Recent Research in Science and Technology 2014, 6(1): 253-257
ISSN: 2076-5061
Available Online: http://recent-science.com/

Long term impact of industrial effluents on agricultural soil

Deepti Sahare

Assistant Professor, Raipur Institute of Technology, Raipur, C.G, India.

Abstract

Rapid industrialization affects the environment in different ways by discharging the large amount of effluent as waste water in the surrounding water bodies, causing the serious problems to environment. Due to lack of irrigation water in the present study area canal water was used in which effluents from various industries were being discharged. Four water samples were collected from four locations and three to four replicate analysis was carried out for each sample. Sampling locations were selected after each 0.5 km from discharging points. Collected water samples were analyzed for physico-chemical characteristic, heavy metal and sulphide content. Five soil samples were collected from different fields and three to four replicate analysis was carried out for each samples. Impact of effluent on agricultural soil, is mainly due to the presence of high nutrient contents (Nitrogen and Phosphorus), high total dissolved solids and other constituents such as heavy metals, which are added to the soil over time. Wastewater can also contain salts that may accumulate in the root zone with possible harmful impacts on soil health and crop yields. The leaching of these salts below the root zone may cause soil and groundwater pollution. Prolonged use of saline and sodium rich wastewater is a potential hazard for soil as it may erode the soil structure and effect productivity. This may result in the land use becoming non-sustainable in the long run. Wastewater induced salinity may reduce crop productivity. The net effect on growth may be a reduction in crop yields and potential loss of income to farmers. Canal water was containing high COD, BOD values and higher heavy metal content and the soil irrigated with this water was showing the poor status of the nutrients and high contamination of heavy metals. The present study was to evaluate the various adverse effects on the soil characteristics irrigated with discharged water.

Keywords: Effluent water, heavy metal, nutrient status, COD, BOD.

INTRODUCTION

Various devastating ecological and human disasters of the last four decades implicate industries as a major contribution to environmental degradation and pollution.[1-5] With increased industrialization in residential areas, different materials are discharged into effluent water which leads to environment pollution. This concern is of special importance where untreated effluent is applied for longer periods to grow vegetables in urban lands. Such uses are on the increase because the effluent contaminated waste water is a free and good source of organic matter as well as plant food nutrient, variable and cheap option for disposal.[6] As a consequence, the use of waste water and other industrial effluents for irrigating agricultural lands is on the rise particularly in peri-urban areas of developing countries. On the other hand, there is increasing concern regarding the exceedance of statutory and advisory food standards for trace metals throughout the world.

Many industries dispose off effluents via the open and covered routes into the main channels, which also carries domestic water. Farmer's fields near these channels are irrigated with these polluted effluents for raising crops. The manufacturing of useful products such as dye stuffs, pigments, drugs, metal surface cleaning agents and discharge of untreated effluents form different industries are causing a wide range of environmental pollution.[7] Some soils contain naturally high levels of potentially toxic substances resulting from weathering of minerals. However, much of soil contamination is the result of human activities including application of effluent waste to land. Heavy metals are inorganic contaminants of greatest concern. They enter agricultural soils mainly through atmospheric deposition and application of soil amendments. Many potential contaminants are necessary for agricultural production but become hazardous when they occur in excess in the soil.[8-9]

An industry which uses the large amount of water in their processes includes chemical manufactures, steel plants, metal processors etc. All types of effluents and most of byproducts from any kind of industry create a most serious pollution to the water bodies and soil bodies.[10] The contamination of soil is often a direct or indirect consequence of industrial activities.[11] With the ever increasing demand on irrigation water supply, farmlands are frequently faced with utilization of poor quality irrigation water. Due to shortage of canal irrigation water formers use industrial effluents which being discharged in canal.[12] Since, the use of such effluents as irrigation water may introduce some metal ions, which may accumulate in the plants.[13] Soil physiochemical properties are adversely affected by high concentration of heavy metals, rendering contaminated soils unsuitable for crop production.[14-15] Metals can also be transported from soil into groundwater resulting in to soil contamination and inhibiting growth of plants.[16] Soils contaminated with toxic metals from point sources are potential exposure routes for surrounding population.[17-18] The heavy metals accumulate in the plant material grown in these soils, which will ultimately go to human

*Corresponding Author

Deepti Sahare
Assistant Professor, Raipur Institute of Technology, Raipur, C.G, India.

Email: deepti_proff@yahoo.com

body through food chain directly or indirectly causing a number of problems. The objective of the present study is to assess the impact of industrial effluent discharged on soil of agricultural field and to analyze physicochemical characteristics of water and soil.

MATERIAL AND METHODS

Study area

Study area was selected around the urla site situated at Raipur, Chhattisgarh state (India). Mostly the water source for irrigation was only water canal passes via industry. The existing industry has been discharging their liquid wastes into a nearby canal. Accordingly some of the farmers of villages are using this canal water for irrigating different crops including rice, wheat, vegetables and fruits etc. By keeping this view it was thought that this activity of the industry may cause the adverse effect not only over environment but also over the farmers, the effects over farmers are in the form of health hazards as well as over the socioeconomic strata of them.

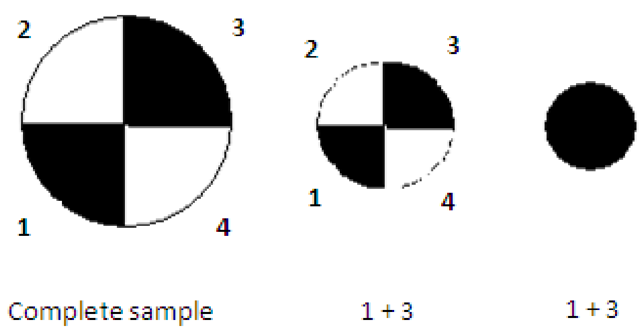
Samples collection for Effluent Water

Four water samples were collected from four locations and three to four replicate analysis was carried out for each sample. The water samples were collected in polyethylene bottles directly from the outlet of the factory linked to canal. Sampling locations were selected after each 0.5 km from discharging points. Initial three samples were taken from 0.5 km distance each, while first location was 0.1 km from first discharging point. On the other hand fourth sample was collected from approximately 0.1 km distance from the second discharging point. Collected water samples were analyzed for physio-chemical characteristic, heavy metal and sulphide content.

Samples collection for Soil

Five soil samples were collected from different fields and three to four replicate analysis was carried out for each samples. Mainly the sampling locations were selected approximately each 0.5 km from both the discharging points. The first sample was collected from 0.1 km distance from the first discharge point; sequentially the other two samples were collected by variable distances from the discharge point. On the other hand fourth sample was collected at the distance of 0.5km from first discharge point and the fifth soil sample was collected from approximately 0.1 km from second discharging point. Soil samples were collected at depth 0-20cm from five spots each by using specific method and analyzed for chemical characteristics and mineral metal content in the soil.

For the sampling of soil, it was kept in a circular form and divided into four equal parts and separation was continued from two opposite directions until only half kg. Soil sample is left and stored in polythene bags for investigations.



Method of analysis for effluent water:

The pH, Electrical conductivity (EC) Total suspended solids (TSS) etc of the samples was determined using the Deluxe water and soil analysis kit.

Chlorides of the samples were determined by using argentometric method of precipitation. Oil and grease was determined by using the partition gravimetric method. Chemical oxygen demand (COD) determines the oxygen equivalent of organic matter that is susceptible to oxidation with the help of strong chemical oxidant. COD was determined by using open reflux method. Biochemical oxygen demand (BOD) is expressed as the weight of oxygen consumed per unit volume of water during defined period of time and temperature for this the samples was incubated for 5 days. For the analysis of the heavy metals 50 ml sample was taken and 5 ml conc. HNO_3 was added then samples were digested. The digested samples were filtered through whatman filter paper no. 42 after filtration the volume was made to 50 ml with the deionized water. Samples were analyzed on atomic absorption spectrophotometer for concentration by using specific cathode lamp. AAS was calibrated for each element using standard solution of known concentration before sample injection.

Method of analysis for soil

20g soil sample was transferred to a 100 ml of beaker and 40 ml distilled water, stirred thoroughly with a glass rod for about 30 minutes and then further this soil water suspension was used for different chemical determinations.

The pH of soil samples were estimated again by deluxe water and soil analysis kit in the same suspension conductivity was also determined. The main source of nitrogen in soil is organic materials. Most of them are not easily breakable but some part of it is present in the form of protein ($-NH_2$) which can be converted into ammonia nitrogen by basic hydrolysis. For this we can use potassium permanganate or Suvaiya and Asija method. Potassium permanganate oxidises protein nitrogen to ammonia nitrogen which comes out as ammonia gas in basic medium. This can be estimated by treatment with boric acid.

Further Known amount of soil was leached with neutral ammonium acetate solution. Leachate was preserved to estimate the soluble cations such as sodium (Na^+), potassium (K^+), and calcium (Ca^{++}) and magnesium (Mg^{++}) ions. Available potassium was estimated by leaching the soil with ammonium acetate and determining the potassium using flame photometer. Available carbon was estimated using Walkley-Black method[19]; available phosphorous was determined by Olsen's method.[20] Heavy metal contents in soil were determined by digesting soil with perchloric acid and conc. nitric acid followed by analysis on atomic absorption spectrophotometer.[21]

OBSERVATION AND RESULT

Table 1. Physiochemical analysis of water

Parameter	Location-1	Location-2	Location-3	Location-4
Temperature	34	30	32	32
pH	8.6	8.6	8.4	9.8
Turbidity	21.2	22	51	73.6
Conductivity (µScm^{-1})	400	409	426	472
TSS (mg/l)	108	102	110	118
Total alkalinity (mg/l)	64	115	105	124
Chlorides (mg/l)	225	116	150	240
COD (mg/l)	280	268	250	296
BOD (mg/l)	36	32	27	54
Oil and grease (mg/l)	8	12	8	18
Sulphide (mg/l)	24	28	54	70

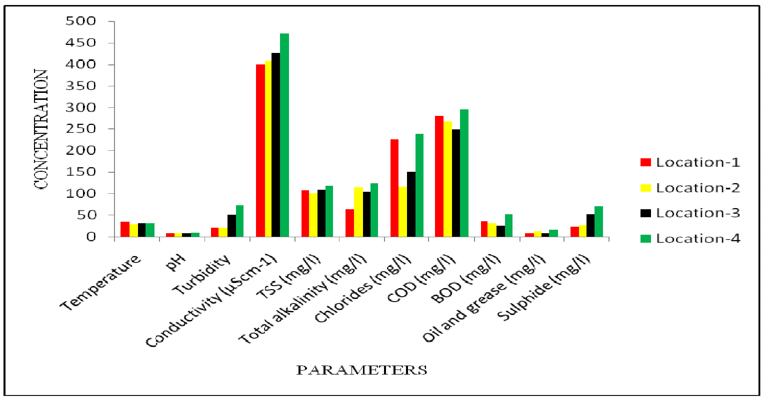


Fig 1. Physiochemical analysis of water

Table 2. Heavy metals content of water

S.No	Sample Location	Ni	Cd	Cr	Cu	Pb	Fe	Mn	Zn	CO
1	Location-1	0.135	0.044	0.011	-	-	3.24	0.04	0.20	0.080
2	Location-2	0.148	0.042	0.016	-	-	3.34	0.114	0.06	0.052
3	Location-3	0.146	0.042	0.005	-	0.005	2.62	0.081	1.08	0.076
4	Location-4	0.301	0.046	0.005	-	0.01	21.6	2.22	0.13	0.151

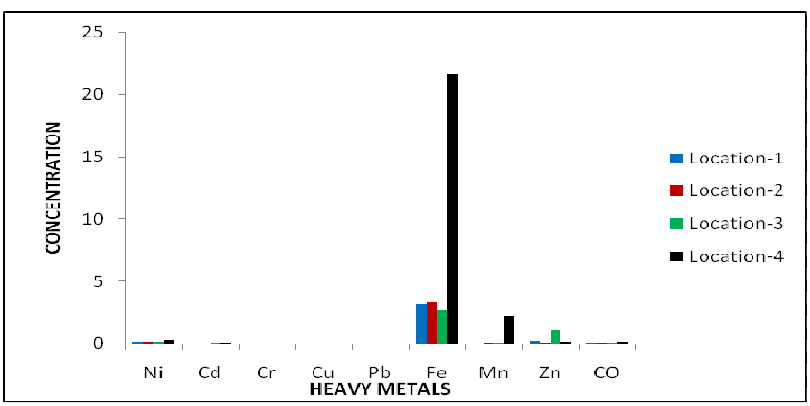


Fig 2. Heavy metals content of water

Table 3. Chemical characteristics of soil extract

Parameter	Location1	Location 2	Location 3	Location 4	Location 5
pH	7.6	7.6	7.6	7.4	10.8
Conductivity (dSm-1)	0.75	0.10	0.48	0.32	0.48
Ca^{++} (meq/l)	10.38	9.89	32.6	15.4	28.4
Mg^{++} (meq/l)	0.24	1.68	1.02	0.86	32.6
Na^{+} (meq/l)	2.58	3.14	1.24	2.52	5.38
K^{+} (meq/l)	0.38	0.05	0.02	0.05	0.20
Organic Carbon %	1.28	2.20	1.34	0.62	1.2
Nitrogen (kg/ha)	212	120	138	126	196
Phosphorus (Kg/ha)	5.32	0.62	1.6	0.76	0.62
Potassium (Kg/ha)	58.2	52	48.9	62.2	68.5

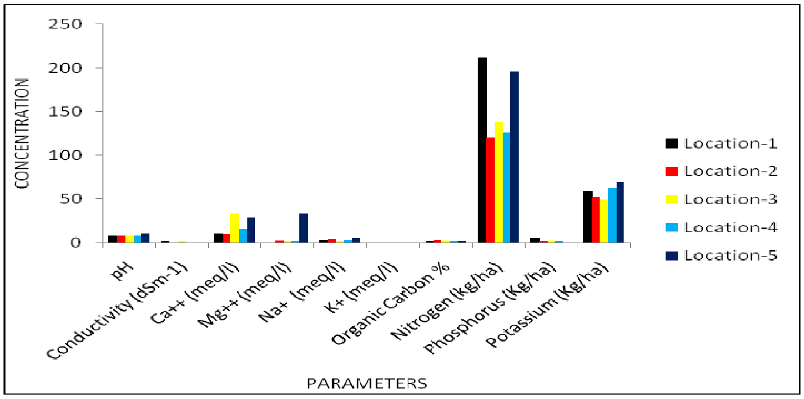


Fig 3. Chemical characteristics of soil extract

Range of major nutrients in soil

Nutrient status	Nitrogen	Phosphorous	Potassium
	(Kg/hac)		
Level in poor soil	<280	<23	<133
Level in medium soil	280-560	23-57	133-337
Level in fertile soil	>560	>57.0	>337

Table 4. Heavy metals content of soil

S.No	Sample Location	Ni	Cd	Cr	Cu	Pb	Fe	Mn	Zn	Co
		(mg/Kg)								
1	Location-1	36.4	5.2	10.2	15	42	700	392	62	20
2	Location-2	36.0	5.2	2.1	3.6	2	542	806	52	30
3	Location-3	31.0	5.2	1.0	-	-	28	412	3	14
4	Location-4	32	3.0	5.6	10	9	242	478	142	20
5	Location-5	40	5.0	4.0	2.8	10	72	902	10	38

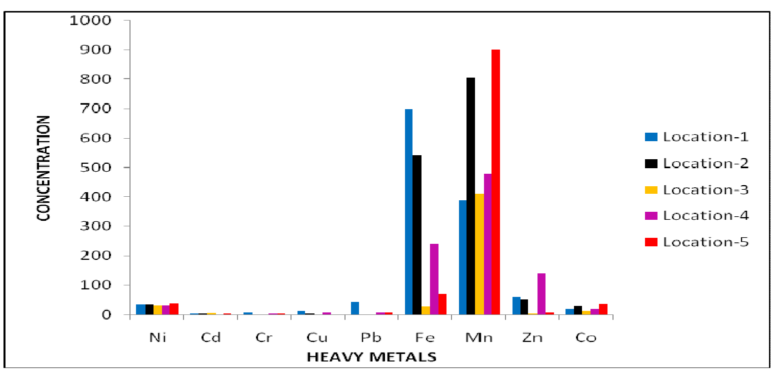


Fig 4. Heavy metals content of soil

DISCUSSION

As it was already mentioned, every manufactured product uses water during some part of the production process. The water discharged during the manufacturing processes of the above mentioned industry may cause the adverse effects over environment. In the same manner color and odor also changes. When the physio-chemical parameters are taken into consideration, the physical parameters shows that the pH, TSS are more while the turbidity is far more as compare to the normal values. The idea about inorganic parameters were total alkalinity and chloride content goes on decreasing while oil and Grease increases significantly in the fourth location. The decreases in chloride content means some quenchers are there in effluent. The high COD value from the effluent of the steel industry suggests that this industry is producing lots of organic substances. The level of sulfide was very high than the normal values. The heavy metals present in the effluent may come from the various metallurgical processes. The data suggest that near about concentrations of all the metals goes on decreasing which indicate that the effluent may contains metal quenchers; thus the trace elements required by the plants are not properly supplied which results the underproduction of the crops in a particular area. The fertility status of the soil was also tested and suggested that the fertility level of the surrounding fields are into very poor category. The above data also suggest that the effluent of the second discharge point cause comparatively deleterious effect over the surrounding environment

CONCLUSIONS

Thus the present work concludes that the effluent from the industry causes the pollution problems in the surrounding environment. The nutrient status of the samples showed that the soil quality of the surrounding field was poor and the effluent discharged in the canal has been affecting the physicochemical characteristics of the soil. The heavy metals in the field were also showing the high concentration which also causes the adverse effects on the soil. Through this study, it is concluded that the industrial effluent has substantially changed the irrigation water quality diverted from canal and consequently some chemical elements also increased in the soil of the irrigated farmland.

ACKNOWLEDGEMENT

The author is thankful to Dr. S.K Rajput, Principal, Dr. K.C.B Govt. P.G. College, Bhilai-III and Raipur Institute of Technology, Mandirhasaud, Raipur to provide the facilities required for research work.

REFERENCES

[1] Webber M.D. and Singh S.S. 2003.Contamination of Agricultural Soils. Health of our soils: Toward sustainable agriculture, Canada.
[2] Gaffoor A, Qadir M, Sadiq M, Murtaza G. and Brar M.S. 2004. J. Indian Soil Sci. 52: 114-117.
[3] Abbas S.T, Sarfraz M, Mehdi S.M, Hassan G, Obaid-Ur-Rehman. 2007. Soil and Tillage Research, 94 (2), 503-509.
[4] Rattan R.K, Datta S.P, Chhonkar P.K, Suribabu K, Singh A.K. 2005. Ecosystems & Environment, 109, 3-4.
[5] S. Bakopoulou, C. Emmanouil, A. Kungolos. 2011. Ecotoxicology and Environmental Safety, 74 (2), 188-194.
[6] Al A.M, Omron S.E. El-Maghraby, M.E.A. Nadeem A.M, El-Eter H, Al- Mohani. 2011. Journal of the Saudi Society of Agricultural Sciences.
[7] Kaur Arminder, Vats Siddharth, Rekhi Sumit, Goel Ankit, Ranjeet S, Tanwar Komal. Gaur K. 2010. Environmental Sciences. 595-599.
[8] Mohd. Ikram Ansari, Abdul Malik. Mutation Research/Genetic 2009. Toxicology and Environmental Mutagenesis, 673 (2), 124-132.
[9] Chandra R, Bharagava R.N, Yadav S, Mohan D. 2009. Journal of Hazardous Materials, 162(2-3), 15,1514-1521.
[10] Haynes R. J, Murtaza G , Naidu R. 2009. Advances in Agronomy, 104,165-267.
[11] Dutta, S.P., Biswas, D.R., Saharan, N. Ghosh, S.K and Rattan, R.K. 2000. J. Indian Soc. Soil. Sci. 48 (4), 836-839.
[12] Mohammad Zubair Alam, Shamim Ahmad, Abdul Malik, Masood Ahmad. 2010. Ecotoxicology and Environmental Safety, Boca Raton, Florida, USA. 73, (7), 383-400.
[13] Asma Aleem, Abdul Malik. Mutation Research/Genetic 2003. Toxicology and Environmental Mutagenesis, Volume 538, Issues 1-2, Pages 145-154.
[14] Dubey S.K, Yadav R.K, Joshi P.K, Chaturvedi R.K, Goel B, Yadav R. and Minhas P.S. 2006. Water use challenges for the future- The 18th World congress of Soil Science, New Delhi, 81-82.
[15] McLaughlin, M.J., N.A. Mair, R.L. Corell, M.K. Smart and C.D. Grant 1998. pp: 253-460. In Proc. 6th Int. Conf. on Contaminated soils, Edinburgh, Telford, London. 17-21
[16] Hindwood A.L., Sim M.R., Jolley D., de klerk N. Bastone E.B., Gerostamoulos J, Drummer, O.H. 2004. Environmental Geochemistry and Health, 26, 27-36.
[17] Pruvot C., Douay F., Herve F. and Waterlot C., 2006. Journal of soils and sediments, 6, 215-220.
[18] Walkley A. and Black C.A. 1934.Soil Sci. 47: 29-38.
[19] Olsen and Mehlich, 2014. Communications in Soil Science and Plant Analysis 45 (16).
[20] Pruvot C, Douay F, Herve F. and Waterlot C, 2006. Journal of soils and sediments, 6, 215-220.