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RESEARCH ARTICLE

Evaluation of Ground Water quality and Its Suitability for Drinking in and around Berhampur, Ganjam, Odisha, India

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ABSTRACT

The physico-chemical characteristics of the ground water of Berhampur, the Silk city of Odisha (India) located in eastern coastal line of Ganjam district was studied during January-2009 to December-2012 in order to find the suitability for drinking. Ground water Samples were collected from 25 locations of Berhampur city in rainy, winter and summer seasons. In this study different water parameters such as temperature, pH, turbidity, hardness, calcium, magnesium, chloride and fluoride are determined by standard procedure and study the suitability for drinking. The data were analyzed with reference to BIS and WHO standards and it was found that the physic-chemical parameters are within the maximum permissible limit of drinking water standards. However fluctuation of hardness, Calcium, Magnesium, Chloride & fluoride content is observed but these values are within the standard limits. Therefore the ground water quality of Berhampur city is suitable for drinking purpose during the research period.

Keywords- Ground water, Physico-Chemical Characteristics, Water quality, Fluoride, Seasonal Variation

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INTRODUCTION

The importance of ground water for the existence of human society is very essential. Ground water is the major source of drinking water in both urban and rural areas of India. Again it is the most important source for agricultural and industrial sector. Water is the basic essential substance for the existence of life. Water accounts for about 70% of the weight of human body. About 80% of the earth's surface is covered by water; out of the total quantity of water present on the earth about 97% are present in oceans and seas which is too saline to drink. 2.4% is trapped in giant glaciers and polar ice caps[1]. Thus not even 1% of water is available for drinking, agriculture, domestic and industrial consumption. The quality of water is a vital factor for mankind as it is directly related with human health. Though the purity of water decreases by human activity, increasing industrialization, urbanization and growth of mechanization are also the main factors for water crises. Now-a-days the pollution in water increases day by day. The surface water as well as the ground water[2] is getting polluted continuously. The relationship of man with the environment[3] is from the very beginning of ancient history. During the last few decades the relationship of man with the environment drastically changed. 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 latitude 19°58'E and longitude 84°51'N. The city is grown into Municipal Corporation which consists of 40 wards and population of about four lacks & the city is situated about 10 km away from Bay of Bengal which makes the city condition extremely humid. The maximum temperature during summer season 33°C, whereas minimum temperature reaches to 16°C, during winter season. The city experiences average annual rain fall of 102 mm with the set of south west monsoon. The geographical map of Berhampur city is shown in the fig.-1.

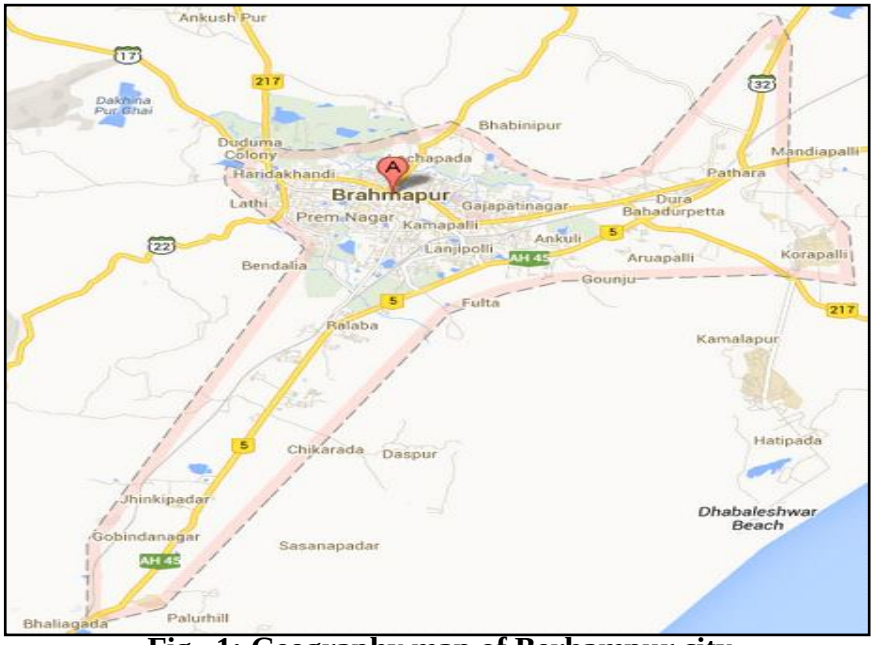

Fig.–1: Geography map of Berhampur city

The soil in the study area in characterized by sandy solid with high percentage of sand (85%) and low clay content having clay (7-12%). For this reason the soil is non-saline in nature with pH of 7 to 7.6. So it can be considered as the soil is neutral to slightly alkaline in nature. The central part

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of marshy area contains black to grey colour sandy silt clays.

MATERIALS AND METHODS

The water samples are collected from hand pumps at different 25 sampling stations around the city, shown in fig.-2 & given in table-1. The samples were collected in 5 litre plastic containers, which were thoroughly washed with the water to be analysed. The pH & temperature testes are carried out at sampling sites[4]. The other parameters are measured by the procedure given by APHA. The investigation period is divided into three season's i.e. Pre-monsoon, Monsoon and Post monsoon. Some of the tests like pH, Conductivity, Temperature, Dissolved Oxygen, and T.D.S are carried out with the help of the instrument **Microprocessor water and soil analysis kit [MODEL LT-59]**

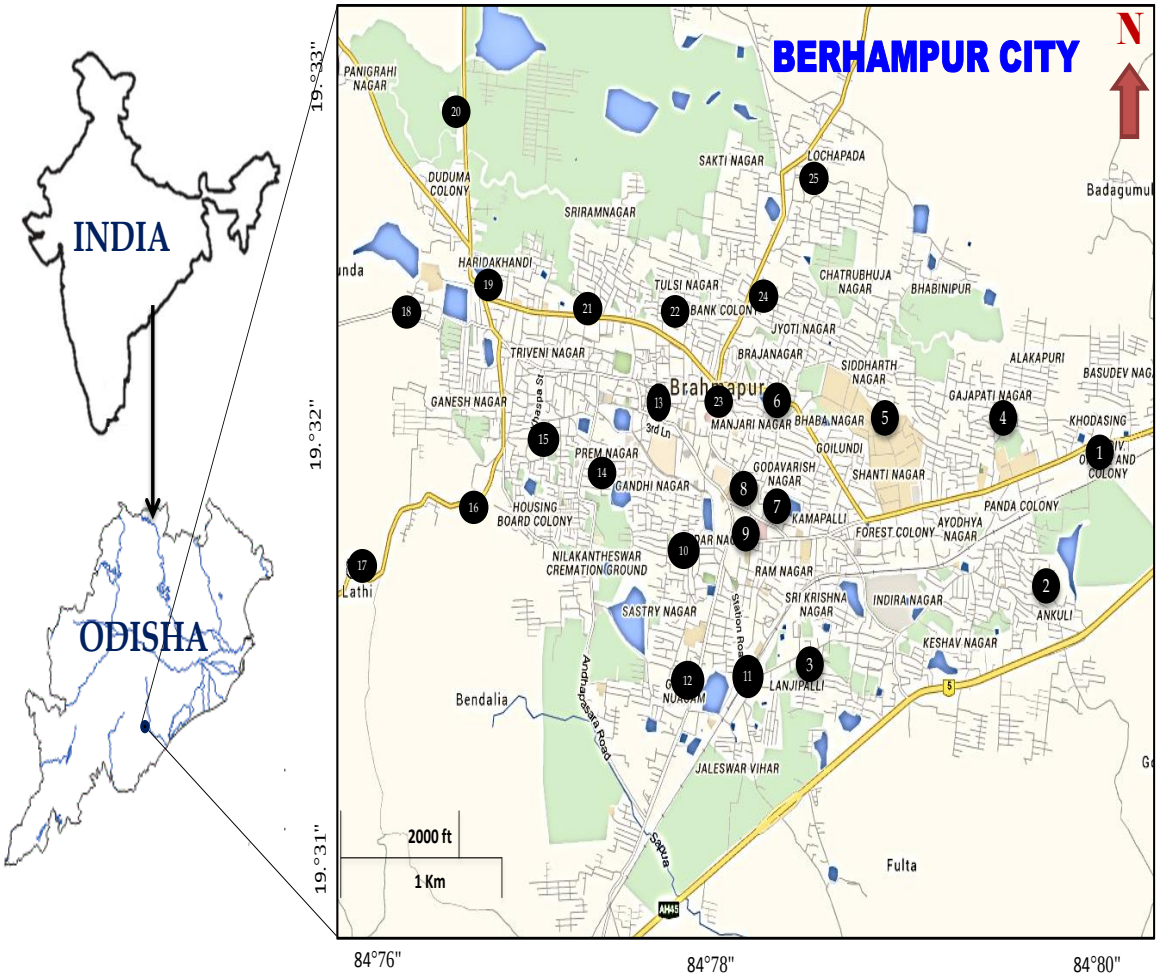

Fig.-2: Location of sampling point along Berhampur city

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Table-1: Location of sampling station at Berhampur Town

Serial number	Sample station	Location Coad	Latitude	Longitude
1	Khodasingi	S_1	$19^0.320'$	$84^0.562'$
2	Industrial estate	S_2	$19^0.381'$	$84^0.821'$
3	Lanjipali	S_3	$19^0.326'$	$84^0.786'$
4	Gajapatinagar	S_4	$19^0.311'$	$84^0.878'$
5	MKCG medical	S_5	$19^0.307'$	$84^0.811'$
6	New Bus stand	S_6	$19^0.382'$	$84^0.829'$
7	Kamapalli	S_7	$19^0.301'$	$84^0.810'$
8	Tata Benz square	S_8	$19^0.304'$	$84^0.811'$
9	MAV school	S_9	$19^0.302'$	$84^0.808'$
10	Bijipur	S_{10}	$19^0.306'$	$84^0.793'$
11	Railway station	S_{11}	$19^0.296'$	$84^0.796'$
12	SBIGosaninuagan	S_{12}	$19^0.296'$	$84^0.792'$
13	Old Bus stand	S_{13}	$19^0.311'$	$84^{0+}.790'$
14	PremNagar	S_{14}	$19^0.326'$	$84^0.786'$
15	Thakurani temple	S_{15}	$19^0.319'$	$84^0.775'$
16	Old Berhampur	S_{16}	$19^0.324'$	$84^0.784'$
17	Lathi	S_{17}	$19^0.325'$	$84^0.842'$
18	Mahurikalua	S_{18}	$19^0.321'$	$84^0.771'$
19	Haradakhandi	S_{19}	$19^0.320'$	$84^0.722'$
20	Auto Nagar	S_{20}	$19^0.323'$	$84^0.729'$
21	Taluka	S_{21}	$19^0.395'$	$84^0.693'$
22	Tulasi Nagar	S_{22}	$19^0.219'$	$84^0.720'$
23	Gate Bazaar	S_{23}	$19^0.321'$	$84^0.821'$
24	Radio station	S_{24}	$19^0.314'$	$84^0.794'$
25	Luchapada	S_{25}	$19^0.325'$	$84^0.802'$

RESULTS AND DISCUSSION

The climate of Berhampur city and its surrounding area has no appreciable seasonal change, temperature fluctuation and was purely uniform in character during 2009-10, The mean air temp was maximum in the month of may and minimum in month of December and January. The monthly minimum average temperature 22.5°C and maximum temperature 30°C. The month of January shows the cold month having temperature 16.3°C as minimum and as maximum 33.6°C in May which was the hottest month. The mean annually variation of maximum mean temperature 30.9°C in 2009, 30.8°C in 2010, 31.2°C in 2011, 30.9°C in 2012which is the characteristic feature of coastal region. In summer month March to May the city experience a few thunder storms. Being close to sea, the humidity range is high (70-90%) and highest humidity observed in month April to Sept due to Monsoon. The maximum and minimum temperature variation during 2009-12 is given in table-2. The region has a semiarid type climate.

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Table-2: Temperature in and around Berhampur (2009-12)

Months	2009		2010		2011		2012	
	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.	Mean Max.	Mean Min.
Jan	29.7	18.4	27.8	16.3	27.7	16.3	27.5	18.7
Feb	31.3	21.3	30.7	19.9	30.1	19.9	30.4	19.6
March	31.8	22.9	31.4	24.4	31.5	23.2	31.4	23.7
April	32.2	26.0	30.5	25.2	32.0	25.0	31.9	25.7
May	32.5	27.1	32.2	27.5	32.6	26.8	32.7	27.4
June	33.6	27.7	32.2	27.5	32.9	27.2	32.6	27.7
July	30.6	26.2	31.7	26.9	31.7	26.5	30.3	26.3
Aug	32.3	27.1	31.8	26.6	31.0	26.1	31.1	26.4
Sept	23.0	26.7	33.0	26.6	32.3	26.1	32.6	26.3
Oct	33.2	23.1	31.0	24.7	33.6	23.9	32.3	23.1
Nov	31.0	21.3	30.7	22.4	31.4	19.6	29.5	20.5
Dec	29.5	17.4	27.0	17.8	27.9	17.1	28.5	17.5

Berhampur city receives the South West monsoon during the period June to Sept and Pre Monsoon is however occasional during April to May.

Comparative Study of Temperature:

Temperature is the most important factor which affects the chemical and biological reactions in water[5]. The range average of temperature was 27.96°C to 29°C, in 2009-2010 and 27.7°C to 28.69°C, in 2010-11 and 28.36°C to 32.56°C,in 2011-2012 shown in fig.-3. The highest average temperate is 32.56°C in the year 2011-12 and lower average temperature 27.7°C at S-13 in the year 2010-11.

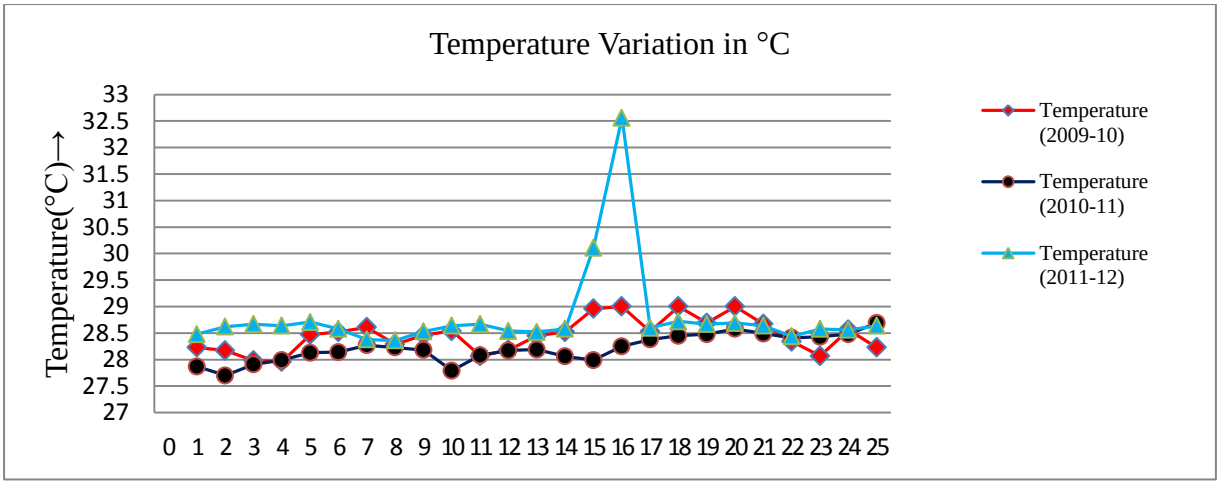

Fig.-3: Temperature Variation in ground water of Berhampur during 2009-12

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COMPARATIVE STUDY OF pH:

The average pH value varied from 7.28 to 7.65, in the years 2009-2010, 7.33. to 7.63,in the year 2010-2011 and 7.26 to 7.96 in the year 2011-2012 shown in fig.-4.The maximum average value of pH was 7.96 in 2012 and minimum value 7.28 in 2009. High pH probability is due to presence of carbonate and bicarbonate[6]. No much difference between the average values of the pH was recorded in the three years.

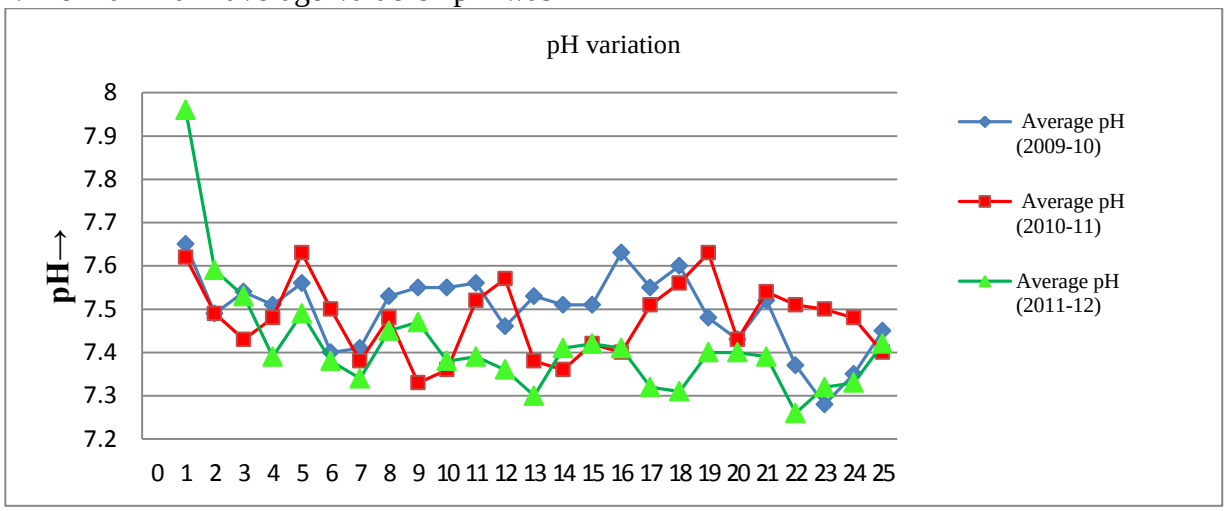

Fig.-4: pH Variation in ground water of Berhampur during 2009-12

Comparative Study of Turbidity:

The average turbidity value varied from 11.01 to 18.71 NTU, in the year 2009-10 it was 12.25. to 18.73 NTU, in the year 2010-11 and11.31 to 19.07 NTU in the year 2011-12 shown in fig.-5.The maximum value 19.07 was obtained 2011-12 and minimum value 11.01 was recorded at December-2009.Turbidity may be due to high level of carbonate and bicarbonate[7-9].

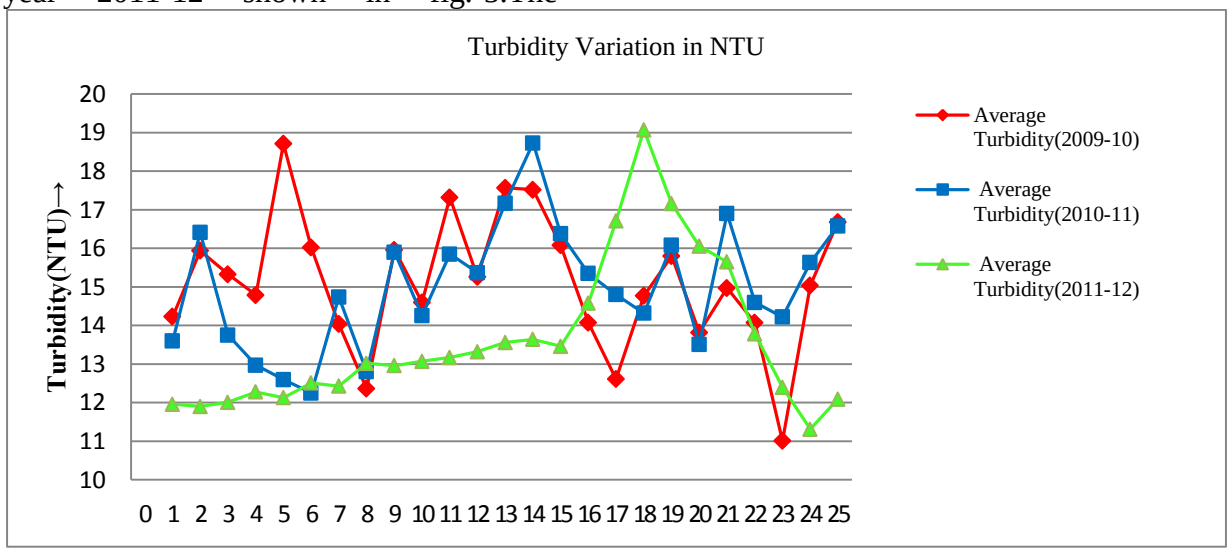

Fig.-5: Turbidity Variation in ground water of Berhampur during 2009-12

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COMPARATIVE STUDY OF TOTAL HARDNESS:

Total hardness is considered as a major character of drinking water. The average total hardness value varied from 269.67 mg/lt. to 688.42 mg/lt. in the year 2009-10, 315.42 mg/lt. to 610.31 mg/lt., in the year 2010-11 and 301.78 mg/lt. to 676.78 mg/lt., in the year 2011-12 shown in fig.-6.The maximum value 676.78 mg/lt. is obtained during 2011-12 and minimum value 296.67 mg/lt., was recorded-2009-10. Hardness increases mainly due to presence of carbonate and bicarbonate. This was attributed to ground water receiving calcium and magnesium rich in minerals leached from the rock and other deposit like in lime stone. Hardness of water has no contribute adverse effect on human health[10-14].

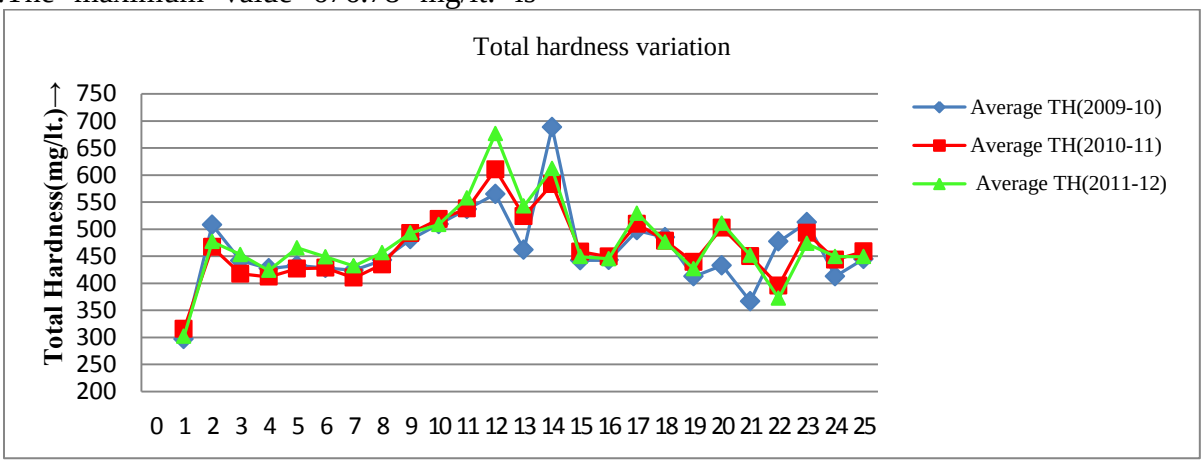

Fig.-6: Total Hardness Variation in ground water of Berhampur during 2009-12

COMPARATIVE STUDY OF CALCIUM:

The average calcium value varied from 134.22mg/lt. to 391.75 mg/lt., in the years 2009-10, 196.25 mg/lt. to 402.67mg/lt., in the year 2010-11 and 202.47mg/lt. To 392.42mg/lt., in the year 2011-12 shown in fig.-7.The maximum value 603mg/lt., was obtained at sample station S-14 in July, 2011 and minimum value 90 mg/lt., was recorded at sample station S-3 in December-2009.The high value of calcium present is due to presence of calcium chloride and calcium carbonate. It is one of the important nutrients required by all the organisms. High concentration of calcium in water is not suitable for washing purpose. Calcium as such has no hazardous effect on human health[15-16].

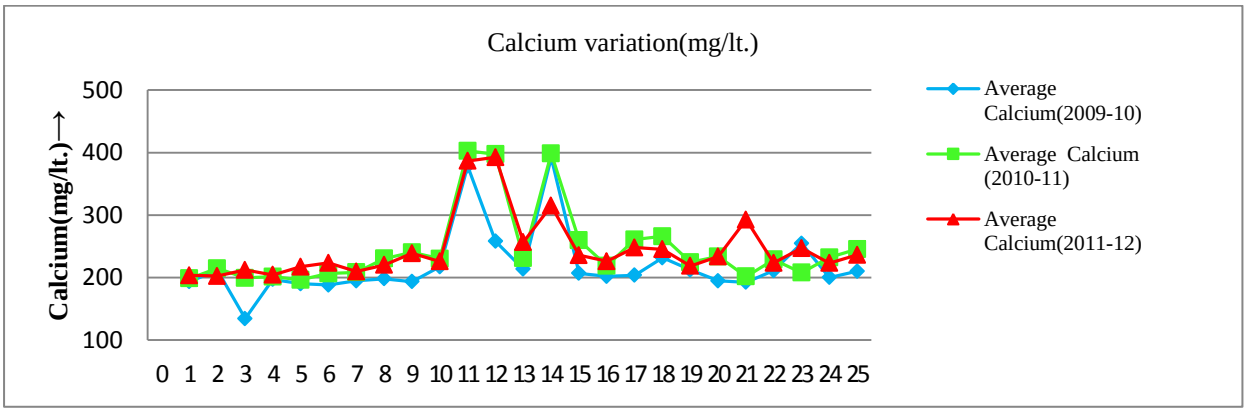

Fig.-7: Calcium Variation in ground water of Berhampur during-2009-12

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Comparative Study of Magnesium:

Magnesium concentration in ground water is generally lower than calcium. It creates hardness of water. The average magnesium value varied from 103.25 mg/lt. to 307.47mg/lt. in the years 2009-10, 107.83mg/lt. to 330.33mg/lt., in the year 2010-11 and 110.5 mg/lt. to 333.83 mg/lt., in the year 2011-2012 shown in fig.-8.The maximum value 359 mg/lt., was obtained at sample station S-5 in June-2011 and minimum value 91 mg/lt., was recorded at sample station S-1 in November-2010. High value of magnesium concentration in ground water may be due to salt water intrusion[17-18].

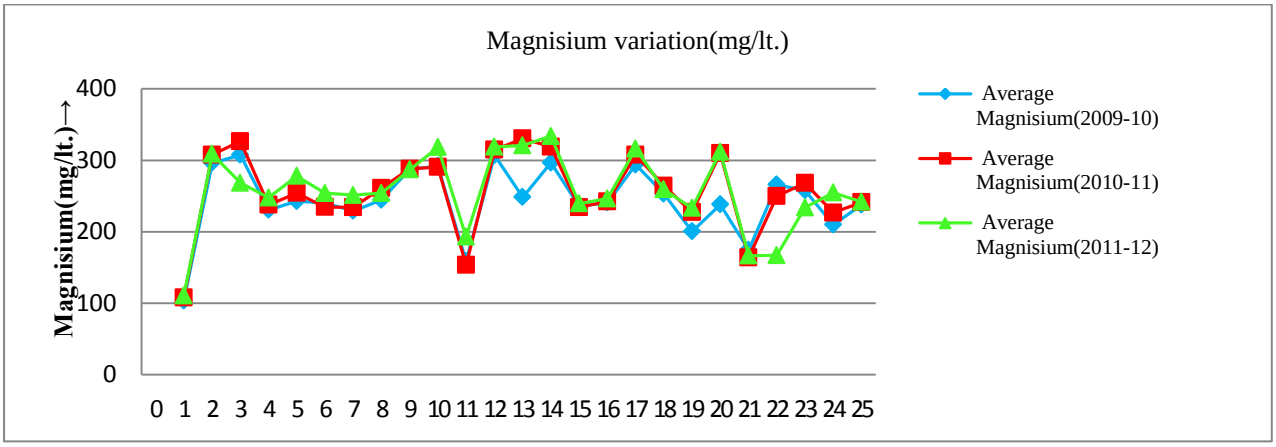

Fig.-8: Magnesium Variation in ground water of Berhampur during 2009-12

Comparative Study of Chloride:

Chlorides are important in detecting the contamination of ground water by waste water[19-20]. The average chloride value varied from 20.97mg/lt. to 122.64 mg/lt. in the years 2009-10, 23.33mg/lt. to 131.94mg/lt. in the year 2010-11 and 29.64mg/lt. to 131.89mg/lt., in the year 2011-12 shown in fig.-9.The maximum value 165mg/lt., was obtained at sample station S-1 in April-2012 and minimum value 9 mg/lt., was recorded at sample station S-20 in April-2010. This was attributed to diverse sources such as weathering and leaching of sedimentary rocks, domestic and industrial waste discharge. High concentration of chloride gives an undesirable test to water. Infants and children may suffer if they consume water having high concentration in chloride as their delicate tissue may be damaged by the high osmotic pressure brought about by the presence of high concentration of salt.

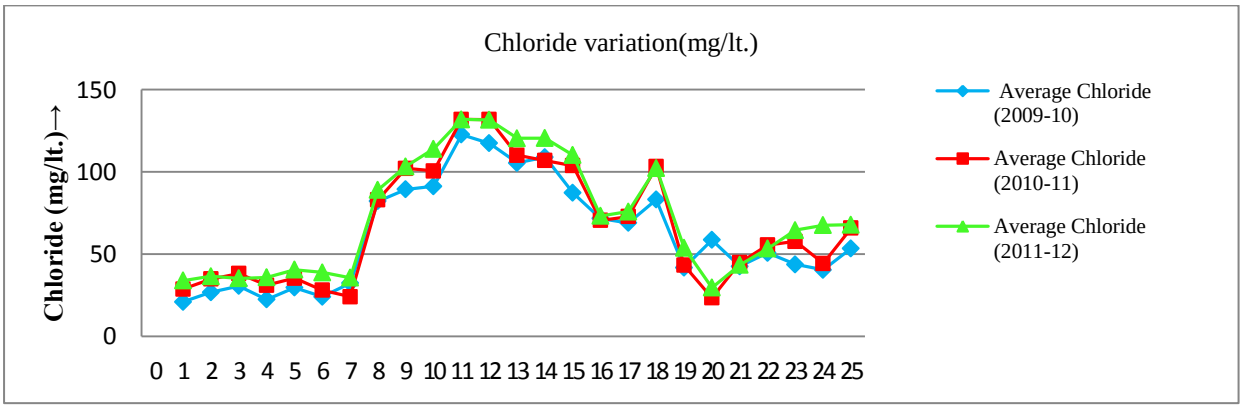

Fig.-9: Chloride Variation in ground water of Berhampur during 2009-12

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Comparative Study of Fluoride:

Concentration of fluoride is significantly low in all the samples. Fluoride ions have dual significance in water, excess concentration of fluoride causes dental fluorisis, at the same time a concentration less than 0.8 mg/lt., results in dental carries[21-22]. Fluorosis is a most wide spread geochemical disease in India, where affecting more than 66 million people including million children under age of 14 years. The average fluoride value in the ground water of Berhampur city varied from 0.15mg/lt. to 1.19mg/lt. in the years 2009-10, 0.22 mg/lt. to 1.14 mg/lt. in the year 2010-11 and 0.17 mg/lt. to 1.09 mg/lt., in the year 2011-12 shown in fig.-10.The maximum value 1.7 mg/lt., was obtained at sample station S-24 in April-2010 and minimum value 0.1mg/lt. was recorded at sample station S-3 in November-2011

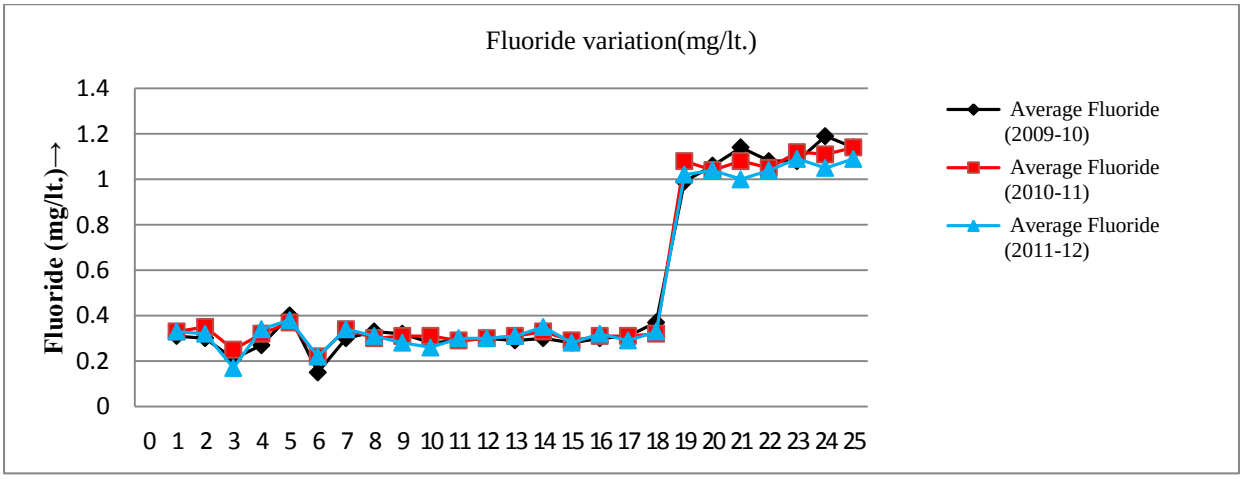

Fig.-10: Fluoride Variation in ground water of Berhampur during-2009-12

CONCLUSION

Ground water quality analysis of Berhampur, Ganjam (Odisha) shows, it is fit for drinking purpose with respect to most of the physico-chemical parameters. Total dissolved solids total hardness and alkalinity are slightly higher but well within the higher limits prescribed by WHO and BIS standards. Chloride, hardness, calcium, magnesium and fluoride content of various areas are very low & in certain areas were high. However, there is the need for routine checks to find the suitability for human consumption.

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