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Abstract - In order to know the surface water pollution in the part of Bhadravathi industrial town, Shimoga District, Karnataka state, the present study has been conducted around Mysore Paper Mill (MPM) solid waste dump site, which may be the source of pollution. Nine surface water samples were collected and analyzed for physico-chemical parameters and heavy metal concentrations. The results indicated that the concentration of Na is high in two samples and very high in three samples. The increase in the concentrations of Na and K in surface water samples may be probably due to the agricultural run-off and effluents discharged from the industries.

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I. Introduction

The environmental problems that arise due to industrial activities are water pollution, air pollution, generation of hazardous waste and noise pollution. The nature of emissions and effluents from industries are varied and industry specific. If the effluents discharged from the industries are left on the land for natural evaporation or the solid wastes disposed as landfill or used for agriculture, the pollutants may reach the surface water bodies through runoff and later infiltrates to pollute the ground water. In this regard the present study is concentrated only on the surface water quality assessment in Bhadravathi industrial town of Karnataka, India.

Bhadravathi town is one of the major industrial areas in Karnataka, in which river Bhadra is passing through the heart of the city and receiving sewage and effluents from Mysore Paper Mill (MPM) and Visweswaraiah Iron and Steel (VISL) industries and domestic wastes. Considering these facts the study area has been chosen in a buffer zone of 4.5 Kms from MPM dumpsite (13^0 48'46"N – 13^0 50' 52" N and 75^0 44' 40" E – 75^0 44' 44"E).

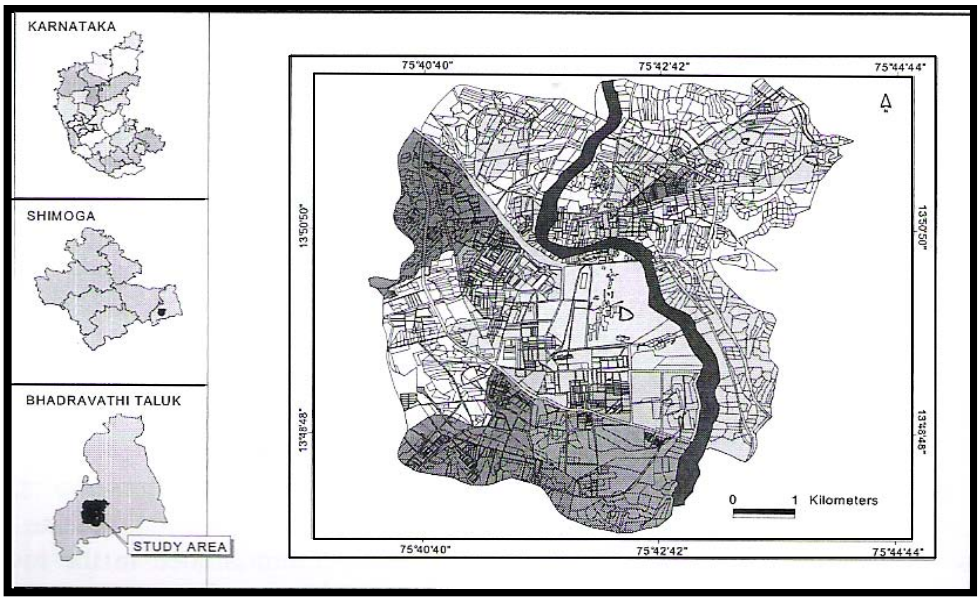

Fig 1 : Map showing the location of the study area

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II. Geology & Soil

Study area consists of ancient rock formation of Achaean age and these are mainly of Dharwar super group and the components of peninsular gneissic complex. The granitic gneisses occurring as scattered out crops, forms the principal exposures of the study area are with minor components of quartz-chlorite schist. These rocks are traversed by three set of joints i.e., N 35^0 W dipping 60^0 E, N 30^0 E dipping 60^0 W & N55^0E dipping almost vertical, respectively for first, second and third set of joints and the major soil type is red loamy.

III. Methodology

The present work is based on nine surface water samples that are collected during the year 2006. Samples were collected were analyzed for pH by Digital pH meter, EC by Conductivity meter, TH, Cl, Mg, Ca by titrimetric method. BOD, COD by Winkler and Reflux condensation methods respectively. TS, TDS, TSS by Evaporation method, SO_4, NO_3, PO_4 by UT-Visible Spectrophotometer, Heavy metals by ICP-AES.

IV. Results and Discussion

pH varies from 6.39 to 8.44 and are with in the permissible limits of 6.5 to 8.5 are prescribed by BIS (1991). The EC values ranges from 238 to 806 and this is within the desirable limit (1500) of BIS except in sample no 4. Concentrations of Cl and TH ranges from 4 to 221 mg/l and 69 to 220 mg/l respectively and these are also well within the permissible limits. Total alkalies expressed as HCO_3 and TDS concentrations of surface water samples of the present study are 120 to 220 mg/l and 155 to 524 mg/l respectively and these are within the permissible limits.

Concentrations of SO_4, NO_3 and PO_4 of the samples are in range of 2.61 to 17.84 mg/l, 3.16 to 23.73 mg/l and 0.93 to 1.94 mg/l respectively and are within the permissible limits. The value of Ca and Mg varies from 17 to 48 mg/l and 6 to 23 mg/l respectively and are well within the permissible limits.

Sodium is present in all natural water as sodium salts, which are high soluble in water. Except in two samples (samples no.3 & 7) concentration of Na is high in sample no 2 & 6 to very high in samples 1, 4 & 5. The concentration of K is within permissible limits excluding sample 4 & 5 in these two samples the levels of K is 45 and 13 respectively. The increase in concentrations of Na and K in the surface water sample no 4 & 5 is probably due to the agricultural run-off and effluents discharged from industries.

BOD of the samples are with in the permissible limits, except sample no 6 & 7, which is 12 and 8 mg/l respectively, this higher values in BOD may be due to sewerage input, which was observed during the field visit.

COD has been found to be more scientific than BOD and it's not much influenced by pH value of water, type of micro-organism, presence of toxic materials, nitrification processes and residual mineral matter (Sharma and Kaur, 1994). The COD values in the study area are slightly higher than the permissible limit of WHO (10 mg/l), except sample no 5. All the above said values are tabulated in Table 1.

a) Status of Heavy metals in the samples

The results obtained indicate that the Al value ranges from 0.009 to 0.153 ppm, Fe varies from 0.025 to 0.204 ppm and Mn varies from 0.003 to 0.232 and are well within the permissible limits set by WHO (2005) and BIS (1991). In transitional trace elements Ni and V are detected in all the samples and are varies from 0.001 to 0.003 and 0.001 to 0.005 respectively and are within the permissible limits. Where as Cr and Co have detected in samples no. 1, 2, 5, 6 and sample no 4 respectively, these are within the permissible limits.

Concentrations of Cu, Pb, Zn and Ba in these samples vary from 0.002 to 0.017 ppm, 0.001 to 0.004 ppm, 0.004 to 0.082 ppm and 0.031 to 0.079 ppm respectively and are well within the permissible limits.

b) Agricultural suitability

Assessment of surface water samples for agricultural suitability, USSL technique is generally followed for the classification of water for irrigation based on conductivity and Sodium Absorption Ratio (SAR). Sample no 3 and 6 belongs to class 1 of USSL, water of this class are low salinity type and can be used to grow almost all type of crops in all variety of soils. Sample no 1,2 and 7 belongs to class 2 of USSL, water of this class are medium salinity type and can be used to grow plants of moderate salt tolerance. Sample no 4 and 5 belongs to class 3 of USSL, water of this class are high salinity type and can be used to grow salt tolerance plants with special management for salinity control.

Sample no.	pH	EC (μmhos/c)	Cl	TH	HCO_3	TDS	BOD	COD	SO_4	NO_3	PO_4	Ca	Mg	Na	K
1	7.05	566	33	140	200	368	6	20	7.76	23.73	1.94	35	13	35	3
2	7.70	434	21	101	152	282	6	20	4.47	3.16	0.93	25	9	24	5
3	7.13	238	4	69	120	115	5	16	5.80	4.66	Nil	17	6	12	2
4	8.05	3440	249	332	780	2236	6	20	9.53	10.41	Nil	52	48	282	45
5	7.68	806	221	220	200	524	3	8	2.61	12.70	Nil	48	23	113	13
6	8.44	396	5	75	128	257	12	40	4.48	3.71	Nil	19	6	22	8
7	6.93	290	24	90	160	189	8	28	17.84	7.11	Nil	24	7	11	3
8	7.91	306	42	228	101	183	2	16	6.84	4.19	ND	34	11	17	2.3
9	7.84	383	46	148	125	230	2.50	20	7.02	5.02	ND	38	12	21	3.4

Table 1 : Physico-chemical parameters of surface water samples (All the values are in mg/l except pH & EC)

Sample no.	Sample location	Al	Fe	Mn	Cr	V	Co	Ni	Cu	Zn	Ba	Pb
1	Near coconut plantation south gate	32	94	15	2	2	BDL	2	5	82	56	1
2	Pond near the river course	39	36	5	2	2	BDL	3	3	13	35	1
3	Near water works	37	89	13	2	2	BDL	1	2	6	31	1
4	Kalingaeshawara temple	126	48	232	5	5	1	3	5	4	73	4
5	Thimmalapura North	39	27	9	2	2	BDL	2	17	5	79	2
6	Pond water near canal	153	111	12	1	1	BDL	2	5	6	63	1
7	Doddagoppenalli tank	9	204	3	1	1	BDL	1	3	6	36	2
8	Down stream of Gondi canal	ND	14	ND	ND	ND	ND	ND	16	20	ND	NIL
9	Up stream of Gondi canal	ND	16	ND	ND	ND	ND	ND	12	24	ND	NIL

Table 2 : Heavy metal concentrations of surface water samples (values are in ppb)

Sample no.	SAR	Mg Hazard	KR	RSC	CR	%Na	EC (μmhos/cm)	USSL Class	Water type
1	1.28	37.2	0.54	0.006	0.63	44.59	250-750	2	$CaHCO_3$
2	1.06	36.4	0.53	0.004	0.50	46.16	250-750	2	Ca-HCO_3
3	0.006	37.1	0.40	0.003	0.55	39.16	0-250	1	Ca-HCO_3
4	6.77	60.3	1.87	6.07	0.57	76.55	750-2250	3	Na-HCO_3
5	3.33	44.5	1.13	0.00	1.68	63.79	750-2250	3	Na-Cl
6	1.44	33.4	0.66	0.00	0.42	54.05	0-250	1	Na-HCO_3
7	0.005	31.1	0.28	0.003	1.37	31.49	250-750	2	Ca-HCO_3
8	0.647	34.3	0.38	0.00	1.30	30.16	250-750	2	Ca-HCO_3
9	0.752	35.0	0.41	0.00	1.10	32.37	25-750	2	Ca-HCO_3

Table 3 : Irrigation suitability factors in study area

Permissible limits of Sodium Adsorption ratio (SAR), Magnesium hazard (MG-Haz), Kelley's radio (KR), Residual sodium carbonate (RSC), Corrosivity ratio (CR) and Sodium percentage (% Na) are 18-26,<50%,<1, 1.5-2.5 meq/l, <1, 40-60% respectively (Sharma B.K., and Kaur.H 1994).

V. Conclusions

As such there is no significant impact on surface water quality due to disposal of solid waste by MPM as landfill. Na and K concentrations in surface water sample no. 4 & 5 are high and are classified as high salinity type water as per USSL classification, this is probably due to the input of agricultural run-off and effluents discharged from industries and quality of these wastes should be monitored regularly. BOD of 6 and 7 no of samples are higher than the permissible limits. The higher level of BOD in these samples is due to sewerage input and the presence of weeds, which was observed during the field visit.

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