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GROUND WATER OF SOUTH ODISHA COAST: CONSERVATION AND MANAGEMENT

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ABSTRACT

Ground water quality parameters namely pH, Electrical Conductance (EC) Total Dissolved Solids (TDS), Total hardness (TH), Total Alkalinity (TA), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potassium (K^{+}), Carbonates (CO^{-}_{3}) & Bicarbonates (HCO^{-}_{3}), Chloride (Cl^{-}) and Sulphate (SO^{-}_{4}) were studied in the South Odisha coast. The study area is ranging from Rushikulya estuary to Bahuda estuary which was measured from 2012 to 2014 comprised of 100 sampling stations. Since, the super cyclone Phailine was occurred during October 2013 therefore special attention was made to understand the impact of the cyclone on the ground water quality. The results of one way ANOVA revealed that there is no significant impact felt on the ground water due to Phailine except the parameters such as pH and TDS ($P < 0.01$). However station no. 44 and 45 have shown poor ground water quality which is neither good for drinking purpose nor for irrigation and other domestic or industrial purposes therefore, it needs immediate attention.

Introduction

Groundwater is the water located under the earth's crust. And it bears 20 % of the total water present in the form of fresh water condition. This water is appeared as one of the safest source for human consumption and other necessary activities such as agriculture and aquaculture. Ground water acts as a long term reservoir of the water beneath the soil and provides a safe source for long term use. It is formed in a complex process. At first the pores present on the soil surface and underneath captures the surface running waters then gradually moves downward to accumulate deep in to the layers of soil and into the rock crevices because of the gravitational force. An aquifer is nothing but the unit of rock or an unconsolidated deposit that can provide usable quantity of water to the mankind from the ground water discharge. The depth at which the soil pore, empty spaces, rock crevices filled with water is called as water table and it recharges the aquifers. Presence of ground water table also recharges deeper ground water and provides the water to flow in the forms of streams, channels etc. Therefore, it plays a vital role in the human use and consumption (Mtoni & Walraevens 2010; Balakrishnan & Ramu 2017). Since, ground water is a good source of fresh water resource and the purest form of water therefore maximum use is practised in the rural and urban areas. So it is more prone to contamination (Muthulakshmi et al., 2009; Mtoni & Walraevens 2010). After considering the importance of the ground to the human daily use and other industrial uses the present experiment is designed to study the ground water parameters of south Odisha coast in order to check the extent of contamination, conservation and management.

Materials and Methods

Study area

The study area, is located 19°05' - 19°30' N and longitudes of 84°35' - 85°05' E in between Rishikulya estuary and Bahuda estuary of South Odisha coast covering an area of 350 sq. km. The width of the coastal tract varies from 4 to 6 km and extends for a length of about 45 km (Sahoo et al. 2018). It is bound by Rushikula River on north and Bahuda Estuary on south and Bay of Bengal on the east. Major parts of study area are underlain by hard crystalline rocks of Archaean age. Rushikulya Bahuda River occupies recent to sub recent sediments along the costal track. It has been observed sometimes laterites occur as a capping over khondalites (Tripathy et al. 1996). Water bearing properties of different geological formations play an important role in the occurrence and movement of

ground water (Krishnan 1982; Sahoo et al. 2018).

Sample collection and analysis

The samples of ground water were collected from 100 sampling points whose details is given in Table no.1 . Various physic chemical parameters were considered for analysis such as pH, Electrical Conductance (EC) Total Dissolved Solids (TDS), Total hardness (TH), Total Alkalinity (TA), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Carbonates (CO_3) & Bicarbonates (HCO_3), Chloride (Cl) and Sulphate (SO_4). The sampling period is ranged from Premonsoon 2012 to Postmonsoon 2014 encompassing 3 years. The physio-chemical parameters were analyised by adopting standard procedure mentioned in Trivedi & Goel (1986) where as the threshold values were obtained from Bureau of Indian Standard (BIS 2012) implemented in 2015. One way ANOVA is calculated by using PAST Software. The threshold values of the observed parameters also studied in terms of WHO (2004) standard for drinking water purpose.

Result and Discussion

The groundwater quality parameters of study area showing acceptable limit, permissible limit, premonsoon, postmonoon, prephailin, postphailin and station numbers more than permissible limit can be viewed from Table no. 2. showed the land use and potential threat to ground water pollution where as percentages of stations higher than permissible limit is given in text. From table it was evident that the pH value was found more during premonsoon period and post phailine periods as compared to post monsoon and pre phailin perods. Observed values were under acceptable range. Electrical conductance was found high in post monsoon and post phailin periods. TDS was high in post monsoon and post phailin periods. Total hardness was found high in premonsoon and pre phailin periods. However total alkalinity was high in post monsoon and pre phailin periods. Calcium and Magnesium is high in premonsoon and prephailin periods. Sodium was high in postmonsoon and prephailin periods while potassium is high in premonsoon and prephailin periods. Bicarbonate was high in premonsoon & postphailin periods.Chloride was high in postmonsoon and prephailin periods. But, sulphate was found high in pre monsoon and pre phailin periods. From the experiment was observed that Bicarbonate was found higher in 2 % of stations. Similarly, pH, Calcium and Sulphate values were found higher in 3 % of the sampling station than the prescribed

permissible limit. Chloride content was found high in the 6% of th total station where as TDS and Magnesium were found high in the 7% of the total stations studied. The parameters whose percentage was high than the prescribed limits of BIS (2012) among the sampling stations are those of total hardness (10 %), Electrical conductance (14 %,) Sodium (17 %), and potassium (18 %). There is no significant difference in the spatial variation of the water quality parameters between premonsoon and postmonsoon season where as prephailn and postphailin scenarios shows difference in some extent.

One Way ANOVA during Pre and Post Phailin

One-Way ANOVA ("analysis of variance") compares the means of two or more independent groups to determine whether they are statistically significantly different. One-Way ANOVA is a parametric test. During the present study an attempt has been made to find out whether there is as any statistically significant variation occurred between the environmental parameters during prephailin and postphailin conditions. The results delivered that except pH, TDS, Bicarbonate and Potassium, none of the other physiochemical parameter showed the significant difference in the study of ANOVA while comparing the values obtained during pre and post monsoon. The pH is regarded as the most important parameter to evaluate the water quality index to denote the extent of pollution by acidic or alkaline wastes. During present study the pH value is under the permissible limit (Saxena et al. 1988). Higher values of hardness values in the sampling stations might be due to the presence of carbonate and non-carbonate hardness. Generally, prolonged drinking of hard water may cause heart disease and formation of kidney stone (Muthulakshmi et al. 2009). Similarly higher values of sodium ions concentrations in the sampling stations can be explained as the influence of saline water intrusion to the coastal aquifer (Mtoni & Walraevens 2010). Excess values of calcium and magnesium ions concentration also indicated saline intrusion and mixing with coastal aquifers (Sridhar et al., 2013; Balakrishnan & Ramu 2017). Excess potassium in the drinking water acts as cathartic (Patil & Patil 2011). TDS values of water samples are also observed high in those stations those are located near the coastal areas.

Conclusion

The ground water quality of 100 stations studied showed that more than 80 % of the stations have shown the values under the permissible limit as per BIS standard as well as for the standards mentioned by

WHO. However, couple of stations had shown the poor ground water quality such as station no. 44 and 45. Changes in the land use pattern, excess withdrawal of ground water through deep bore wells, dug wells and tube wells those are believed to be the real cause of saline water intrusion in the coastal aquifers. The impact of ground water quality on health standard is yet to be studied.

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Table-1 Geographic Coordinates (Latitude and Longitude) of study area of sample location.

Station	Latitude	Longitude	Local Name
1	19.269	84.898	At Gopalpur Raod
2	19.256	84.905	At Gopalpur Club
3	19.272	84.895	Naranpur village
4	19.267	84.911	Near Haripur School
5	19.269	84.909	Harpiur Dockwell
6	19.279	84.912	Upllapatti Rest House
7	19.284	84.920	Basanputti Rest shed
8	19.287	84.9166	Basanputti hanuman statue
9	19.295	84.9218	Kaliputi UP School
10	19.297	84.932	Badakutti
11	19.300	84.935	Badapaudi end village
12	19.303	84.935	Badakutti Anganwadi
13	19.300	84.943	Badakutti tera street
14	19.3121	84.955	Maatikhala IRE Gate
15	19.3124	84.971	Bada Arji palli
16	19.316	84.978	K. Arjipalli
17	19.322	84.977	Sana arjipalli
18	19.322	84.982	Katur Sana arjipalli
19	19.317	84.975	Sana Arjipalli
20	19.322	84.962	Kanmanaa
21	19.332	84.970	Tikri Bsrhasmpur Fishery office
22	19.336	84.972	Tikri Berhampur
23	19.343	84.975	Old Chatrapur
24	19.349	84.9777	Old Chatrapur near N.H.

25	19.348	84.977	Old Chatrapur inside N.H.
26	19.345	84.986	Taria patapur Church
27	19.355	84.991	Old Police line Chatrapur
28	19.359	84.998	Paalia chatrapur
29	19.374	85.031	Telugu Nuagaon angan waddy
30	19.3762	85.032	Telugu Nuagaon
31	19.37	85.0331	Telugu Nuagaon last
32	19.371	85.0328	Augasti Nuagaon
33	19.3705	85.0346	Telugu Nuagaon dash street
34	19.369	85.0330	Augasti Nuagaon dockwell
35	19.360	85.0345	Nolia nuan gaon pundia street
36	19.355	85.037	Nolia nuan gaon
37	19.353	85.0397	Nolia nuangaon beach
38	19.355	85.039	Nolia nuangaon cyclone centre
39	19.3622	85.0117	Tampra lake boat club
40	19.359	85.0009	Palia chatrapur gauda street
41	19.1345	84.7514	Sorala
42	19.1385	84.7529	Haatipada
43	19.1378	84.752	Sorala Hospital
44	19.144	84.750	Sorala Highschool
45	19.144	84.7511	Sorala UP school
46	19.1491	84.753	Goindapur junction
47	19.113	84.776	Sonpur high school
48	19.113	84.776	Sonpur Up School
49	19.122	84.774	Aiya Sonepur
50	19.1229	84.7754	Aiya Sonepur dockwell
51	19.131	84.7836	Katur Nua Gaon
52	19.133	84.7858	katur UP School
53	19.1367	84.7818	Aldipur
54	19.137	84.796	Ramiahpatanam
55	19.1345	84.784	Sanchandrapahad
56	19.1456	84.7887	Badachandrapahad
57	19.1483	84.773	Firozpentha
58	19.159	84.775	Bihswanaathpur
59	19.168	84.777	Naupalli
60	19.1723	84.778	Mahasaaahi
61	19.1703	84.7803	Jalairi pentha
62	19.1730	84.7763	Mahasing pentha Dockwell
63	19.1724	84.77	Mahasing pentha
64	19.177	84.7661	Oredenga school
65	19.183	84.7666	Hadadanga
66	19.2110	84.8079	Gunpur

67	19.2031	84.8087	Tuulu
68	19.1953	84.812	Indrakhi
69	19.1797	84.8171	Nakaram school
70	19.1742	84.811	Damkapoda
71	19.1891	84.8276	Markendi
72	19.2065	84.8436	Garempetha
73	19.1949	84.800	Panapalli
74	19.1867	84.798	Melakularapura
75	19.1828	84.7990	Mendrajpur
76	19.1644	84.7658	Parampentha school
77	19.1620	84.799	Badaeksing
78	19.155	84.792	Sanaeksing
79	19.2231	84.8139	Dumbuni
80	19.259	84.896	Venketeraipur
81	19.259	84.889	Digapallischool
82	19.258	84.8858	Digapalli
83	19.2516	84.881	Old Buxipalli 1
84	19.251	84.884	Old Buxipalli 2
85	19.2498	84.891	Ganga Bihar
86	19.251	84.894	New Baripalli
87	19.224	84.8675	New Golabandha school
88	19.226	84.8686	Dhabaleswar DockWell H.temple
89	19.2384	84.866	Hatipada rest house
90	19.2436	84.867	Dhabaleswar
91	19.247	84.8643	Old Golabandha Junction
92	19.2513	84.863	Old Kamlapur Dockwell
93	19.256	84.863	New Kamlapur H. Statute
94	19.26788	84.863	kandrapalli
95	19.271	84.86788	Tarinipentha school
96	19.286	84.87847	Karpalli village
97	19.289	84.8821	Satyanarayanpur
98	19.295	84.8810	Rangeilunda OutPost
99	19.29	84.883	B.U. Shiba Temple
100	19.299	84.874	B.U. 3rd Hostel

Table-2 Groundwater quality parameters of study area showing Acceptable limit, Permissible limit, Premonsoon, Postmonoon, Prephailin, Postphailin and station numbers more than permissible limit

Parameters	Acceptable Limit	Permissible Limit	Pre Monsoon	Post Monsoon	Pre Phailin	Post Phailin	Sampling Stations having value more than permissible limit
pH	6.5	8.5	7.07	7.04	7.07	7.3	7, 39, 57
E.C µmhos/cm	1500	2000	1884.8	1966.35	1296.38	1824.5	1,21,23,43,44,45,47, 48,49,50,51, 54, 58,83
T.D.S mg/l	500	2000	1672.2	1734.33	409.10	1670.7	1,44,45,51,58,81,83
TOTAL HARDNESS mg/l	200	600	376.1	364.57	397.92	319.5	1,23,40,43,44,45,48, 51,58,83
TOTAL ALKALINITY mg/l	200	600	342.8	344.22	409.10	335.0	1,23,43,44,45,48,58, 83
CALCIUM (Ca)	75	200	200.5	195.36	186.34	183.8	44,45,48
MAGNESIUM(Mg) mg/l	30	100	81.4	78.31	80.22	77.2	1, 23,41,44,51,58,83
SODIUM (Na)	20	200	290.7	300.40	278.68	264.8	-
POTASSIUM(K) mg/l	12	0	33.5	30.24	24.97	24.9	-
BICARBONATE (HCO3) mg/l	200	600	253.5	243.28	214.76	232.0	48,61
CHLORIDE (Cl) mg/l	250	1000	644.7	675.33	631.38	610.3	1,44,45,58,70,83
SULPHATE (SO_4) mg/l	200	400	131.3	126.93	120.18	115.2	44,45,58

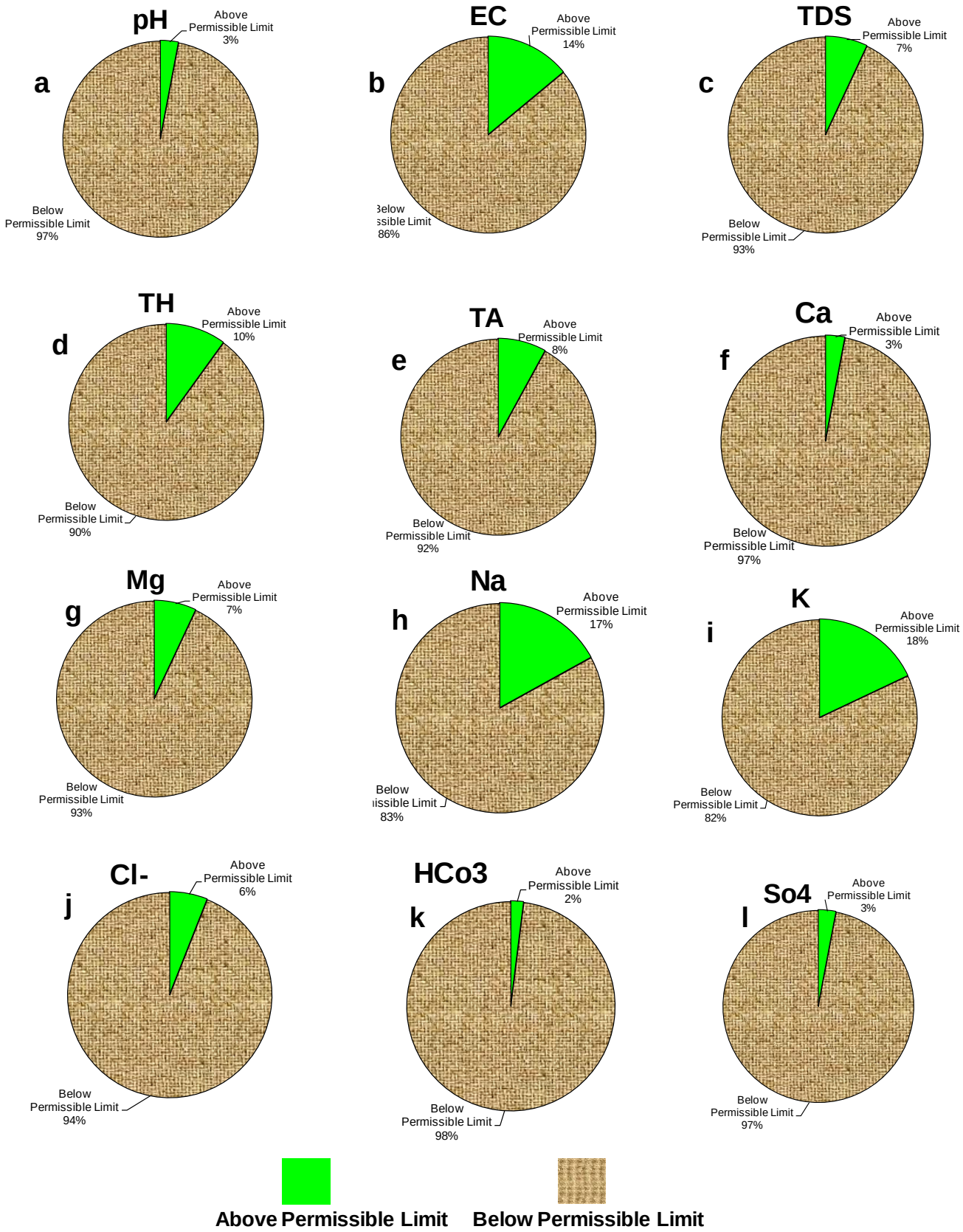

Figure-1 Images showing the parentage of stations having above the permissible limit or Below the Permissible limit.