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Assessment of Ground Water Quality By Using Water Quality Index Method of Berhampur Town In Odisha, India

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Berhampur, the silk city of Odisha (India) is under the process of rapid urbanization with human population exceeding more than four lacks. Such growth in population of Berhampur Municipal Corporation has increased the requirement of water for human activities. Due to this reason the huge amount of waste water is generated which is discharged to the Bay of Bengal through small sewage system. The present study is carried out the impact of ground water quality status of Berhampur town. The water samples collected from ten different locations have been chosen separately across Berhampur Municipal Corporation depending on pollution load and water logging. The samples were collected in three different seasons i.e monsoon (MN, June-September), post monsoon (PM, November-January) and pre monsoon (PRM, March-May) and to determine the physical, chemical and biological parameters. The WQI reflects a composite influence of contributing factors on the quality of water for any type of water system. So WQI is an important parameter for assessment and management of ground water. Now a day's water quality of different water system has been communicated on the basis of calculated WQI. The presents study revels that water quality index is 1 to 10 sampling station (S-1, S-2, S-4, S-5, S-6, S-7, S-8) come under good water quality and station (S-3, S-9, S-10) belongs to poor water. This may be due the sewage water logging in those study area which will definitely put serious impact up on socio-economic development of the people in this area in future.

Key words: Ground water, Water Quality Parameters, Water Quality Index.

INTRODUCTION

Berhampur, one of the largest city of Odisha nick name silk city is located in eastern coast line of Ganjam district, Odisha, India. It is situated in between 19Ú58'E Latitude and 84Ú5''N Longitude. The city is grown into Municipal Corporation which consists of 40 wards and population of about four lacks. This city is situated about 15 km away from Bay of Bengal which makes the city condition extremely humid. The maximum temperature during summer season 40^{0}C, whereas minimum temperature reaches to 22^{0}C during winter season. The city experiences average annual rain fall of 1250mm with the set of south west monsoon.

On account of rapid urbanization there has been a rapid growth in huge building, apartment, hotel, hospital, technical institute, transportation and vehicles. This leads to the increase in requirement of water for domestic purpose as well as drinking purposes. The river Rusikulya is the major distributing river for water supply as well as Dakhinapur reservoir is the second source of water for Berhampur city. This water supply is insufficient for the total pollution for which about 55% human population depends on ground water. But the ground water is getting polluted due to various human activities and water logging of waste water from the houses due to improper sewage system for which ground water is contaminated due to seepage from effluent bearing

water body (Adekunle, 2009). Over burden of the population pressure unplanned urbanization on restricted exploration and dumping of the polluted water at in appropriate place enhance infiltration of harmful compounds to the ground water (Pandey and Tiwari, 2009).

In view of this it is imperative to analyse the ground water quality in order to know the level of pollution, so that appropriate measures could be taken to over come the pollution problem and make the ground water pollution free or pollution minimized.

MATERIAL AND METHOD

Only tube wells were selected from ten sampling points Table 1. The grab samples were collected in plastic and glass bottles as per the requirement. The sampling was done during June 11 to May 12 on three monsoon seasons .Different physical, chemical and biological parameters such as pH, turbidity, E-conductivity, total alkalinity, TH, TDS, Iron, Cl^-, NO_3^-, Calcium and magnesium were analyzed in laboratory as per following procedure in Table-2. All chemicals and reagents used for the analysis were of analytical reagent grade (Patel and Sing, 1998),(Trivedy and Goel,1984).

Table. 1: Location of point of ground water in Berhampur town

Sl No point	Code No	Location of sampling
1	S1	Khodasing (TW)
2	S2	Industrial Estate(TW)
3	S3	M.K.C.G. Medical(TW)
4	S4	New Bustand(TW)
5	S5	Old Bustand(TW)
6	S6	Gandhi Nagar(TW)
7	S7	Gate Bazar(TW)
8	S8	Radio Station(TW)
9	S9	Haradakhandi(TW)
10	S10	Rail way station (TW)

Water quality Index (WQI)

For computing WQI three steps are followed. In the first step each of the parameters has been assigned a weight according to its relative importance in the overall quality of water for drinking purpose (Table.3). The maximum weight of 5 has been assigned to the parameter NO_3^{-1} due to its major importance in water quality assessment. Magnesium which is given the minimum weight of 1, as magnesium by itself may not be harmful to other. In the second step, the relative weight (w_i) is computed from the following equation:

$$W_{i=} w_i/\Sigma_{i=1}^{n} w_i$$

where W_i is the relative weight w_i is the weight each parameter and n is the number of parameter calculated relative weight (W_i) values of each parameter are also given in Table- 04. In third step a quality, rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines in the WHO and the result multiplied by 100.

Table. 2: Methods of analysis of different parameters

Sl. No	Parameters	Unit	Method of Analysis
1	pH value		pH meter
2	Turbidity	NTU	Nephlo turbidity
3	TDS	mg/l	Gravimetric method
4	E.C	MS/cm	Conductivity meter
5	TH	mg/l	Titrimetricmethod(EDTA)
6	Alkalinity	mg/l	Titration with H_2SO_4
7	Ca^{2+}	mg/l	EDTA Titration
8	Mg^{2+}	mg/l	EDTA Titration
9	Cl^-	mg /l	$AgNO_3$Argentometrictitration
10	NO_3^-	mg/l	UV screening

$$Qi = (ci/Si) \times 100$$

Where qi is the quality rating, Ci is the concentration each chemical parameter on each water sample in mg /l, Si is the Indian drinking water standard for each chemical parameter in mg/l according to guideline of the BIS -10500, 1991. Forth computing the WQI the first is determined the each chemical parameter which is used then the WQI as per the following equation,

$$Si = WI \times qi$$
$$WQI = \Sigma Si$$

Si is the sub index of ten parameter ,qi is the rating base on concentration of the ten parameter , and n is the number of the parameter .The computed WQI values are classified in to four types Excellent

Table. 3: Water quality classification based in WQI value

WQI	Water quality
< 50	Excellent
50 -100	Good
100-200	Poor
200-300	Very Poor

Table. 4: Relative values of chemical parameter

Parameter	Highest permitted value for water with reference to WHO standards	Weight (w_i)	Relative weight(Wi)
PH	7.0 – 8.5	4	0.1379
Turbidity	5	4	0.1379
TDS	500	4	0.1379
TH	300	2	0.689
Alkalinity	900	3	0.1034
Ca^{2+}	75	2	0.689
Mg^{2+}	50	2	0.689
Cl^{-1}	200	3	0.134
No_3^{-1}	50	5	0.1724
		Σw_i=29	

Table. 5: Seasonal variation of pH value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (7.0 to 8.5)
1	S1	7.2	7.1	7.1	7.13	Permissible
2	S2	7.3	6.9	7.0	7.06	Permissible
3	S3	7.4	7.3	7.1	7.26	permissible
4	S4	7.3	7.1	7.0	7.13	permissible
5	S5	7.5	7.1	7.0	7.20	permissible
6	S6	7.4	7.2	7.1	7.23	permissible
7	S7	7.4	7.3	7.1	7.26	permissible
8	S8	7.6	7.2	7.2	7.33	permissible
9	S9	7.8	7.2	7.2	7.40	permissible
10	S10	7.6	7.3	7.3	7.40	permissible

water to, unsuitable for the drinking**.**

RESULT AND DISCUSSION

The result of different parameter compered individually by taking data of pre monsoon, monsoon & post monsoon seasons which are reflected in table 05 to 14 and in figure 2.

pH

Maximum pH observed at sample station S-9 i.e. 7.8 and minimum was observed at sample station S-2 is 6.9. The pH range in all the station is with in permissible limit i.e. 07 to 8.5 (WHO) standard.

Turbidity

Maximum turbidity was observed at sample station S-5 is 16.2 and minimum was observed at sample station S-7 is 9.5 NTU. The result revels that the turbidity range all the station is above the desirable limit value i.e. 5 (NTU) in drinking water (WHO) standard. This may attributed to the pressure

Table. 6: Seasonal variation of turbidity (NTU) value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (5.0NTU)
1	S1	10.9	12.9	13.9	12.56	Excessive
2	S2	11.8	12.4	14.8	13.0	Excessive
3	S3	10.5	11.3	15.4	12.4	Excessive
4	S4	10.5	11.4	14.7	12.2	Excessive
5	S5	10.3	12.3	16.2	12.93	Excessive
6	S6	10.2	12.2	15.8	12.73	Excessive
7	S7	9.5	11.3	14.7	11.83	Excessive
8	S8	10.2	11.9	15.2	12.43	Excessive
9	S9	9.5	12.4	14.9	12.26	Excessive
10	S10	10.2	13.3	15.4	12.96	Excessive

Table. 7: Seasonal variation of Total dissolved solid (TDS) mg/l value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (500mg/l)
1	S1	510	540	640	563.33	Excessive
2	S2	515	534	690	579.66	Excessive
3	S3	600	683	804	695.66	Excessive
4	S4	540	666	712	639.33	Excessive
5	S5	576	612	712	633.33	Excessive
6	S6	582	635	810	675.66	Excessive
7	S7	573	679	799	683.66	Excessive
8	S8	587	671	810	689.33	Excessive
9	S9	590	683	799	690.66	Excessive
10	S10	601	698	840	713.00	Excessive

of Ca^{2+} and total Hardness (TH).

TDS

Maximum Total Dissolved Solid (TDS) was observed at sample station S-10 is 840 mg/l and minimum was observed at sample station S-1 is 510 mg/l. The result revels that this value is excessive value for drinking water at the ten sample station i.e. 500 mg/l (WHO) standard. In water total dissolved solids are composed mainly Carbonate, bicarbonate, Magnesium, Salt and other particles.

Electrical conductyvity

Maximum E-Conductivity (EC) was observed at sample station S-10 i.e. 2.3 ms/cm and minimum was observed at sample station S 1 i.e 1.1 ms/cm (Fig. 2). The result revels that this value is within the range value for drinking water at the ten sample station i.e. 1.1 to 1.3 ms/cm (WHO) standard.

Total hardness (TH)

Maximum Total Hardness (TH) was observed at sample station S-10 is 574 mg/l in pre monsoon season and minimum was observed at sample station S-3 is 295 mg/l in monsoon

Table. 8: Seasonal variation of Electrical conductivity (EC) MS/cm value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (1.1-3.0 MS/cm)
1	S1	1.1	1.3	1.2	1.2	Permissible
2	S2	1.2	1.4	1.2	1.26	Permissible
3	S3	1.7	1.9	1.6	1.73	Permissible
4	S4	1.6	1.7	1.5	1.6	Permissible
5	S5	1.5	1.7	1.6	1.6	Permissible
6	S6	1.4	1.7	1.3	1.46	Permissible
7	S7	1.5	1.5	1.2	1.4	Permissible
8	S8	1.4	1.8	1.3	1.5	Permissible
9	S9	1.9	1.9	1.5	1.7	Permissible
10	S10	2.0	2.3	1.9	2.1	Permissible

Table. 9: Seasonal variation of Total Hard ness (TH) mg/l value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (300 mg/l)
1	S1	308	323	337	322.66	Excessive
2	S2	316	346	365	342.33	Excessive
3	S3	402	425	442	423.00	Excessive
4	S4	308	322	336	322.00	Excessive
5	S5	322	335	358	338.33	Excessive
6	S6	325	340	360	341.66	Excessive
7	S7	348	362	377	362.33	Excessive
8	S8	295	305	322	307.33	Excessive
9	S9	410	430	451	430.33	Excessive
10	S10	525	560	574	553.00	Excessive

season(Fig. 2). The TH of all station has crossed the permissible limit i.e. 300 mg/l (WHO) standard. This value is more pronounced in pre monsoon season (Fig. 2). This may be due to nature accumulation of salt from contact with soil or it may enter from direct pollution by the human activity. This revels that the drinking water of such station for under hard water category.

Alkalinity

The alkalinity value seems to be highest in monsoon season at station S-9 is 850 mg/l at sample station and minimum at sample station S-7 is 440 mg/l in post monsoon season. The high alkalinity value in the study is at sample station S-9 in monsoon season is due to increase in action of carbonate as the basic material in the soil, due to this reason the drinking water sample station of S-9 is unpleasant to taste.

Cl^-

Maximum chloride was observed at sample station S-10 is 239 mg/l in post monsoon season and minimum was observed at sample station S-1 is

Fig. 10: Seasonal variation of Alkalinity mg/l value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (900 mg/l)
1	S1	652	630	615	632.33	Permissible
2	S2	702	690	670	687.33	Permissible
3	S3	590	540	525	551.667	Permissible
4	S4	680	530	510	573.33	Permissible
5	S5	648	634	522	601.33	Permissible
6	S6	705	659	634	666.00	Permissible
7	S7	680	440	510	543.33	Permissible
8	S8	710	670	642	674.00	Permissible
9	S9	850	740	620	736.66	Permissible
10	S10	600	530	511	547.00	Permissible

Fig. 11: Seasonal variation of chloride (Cl-1) mg/l value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (200 mg/l)
1	S1	98	105	110	104.33	Permissible
2	S2	105	125	127	119.00	Permissible
3	S3	220	215	217	217.33	Excessive
4	S4	115	124	125	121.33	Permissible
5	S5	118	127	127	124.00	Permissible
6	S6	106	121	121	116.00	Permissible
7	S7	118	127	130	125.00	Permissible
8	S8	129	139	140	136.00	Permissible
9	S9	225	218	216	219.66	Excessive
10	S10	230	239	236	235.00	Excessive

98mg/l in monsoon season. The result shows that at station S-9 the Cl^- value is also high. In this season the high amount of Cl^- in ground water may be due to atmospheric precipitation, animal feeds, use of inorganic fertilizer and leaching process of the soil.

Ca^{2+}

All the stations have high amount of Ca^{2+} ion present. High amount of calcium was found in the monsoon season ,post monsoon, pre monsoon which is due to geological material aquifers which is composed of calcium mixed with ground water and is found in it suspension. Maximum calcium was observed at sample station S-7 is 180 mg/l in pre monsoon season (Fig. 2).

Mg^{2+}

The magnesium values seems to be highest in monsoon season at the sample station S-10 is 295 mg/l and minimum at the sample station S-6 is 120mg/l in pre monsoon season. The results revel that the values of magnesium range in all stations above the desirable limit value i.e 50 mg/l in drinking water (WHO) standard. This may be attributed to domestic waste, medical waste and also fall in water

Fig. 12: Seasonal variation of calcium (Ca2+) mg/l value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (75 mg/l)
1	S1	69	82	79	76.66	Excessive
2	S2	78	99	80	85.66	Excessive
3	S3	92	115	104	103.66	Excessive
4	S4	75	102	89	88.66	Excessive
5	S5	81	116	102	99.66	Excessive
6	S6	79	124	111	104.66	Excessive
7	S7	110	126	180	138.66	Excessive
8	S8	120	145	122	129.00	Excessive
9	S9	125	147	127	133.00	Excessive
10	S10	111	112	110	111.00	Excessive

Fig. 13: Seasonal variation of Magnesium (Mg2+) mg/l value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (50 mg/l)
1	S1	180	169	132	160.33	Excessive
2	S2	176	158	127	153.66	Excessive
3	S3	200	190	140	176.66	Excessive
4	S4	182	173	144	166.33	Excessive
5	S5	170	156	123	149.66	Excessive
6	S6	162	149	120	143.66	Excessive
7	S7	158	151	129	146.00	Excessive
8	S8	151	142	131	141.33	Excessive
9	S9	150	142	131	141.00	Excessive
10	S10	295	282	138	238.32	Excessive

level.

NO_3^-

In the study area there is no significant change in nitrate concentration and the maximum nitrate was observed at sample station S-9 is 38.5 mg/l in monsoon season and minimum was observed sample station S-5 in 22.1 mg/l in pre monsoon season (Fig. 2). The Nitrate range in all the stations is within the permissible limit i.e 50 mg/l (WHO) standard.

CONCLUSION

From the above study it is concluded that all the ten selected location of the Berhampur city does not meet all the standard values of parameters, It is observed that the location S-3, S-9 and S-10 have highest values of parameters except nitrate, magnesium, pH, alkalinity .the highest value Of WQI .Therefore observed at S-3, S-9, and S-10 this three

Fig. 14: Seasonal variation of Nitrate (No3-) mg/l value with average and permissible value

Sl. No	Location Points	Mon soon	Post monsoon	Pre monsoon	Average	Remarks: Permissible value with reference to WHO (50 mg/l)
1	S1	35.1	33.2	31.2	33.16	Permissible
2	S2	36.0	34.5	34.5	35.00	Permissible
3	S3	26.8	25.3	34.7	28.93	Permissible
4	S4	24.6	24.6	22.3	23.83	Permissible
5	S5	22.2	23.2	22.1	22.50	Permissible
6	S6	32.4	32.4	31.0	31.93	Permissible
7	S7	29.0	28.4	28.4	28.60	Permissible
8	S8	37.2	35.2	34.3	35.56	Permissible
9	S9	38.5	38.4	32.1	36.33	Permissible
10	S10	36.2	34.3	34.3	34.93	Permissible

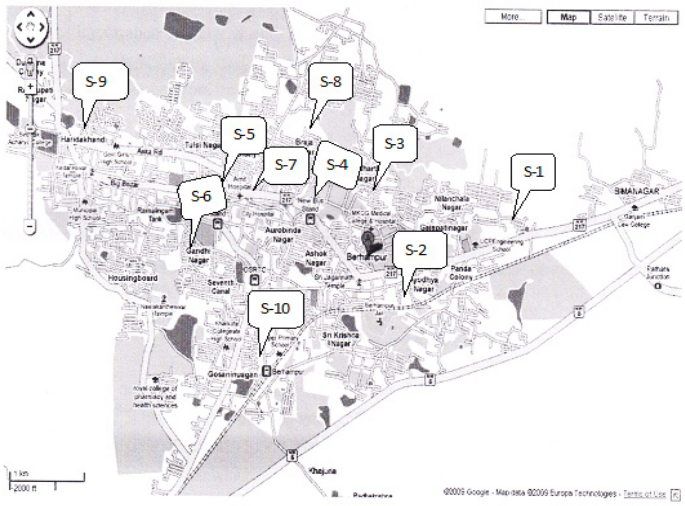

Fig. 1: Sampling location point along the Berhampur city

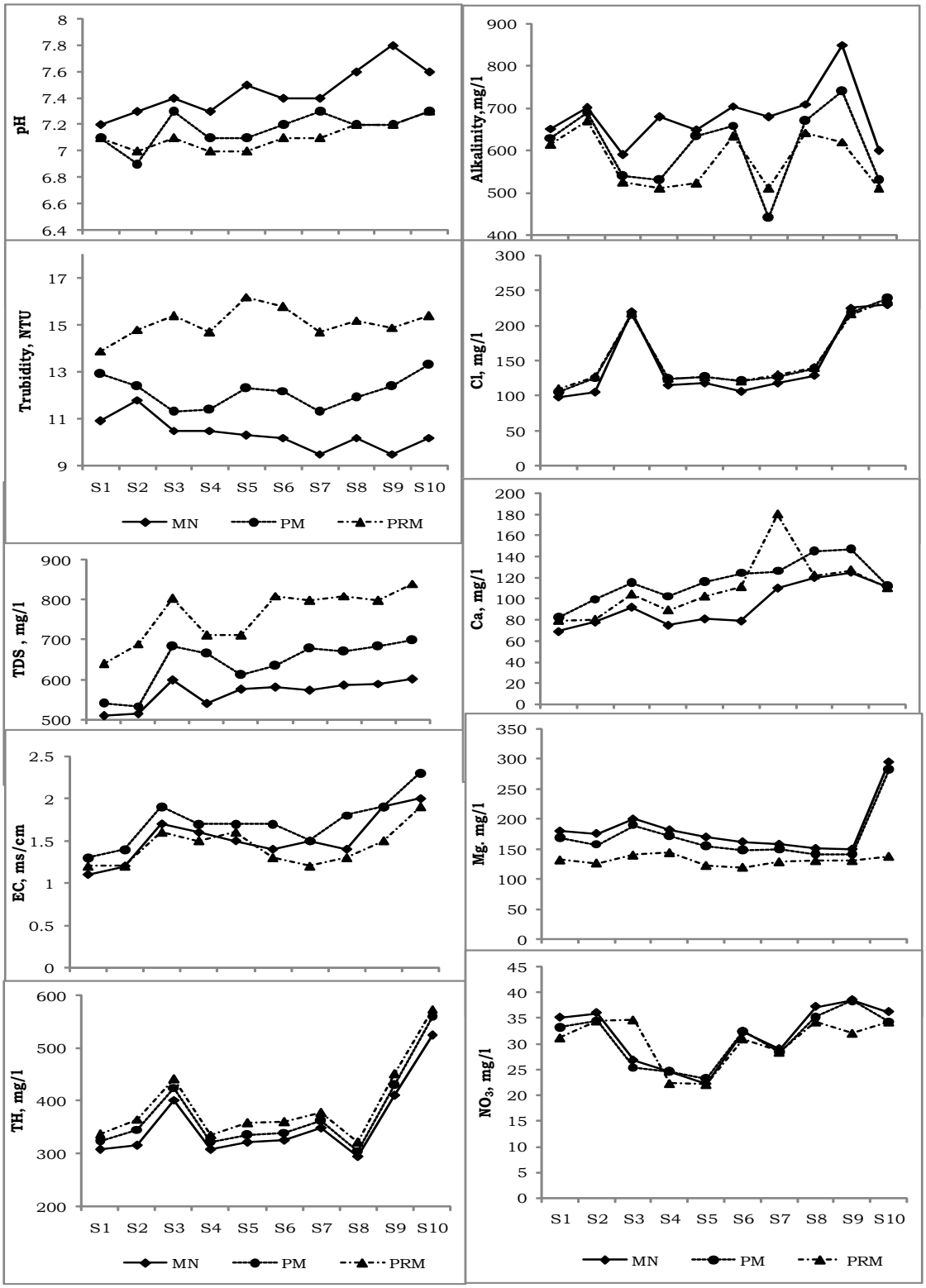

Fig. 2: Seasonal variation of water quality parameters along Berhampur city

location of ground water are not suitable for human consumption, for there the value of magnesium, calcium, and chloride are significantly inter related and indicate that the hard ness of water is permanent in nature. So the ground water need some degree of treatment before consumption and the ground water needs to be protected from future contamination and the quality of ground water may be improved by the inflow of fresh water of good quality during rainy season.

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