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Ground water quality status Analysis of Cuttack town of Odisha, India

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Abstract: *A qualitative study was carried out to assess the quality of ground water in Cuttack town. It was observed that most of the parameters were below the permissible limit as per BIS & PCB standards. Khan nagar and Tulasipur industrial areas were found to be more polluted. The ground water of the concenred area was safe with respect to TC, FC as none of the locations were above the WHO limit in any seasons. It has been observed from correlation coefficient that TH, Conductivity,* Cl^-*, TDS have strong correlation with each other. Iron is negatively correlated with TH and* F^- *is negatively correlated with pH.*
Key Word*:Ground water, Pollution, Physico-chemical parameters, TDS, Hardness, Turbidity.*

I. Introduction

Pollution of ground water has been reported for a number of cities throughout the world. Dependence on ground water resources for municipal supply is growing due to paucity and pollution of surface water bodies. Cuttack, the erstwhile state capital of Odisha and is a traditional Indian town organically developed over the time. The huge population of this area use ground water for drinking and other purposes . A number of dug and tube wells have been constructed to meet the short supply of municipality. So it is essential to have a study of ground water quality as it is being polluted. MSW (Municipality Solid Waste) is heterogeneous in nature and contains paper, plastic, rag, metal, glass pieces, ash, composite matter, dead animals, discarded chemicals, paints, hazardous hospital waste and agricultural residues. Presently most of the MSW in Cuttack city is being disposed unscientifically like other cities of India. Generally MSW is collected and deposited in sanitary landfills. During land filling of solid waste continuous pressure results in the quizzing of a contaminated liquid as leachate which contains dissolved, suspended and microbial contaminants from solid waste. The leachate has high organic contents, soluble salts and other constituents capable of polluting ground water. This polluted ground water is unfit for drinking and causes jaundice, nausea, asthma and infertility.

The quality of ground water of this area still remains largely uncharted and a possibility of severe contamination looms large. Keeping this in view a systematic study on the groundwater quality was carried out over a period of two years from January 2009 to December 2010, which include various Physico-Chemical and microbiological parameters.

Description of study area Cuttack having latitude of 20 o 29' to 20 o 26'N and longitude of 85 o 48' to 85 o 56' E. River Mahanadi and its major distributaries Kathajodi surrounds the city in north and south boundaries and the city is situated on a doab land. Low lying areas are available centrally. The ground height of the study area varies from 19 to 20 m on the north. The soil beneath the city is composed of unconsolidated alluvium in alternating sequence of sand, silt, and clay, the depth of which continues up to 120m and is placed above Gondwanaland sedimentary rock of Archean crystallines (Mahallick, 1992). The depth of water table changes with monsoon, going down to 4-6 m during pre monsoon and rises to 0 to 3m during monsoon and post monsoon period, (CGWD, 1995). Within a depth of 90 meters besides the water tables two confined aquifers could be identified which are lined by impervious clay minerals. The first confined aquifer lies at a depth of 30 meters with thickness varying from 15 to 40 meters separated from the second confined aquifers by clay bed of 15 to 20 meters thickness. There is a possibility of third confined aquifer below theclay layer overlying the Gondwana basement (Mahallik, 1992).

II. Experimental Section

To have a through idea regarding ground water quality of Cuttack seven different locations were chosen. The locations were chosen keeping in mind that all the areas of Cuttack can be covered properly. The detailed locations of sampling points are described in table-01. From each location a particular tube well was chosen and grab sampling was done quarterly from that particular tube well. The samples were collected in plastic and glass bottles as per requirement. Using these samples different physical, chemical and microbiological parameters such as pH, turbidity, conductivity, total hardness, chloride, total dissolved solids, iron, fluoride, TC, FC were studied. All chemicals/reagents used were of analytical reagent grade. After sample collection and under preservation the samples are analyzed in laboratory according to water and waste water analysis by APHA 2000, (19 th Edition).

III. Results And Discussion

pH: pH of the ground water samples varies between 5.0 to 6.8 during the study period. None of the samples exceeds WHO limit for drinking purpose. A very little variation in pH was noticed during different seasons in all locations. It is also noticed that in summer the acidic character slightly increases compare to rainy and winter seasons. It may be due to decrease of water level.

Turbidity: The turbidity of ground water samples varies between 0.2 to 3.8 NTU. No marked seasonal variation was observed in the samples . Turbidity in ground water should be less than 5NTU. The turbidity is below 5NTU in all the samples collected from Cuttack city.

Conductivity: The conductivity of ground water of study area ranged between 120 to 1088 µmho/cm. No marked seasonal variation was observed in the samples. But a marked spatial variation was observed in the samples. L-06 and L-07 recorded relatively higher conductance which might be attributed to the interface of sewage. Conductivity of water is dependent upon the ions concentration and ionic mobility of the mineral contents in water. In a simpler way, it is an index of the degree to which water is mineralized. Normally the conductivity of the water increased with increase in Na^+, K^+, Cl^-, alkalinity and total dissolved solids. The EC of all the samples showed almost similar values to some parameters like TDS. The sewage contamination may be responsible for the higher EC values in the samples.

Total Hardness: Total hardness represented by $CaCO_3$ in water samples ranged from 50 to 411 mg/l during the study period. No marked seasonal variation was observed in the samples. High values were observed in the samples of L-07, L-06, L-01. Calcium and Magnesium ions as their bicarbonates, sulphate, and chlorides render the water hard both temporarily and permanently. High value of hardness observed in the ground water of study area seemed to have been influenced by their proximity to the sewage drains as higher hardness was observed in samples which are located close to it.

Chloride: The chloride content of water samples varies from 12 to 62 mg/l during study period. A decreased trend was observed during rainy season in all the stations. All the samples were found below permissible limit(250 mg/l) set by WHO in all seasons.

Total Dissolved Solids: Total Dissolved Solid (TDS) values indicate the general nature of water. The TDS of samples varied from 88 to 678 mg/l within the study period. Samples drawn from L-06, L-07 recorded high values of TDS. Higher values of TDS associated with higher residues are normally less potable and may induce an unfavourable physiological reaction in the transit consumer. Those samples which are found to have more TDS may be influenced by domestic sewage as the sewage water was found to have high TDS value through out the year. A well marked temporal variation was observed in the samples. The samples in summer seasons exhibit maximum concentration of TDS compared to other seasons. Drying up of the clayed material above the water table during summer might have led to oxidation which increase the stability of minerals by theinfiltrating water during the recharge period.

Iron: The analysis of ground water in the study area shows Iron concentration ranging from 0.028 to 1.6mg/l during the study periods. Seasonal variation was observed in water samples. Higher values were recorded in summer may be due to decrease of water levels. Except L-06,L-03, L-02, rest of the samples registered lower amounts of iron concentration. Iron in ground water supplies is a common problem while WHO recommended level is <0.3 mg/l. The iron occurs naturally in the aquifers but levels in ground water can be increased by dissolution of ferrous borehole and hand pumps components. Iron is generally present in organic waste and as plant debris in soil. Activities in the biosphere may have strong influence on the occurrence of the element in ground water. Presence of clay layers above the aquifer of the study area promotes the development of reducing environment and therefore higher levels of the element in the ground water. Enrichment of Fe in all the seasons indicates the biological cycle and consequent leaching from top soil to the ground water.

Flouride: The fluoride concentration of samples varied from 0.20 to 0.58 mg/l during study period. Though there was no systematic change observed in the concentration so far as seasonal variation concerned but a little variation was observed among the samples. All the samples found below permissible limit set by WHO and other regulating organizations. A little increase in the concentration was observed at few locations in all seasons which may be attributed to the geological deposition and geochemistry of the location . As the sewage water contain negligible amount of Flouride, there was no chance of contamination of the ion with the nearest ground water source.

TC and FC : The ground water of the study area was safe as none of the locations crossed the WHO limit for TC and FC in any season. Higher counts of the faecal origin is indicative of dangerous pollution.

Correlation Coefficient: In the present study in order to establish the natural process and the sources of pollution a 8×8 correlation matrix from normalized variables and 6 observations for each point have been computed. Prior to statistical analysis Mean, Standard deviation was calculated. From correlation coefficient matrixes it has been observed that EC, TH, Cl^- , TDS have strong correlation with each other. No clear correlation between pH and any variables (except F^- which is negatively correlated with pH) was noticed which indicates that the concentration of different variables except F^- may not be influenced by the little change in acidic or alkaline conditions of water. Iron is negatively correlated with TH and F^- is negatively correlated with pH.

Table 1 Locations of ground water sampling stations

Stations	Locations	Code No
01	Bus stand area	L-01
02	C.D.A area	L-02
03	Pattapolo area	L-03
04	Barabati area	L-04
05	Near S.C.B. medical college	L-05
06	Khapuria industrial area	L-06
07	Kalyani nagar of	L-07

Table 2 Mean Std. Deviation and co-relation between different parameters for 2009

	Mean	Std. Deviation	N
pH	6.129	0.4291	21
Tubd	1.443	0.9595	21
Cond	485.52	315.944	21
TH	142.24	95.434	21
CL^-	32.29	15.470	21
TDS	308.38	211.293	21
Fe	0.4202	0.36772	21
F^-	0.3169	0.07727	21

	pH	Tubd	Cond	TH	CL^-	TDS	Fe	F^-
pH	1							
Tubd	0.285	1						
Cond	-0.188	0.402	1					
TH	-0.72	0.518*	0.890**	1				
CL^-	-0.254	0.339	0.908**	0.842**	1			
TDS	-0.163	0.404	0.994**	0.889**	0.917**	1		
Fe	-0.248	-0.398	-0.231	-0.434*	-0.346	-0.242	1	
F^-	-0.498*	-0.299	0.547*	0.445*	0.546*	0.532*	-0.263	1

Table 3 Mean, Std. Deviation and co-relation between different parameters for 2010

	Mean	Std. Deviation	N					
pH	5.976	.4949	21					
Tubd	.887	.3443	21					
Cond	472.38	310.005	21					
TH	141.43	92.532	21					
CL^-	31.52	13.582	21					
TDS	297.19	188.286	21					
Fe	.4880	.41916	21					
F	.34467	.114662	21					
	pH	Tubd	Cond	TH	CL^-	TDS	Fe	F
pH	1							
Tubd	.402	1						
Cond	.006	.064	1					
TH	.038	.041	.879**	1				
CL^-	-.054	.006	.926 **	.857 **	1			
TDS	.033	.122	.988 **	.909 **	.931**	1		
Fe	-.198	.024	-.290	-.512*	-.426	-.336	1	
F	-.580 **	-.210	.370	.191	.351	.302	.122	1

Table 4 Yearly average of physico-chemical and microbial parameters for 2009

S.Nl	pH	Turbidity	Conductivity	TH	Cl^-	TDS	Iron	F	TC	FC
L-01	6.5	1.3	296	110	34.0	194	0.05	0.29	<2	<2
L-02	6.2	0.7	152	56	15.3	95	1.08	0.23	<2	<2
L-03	6.2	2.3	383	102	26.0	239	0.45	0.25	<2	<2
L-04	5.7	1.3	346	89	27.3	210	0.33	0.32	<2	<2
L-05	6.3	0.7	312	107	18.0	170	0.3	0.38	<2	<2
L-06	6.0	1.2	924	187	48.0	594	0.69	0.37	<2	<2
L-07	6.0	2.5	986	345	57.3	656	0.04	0.38	<2	<2

Table 5 Yearly average of physico-chemical and microbial parameters for 2010

S.Nl	pH	Turbidity	Conductivity	TH	Cl^-	TDS	Iron	F	TC	FC
L-01	6.3	0.7	347	143	32.0	239	0.04	0.31	<2	<2
L-02	6.0	0.9	156	59	14.0	103	1.23	0.30	<2	<2
L-03	6.0	1.2	355	93	26.3	261	0.6	0.32	<2	<2
L-04	5.8	1.0	276	82	28.6	179	0.38	0.35	<2	<2
L-05	5.7	0.5	296	96	21.0	155	0.35	0.44	<2	<2
L-06	6.1	0.9	885	175	45.3	510	0.77	0.40	<2	<2
L-07	5.9	1.0	985	342	53.3	633	0.05	0.41	<2	<2

Seasonal variation of physico-chemical and microbial parameters for 2009 and 2010

Table 6 pH

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	6.8	6.0	6.6	6.6	6.0	6.4
L-02	6.4	5.8	6.4	6.2	5.6	6.0
L-03	6.3	5.9	6.5	6.8	5.2	6.2
L-04	5.8	5.2	6.0	6.4	5.1	6.0
L-05	6.4	5.8	6.6	6.3	5.0	5.8
L-06	6.0	5.4	6.6	6.2	5.6	6.4
L-07	6.2	5.6	6.4	6.1	5.4	6.2

Table 7 Turbidity (NTU)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	1.4	0.4	2.0	0.6	0.4	1.02
L-02	0.4	0.2	1.6	1.4	0.4	1.0
L-03	3.6	1.4	2	1.6	1.2	0.8
L-04	2.0	0.8	1.2	1	0.8	1.2
L-05	0.8	0.4	1	0.6	0.4	0.6
L-06	1.6	0.9	1.2	1.0	0.8	8.0
L-07	3.8	1.2	2.4	1.0	0.6	1.4

Table 8 Conductivity (μ mho/cm)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	388	266	232	370	312	358
L-02	120	178	158	146	158	164
L-03	422	378	350	378	356	330
L-04	332	370	336	300	276	252
L-05	301	328	306	288	309	292
L-06	972	958	842	888	912	856
L-07	1086	950	923	972	1088	894

Table 9 Total Hardness(mg/l)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	120	106	104	134	158	136
L-02	50	61	58	58	64	56
L-03	112	100	94	100	94	84
L-04	96	84	86	92	80	74
L-05	114	107	100	104	95	90
L-06	234	169	158	188	168	170
L-07	411	322	301	380	333	312

Table 10 chloride(mg/l)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	44	32	26	40	30	26
L-02	16	18	12	14	16	12
L-03	30	28	20	28	30	21
L-04	26	34	22	28	34	24
L-05	18	20	16	20	24	19
L-06	48	56	40	42	50	44
L-07	56	62	54	52	60	48

Table 11 TDS(mg/l)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	238	194	150	242	236	240
L-02	88	104	94	92	106	110
L-03	292	218	208	268	260	254
L-04	206	216	209	194	180	164
L-05	165	178	166	150	161	154
L-06	604	598	580	524	518	489
L-07	676	652	640	612	678	609

Table 12 Iron(mg/l)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	0.028	0.08	0.03	0.04	0.06	0.03
L-02	0.96	1.4	0.88	1.1	1.6	1.0
L-03	0.44	0.56	0.34	0.56	0.69	0.54
L-04	0.32	0.4	0.28	0.36	0.48	0.3
L-05	0.3	0.38	0.22	0.34	0.46	0.26
L-06	0.62	0.88	0.58	0.66	0.94	0.72
L-07	0.037	0.056	0.032	0.04	0.06	0.038

Table 13 Flouride(mg/l)

Locations	Winter-09	Summer-09	Rainy-09	Winter-10	Summer-10	Rainy-10
L-01	0.29	0.36	0.22	0.31	0.38	0.23
L-02	0.2	0.26	0.22	0.24	0.39	0.26
L-03	0.218	0.29	0.23	0.31	0.36	0.3
L-04	0.268	0.39	0.3	0.32	0.42	0.31
L-05	0.34	0.44	0.36	0.36	0.58	0.38
L-06	0.32	0.44	0.36	0.36	0.51	0.32
L-07	0.32	0.44	0.39	0.34	0.54	0.36

Yearly average of physico-chemical and microbial parameters of the year 2009-2010

Fig 1

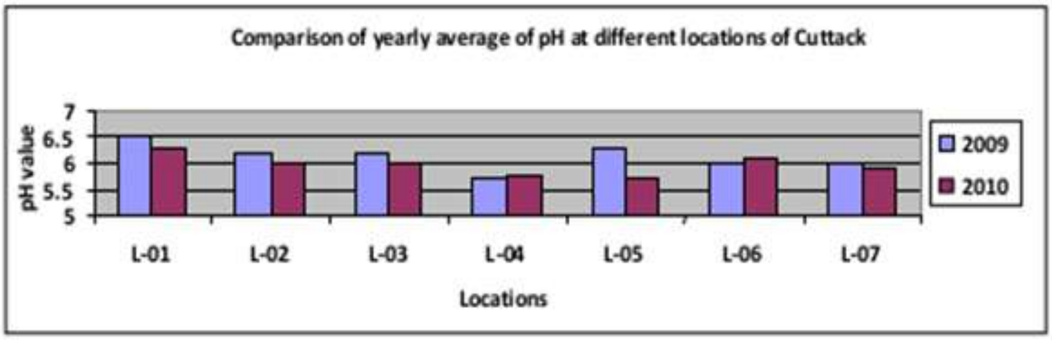


Fig 2

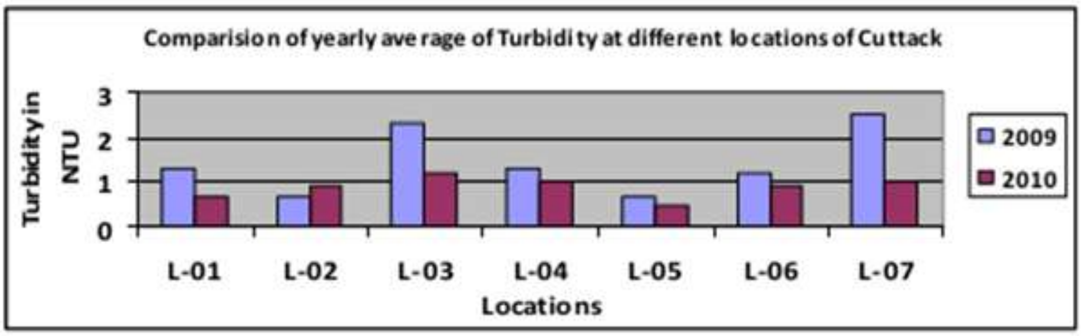


Fig 3

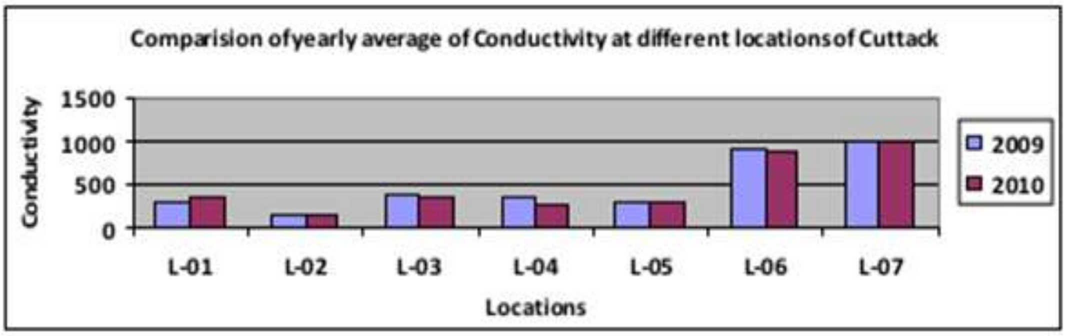
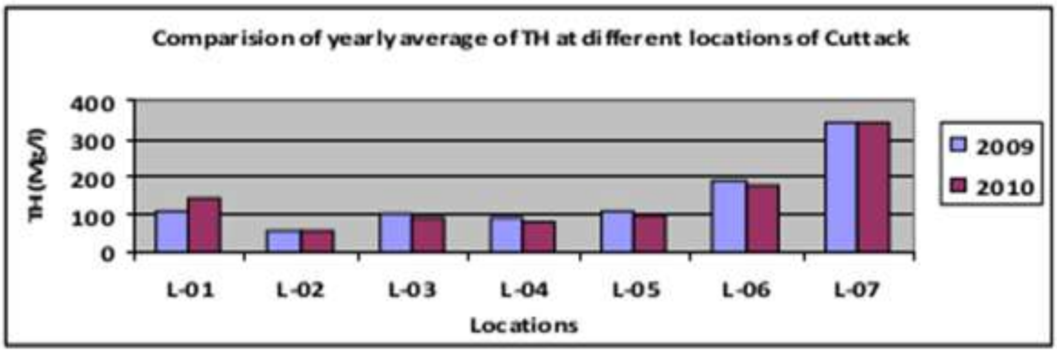


Fig 4



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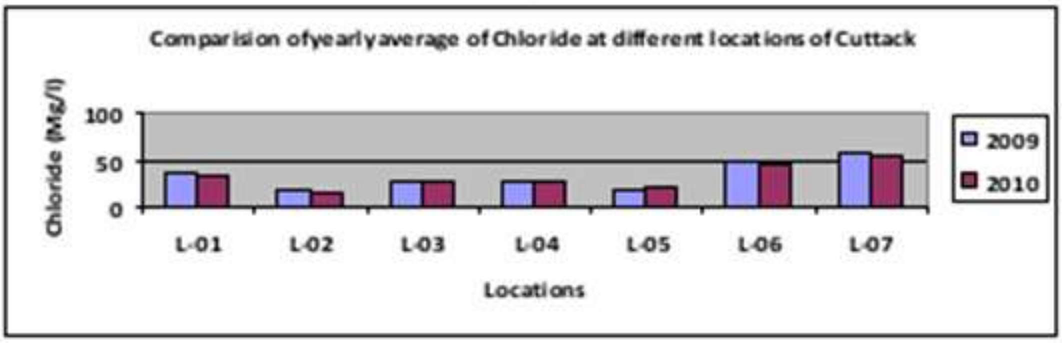

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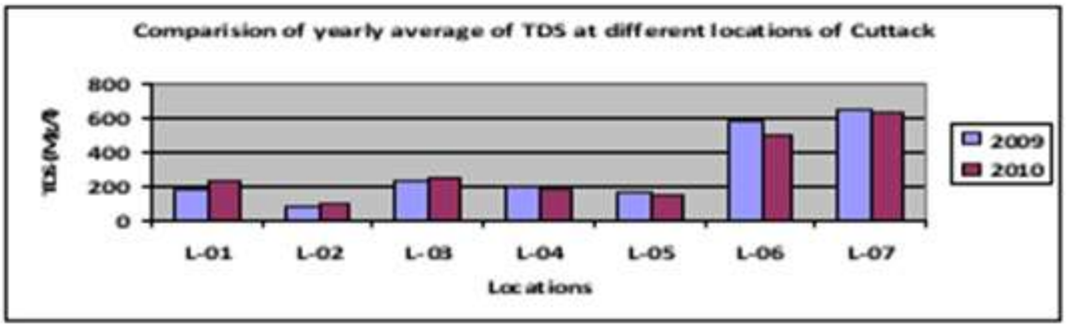

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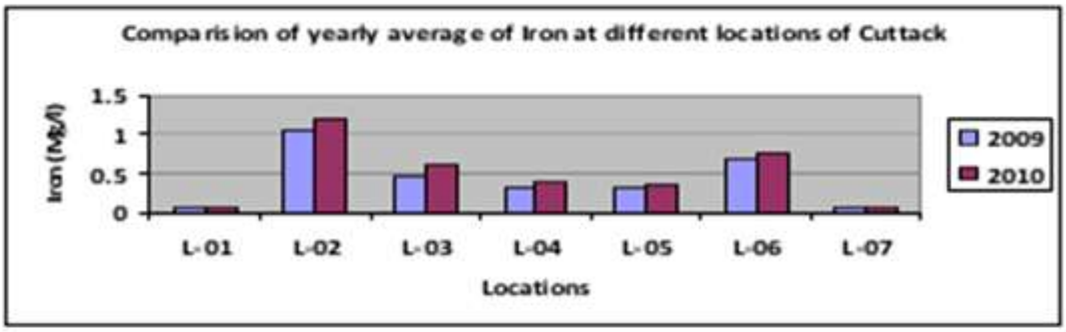

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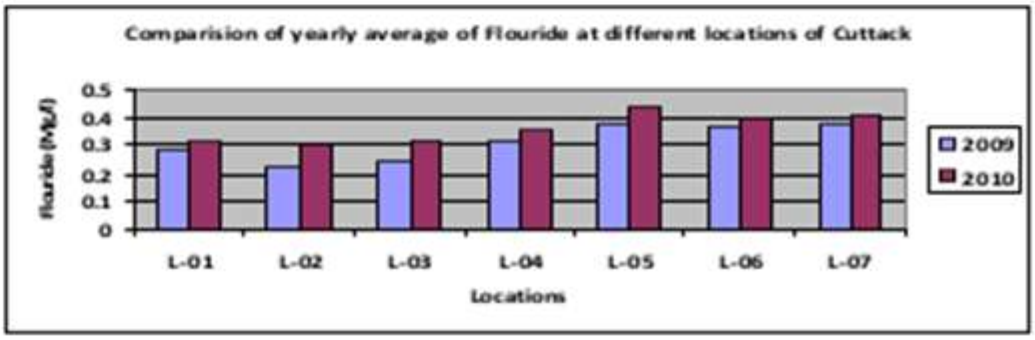


Seasonal variation of physico-chemical and microbial parameters for 2009 and 2010

Fig 9

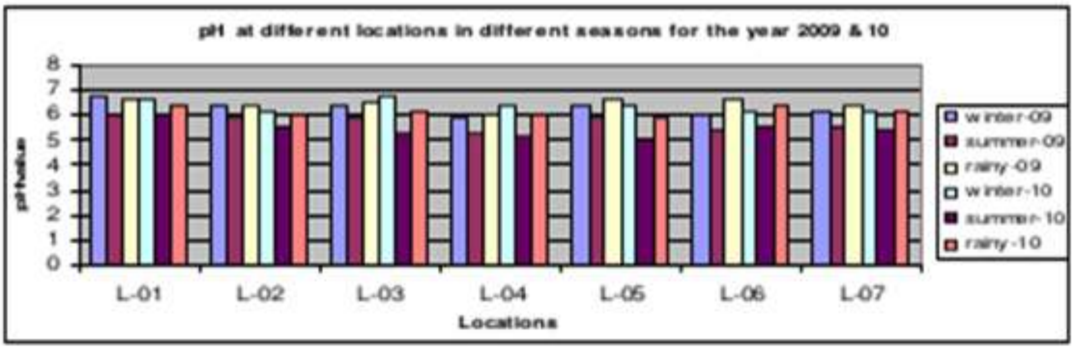


Fig 10

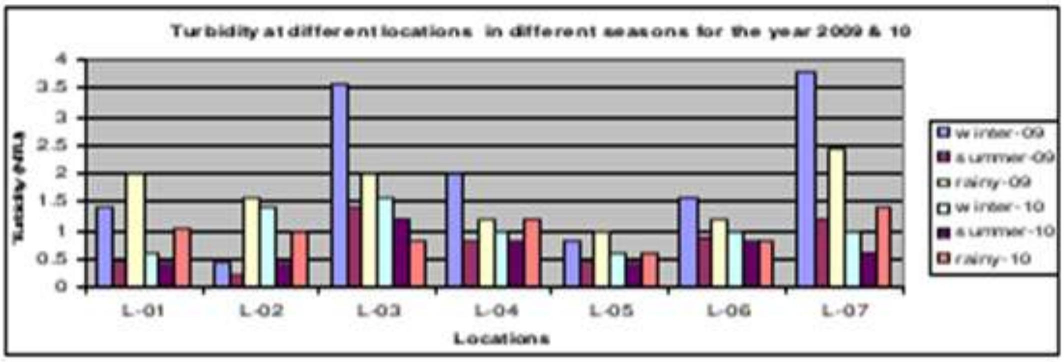


Fig 11

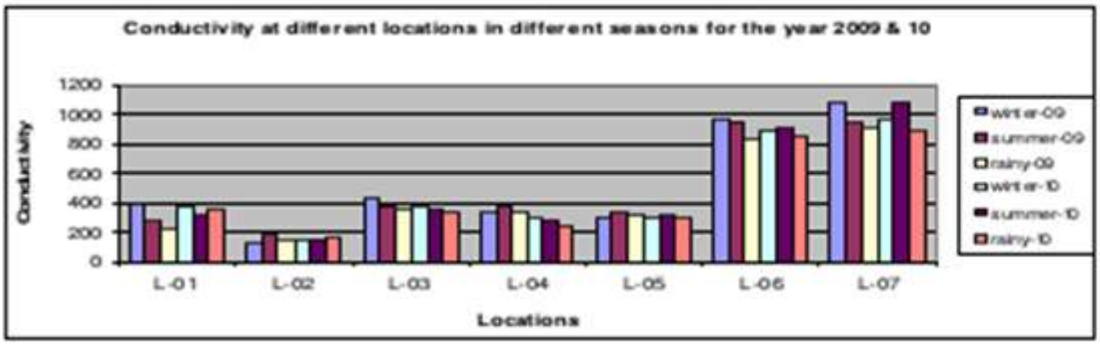


Fig 12

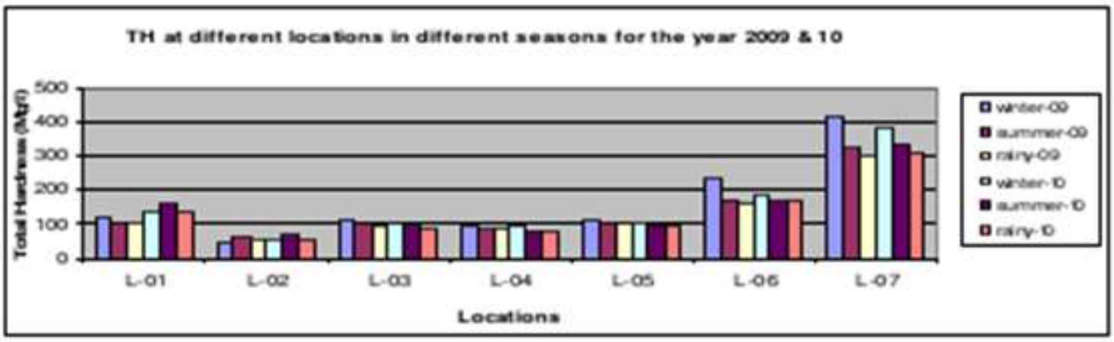


Fig 13

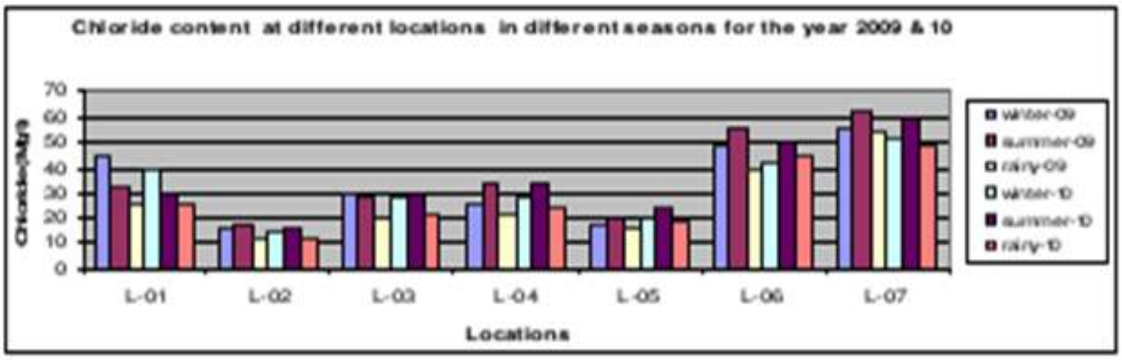


Fig 14

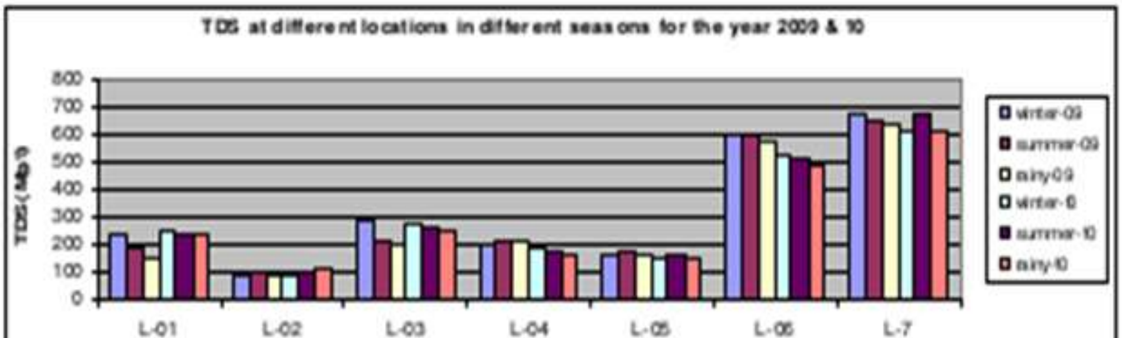


Fig 15

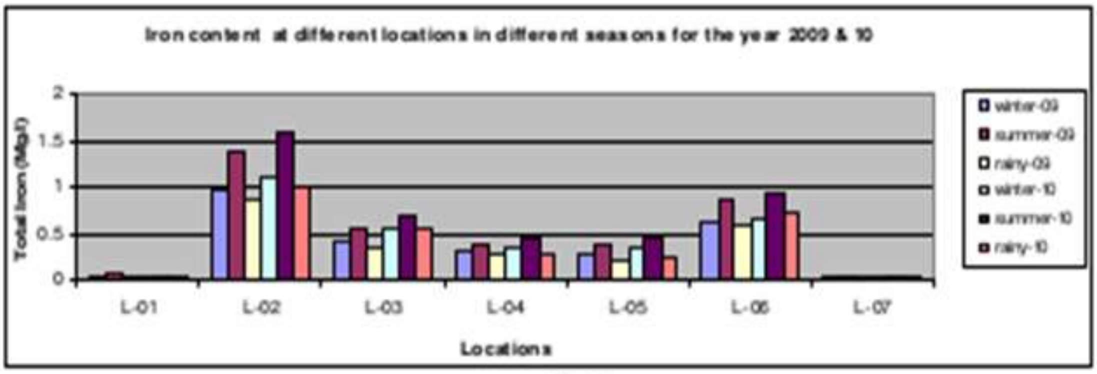
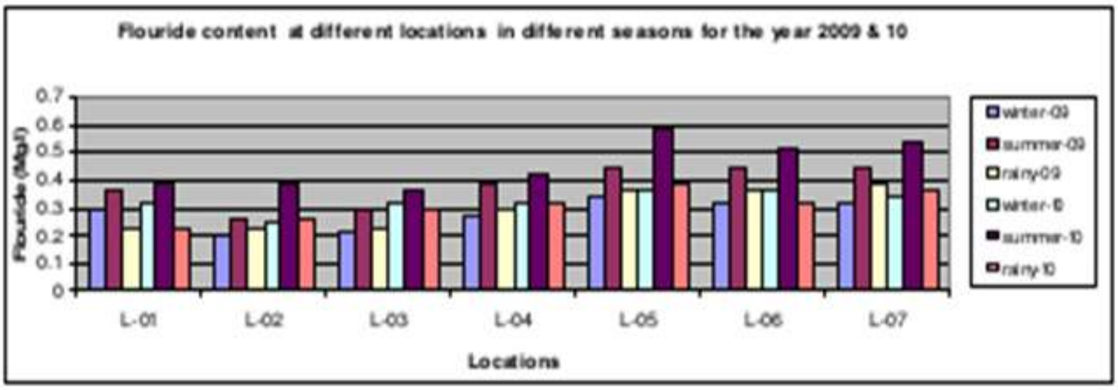


Fig 16



IV. Conclusion

From the results obtained and subsequent discussion it was found that the most potential source of ground water contamination from Physico-Chemical as well as microbial point of view is the domestic sewerage. Almost all ground water sources located near to the drains are relatively more polluted. Hence these tube wells should be abandoned or should not be used for drinking purposes by the residents of that locality. The Physico-Chemical and microbial parameters show that ground water is safe for consumption being with safe limits prescribed by WHO. But the tube wells located adjacent to the unprotected septic tanks are contaminated. Awareness should be created among the people about the effect of using polluted water. Municipal Corporation should look into the matter to make concrete drain and concrete septic tank and treatment system and make the tube wells away from the source of pollution. The high amounts of iron contents found in water samples may be due to contamination from hand pumps of iron make should be replaced with PVC pipes.

The high population density of Cuttack city demanding high volume of water for drinking and bathing. As a result there is depletion of ground water table and also the ground water is getting contaminated due to unplanned way of discharge of solid waste and domestic waste. We should make a rule in each house hold and all institutions and offices to make water harvesting in their own building in order to increase the ground water table. Also the Government should take cess for using ground water and permission should be taken before digging the tube wells. By this way the extravagant use of ground water can be restricted.

References

[1]. APHA. Standard methods of the examination of water and waste water (19 th Ed).American Public Health Association, New York, 2000.
[2]. WHO, World Health Organisation, International Standard Standards for Drinking Water, Geneva,Switzerland,1992.
[3]. ISI, 1966.Methods for sampling part1 (6).IS 2488.
[4]. BIS, Specification for drinking water. Bureau of Indian Standards, New Delhi 1998, 171-178.
[5]. UNESCO, Groundwater UNESCO Environmental and development briefs no.2, 1992, 14P
[6]. Vogel's Text Book of Quantitative Chemical Analysis, Jeffery G.H, Basset J, mendham J and Denny RC, 5th Ed, ELBS, 1989.
[7]. SK Patnaik ; Rout SP. Indian journal of Environmental Protection (2001), 21(4), 355-358.
[8]. KV Meta. Journal of Chemical and Pharmaceutical Research. 2010. 2(4), 663-670.
[9]. SMMN Khan; AR Kumar. Journal of Chemical and Pharmaceutical Research. 2010. 4(10), 4514-4521.
[10]. B Behera; M Das; GS Rana. Journal of Chemical and Pharmaceutical Research.2 010. 4(8), 3803-3807.
[11]. J Das; RK Sahoo; BK Sinha. Indian journal of Environmental Protection (2002), 22(3), 95-103.