31.6
9	Sulphate	47.3	291.7	123.3	72.2	36.4	139.3	82.7	26.4
10	Phosphate	7.0	44.8	20.4	8.6	4.3	74.2	25.5	15.8
11	Sodium	88.9	258.8	142.3	44.8	4.3	176.6	43.8	44.1
12	Potassium	1.8	27.7	12.2	5.7	0.6	18.1	8.6	6.2
13	Calcium	72.4	162.8	112.5	26.1	37.8	202.1	140.2	39.3
14	Magnesium	3.0	207.5	38.9	48.4	2.5	34.5	19.1	8.5

Evaluation of soil quality of farms of Tadali area, Chandrapur city. Duration: August 2010 – August 2012: Statistical analysis of soil samples showing minimum, maximum, mean and standard deviation of farms of Tadali area are given in Table 2. During the tenure of investigation pH ranged from 6.7 - 8.0 with a mean of 7.4. Content of total dissolved solid, total alkalinity, total hardness, chloride, fluoride, nitrate, sulphate, phosphate, sodium, potassium, calcium and magnesium ranged from 679 - 1146, 154 - 536, 125 - 559, 54 – 142, 1.67 - 3.32, 51.5 – 172.0, 36.4 - 139.3, 4.3-74.2, 4.3 – 176.6, 0.6 -18.1, 37.8 - 202.1 and 2.5 - 34.5 with corresponding mean values of 922, 373, 423, 102, 2.5, 104.0, 82.7, 25.5, 43.8, 8.6,140.2 and 19.1 ppm respectively. It indicates that the sources are affected unevenly due to different industries. Mainly iron manufacturing industries and some others situated in this area, discharge of these industries, transportation of heavy vehicles carrying raw material and products and other related activities, which also become evident from figure 4.29a - 4.32c, soil quality seems to be affected and contaminated by these industries and also shows seasonal variations.[5]

Evaluation of soil quality of farms of Urjanagar area of Chandrapur city. Duration: August 2010-August 2012: As summarized in Table 4.19 for all soil samples of Urjanagar area of Chandrapur city, during the tenure of investigation pH ranged from 7.2 - 7.8 with a mean of 7.5, conductivity ranged from 726.3 - 1102.2 µmhos/cm with mean of 889.1 µmhos /cm. Content of total dissolved solids, alkalinity, total hardness, chloride, fluoride, nitrate, sulphate, phosphate, sodium, potassium, calcium and magnesium ranged from 676 - 1078, 351 - 610, 188 - 398, 3.0 - 79.2, 1.6 - 98.2, 73.5 - 148.3, 29.5 - 98.3, 7.5 - 41.2, 15.4 - 118.5, 1.6 - 46.5, 50.0 - 136.5 and 2.8 - 23.0 ppm with corresponding mean values 820, 455, 315, 50, 16.2, 97.1, 61.5, 14.2, 65.5, 10.2, 103.0 and 13.02 ppm respectively.

The values of standard deviations as shown in Table 3. for most of the parameters are high but low compared to soil samples of Tadali and Chandrapur MIDC area indicating that, the sources are affected to lesser extent. A major pollutant which affects and contaminate soil is coal ash and other solid waste generated in thermal power plant and different activities carried out in surrounding area. The different dosing of fertilizers and manures used during farming and different crop patterns may also contribute to these inconsistencies.

It also show variation which also indicate contamination of soil sampling sites due to waste generated from STPS and dumping of coal ash and other domestic activities related to STPS.

Table 3. Statistical analysis for all soil samples at Tadali area Chandrapur.From Aug.10-Aug.12.

Sr. No.	Parameters	Urganagar				Datada			
		Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.
1	pH	7.2	7.8	7.5	0.2	7.1	7.9	7.5	0.2
2	Conductivity	726	1102	889	97.1	789	1310	974	129.3
3	TDS	676	1078	820	102.1	712	1276	913	129.1
4	Total Alkalinity$_3$	351	610	455	52.9	413	681	493	78.3
5	Total Hardness$_3$	188	398	315	55.0	125.4	395.1	270.8	70.2
6	Chlorides	2.9	79.2	50.1	21.5	2.9	122.1	65.4	32.6
7	Flouride	1.6	98.2	16.2	28.8	1.5	132.0	19.3	33.9
8	Nitrate	73.5	148.3	97.1	17.7	30.2	121.2	83.5	17.8
9	Sulphate	29.5	98.3	61.5	15.4	17.9	157.7	83.7	27.9
10	Phosphate	7.5	41.2	14.2	8.1	6.4	46.0	15.8	9.9
11	Sodium	15.4	118.5	65.5	27.3	63.7	197.6	115.6	41.4
12	Potassium	1.6	46.5	10.2	8.9	2.3	74.6	18.5	15.9
13	Calcium	50.0	136.5	103.0	20.1	35.7	125.3	83.1	27.9
14	Magnesium	2.8	23.0	13.0	5.5	0.8	21.8	12.2	6.2

Evaluation of Soil quality of farms of Datada area of Chandrapur city. Duration: August 2010 - August 2012: Statistical analysis of soil samples for Datada area of Chandrapur city are summarized in Table 3. for all soil samples. During the tenure of investigation, value of pH ranged from 7.1 - 7.9 with a mean of 7.5, conductivity ranged from 789 - 1310 µ mhos/cm with mean 974 µmhos/cm. Content of total dissolved solids, alkalinity, total hardness, chloride, fluoride, nitrate, sulphate, phosphate, sodium, potassium, calcium and magnesium ranged from 712 - 1276, 413 - 681, 125 - 395, 2.9 -122.1, 1.5 -132.0, 30.2 -121.2, 17.9 -157.7, 6.4 – 46.0, 63.7 - 197.6, 2.3 - 74.6, 35.7 - 125.3 and 0.8 - 21.8 ppm with corresponding mean values of 913, 493, 271, 65.4, 19.3, 83.5, 83.7, 15.8, 115.6, 18.5, 83.07 and 12.2 ppm respectively.

The values of standard deviation for most of the parameters as shown in Table 3. indicate that the sources are affected unevenly due to different industries and industrial activities carried out in this area. Transportation of heavy vehicles carrying raw material and products and other related activities also affect and contaminate the soil in this area.

Variations of some parameters, seems to be affected and contaminated due to presence of various industries situated in this area, different industrial and domestic activities running nearby and heavy transportation. No

regular trend has been found in the values of parameters studied. The different dosing of fertilizers and manures used during farming was also responsible for it.

Overall statistical analysis of all soil samples Duration: August 2010 - August 2012: As shown in Table 4., pH ranged from 7.2 – 8.0 with a mean value of 7.6. Conductivity, TDS, Total alkalinity, total hardness, chloride, fluoride, nitrate, suphate, phosphate, sodium, potassium, calcium and magnesium ranged from 770 - 1267, 679 - 1146, 154 - 536, 125 - 559, 54.2 - 141.8, 1.67 - 3.32, 51.5 - 172, 36.4 - 139.3, 4.3 -74.2, 4.3 - 176.6, 0.6 - 18.1, 37.8 - 202.1 and 2.5 - 34.5 ppm with mean value 979, 922, 373, 422, 102.5, 2.47, 104.0, 82.7, 25.5, 43.8, 8.62, 140.2, 19.1 ppm respectively. Various factors responsible for variation of different parameters are different industries, industrial activities and large number of different coal handling activities like presence of coal station, transportation of coal, heavy vehicle traffic and presence of dumping station of solid waste from city and coal ash. In addition to it presences of coal mine nearby affect the quality of soil. Mining tends to make notable impacts on quality of soil and other environmental factor, depending on wheather the mine is working or abandoned, mining method used and geological condition(Bell et al., 2001)[6]. The unscientific mining of minerals posses a serious threat to the environment, resulting in the reduction of forest cover, erosion of soil, pollution of soil, water and air, reduction in biodiversity [7,8]

Table 4. Statistical analysis for all soil samples at all Locations of Chandrapur. From Aug.10-Aug.12.

Sr. No.	Parameters	All Samples				Overburden soil sample (PS4)			
		Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.
1	pH	6.7	8.0	7.5	0.2	7.4	7.8	7.6	0.1
2	Conductivity	726	1523	1004	129.0	1030	1321	1175	86.3
3	TDS	676	1507	947	131.9	991	1319	1145	96.1
4	Total Alkalinity$_3$	154	681	458	76.8	465	613	531	57.0
5	Total Hardness$_3$	125	559	342	77.8	330	468	402	47.7
6	Chlorides	2.9	148.6	82.7	25.07	121.4	148.6	133.2	9.3
7	Flouride	1.2	132.0	10.1	15.9	1.2	3.0	2.3	0.62
8	Nitrate	30.2	172.0	100.5	21.3	105.5	158.7	130.1	18.7
9	Sulphate	17.9	291.7	87.8	35.5	47.3	87.6	70.7	15.8
10	Phosphate	4.3	74.2	19.0	10.6	7.0	27.3	15.9	7.3
11	Sodium	4.3	258.8	91.8	39.4	90.4	119.5	106.3	11.9
12	Potassium	0.6	74.6	12.4	9.20	6.3	18.8	12.5	4.7
13	Calcium	35.7	202.1	109.7	28.4	121.4	162.8	138.2	16.7
14	Magnesium	0.8	207.5	20.8	17.1	3.0	119.5	36.6	40.05

All parameters are in ppm except Electrical Conductivity (E.C.) in µmhos/cm & pH.

Characteristics of over burden soil sample (PS4). Duration: August 2010-August 2011: As shown in Table 4., the values of parameters of soil sample (PS4) from Padoli area was found comparatively high, may be due to PS4 ranged from 7.4 - 7.8 with a mean 7.7. Electrical conductivity ranged from 1030 - 1321 µmhos/cm with mean of 1175 µmhos/cm. Content of other parameters like TDS, total alkalinity, total hardness, chloride, fluoride, nitrate, sulphate, phosphate, sodium, potassium, calcium , magnesium ranged from 991 - 1316, 465 - 613, 330 - 468, 121.4 - 148.6, 1.21 - 3.0, 105.5 -158.7, 47.3 - 87.6, 7.0 - 27.3, 90.4 - 119.5, 6.3 -18.8, 121.4 - 162.8 and 3 - 119.5 with mean of 1146, 531, 402, 133.2, 2.3, 130.1, 70.7, 15.9, 106.3, 12.47,138.2, and 36.6 respectively.

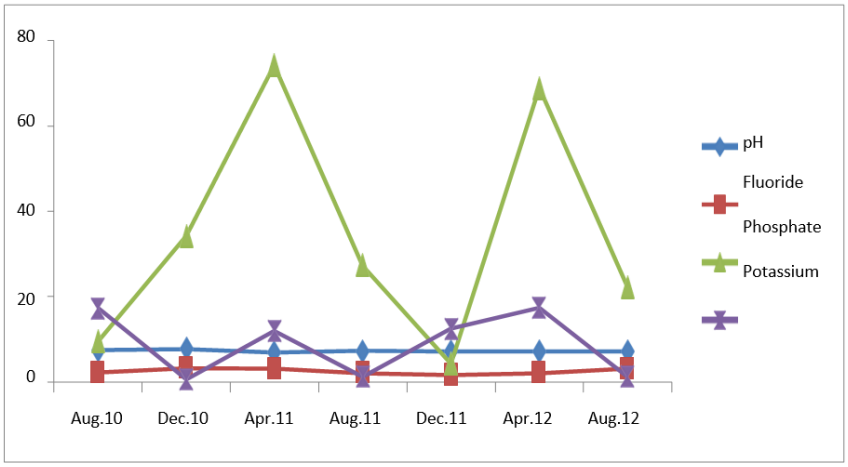

Fig 1. Variation of pH, Fluoride, Phosphate, Potassium of soil sample (PS4)

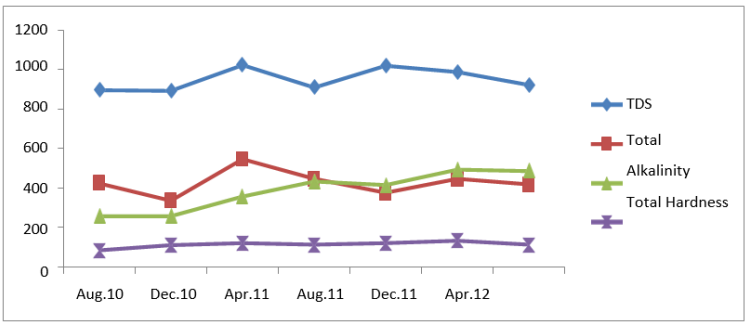

Fig2. Variation of TDS, Total Alkalinity, Total Hardness,Chloride of soil (PS4)

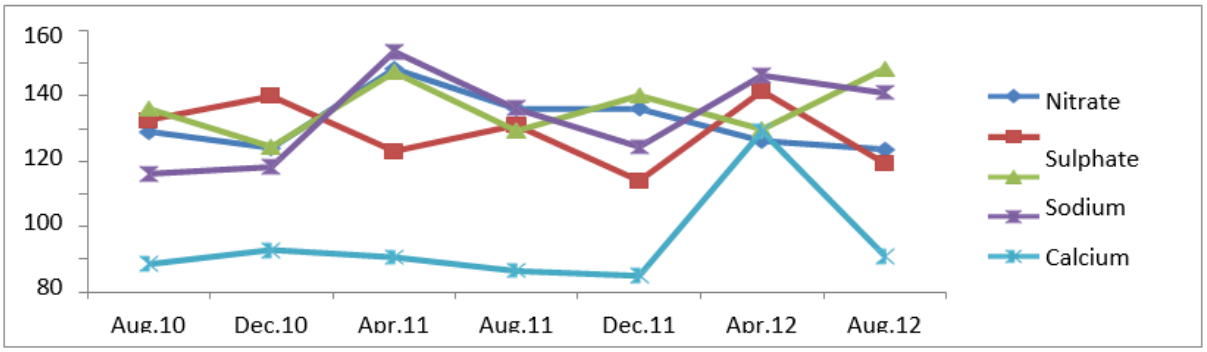

Fig.3 Variation of Nitrate, Sulphate, Sodium, Calcium, Magnesium of soil (PS4)

3. CONCLUSION

All soil sampling locations at Chandrapur and surrounding areas were found affected and contaminated due to various industrial activities carried out around Chandrapur city, STPS and industrial waste generated at Chandrapur MIDC area and discharge of sponge iron industries in Tadali area. The overburden soil sample (MS4) shows exceptionally high TDS, chloride, sulphate, calcium and magnesium. During monsoon, wash out of overburden contributes extensively towards contamination of soil of surrounding area and water. Dueto continuous exposure of this land to industrial activities, the productivity of this land was found to be decreased. There is also rapid urbanization occurring due to increased industrialization. It is estimated that nearly 450 ha. of productive forest or agricultural land is diverted for the coal mine with a annual production of about 8,00,000 tons of coal. In the mine area itself substantial area is occupied by external over burden dump. The other impacts associated with mining include loss of natural vegetation and soil erosion. Hence, conscious steps are required to be taken for ensuring the city's environmental sustainability. There is an urgent need to develop and implement an action plan to mitigate the adverse impacts of these activities on the environment in Chandrapur.

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