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Surface And Ground Water Quality of Potable Water in the Regions of Godavari Western Delta, West Godavari District, Andhra Pradesh, India.

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Abstract: A study was carried out to see the quality of potable water of surface and ground water. Both surface and groundwater sources are contaminated by Physico-Chemical pollutants and biological contamination arising from point and non-point sources. In general ground water is less vulnerable to pollution than surface water. In this paper drinking water quality of western delta of West Godavari with seasonal variation is presented. It is observed that the drinking water quality is very poor in both the seasons. In summer season the salt concentrations is further increased and thereby increases in total dissolved salts (TDS), EC, Hardness, Alkalinity and Nitrate values. There is a reduction in the values of dissolved oxygen thereby increase in BOD and COD values in summer when compared with winter.

Keywords: surface water, ground water, Drinking water quality, Biological contamination.

I. INTRODUCTION

The hydrological cycle interconnects surface and groundwater which means they may contaminate one another. As rain falls on the earth's surface, some water runs off the land to rivers, lakes, streams and oceans. Some water is also evaporated and absorbed by plants or continues to move down to become groundwater. Groundwater very slowly moves towards low areas such as streams and lakes which are once again end up in surface water. This cycle is continuous and shows how the two are interconnected.

Groundwater pollution differs from surface water contamination in several important respects. Among them, it does not typically flow to a single outlet. It can affect people through wells dug in a contaminated aquifer, as it can flow into streams and lakes. Groundwater pollution also occurs on a different timescale than surface water contamination. Flow rates vary widely and can be as slow as 2 miles a year. This is because groundwater experiences far more friction as it moves through the pores in soil than surface water. Surface water more easily contaminated than groundwater. Filtration through the soil helps clean ground water. These distinctions depend on topography, hydrology and the source of ground water recharge and have implications for limiting as well as remediating contamination.

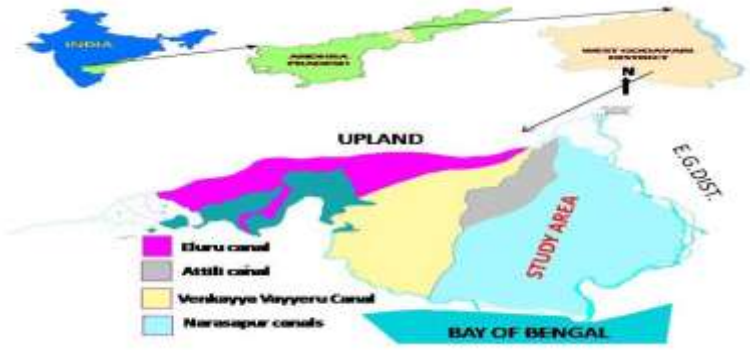
Neither water source can ever be entirely free from water contaminants. Health effects of groundwater pollution depend on the specific pollutant in the water. Pollution from groundwater often causes diarrhea and stomach irritation. Accumulation of heavy metals and some organic pollutants can lead to cancer, reproductive abnormalities and other more severe health effects. Nitrates in drinking water can cause cyanosis, a reduction of the oxygen carrying capacity of the blood. Lead is a toxic substance and is very dangerous particularly for children. Other heavy metals present in groundwater are cadmium, zinc, mercury etc.

Water quality analysis is one of the most important aspects in groundwater studies. The hydro chemical study reveals quality of water that is suitable for drinking, agriculture and industrial purposes. Further, it is possible to understand the change in [1, 2] quality due to rock-water interaction or any type of anthropogenic influence. Groundwater often consists of seven major chemical elements- Ca+, Mg+, Cl^-, HCO, Na+, K+, and $SO4^{-2}$. The chemical parameters of groundwater play a significant role in classifying and assessing water quality Therefore, this study was done considering the following objectives:

i) To analyze the water quality of the surface and groundwater in the study area, and
ii) To assess the impact of Physico-chemical pollutants on the water quality

II. STUDY AREA

The study area is situated in the Southern part of West Godavari District. It is bounded in the East by Godavari River, North by Eluru canal, West by Upputeru river & Kolleru lake and South by Bay of Bengal. The study area lies between16°19'05.02" to 16°56'08.37" N latitudes and 80°58'16.10" to 81°51'26.10"E longitudes.



III. METHODOLOGY

3.1 Collection of Surface Water

In the study area, people use surface water which comes from the Narasapur Canal, then into the summer storage ponds as raw water for the treatment purpose. Therefore, surface water samples were collected from different summer storage ponds located in Palakollu, Narasapur and Mogalturu mandals of west Godavari District, Andhra Pradesh. Samplings were performed in the month of November 2015 to January 2016 for the winter season and in March 2016 to May 2016 for the summer season. Each time a total of 30 samples from the summer storage ponds and from treated water samples were collected from 15 villages of the three mandals. Surface water from the ponds was collected from 30 cm below the water surface in a clean and well-dried 1000 ml plastic bottle with airtight screw cork. Treated water samples were collected from RWS taps during the supply to the public. Before collection of water the bottles were rinsed with pond and treated water from the specific sources. Immediately after sampling the water was transferred to laboratory for chemical analysis.

3.2 Collection of Ground Water

A total of 16 water samples were collected from 16 villages. To observe the seasonal variation, ground water sampling was done both in the winter and summer seasons. During ground water sample collection, the tubewell was first pumped for 30 minutes to pump out the stagnant water present in the pipes. Next, fresh ground water was collected in a 1000 ml clean plastic bottle with airtight screw cork from each of the selected tubewells. Before collection of water the bottle was rinsed with tube-well water several times. The collected samples were preserved in a cool place in the lab before analysis.

3.3 Water Analysis

Water pH was measured directly in sampled water immediately after sampling in the field using the EUTECH Instrument of pH meter; Electrical conductivity was measured directly in water by the EUTECH Instrument EC Meter. Potassium (K+) and Sodium (Na+) contents of water were separately measured by Flame photometer.

water samples collected from the study area have been analyzed in the laboratory for various chemical parameters like TDS, Alkalinity, Ammonia, Nitrite, Nitrate, DO, BOD, COD, and MPN by APHA standard methods (3,4).

IV. RESULTS AND DISCUSSIONS

4.1 P^H: This is a measure of the intensity of the alkaline or acid condition of water. It is a way of expressing hydrogen ion concentration. The values vary from 6.9 to 8.3 in groundwater during winter season, 7.5 to 9.8during summer season. Surface water values vary from 7.7 to 8.6 during winter season, 7.3 to 9.1 during summer season, where as the standard value lies between 6.5 to 8.5. P^H values are high in surface water when compared to that of ground water. Panditavilluru, Poduru, Vadangi, Digamarru, Chitavaram, Narasapuram, Mogalturu have high P^H values in the surface water before treatment but their values are in normal range after treatment.

4.2 Total Dissolved Solids (TDS): TDS is composed mainly of Carbonated, Bicarbonates, Chlorides, Phosphates, Nitrates, Calcium, Magnesium, Sodium, Potassium and Manganese. In addition to that organic matter and other salts may also contribute to TDS. The TDS values vary from 330ppm to 1130 ppm in groundwater during winter season, 280ppm to 990ppm during summer season. Surface water values vary from 130ppm to 390 ppm during winter season, 140ppm to 1600ppm during summer season. The desirable range of TDS value is between 150ppm to 500 ppm.

4.3 Electrical Conductivity (E.C): The conductivity of water is an expression of its ability to conduct an electric current. As this property is related to the ionic content of the sample which is in turn a function of the dissolved (ionisable) solids concentration, the relevance of easily performed conductivity measurements is apparent. For many surface waters the following approximation will apply: Conductivity (µS/cm) x 2/3= Total Dissolved Solids (mg/l). The TDS and EC values well obeyed this equation.

4.4 Total Hardness (TH): Total hardness of water is characterized by content of Calcium and Magnesium salts. It is the total of Calcium hardness and Magnesium hardness.

4.5 Calcium Hardness: High levels may be beneficial and waters which are rich in Calcium are very palatable. This element is the most important and abundant in the human body and adequate intake is essential for normal growth and health. The maximum daily requirement is of the order of 1-2 grams and comes especially from dairy products.

4.6 Magnesium Hardness: Magnesium is also an essential element of the body particularly for cardiovascular functions. Hardness values vary from 70 ppm to 450 ppm. The maximum permissible value of hardness for drinking water is 300ppm. In ground water almost 50% of samples have higher values than the permissible limit but in surface water samples, all water samples have the values below 300 ppm.

4.7 Nitrates: Nitrate is a significant parameter of water showing pollution status and anthropogenic load on water (5).Relatively little of the nitrate found in natural waters is of mineral origin; most of the nitrates are coming from organic and inorganic sources, the former including waste discharges and the latter comprising chiefly artificial fertilizers. However, bacterial oxidation and fixing of nitrogen by plants can both produce nitrates. Interest is centered on nitrate concentrations for various reasons. Rivers with high levels of nitrate are more likely to indicate significant run-off agricultural land than anything else. Nitrate levels in the study area are ranged from 0 ppm to 65.3 ppm. The permissible value of Nitrate in drinking water is 45ppm. Ground water samples have high values of nitrates (crossed the permissible limit in some Villages), when compared to that of surface water samples.

4.8 Biological Oxygen Demand (B.O.D): BOD value indicated the presence of organic pollution in the water, which imposes adverse effect on the water quality of aquatic system. BOD determination is a chemical procedure for determining the amount of D.O needed by aerobic organisms in a water body to break the organic materials present in the given water sample at certain temperature over a specific period of time. Drinking water usually has a BOD of less than 1mg/L but when BOD value reaches 5mg/L, the water is doubtful in purity. It is the only parameter, to give an idea of the biodegradability of any sample & self-purification capacity of rivers and streams. The BOD values vary from 1.2 ppm to 12.6 ppm in groundwater during winter season, 1.2 ppm to

4.8 ppm during summer season. Surface water values vary from 1.5 ppm to 4.8 ppm during winter season, 1.2 ppm to 13.2 ppm during summer season.

4.9 Chemical Oxygen Demand (C.O.D): COD test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water, making COD a useful measure of water quality. COD determines the quantity of oxygen required to oxidize the organic matter in water or waste water sample under specific conditions of oxidizing agent, temperature and time. The ratio of BOD to COD is useful to assess the amenability of waste for biological treatment. Ratio of BOD to COD greater than or equal to 0.8 indicates, that waste water highly polluted and amenable to the biological treatment. The COD values vary from 6.4 ppm to 25.6 ppm in groundwater during winter season, 6.4 ppm to 70.4 ppm during summer season. Surface water values vary from 3.2 ppm to 32 ppm during winter season, 3.2 ppm to 48 ppm during summer season.

4.10 Microbiological Quality of Drinking Water: The presence of Total Coliform bacteria in water is measured in the form of MPN index, i.e. Most Probable Number in 100 ml water sample. Coliform bacteria naturally present in the gastro intestinal tract of humans and animals. The presence of Coliform bacteria in water indicates that, water has been contaminated with fecal matter of human or any other animal. Presence of E.coli in water indicated recent fecal contamination and may indicate the possible presence of disease causing pathogenic microorganisms. MPN index and E.coli in drinking water are used as indicators to measure the degree of pollution and sanitary quality of drinking water.

Table 1: Average Physico-Chemical values of Source water in different seasons.

Sl. NO	Para meter	GROUND WATER				SURFACE WATER			
		WINTER		SUMMER		WINTER		SUMMER	
		Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
1	P^H	8.0	8.0	7.9	8.1	8.8	8.2	8.7	8.3
2	TDS	731	778	889	736	177	204	197	310
3	EC	1074	1125	1288	1071	262	285	294	457
4	TH	241	271	270	235	104	104	122	136
5	TA	387	393	446	401	106	110	125	155
6	NH_3	0.04	0.10	0.00	0.00	0.02	0.03	0.00	0.00
7	NO_2	0.6	0.4	0.3	0.2	0.02	0.04	0.10	0.00
8	NO_3	27.73	11.60	29.9	20.6	6.80	5.5	9.2	7.5
9	D.O	5.55	---	6.1	---	6.33	---	5	---
10	B.O.D	4.16	---	3.1	---	2.78	---	5.5	---
11	C.O.D	15.8	---	19.7	---	10.67	---	27.3	---
12	Na^+	112.5	129	136.6	132	40.40	2.9	44	56
13	K^+	12.69	20	21	18	2.93	40.4	4.9	5.3

Table 2: Microbiological Parameters of Ground water (After Treatment) in different villages during Winter season Vs Summer season.

S. NO	PLACE	WINTER SEASON			SUMMER SEASON		
		MPN/100ml	TFC/100ml	E.coli (CFU)/1ml	MPN /100ml	TFC /100ml	E.coli (CFU)/1ml
1	Ajjaram	460	23	$112X10^2$	23	0	0
2	Peravali	0	0	0	240	93	0
3	Kothapalli	≥2400	0	$253X10^2$	0	0	0
4	Kapavaram	0	0	0	≥2400	460	8
5	Thurupuvipparu	0	0	0	≥2400	150	72
6	Kakulillindaparu	0	0	0	460	0	0
7	Surampudi	93	0	0	43	39	0
8	Rapaka	1100	460	$27X10^2$	150	0	0
9	Gollagunta	0	0	0	≥2400	43	98
10	Penugonda	0	0	0	≥2400	0	0
11	Mallapudibba	0	0	0	≥2400	≥2400	32
12	Venkataramapuram	1600	16	$46X10^2$	≥2400	11	6
13	Neggipudi	≥2400	0	$186X10^2$	1600	150	0
14	Maruteru	0	0	0	≥2400	1600	22
15	Kavitam	0	0	0	43	0	0
16	Jinnuru	≥2400	460	$115X10^2$	460	43	0

Table 3: Microbiological Parameters of Surface water (After Treatment) in different villages during Winter season Vs Summer season.

S. NO	PLACE	WINTER SEASON			SUMMER SEASON		
		MPN/100ml	TFC/100ml	E.coli (CFU)/1ml	MPN /100ml	TFC /100ml	E.coli (CFU)/1ml
1	Panditavilluru	460	210	$147X10^2$	0	0	0
2	Poduru	≥2400	460	$117X10^2$	43	0	0
3	Vedangi	≥2400	1100	$96X10^2$	≥2400	29	15
4	Bollatigunta	≥2400	240	$32X10^2$	43	0	0
5	Panumantha	0	0	0	0	0	0
6	Uilamparu	1100	210	0	0	0	0
7	Palakollu	0	0	0	0	0	0
8	Chandaparru	≥2400	1100	$146x10^2$	23	0	0
9	Aggarru	≥2400	23	0	93	0	0
10	Gorintada	≥2400	23	0	460	43	0
11	Digamarru	≥2400	23	0	240	0	0
12	Chitavaram	≥2400	150	0	0	0	0
13	Narasapuram	23	0	0	0	0	0
14	Mogalturu	0	0	0	93	15	0
15	Modi	0	0	0	≥2400	1600	0

Table 4: Suitability of Drinking water in terms of MPN of Surface &Ground waters with seasons

Season	Ground water	Surface water	Total no. of samples
Winter season	56% (9/16)	27% (4/15)	31
Summer season	38% (6/16)	40% (6/15)	31

V. CONCLUSIONS

The observed quality of treated surface water samples, during summer season the values of PH, TDS, EC, TH,TA, Nitrate, BOD, Sodium and Potassium levels were increased but Ammonia and Nitrate values were decreased.COD values in both surface and groundwater samples the levels were increased in summer season when compared to that of winter season. Microbiological contamination is less in summer (40% suitability) than in winter season (27% suitability)

In the treated Groundwater samples, chemical parameters like TDS, EC, TH, Ammonia, BOD, Nitrite, Potassium levels were decreased in summer season than in winter season. But the values of PH, TA, Nitrate, Sodium values were slightly increased during summer season. Microbiological contamination is less in winter season (56% suitability) than in summer season (38% suitability).

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