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Heavy Metal Contamination in Soils near Siddheshwar Dam Maharashtra, India

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Abstract

The accumulation of heavy metals such as iron, chromium, zinc and manganese in soil has been an interesting and an important research thrust. A study was conducted to investigate to study accumulation of heavy metals in soil samples collected from the surface of the soil near Siddheshwar dam area in Hingoli, Maharashtra. The concentration of these metals was determined by UV-spectrophotometer. The concentration of heavy metals was found to be below the permissible range. The physico-chemical characteristics like temperature, electrical conductivity, and water holding capacity, soil moisture, pH, chloride, Fluoride, organic carbon, organic matter, alkalinity, calcium, and magnesium were also been studied. These parameters have been detected by standard methods.

Keywords: Heavy metals, soil, dam sediment, UV-spectrophotometer.

Introduction

For our better living standards we need pure clean air, pure water, nutritious foods, clothes and space etc. which are the basic needs for life. But the quality of air and water is likely to deteriorate because of population explosion, rapid industrialization and urbanization[1].

Soil is one of the most significant ecological factors, on which plants depend for their nutrients, water and mineral supply. Soil is a weathered layer of the earth crust which is having living organisms and products of their decay intermingled. The major inorganic constituents of soil are the compounds of Al, Si, Ca, Mg, Fe, and K. However, it also contains minor quantities of B, Mn, Zn, Cu, Mo, Co, I and F. The main organic constituent of soil is humus[2]. Metals have played a critical role in industrial development and technological advances. Most metals are not destroyed; indeed, they are accumulating at an accelerated pace, due to the ever-growing demands of modern society[3].

The different probable sources for the accumulation of heavy metals in soil are geological conditions of that particular area, use of pesticides and fertilizers in agricultural fields, disposal of industrial and municipal wastes and mining. Availability of heavy metals in the environment markedly influences their effect on living things. Measurement of the total metal concentration in soil is therefore unlikely to reflect the amount of metal actual available to the biota.

Soil or sediment is an integral part of an aquatic ecosystem which is significant due to complex reaction which occur within itself and also due to exchange of chemicals between soil and water. The absorption of heavy metals by the plants from soil comprises a particularly noticeable path for such elements to enter the food chain and eventually becomes hazardous for living organisms. Recently pollution of general environment has increasingly gathered a global interest. In this respect, contamination of agricultural soils with heavy metals has always been considered a critical challenge in scientific community[4].

The soil temperature plays an important role in many processes, which take place in the soil such as chemical reactions and biological interactions. Soil temperature varies in response to exchange processes that take place primarily through the soil surface. Soil moisture is difficult to define because it means different things in different disciplines. For example, a farmer's concept of soil moisture is different from that of a water resource manager or a weather forecaster. Generally, however, soil moisture is the water that is held in the spaces between soil particles. Surface soil moisture is the water that is in the upper 10 cm of soil, whereas root zone soil moisture is the water that is available to plants, which is generally considered to be in the upper 200 cm of soil. The electrical conductivity (EC) varies not only to the concentration of salts present, but also to the chemical composition of the nutrient solution[5].

The soil pH defined as the negative logarithm of hydroxide ions in the soil. The pH can affect the availability of nutrients in the soil. The soil organic carbon refers to the amount of carbon stored in the soil. It improves the physical properties of soil. It increases the cation exchange capacity (CEC) and water holding capacity of sandy soil and it contributes to the structural stability of clay soils by helping to bind particles into aggregates. The organic matter in soil derives from plants and animals. When the organic matter has broken down into stable humic substances that resist further decomposition it is called humus .One of the advantages of humus is that it is able to withhold water and nutrients, therefore giving plants the capacity for growth. Another advantage of humus is that it helps the soil to

stick together which allows nematodes, or microscopic bacteria, to easily decay the nutrients in the soil. Chloride is a critical component in the development of plants. Too little and excess chloride in plants can cause a variety of symptoms. The high levels of magnesium causes calcium deficiency in soil, its deficiency in soil attributed to high concentrations of Ca, Na and K which are added as artificial fertilisers.The some elements like Mg, Zn, Fe and V may be involved in photosynthesis but, if present at high levels, they pose lethal effects on crop production[6,7].

The present work started to study the physico-chemical parameters and heavy metals of the soil.

Study Area: Siddheshwar dam constructed on Purna River at Siddheshwar village in the Hingoli district of Maharashtra state has been selected for carrying out this work. It is situated at northern part of Marathwada region.

Material and Methods

Sample Collection: The soil samples were collected from a sub-surface of dam by using a corer and were brought to the laboratory in a plastic pouch in the year 2009. Determining the pH, first the soil samples were mixed thoroughly, air dried and passed through a mesh sieve. The samples were used for subsequent physico-chemical analysis by following methods.

Determination of the physico-chemical parameters of the soil samples

Temperature: The temperature of the soil samples measured by micro thermometers.

Soil moisture: The soil is dried in an oven at 150^{o}C. The difference in the initial and final weight of the soil determines soil moisture.

Water Holding Capacity (WHC): WHC can be determined as the amount of maximum water held in saturated solids.

Electrical conductivity (EC): The EC of the soil was determined in 1:5 soil: water suspension with the help of a Conductivity meter.

Soil pH: The pH of the soil was determined in 1:5 soils: water suspension with the help of a pH meter.

Organic carbon (OC): Organic carbon content of the samples was determined by titrometric method and represented as % of OC (percent of organic carbon).
Organic matter (OM): Organic matter content of the samples was calculated from organic carbon by multiplying it by Von Bemmlen factor.

Calcium (Ca) and Magnesium (Mg): Ca and Mg were determined by complexometric titration method[8].

Chloride: The chloride is an essential ion for plant growth. The chloride present in the sample was determined in 1:5 soils: water suspension by Argentometric method.

Fluoride: The fluoride present in the sample was determined in 1:5 soils: water suspension by SPANDS method on UV-Spectrophotometer.

Alkalinity: Soil alkalinity is due to presence of soil minerals producing sodium carbonate upon weathering. It was determined by titrating the soil suspension with a strong acid using methyl orange as an indicator[9].

Heavy Metals: By acid digestion of soil extract using standard methods for estimation of Iron by Thiocynate, Chromium by Diphenylcarbazide, Zinc by Dithiozone and Manganese by Persulphate Method on UV-Spectrophotometer[10].

Figure-1
Location of Siddheshwar dam in Maharashtra

Results and Discussion

Soil Parameters: Different parameters of the soil from siddheshwar dam area have been studied. The obtained results are shown in table 1. The recorded soil temperature was 26.8^{o}C, as the atmospheric temperature increases soil temperature also increases. The water holding capacity of the soil samples was calculated as 46% and soil moisture was 12.7%. As the soil moisture decreases WHC increases. Electrical conductivity indicates the amount of soluble ions (salt) in soil. The electrical conductivity of soil was 3.01mS/cm.Higher EC indicates accumulation of salts in the soil.

Generally, the soils pH is acidic or neutral. The pH of the soil from selected site recorded close to acidic character (pH=5.44). The pH can affect the availability of nutrients in the soil. The estimated Organic Carbon and Organic Matter were 0.09% and 0.1566% respectively. The organic matter utilized by plants and microorganisms.

The chloride content in soil was 24.35%; fluoride was 0.205 mg/l and alkalinity 25 meq/100g. The calcium and magnesium present in soil samples were 112 mg/kg and 155 mg/kg respectively. High concentration of Ca and Mg increases pH of the soil.

Heavy metals in the soil: The concentrations of the heavy metals found in the soil samples of selected site were as shown in table 2. The Iron chromium, zinc and manganese concentrations were 60 mg/kg and 40 mg/kg, 21.75 mg/kg and 12.59 mg/kg respectively as shown in table 2.

The pH range was found to be in the range of 4.62 to 6.86. The percentage of organic carbon was not uniform (0.09 to 3.24%) and percentage of organic matter was also varied from 0.16% to 4.65%. The concentration of Calcium (1.8 meq/100g-8.4 meq/100g) and Magnesium (0.2 meq/100g -6.0 meq/100g) were reported from soil of wildlife sanctuary[11].

The researchers have done assessment of soil near Rudrasagar Oil Field in Assam. They have observed pH, EC, OC, Chloride, Cr, Mn, and Zn in the range 5.01-5.63, 0.05-0.23 mS/cm, 1.95-3.9 %, 37.2-74.4 mg/kg, 155.3-179.1 mg/kg, 99-131 mg/kg and 88.5-119.7 mg/kg respectively[12].

The observed physico-chemical characteristics of soil samples collected around Mysore city. The pH range was observed from 7.28 to 8.62. Water holding capacity found to be varied from 40% to 64%. The concentration for Calcium was observed to be 2.605 mg/kg to 4.80 mg/kg and for Magnesium from 0.462 mg/kg to 0.998 mg/kg[13].

The observed Fe, Zn, and Mn concentrations in the soil samples taken from the nurseries in Dungun, Terengganu in the range of 1.5-7.6, 13-74, and 23-338 mg/Kg respectively[14].

The concentrations of heavy metals Fe, Cr, Zn, and Mn obtained in the soil samples taken from Alau and Gongulon Dams, Maiduguri were 51.02 ± 0.60 and 60.20 ± 0.70, 65.50 ± 0.68 and 76.18 ± 5.49, 13.56 ± 0.38 and 16.72 ± 0.16, 13.81 ± 0.01 15.12 ± 0.26 mg/Kg respectively during the period of December, 2007 to May, 2008 [15].

The Zinc content found in field soil 63-161mg/Kg, p H 6-7.5 and organic carbon 2.1-2.7% from the towns of Zuchwil and Oberuzwil in Switzerland during the year 1998 and 2000 respectively[16].

The investigated Fe, Cr, Zn and Mn heavy metal concentrations 14.51 mg/Kg, 0.247 mg/Kg, 2.03 mg/Kg, and 2.90 mg/Kg in effluent irrigated soil. Also they found same metals 7.49 mg/Kg, 0.063 mg/Kg, 0.60 mg/Kg and 2.1 mg/Kg from well water irrigated soil[17].

The Iron, Zinc and Manganese metal contents were 64-90.4 mg/Kg, 3.8-398.5 mg/Kg and 4.4-40.6 mg/Kg in the soils near industrial belt in Visakhapatnam respectively[18].

The presence of heavy metals in the environment and specifically, in soils, industrial and domestic urban wastes endangers living organisms. Once it gets into food chain, through plants, animals and water sources leads to biomagnification and bioaccumulation in living cells and tisues[19].

The mean values of iron, zinc, chromium and manganese observed from the place near paint industry of Nigeria were ranged between 61.22-70.12, 4.35-7.88, 0.01-0.16 and 11.52-14.53 mg/Kg respectively[20].

The study of the soil samples collected from Siddheshwar dam with reference to accumulation of heavy metals and physico-chemical parameters shows that observed results are nearly in the range of results reported in the above cited articles.

Table-1
The average values of physico-chemical parameters of the soil samples from Siddheshwar dam of Hingoli district, Maharashtra

S.N.	Soil Parameters	Average
1	Temperature	26.8^{o}C
2	Water Holding Capacity (WHC)	46%
3	Soil Moisture	12.7%
4	Conductivity	3.01 mS/cm
5	pH	5.44
6	Organic Carbon (OC)	0.09%
7	Organic Matter (OM)	0.1566%
8	Alkalinity	25 meq/100gm
9	Chloride	24.35%
10	Fluoride	0.205 mg/L
11	Calcium (Ca)	112 mg/Kg
12	Magnesium (Mg)	155 mg/Kg

Table-2
The mean Heavy metal concentration in the soil samples from Siddheshwar dam, Maharashtra

Sr. No.	Heavy Metal	Concentration (mg/Kg)
1	Iron (Fe)	60
2	Chromium (Cr)	40
3	Zinc (Zn)	21.75
4	Manganese (Mn)	12.59

Conclusion

From this study, it was concluded that the study area has black cotton soil, which is rich in calcium and magnesium. The soil is mainly alluvial in nature.

From the results of the work, it can be concluded that the pH of the soil sample was slightly acidic. The organic carbon is low in the soil sample. The soil sample contains iron above the permissible limit. The organic manures have to be use for improvement in fertility of soil instead of chemical fertilizers. Increase the use of the natural pesticides to avoid side effects of other pesticides.

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References

1. Srivastava K.P. and Singh Vikash Kumar, Impact of Air-Pollution on pH of soil of Saran, Bihar, India, *Research Journal of Recent Sciences,* **1(4),** 9-13 **(2012)**

2. Sharma B.K., Environmental chemistry, IV ^{ed}, Goel Publication House, Meerut, **(2001)**

3. Eruola A.O., Ufoegbune G.C., Eruola A.O., Awomeso J.A. and Abhulimen S.A., Assessment of Cadmium, Lead and Iron in Hand Dug Wells of Ilaro and Aiyetoro, Ogun State, South-Western Nigeria, *Research Journal of Chemical Sciences*, **1(9)**, 1-5 **(2011)**

4. Biswal D., Muralidhar J. and Patra, Heavy metal concentration in sediment water of river Kusei, *Indian Journal of Environmental Health*, **40**, 349-358 **(1998)**

5. Patil B.H. and Srivastava V.S., Accumulation of heavy metals through industrialization, *International Journal of Chemical Sciences*, **2(4),** 637-641 **(2004)**

6. Sachan S. Singh S.K. and Srivastava P.C., Build-up of heavy metals in soil-water-plant continuum as influenced by irrigation with contaminated effluent, *Journal of Environmental Science and Enggineering*, **49(4),** 293-296 **(2007)**

7. Srivastava V.S. and Patil B.H., Metallic and some physico-chemical studies of soil and aquatic sediments, *Ecology, Environment and Conservation*, **9(1),** 75-77 **(2003)**

8. Jackson M.L., Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi **(1973)**

9. Chhatwal G.R., Mehra M.C., Katiyal T., Satake M., Katiyal Mohan and Nagahiro T., Environmental Analysis (Air, Water and Soil), Anmol Publications, New Delhi, 1^{Ed} **(1989)**

10. APHA, Standard methods for the examination of water and wastewater, 20th edition, American Public Health Association Washington D.C., **(2000)**

11. Nath S.K. and Sarma S.K., Physico-chemical properties of soil of Laokhowa Wildlife Sanctuary, Nagaon, Assam, *Nature Environment and pollution Technology*, **7(3),** 561-564 **(2008)**

12. Kalita Mukut, Bhattacharyya K.G. and Devi Arundhati, Assessment of soil field soil with special reference to the presence of heavy metals: a case study in agricultural soil at Rudrasagar oil field, Assam, *Indian Journal of Environmental Protection*, **29(12),** 1065-1071 **(2009)**

13. Madoodi M.N. and Belagali S.L., Survey of pesticide in soils around Mysore city, *Nature Environment and pollution Technology,* **7(1),** 21-26 **(2008)**

14. Tahir Norhayati Mohd, Poh Seng Chee and Maisarah Jaafar, Determination of heavy metals content in soils and indoor dusts from nurseries in Dungun, Terengganu, *The Malaysian Journal of Analytical Sciences,* **11(1),** 280-286 **(2007)**

15. Uwah E.I., Ndahi N.P. and Ogugbuaja V.O., Study of the levels of some agricultural pollutants in soils, and water leaf (Talinum Triangulare) obtained in Maiduguri, Nigeria, *Journal of Applied Sciences in Environmental Sanitation*, **4(2),** 71-78 **(2009)**

16. Mozafar A., Ruh R., Klingel P., Gamperi H., Egli S. and Frossarossard E., Effect of heavy metal contaminated shooting rangesoils on Mycorrhizal colonization of roots and metal uptake by Leek, *Environmental Monitoring and Assessment*, 177–191 **(2002)**

17. Ratna P. Roy, Jagdish Prasad and Joshi A.P., Effect of Sugar Factory effluent on some physico-chemical properties of soils-A case study, *Journal of Environmental Science and Enggineering,* **49(4),** 277-282 **(2007)**

18. Rao Narasimha S.L. and Sarma D.R.R., Trace metals in soils near an industrial belt in Visakhapatnam, India, *Pollution Research*, **17(4),** 377-380 **(1998)**

19. Ujowundu C.O., Kalu F.N., Nwaoguikpe R.N., Kalu O.I., Ihejirika C.E., Nwosunjoku E.C., Okechukwu R.I., Biochemical and Physical Characterization of Diesel Petroleum Contaminated Soil in Southeastern Nigeria, *Research Journal of Chemical Sciences,* **1(8),** 57-62 **(2011)**

20. Nwajei G.E., Okwagi P., Nwajei R.I. and Obi-Iyeke G.E., Analytical Assessment of Trace Elements in Soils, Tomato Leaves and Fruits in the Vicinity of Paint Industry, Nigeria, *Research Journal of Recent Sciences,* **1(4),** 22-26 **(2012)**