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Studies of Physicochemical and Some Heavy Metals in Soil and Lake Sediments

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Abstract

The present work attempts to establish the distribution of Iron, Manganese, Zinc, Copper, Boron and molybdenum and physic-chemical properties of the soil and lake sediments in Bijapur district. The area under study receives domestic raw sewage from surrounding populated neighborhoods through rain water, main tributary of the lake. Concentrations of heavy metals in soil are compared with many guidelines to predict status of pollution.

KEYWORDS: Heavy Metals, Lake sediments, Pollution, Soil Samples, etc

INTRODUCTION

In many developing countries, the expansion of urban centers is of considerable importance for socio- economic growth and this continuously modifies the physical, chemical and biological composition of our living environment [1]. Thus, many people living within these urban centers are often exposed to such unnatural environment since they depend on resources from water, soil and air. Heavy metals are considered as the most important form of pollution of the aquatic environment because of their toxicity and accumulation by marine organisms [2]. The sediment transported in streams originates either from the stream channel or from the soil surface in the watershed [3]. Very small amount of certain heavy metals are essential for life and it has been stated that they are more important than vitamins since they cannot be synthesized by living matter. Copper, zinc and chromium, although essential at low levels, are very toxic at higher concentrations [4]. Heavy metals are stable and persistent environmental contaminants since they are not biologically degraded like many organic pollutants; thus, they tend to accumulate, particularly in sediments in association with organic and inorganic matter and involve adsorption, complex formation and chemical combination [5.6]. Some trace metals are necessary in small amounts for individual metabolic processes, being assimilated by marine organisms. However, their capacity to form complexes with organic substances can result in concentrations up to 1000 times higher than their assimilation and fixation in tissues, becoming toxic to organisms [7]. Rapid urbanization and industrialization with improper environmental planning often lead to discharge of industrial and sewage effluents into rivers and lakes. The lakes have a complex and fragile ecosystem, as they do not have self-cleaning ability and, therefore, readily accumulate pollutants [8,9].

STUDY AREA

Bijapur District is a district in the state of Karnataka in southern India. The city of Bijapur is the headquarters of the district, and is located 530 km northwest of Bangalore. Bijapur is well known for the great monuments of historical importance built during the Adil Shahi dynasty. The soils of Bijapur District can be categorized as a low to moderately yielding area (1000 to 8000 L/h) 72.2% of district falling in this category. From considerable part of the district (9%) poor yielding (less than 1000 L/h sources) or non–feasible areas have been reported. The talukas having largest poor yielding area, are Muddebihal (19%) followed by Indi (15%), Bijapur and sindagi (13% each), Basavan Bagewadi (4%). Low yielding areas (1000 to 4000 L/h source) in the district constitute about 40% of the district, with the largest being Basavan Bagewadi (54%) and smallest in Indi taluka Moderate yields (4000 to 8000 L/h source) are reported from 36% of the district, highest being in Bijapur with 70% of the area, and lowest being in Sindagi with 19% of the taluka. High yielding areas (more than 8000 L/h sources) over 15% of the district. The smallest areas under this category are in Sindagi Taluka (2% each) and largest is in Muddebihal (29% each) where very lengthy contact zones occur between traps and other formations.

MATERIAL AND METHODS

Data collection and analysis- 10 soil samples (three replicates) were collected at surface level (0-10 cm in depth) were collected from various locations. The collected samples were air dried and sieved into course and fine fractions. Well mixed samples of 2 g each were taken in 250 mL glass beakers and digested with 8 mL of aqua regia on a sand bath for 2 hours[10]. After evaporation to near dryness the samples were dissolved with 10 mL of 2% nitric acid, filtered and then diluted to 50 mL with distilled water. The available nitrogen was determined by the method described by Subbaiah and Asija[11]. The available phosphorus and potassium in the soil were determined by the method described by Jackson[12]. Heavy metal concentrations (Cu, Fe, Mn, Zn) of each fraction was analyzed by Atomic Absorption Spectrophotometer using GBC Avanta version 1.31 by flame Automization[13,14]. Quality assurance was guaranteed through double determinations and use of blanks for correction of background and other sources of error. Quality assurance was guaranteed through double determinations and use of blanks for correction of background and other sources of error. EC of soil samples were determined from saturation extract by conductivity meter. Measurement of pH of the soil samples were done (soil and water ratio 1 : 25) were done with the help of glass electrode pH meter. Nickel and cadmium were analysed according to USEPA method (3050).

RESULT AND DISCUSSION

The analytical data of soil samples are presented in Table 1. The soil pH of samples ranged from 7.5 to 8.6, slightly above the optimum range (5.5-8.00) considered to be satisfactory for horticulture crops. The electrical conductivity values varied from 0.53 to 2.37 dS/m, well below the critical concentration. The electrical conductivity of a soil is used to measure the potential risk of salt injury to plants, and it is currently measured with a 1:2 soil: water mixture. This measurement includes all soluble salts, not just sodium chloride that most people are familiar with. Electrical conductivity readings can vary dramatically within fields and across time and are greatly affected by environmental conditions (e.g., rainfall). Sodium content ranged from 0.058 to 4.068 mg/acre. A soil high in sodium, also known as a “sodic” soil, is one in which sodium occupies an excess amount of space on soil exchange sites. As soil sodium levels increase soluble calcium levels decrease. And its soluble calcium that gives soil its friable, loamy, permeable structure. A continued decline in soluble calcium brought on by ever increasing soil sodium causes the soil to lose these favorable structural properties, resulting in impaired drainage and increased compaction. Left untreated, a sodic soil will eventually see decline in turf vigor. Toxicity arising from the sodium ion itself is rare, due to the fact that problems with soil structure usually arise well before sodium can build to toxic levels. A soil high in sodium, also known as a “sodic” soil, is one in which sodium occupies an excess amount of space on soil exchange sites. As soil sodium levels increase soluble calcium levels decrease. And its soluble calcium that gives soil its friable, loamy, permeable structure. A continued decline in soluble calcium brought on by ever increasing soil sodium causes the soil to lose these favorable structural properties, resulting in impaired drainage and increased compaction. Left untreated, a sodic soil will eventually see decline in turf vigor. Toxicity arising from the sodium ion itself is rare, due to the fact that problems with soil structure usually arise well before sodium can build to toxic levels. Organic carbon content ranged from 0.320 to 2.140 kg/ha. Soil organic matter also influences environmental processes at a global scale. Top soils are a huge terrestrial reservoir of C, which has a modifying effect on carbon dioxide concentrations in the atmosphere and can thus influence climate warming [14]. Available nitrogen ranged from 75.260 to 328kg/ha, this might be due to higher range of mineralization due to high temperature (dry zone) and loss of nitrogen in the form of ammonia as the soils are calcareous. Total nitrogen concentration varied from 0.013 to 0.615kg/ha. The available phosphorus content ranged from 5.01 to 73.6 Kg/ha which was high in range. Phosphorus and potassium are two of the three macronutrients (the other being nitrogen) required by plants for optimum growth. They are required in larger amounts compared to the micronutrients (e.g., zinc, iron, boron, etc.). Yield response to P fertilization is not likely when the soil P is ≥36 ppm (72 lb/acre) for row and forage crops, above 25 ppm (50 lb/acre) for fruit crops and above 75 ppm (150 lb/acre) for vegetable production. Responses to potassium fertilization are not likely when the soil tests above 175 ppm (350 lb/acre) for vegetables, row and forage crops and above 90 ppm (180 lb/acre) for fruit crops.

The available potassium ranged from 76.16 to 795.2 kg/ha which is above optimum level(175kg/ha) and this may be attributed to high fertilization. The calcium content ranged from 0.68 to 14.80 kg/ha. Most sandy soils have calcium concentrations below 400 to 500 parts per million (800 to 1,000 lb/acre), while clayey soils usually test above 2,500 ppm. Normally, the higher the calcium level, the greater the soil clay content. Recent limestone applications may result in higher calcium levels. If the soil pH is maintained in the recommended range for the crop grown, calcium deficiency is very unlikely. In general, the higher the clay content, the more lime will be required to raise soil pH to the desired level. Magnesium concentration ranged from 0.29 to 7.4 kg/ha. Limited information is available on the crop response to magnesium fertilization but if the soil tests below 31 ppm (62 lb/acre), the soil test report will suggest an application of magnesium. Most soils low in magnesium are often acidic and low in calcium. Sulphate content varied from 1.20 to 62.30kg/ha (10 kg/ha) which is high in range[15] .Iron concentration ranged from 0.81 to 9.38kg/ha. Iron is very insoluble under oxidizing condition in soil, the organic matter in the soil may form chelate complex by keep considerable amount of Fe (III) in a mobile form. Manganese content varied from 0.18 to 3.41 kg/ha (≤40kg/ha) which is low in range. Soil test Mn values <40 ppm (80 lb/acre) are considered low. Although Mn fertilizer is not currently recommended for agronomic crops in Arkansas, manganese deficiencies are sometimes observed on soil with pH >6.5 and soil test Mn concentrations below 20 ppm (40 lb/acre) and may require application of Mn fertilizer. Zinc concentration ranged from 0.112 to 2.810 kg/ha (8kg/ha optimum)[16]. Copper concentration varied from 0.68 to 3.28kg/ha(<1.0 kg/ha) which is above the limit. A very high level of any micronutrient does not necessarily indicate that a plant nutrient toxicity will develop. For example, soil test iron values above 200 ppm (400 lb/acre) and zinc values above 40 ppm (80 lb/acre) are sometimes observed, but rarely are these concentrations toxic to plants. In contrast, manganese levels exceeding 200 ppm (400 lb/acre), coupled with a soil pH below 5.2, may result in manganese toxicity. This particular problem is easily corrected by applying recommended rates of lime to the soil. Soil test Mn values < 40 ppm (80 lb/acre) are considered low. Although Mn fertilizer is not currently recommended for agronomic crops in Arkansas, manganese deficiencies are sometimes observed on soil with pH >6.5 and soil test Mn concentrations below 20 ppm (40 lb/acre) and may require application of Mn fertilizer [17]. Boron concentration ranged from 0.120 to 0.780 kg/ha. Boron helps in the metabolism or utilization of Ca, Cu, Mg, glucose, triglycerides and estrogen in our life processes[18] Out of the 18 water samples 4 samples recorded higher than the prescribed WHO limit (0.5 ppm) and all samples falls with in the BIS (105000) limit. Moreover use of boron compounds as fertilizer, insecticide and herbicides at regular intervals and paddy fields around the tea gardens are subjected to wastewater irrigation disposal hence possibility of boron leaching in under ground water.. While molybdenum concentration found to be from 0.040 to 0.180 kg/ha. Molybdenum as a microelement is of great interest because high concentrations of Mo in soils, sediments and sludge’s, either from natural sources or through pollution, can enter the food chain through plant uptake, direct ingestion of soil by animals or through water supplies. As a result, strict control of Mo concentrations in environmental samples is necessary. Investigation of the sources of molybdenum in the geological matrices indicates an increased awareness of the potential exposure arising from environmental pollution [19].

Conclusion

This paper proposes the determination of trace elements and some physic-chemical properties in lake residues and natural soils. Heavy metal levels were found to be higher than in the worldwide levels, but in some soil samples, heavy metal concentrations agree with worldwide levels. Its levels were found to be rather high in samples.

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REFERENCES

1. Munendra Singh, German Müller and I.B. Singh, 2002, Heavy metals in freshly deposited stream sediments of rivers associated with urbanization of the Ganga plain, India. Water, Air and Soil Pollution, 141: 35-54..
2. Ochieng, H., E.S. Steveninck and F.M. Wanda, 2008. Mouthparts deformities in chironomides (dipteral) as indicators of heavy metal pollution in northern LakeVictoria, Uganda. Afr. J. Aqua. Sci., 33(2): 135-142.
3. Carter J, Owens P N,Walling D E and Leeks GJL 2003 Finger printing sediment sources in a large urban river system;Sci Total Environ,314-316,513-534.
4. Mertz, W., 1981. The essential trace elements Science, 213: 1332-1338.

5. Pradeep Shrivastava, Alok Saxena and Abha Swarup, 2003. Heavy metal pollution in a sewage-fed lake of Bhopal, (M. P.) India. Lakes & Reservoirs: Research and Management, 8: 1-4.
6. Tahri, M., F. Benyaïch, M. Bounakhla, E. Bilal J.J. Gruffat , J. Moutte and D. Garcia, 2005. Multivariate analysis of heavy metal contents in Multivariate analysis of heavy metal contents in (Central Morocco). Environmental Monitoring and Assessment, 102: 405-417.
7. CETESB, 1982. Bioacumulaçao de metais pesados em peixes da Baia de Santos e São Vicente, São Paulo, Brasil, Relatorio tecnico.
8. Lokeshwari, H., and G.T. Chandrappa. 2006. Impact of heavy metal contamination of Bellandur Lake on soil and cultivated Vegetation. Current Science 91: 622–7.
9. K.G.Pujar,M.S.Yadawe,S.C.Hiremath,U.S.Pujeri and A.S.Pujar Snalysis of Physico-chemical and heavy metal concentration in soil of Bijapur taluka., Sci. Revs. Chem. Commun.: 2(1), 2012, 76-79
10. Ming Chen and Ma, Q. Lena, Soil Sci. Socamj., **65**, 491-499 (2001).
11. B. V. Subbaiah, and G. L. Asija, A A Rapid Procedure for Determination of Available Nitrogen in Soil, Current Science **25,** 259-260 (1956).
12. M. L. Jackson, Soil Chemical Analysis Prentice Hall of India Pvt. Ltd., New Delhi (1967) pp. 205.
13. B. S. Lork, R. K. Mahajan and Tps, Indian J. Environ. Health, **44(2)**, 164-167 (2002).
14. Paustian, K., O. Andren, H.H. Janzen, R. Lal, P. Smith, G. Tian, H. Tiessen M. Van Noorwijk, and P.L. Woomer. **1997a**. *Soil Use and Mgt.* 13:230-244.
15. Muneshwar Singh and G. S. Shekhon, DTPA Extractable Micronutrient Cations in Twenty Soil Series of India, Ind. Soc .Soil Sci., **39**, 129-133 (1991).
16. H. E. Neue and C. P. Mamaril, Zinc Sulphur and Other Micronutrients in Wetland Sol. Characterization, Classification and Utilization, Proc., Workshop 26 March - 5th April 1984, International Rice Research Institute Philipines (1985) pp. 307-319.
17. Division of Agriculture research and extension University of Arkanas.
18. F.N. Nilsen, J. Trace Elements Exp. Medicine, 1992, 5, 237-246.
19. A.K. Das, R. Chakraborty, M.L. Cervera and M. de la Guardia, *Talanta*, **71**, 987 (2007).

TABLE. 1
PHYSICOCHEMICAL AND HEAVY METAL ANALYSIS OF SOIL AND SEDIMENTS

S.No & Name of place	pH	EC	Sodium	Organic carbon	Available N	Total N	Available P	Available K	Calcium	Magnesium	Sulphate	IronFe	Mangenese	Zinc	Copper	Boron	Molybdenum
1(Kavatagi)	7.7	1.87	0.102	1.016	213.24	0.045	23.3	488.3	13.18	7.4	11.91	5.97	1.86	0.112	1.27	0.740	0.050
2(Babanagar)	7.5	1.37	0.068	0.986	301.05	0.051	19.3	334.8	14.80	6.5	25.30	8.32	3.41	0.792	1.00	0.780	0.040
3 (Tikota)	7.8	0.66	0.095	0.914	225.79	0.021	26.1	795.2	12.50	6.3	62.30	6.94	2.91	0.790	1.43	0.310	0.080
4(Dandaragi)	7.9	1.22	0.115	2.140	137.90	0.034	26.4	319.2	11.90	7.3	10.17	8.79	2.47	0.238	1.93	0.080	0.060
5(Lohagaon)	8.3	0.53	0.140	1.160	75.260	0.027	21.1	387.5	9.30	5.6	10.15	9.38	1.94	0.746	0.95	0.060	0.056
6(Ittangihal)	8.0	0.79	0.058	1.930	163.07	0.029	19.2	76.16	11.7	6.9	9.94	7.46	2.79	0.912	1.13	0.080	0.062
7(Nimbaragi)	8.3	2.29	4.068	0.791	175.60	0.435	5.01	375.6	0.89	0.38	4.85	1.78	0.18	2.810	1.58	0.740	0.050
8(Bhutanal)	8.3	1.30	3.814	0.152	213.20	0.325	6.75	180.4	0.98	0.52	5.71	1.85	0.56	1.820	0.68	0.780	0.050
9(Bhutanal)	8.7	0.68	1.328	0.971	238.20	0.615	5.46	239.5	0.88	0.33	3.62	0.81	0.81	1.280	1.68	0.380	0.080
10(Minchanal	8.5	0.86	1.781	1.172	188.16	0.385	7.38	326.5	0.68	0.75	1.20	0.91	0.65	1.780	2.58	0.280	0.060
11(Tamba)	8.3	2.37	0.790	0.420	188.00	0.042	67.5	296.0	2.88	0.29	34.20	4.126	1.27	0.812	3.28	0.180	0.080
12(Nimbal)	8.6	2.32	0.740	0.390	175.00	0.04	67.9	418.0	2.72	0.298	33.62	3.91	1.28	0.670	2.73	0.120	0.040
13(Kannolli)	8.3	2.37	0.790	0.42	188.00	0.042	67.5	296.0	2.88	0.292	34.20	4.20	1.27	0.812	3.28	0.180	0.080
14(Baratagi)	8.6	2.32	0.740	0.390	175.00	0.046	67.9	418.0	2.72	0.298	33.62	3.912	1.28	0.673	2.73	0.120	0.040
15(Horti)	7.6	2.20	0.530	1.390	328.00	0.013	59.0	296.2	2.38	0.440	48.69	7.162	1.95	0.243	1.04	0.361	0.180
16(Babaleshwar)	8.1	1.16	0.850	0.450	157.00	0.028	71.7	432.1	1.24	0.421	37.43	8.62	1.68	0.532	1.37	0.212	0.090
17(Kakhandaki)	8.6	1.20	0.860	0.320	163.00	0.023	73.6	428.6	1.27	0.461	38.21	8.61	1.68	0.525	1.47	0.223	0.060