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EUTROFICATION DUE TO INDUSTRIALIZATION IN ANGUL-TALCHER INDUSTRIAL COMPLEX OF ODISHA

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Abstract: Eutrofication is the contamination of water due to ageing of water resources and introduction of some external materials in it as well. Water may be polluted either from natural sources or by human activities. The water resources of Angul-Talcher industrial complex contain fluoride more than the standard water quality are toxic to human beings, animals and plants (causes old age to set in early). The untreated/partly treated wastes and waste water from different industries & coal mines to Brahmani river at Talcher adversely affect the water quality and water uses .These effluents discharge to the nearby rivers and ponds eutroficate the water resources and thus making them to shrinking drains . The river Nandira, at Talcher is said to be dead due to discharge of fly ash effluents into the river. The river Nandira and the creeks receiving fly ash effluents join to the river Brahmani in which the water is polluted with the heavy metals ion concentration . The ground water of open wells near to NALCO smelter plant was detected containing high amounts of fluoride and contributes certainly the "fuel for pollution" pursued by industrialization induced eutrofication in Angul- Talcher industrial complex of Odisha, needs attention for early remedial measure.

Key words: Eutrofication, Physico-chemical parameters, pH, Electrical Conductivity (EC) Total dissolved solid (TDS), Total hardness (TH), Iron (Fe), Chloride (Cl^-) and Fluoride (F^-), Correlations matrix.

Introduction

We trash the earth not because we are evil but because our industrial system leaves us with no choice. Our high rises factories and farms, freeways, mining excavations and power plants were conceived before we had a clue how the planet works .They are primitive inventions that have been signed by people who did not fully grip the consequences of their action; breeds the grounds for pollution, poverty, diseases and despair; needs careful planning (specially Zero discharge) for the flagship of sustainable development.

Water has become one of the most abused resources in Odisha, and there are growing conflicts in sharing inter-state and intra-state; our rivers have become almost seasonal. Our water bodies have become polluted in spite of hygienic personal practices. Our community

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sense of conservation is at an abysmal low, and that has made clean water availability a huge crisis. Pollution from Industrial and municipal sources, exploitation by industries and other commercial activities are leading to conflicts as well as depletion and eutrofication [1, 2].

Industrial pollution**,** especially in the industrial estates and industries in Angul-Talcher industrial complex has made life miserable in these areas. Urbanization is at its growing trend and has impacted the urban landscapes and living environment, making it more and more un-inhabitable.

And most importantly, the health of the Angulites is deteriorating, if one is to interpret the statistics that show recurring contagious diseases, alarmingly increasing life-style diseases, increasing rates of diseases affecting the growing child especially related to mental growth and learning disabilities, increasing rate of Tuberculosis, Cancers of almost all types.

As per statistics, nearly 90 millions of people in India including 6 billions of children are suffering from fluoride related diseases like dental fluorosis, skeletal and/or non-skeletal fluorosis which damage bones and ligaments [3]. There are also reports that out of 30 districts of Odisha, the ground water of 27 districts are contaminated with fluoride ion resulting in acute health disorder [4, 5] . After Khurdha and Nuapada, fluoride contaminated diseases are mostly seen in the district of Angul which may be due to rapid industrialization and wide spread mining activities in the area [6, 7] . In the present work an attempt has been made to study the pollution load in the different area within Angul- Talcher industrial complex during pre and post-monsoon period during the year 2009-10. The pollution load is monitored by measuring the concentration of fluoride ion and other related water quality parameters such as pH, EC, TDS, TH, Fe and Cl^- etc.

Study area

Angul -Talcher Industrial complex of Odisha is situated at latitude 20^0 95 'N to 21^0 10 'N and longitude 84^0 55' E to 85^0 28 'E ,139 meter above sea level (MSL) and 150 km away from Bhubaneswar, the state capital of Odisha. It is a thickly populated area and the people of this area are mainly dependent upon agriculture. This area is one of the largest coal belts of India. The two major rivers namely Mahanadi and Bramhani are flowing on the two sides of the study area. Taking the advantages of the location, vast coal deposits, water availability and the manpower, Mahanadi Coal Fields Ltd. (MCL) has developed a number of open cast and underground mines in this industrial complex. Besides, a good number of coal based Thermal Power Plants (National Thermal Power Corporation, Kaniha, National Thermal Power Station, Talcher, Captive Power Plant, NALCO, Angul), several heavy industries (National

Aluminum Company, Angul, Heavy Water Project, Vikrampur, Bhushan Steel and Strips Ltd, Jindal Power and Steel Ltd, Silicon Steel, Nava Bharat Ferroalloys, Monet Ispat Ltd, Rungta Mines Ltd etc), coal washeries and a large number of ancillary medium and small scale industrial units have come up in the area in the last few decade . All these mining and industrial activities have caused significant degradation of environmental quality and now this area is considered as one among 24 hot spots of India. Besides air pollution, the river Brahmani passing through the area also gets polluted. Though coal mines are not having any effluents discharged, the washout of mining areas and drain water from workshops & townships ultimately goes to the river. The coal washeries coming up in the locality may add in future. There are reports of air pollution & lowering of water table due to fast face mining activities and rapid industrialization.

Materials and Methods

(A) Sample Collection: Water samples in the study area have been monitored at 16 different stations during pre- monsoon and post monsoon season of the year 2009-10. The choice of the stations have been mostly on the basis of major industries, coal mines and important townships which are expected to make significant contribution to the pollution load on the water bodies in the study area. Details of sampling locations are illustrated in Table –I. Water sample were collected from the said monitoring stations in clear polythene bottles at low temperature (i.e. 4^0C) putting ice in box to avoid unpredictable changes in characteristics as per standard procedure (APHA, 1998).

(B) Physico – Chemical Analysis:

Procedure as laid down (APHA-1998) have been followed for the analysis of different parameters such as pH, Electrical Conductivity (EC) Total dissolved solid (TDS), Total hardness (TH), Iron (Fe), Chloride (Cl^-) and Fluoride (F^-) [8, 9, 10]. Fluoride in water sample has been determined by SPADANS–Zirconyl Oxychloride method using UV-VIS spectrophotometer (Shimadzu-1700). The absorbance values obtained at λ_{Max}-570 nm are compared with the standard calibration curve for fluoride concentration. The results were compared with standard results of Indian standards [11, 12].

Table I: Sampling stations within the study area

Code No.	Monitoring stations	Distance from Dist. Head quarter(km)	Major contribution to water pollution
GW 1	Tamrit colony Bore well	0	Effluents of Angul Municipality
GW 2	Bonda, Bore well	15	Wastes of NALCO Smelter, washings of heavy vehicles
GW 3	Gopinathpur, Tube well	25	Mining & industrial wastes
GW 4	Takua , Open well	45	Industrial & mining wastes
GW 5	Danara , Open well	25	Mining wastes
GW 6	Kalinga OCP Bore well	25	Mining wastes
GW 7	Godiabandha Open well	30	Mining area & industrial waste
GW 8	ITI Chhak Talcher Open well	25	Industrial , mining & municipal wastes
GW 9	Tentuloi village Tube well	18	Solid waste & effluent water of coal washeries
GW 10	Gotmara village Bore well	15	Fly ash &waste water of CPP,NALCO
GW 11	Giranga Open well	12	Waste of NALCO township & Ash pond of CPP(NALCO)
GW 12	Kulad Bore well	13	Effluent of NALCO smelter & washings of heavy vehicles
GW 13	Languliabeda Bore well	15	Effluent water of NALCO Smelter containing fluoride
GW 14	Tulasipal, Bore well	15	Wastes of NALCO Smelter, washings of heavy vehicles
GW 15	Gadarkhai, bore well	10	Effluent water of NALCO Smelter containing fluoride
GW 16	NuaSahi, Open well	15	Agricultural wastes, Effluent water of NALCO

Table II: Analytical data of fluoride and other related water quality parameters in pre and post monsoon seasons of the study area for 2009-10.

Monitoring stations	**Pre-monsoon**							**Post-monsoon**						
	pH	**EC**	**TDS**	**TH**	**Cl^-**	**Fe**	**F^-**	**pH**	**EC**	**TDS**	**TH**	**Cl^-**	**Fe**	**F^-**
Tamrit colony Tube well	7.9	458	204	172	35.4	0.48	1.31	7.5	428	197	347	39	1.4	1.25

Bonda Borewell	7.9	956	856	443	61	0.50	1.18	7.3	1033	736	486	49.2	0.58	1.36
Gopinathpur Tube well	8.3	661	286	172	34.2	0.05	1.12	7.2	944	266	356	31.6	0.05	1.1
Takua Dug well	8.1	339	223	118	25.4	0.46	1.35	7.7	441	201	109	23.1	0.44	1.49
Danara Dug well	8.3	379	298	121	63	0.07	0.95	7.7	571	181	114	65.5	0.09	0.91
Kalinga OCP Bore well	8.2	423	202	100	65.8	0.80	1.36	7.9	387	201	98	63	1.35	1.58
Godiabandha Open well	8.1	342	199	94	25.7	0.82	0.16	7.6	504	289	100	21.9	1.4	0.45
ITI chhak Dug well	8.4	389	203	93	63	0.88	0.18	7.7	599	299	99	65	1.46	0.45
Tentuloi Tube well	7.8	966	747	362	54.2	0.42	2.3	7.4	1023	661	350	51.4	0.4	2.4
Gotmara Bore well	8.2	689	648	170	36.2	0.82	1.4	7.5	998	616	351	34.6	1.48	1.29
Giranga Open well	8.1	684	497	168	36.3	0.85	1.27	7.6	972	393	345	34.9	1.34	1.18
Kulad Bore Well	8.2	789	741	372	54.3	1.02	1.89	7.7	963	581	356	51.6	1.46	1.99
Languliabeda Bore well	8.3	513	332	438	33.4	0.83	1.92	7.7	541	313	415	30.7	1.51	2.2
Tulasipal Bore well	7.8	1069	733	496	66	0.61	2.1	7.3	1031	800	407	53.5	0.94	2.6
Gadarakhai Bore well	7.9	794	561	418	65	1.3	2.2	7.6	1057	571	373	47.3	1.79	2.8
Nuasahi well water	8.6	651	275	443	60.5	0.88	1.47	8.2	935	272	483	48.3	1.49	1.39

All parameters are expressed in mg/lit. except pH and EC (µS/cm)

Table III: Correlations matrix for different water parameters :2009-10

Parameters	pH	EC	TDS	TH	Cl^-	Fe	F^-
pH	1	-.492**	-.297*	-.257	.165	-.125	-.256
EC		1	.789**	.743**	.190	.121	.545**
TDS			1	.601**	.254	.043	.560**
TH				1	.145	.213	.618**
Cl^-					1	-.022	.153
Fe						1	.168
F^-							1

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Results and Discussion

The average values of physico-chemical parameters of the water samples collected are summarized in Table – II for the pre and post monsoon season for the year 2009-10.

The study of the analytical results indicates that ground water in Angul -Talcher industrial complex is slightly alkaline with pH ranging from 7.8 to 8.6 and 7.2 to 8.2 in both the seasons. The pH value of Nuasahi village is beyond the desirable limit (6.5 to 8.5). pH shows negative correlation with EC, TDS, TH, Fe and F^- as per correlations matrix (table-III).

Electrical conductivity ranges from 339 to 1069 µs/cm and 387 to1057 µs/cm during pre monsoon and post monsoon seasons respectively which exceed the maximum permissible limit (300-400 µs/cm) for drinking water. Electrical conductivity shows higher positive correlation with TDS, TH and F^-. Electrical conductivity was minimum at Takua village and maximum at Tulasipal village during the pre monsoon season respectively.

The TDS values of different water samples range from 199 to 856 mg/lit. and 181 to 800 mg/lit. during pre-monsoon and post monsoon seasons respectively. TDS shows higher positive correlation with TH and F^-.Minimum and maximum TDS were observed at Danara village and at Bonda village during post & pre monsoon seasons respectively.

Total hardness from 93 to 496 mg/lit. and from 98 to 486 mg/lit. observed during pre-monsoon and post monsoon seasons respectively were within the standard limits as compared to Indian standard. Total hardness shows higher positive correlation with F^- only. The concentration of chloride was found below 100mg/lit.

The value of iron ranges from 0.05 to 1.3mg/lit. and from 0.05 to1.79mg/lit. during pre-monsoon and post monsoon seasons respectively. The excess of iron concentration has been found in all industrial zones except at Gopinathpur, Takua & Danara villages which are far away from industrials habitations ; iron concentration at Gadarakhai village (1.79mg/lit.) is far above the desirable limit (0.3mg/lit, WHO-1993).Iron shows no significant correlation between any pairs of parameters as per the analysis.

The result of the chemical analysis indicates the occurrence of high fluoride content in ground water of Angul – Talcher industrial complex without any definite pattern. During pre-monsoon period, it ranges from 0.16mg/lit. to 2.3mg/lit. and in post monsoon period, it ranges from 0.45mg/lit. to 2.80mg/lit. which indicates an increase in the fluoride content in post monsoon season. The concentration of fluoride ions in the water samples of Kulad, Languliabeda, Tulasipal and Gadarkhai, the villages close to NALCO smelter plant touches the maximum permissible limit as laid down by various organizations. It may be due to the effluent of water and waste disposal of NALCO smelter plant containing high fluoride ion. The high fluoride content in ground water is also found to be associated with relatively high TDS and high TH.

Conclusion

In general the chemical quality of ground water in Angul- Talcher industrial complex is good and suitable for drinking and domestic purposes except the villages near mining and industrial areas. There is also occurrence of high fluoride content without any definite pattern, which may be due to industrial and mining activities, erosion of bed rocks and climatic conditions of the study area. However the concentration of Fluoride ions in the water samples of villages close to NALCO smelter plant touches the maximum permissible limit. High amounts of fluoride in water recourses contributes certainly the “fuel for pollution” pursued by industrialization induced eutrofication in Angul- Talcher industrial complex of Odisha, needs attention for early remedial measure. Thus it is recommended for extensive studies so to aware every individual and their participations for the sustainable development of ground water quality of Angul- Talcher industrial complex.

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