PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER IN KASARI RIVER BASIN, KOLHAPUR DISTRICT, MAHARASHTRA, INDIA

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ABSTRACT

There are many pollutants in groundwater due to seepage viz. organic and inorganic pollutants,The study was conducted over twenty nine villages in Kasari river basin Kolhapur district, Maharashtra. It covers more than 1177.50 Sq. Km, assessing the suitability of ground water quality for drinking purpose through water quality index investigation of twenty nine bore wells. The water samples were collected in clean polyethylene plastic containers from sites. For calculating WQI, parameters such as pH, TDS, EC, TH, Total alkalinity, Sulphate, Chloride, Nitrate, Calcium and Magnesium have been considered. The study spread over pre monsoon, and post monsoon seasons. It is observed that the quality of groundwater is not suitable for drinking and domestic purpose in some sampling sites.

Keywords -- Ground Water, Perambalur, Water Quality Index, Kasari River Basin

I. INTRODUCTION

Ground water is about 20% of the world resource of fresh water and widely used by industry, irrigation and domestic purposes. Only about 1% of all of fresh water available from rivers, ponds and lakes, out of 0.03% water require for survival and growth of many forms of animal and plant life on the earth surface [10]. In town and villages people completely depend on ground water for domestic as well as for agriculture purpose, hence quality of ground water is very important. Ground water is also polluted by acid rain, fertilizers, industrial waste, garbage and domestic waste [1]. Groundwater is a highly useful and often abundant resource, however over use or overdraft can cause major problems to human beings and to the environment.

1.1 Study Area

The Kasari river basin is located between North latitudes 16^0 30^1 and 16^0 55^1 North and East Longitude 73^0 40^1 and 74^0 15^1(Fig.1.). The study area falls in the survey of India topological sheet number 47H/13, 47H/14, 47L/1 and47L/2 of the scale 1:50,000.The Fig No.2. also shows the drainage pattern of the study area. The area experiences humid and subtropical climate. Due to availability of water from Kasari river, dug wells and bore wells, the 90% of this area is under single crop cultivation (sugar cane) from a decade. It is essential to study the ground water quality of Kasari river area is an environment importance. The safe potable water is enormously essential for living and groundwater is one of the sources for human consumption in both urban as well as rural areas. In India more than 80 percent of the rural population depends on untreated groundwater for potable water supplies [2]. The major anthropogenic activities for continuous groundwater quality deterioration are urbanization, industrialization, and agriculture run off. A study conducted by Central Ground Water Board in 2009 indicated that the groundwater quality was good and suitable for drinking and irrigation purpose, however, localized nitrate and fluoride contamination have been observed [11]. In the present study, the groundwater quality of Kasari river basin was studied by using physico-chemical parameters, further Water Quality Index (WQI) was calculated using indicator parameters. The chemical composition of groundwater plays a significant role in determining the water quality for various utility purposes [3]. The objective of the study is to analyze the physico-chemical parameters of water along selected villages in Kasari river basin for pre monsoon and post monsoon period.

About 78 percent of the groundwater used for irrigation, Groundwater also provides a significant amount of the base flow for the Kasari rivers and streams, and is, therefore, of key importance to the maintenance of the Kasari rivers environment and economy of the area. The ground water used by villages is produced primarily from aquifers, underground layers of rock with water stored in pore spaces, cracks or voids. Major aquifers are defined as producing large quantities of water in a comparatively large geographic area, whereas minor aquifers produce significant quantities of water within smaller geographic areas or small quantities in large geographic areas. Minor aquifers are very important as they may constitute the only significant source of water supply in some regions of the basin. The major and minor aquifers are composed of igneous rock types, including basalt, red bole etc.

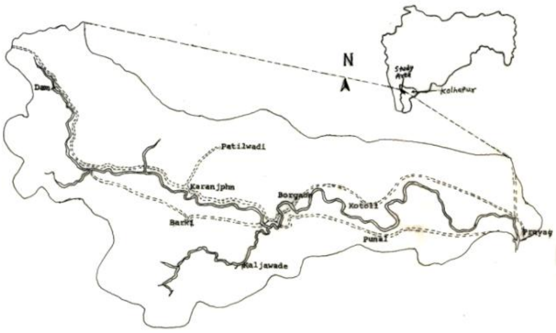


Fig. 1Study Area

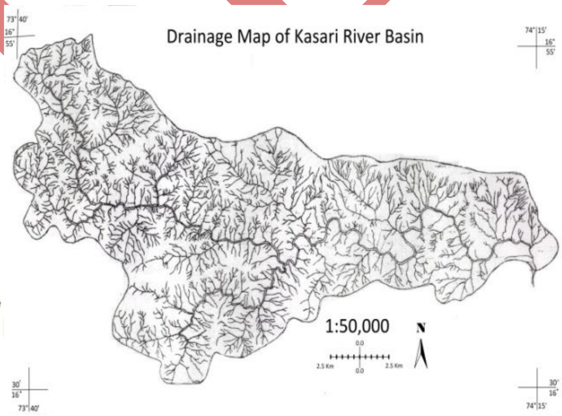


Fig. 2 Drainage Map of Kasari River Basin

II. MATERIALS AND METHODS

One liter of groundwater samples were collected in a clean polyethylene bottles from all the sampling locations in dug wells and bore wells, labeled properly and analyzed in laboratory from the study area. The samples collected were characterized by different parameters such as pH, conductivity, TDS, acidity, alkalinity, total hardness, Chloride content, etc. has been studied using standard methods[12].

2.1 Sample Collection

This study involved the use of primary data by collecting water samples from boreholes within Kasari basin. Water samples were collected from twenty nine boreholes across the study area (Figure 1) into a well-labeled polyethylene bottles. The bottles were properly rinsed with the borehole water to be sampled before the main water sample was collected in order to avoid contamination. Water samples were then subjected to laboratory analyses.

III. RESULTS AND DISCUSSION

The physicochemical results have been subjected to statistical analysis and given in the Table 1.The observed ranges of the samples were compared with Bureau of Indian Standards[13]. The samples collected showed considerable variations in the quality of groundwater.

Table 1 Standard limits of Groundwater

Parameters	**Standard limits(BIS-10500: 1991)**	
	Acceptable limit	**Maximum Possible limit**
pH	**6.5-8.5**	No relaxation
EC((µmho/cm)	**1500**	**3000**
TDS(mg/l)	**500**	**2000**
Cl- (mg/l)	**250**	**1000**
SO_4^{2}-(mg/l)	**250**	**400**
NO3-(mg/l)	**45**	**100**
Alkalinitymg/l	**200**	**600**
Ca_2+ (mg/l)	**75**	**200**
Na+ (mg/l)	**200**	**400**
Mg2+ (mg/l)	**75**	**200**
Fluoride	**0.6**	**1.5**

The pH value of the samples in the study area varied from 6.6 to 8.7 with a mean of 7.6 indicating slightly acidic to slightly alkaline nature(Graph No.1). In the study area 99% of groundwater samples were found exceeding the acceptable limit of BIS. It was noticed that the pH value of the water appears to be dependent upon the relative quantities of calcium, carbonates and bicarbonates. The water tends to be more alkaline when it possesses carbonates [4].

Electrical conductivity value of the study area varied from 270 to 2010 µmhos/cm with a mean of 1140 µmhos/cm and 1% samples exceeded standards of BIS prescribed for drinking(Graph No.2). Electrical conductivity is a measure of water's capacity to conduct electric current. As most of the salts in the water are present in the ionic form, are responsible to conduct electric current. Generally, groundwater tends to have high electrical conductivity due to the presence of high amount of dissolved salts. Electrical conductivity is a decisive parameter in determining suitability of water for particular purpose and classified according to electrical conductivity as follows,

Table No.2 Standard limits of EC

EC in µmhos/cm at 25°C	**Classification**
< 250	Excellent
250 – 750	Good
750 – 2000	Permissible
2000 – 3000	Doubtful
> 3000	Unsuitable

The Fluoride element is found in the environment and constitutes 0.06 – 0.09 % of the earth's crust. It is present in water, foods and air. Fluoride is commonly associated with volcanic activity and gases emitted from the earth's crust. Thermal waters, especially those of high pH, are also rich in fluoride. Fluoride has various uses in many industries including toothpaste, ceramics, tiles, bricks, etc. Fluoride is not found naturally in the air in large quantities. Average concentrations of fluoride found in the air are in the magnitude of 0.5 mg/m^3[14]. The observed quantity of the fluoride in the samples are 0.2 to 1.65.mg/l(Graph No.3).

The total dissolved solids (TDS) in the study area varied from 600 to 1700 mg/l with a mean value of 1150mg/l and 90% of the samples were found as per the limit of BIS. (Graph No.4) In water samples, most of the matter is in dissolved form and consists mainly of inorganic salts, small amounts of organic matter and dissolved gases, which contribute to TDS. Based on TDS groundwater is classified as follows:

Table No.3 Standard limits of TDS

Classification	TDS in mg/l
Non – saline	< 1000
Slightly saline	1000 – 3000
Moderately saline	3000 – 10000
Very saline	> 10000

Calcium is one of the most abundant substance found in natural water in higher quantities in the rocks. Higher level of calcium is not desirable in washing, bathing and laundering, while small concentration of calcium is beneficial in reducing the corrosion in pipes. Calcium in the study area varied widely from 256 mg/l to49 mg/l. samples were found the acceptable limits of BIS (Graph No.5).

Magnesium occurs in water mainly due to the presence of olivine, biotite, augite and talc minerals. Permissible limit of magnesium is 30 mg/l. Water quality analysis of the samples collected indicates that the magnesium concentration ranges from 10 mg/l to 26 mg/l. Minimum value of 10 mg/l was observed at Patilwadi village and the maximum value of 26 mg/l at Karanjphen village (Graph No.6).

The sodium in irrigation waters is usually denoted as per cent sodium and can be determined using the following formula.

$$\% Na = (Na^{+}) X 100/ (Ca^{2+} + Mg^{2+} + Na^{+1} + K^{+1})$$

Where the quantities of Ca^{2+}, Mg^{2+} Na^{+} and K^{+} are expressed in milli equivalents per liter (epm). [5] (Graph No.7)

Table No.4 Standard limits of percent sodium

Sodium %	Water class
<20	Excellent
20-40	Good
40-60	Permissible
60-80	Doubtful
>80	Unsuitable

The chloride concentration varied from 190mg/l and 320mg/l during pre and post monsoon. Most of sites in study area have higher concentration of chlorides, which could be dangerous from health point of view. **Sites B1, W3 and B7** shows extremely high concentration of chlorides as these sites are directly affected by industrial discharge (Graph No. 9.)

The content of HCO3 have no known adverse health effects, however it should not exceed the safe limits of 300 mg l-1 and 250 mg l-1 respectively in drinking water. The analytical data show that HCO3 exceeds the safe limits in about 2% of the samples (Graph No. 10).

The concentration level of Sulphate in the water is 11-99 mg/l compared to WHO (2006) standard (Graph No.11). Sulphate concentration in the area is low and therefore poses no problem for the groundwater quality. The low values are most probably due to the removal of $SO4^{2-}$ by the action of bacteria [6]. The low concentrations of sulphate suggest absence of any abuse of the water by septic tanks in the area. The Sulphate probably owes its source in the area to industrial waste from adjoining areas.

Water hardness is caused primarily by the presence of cations such as calcium and magnesium and anions such as carbonate, bicarbonate, chloride and sulfate in water. Water hardness has no known adverse effects; however, some evidence indicates its role in heart disease. Hard water is unsuitable for domestic use. In Asurle region, the total hardness varies between 70 to 1060 ppm for the pre-monsoon period. For the post-monsoon period the value varies from 55 to 824ppm

Table No.5. Physico-chemical analysis of ground water in Kasari river basin area during Pre monsoon season.

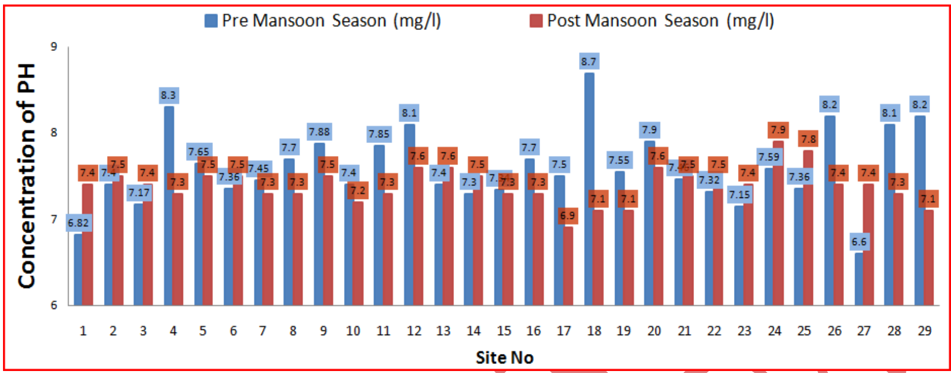
Sr. No.	Site No.	PH	EC µS/cm	F	TDS	Cations				Anions		
						Ca	Mg	Na	K	Cl	HCO_3	SO_4
1	1	6.82	740	0.6	1852	59	19	38	20	180	297	59
2	2	7.4	860	0.7	1027	87	14	29	12	299	654	98
3	3	7.17	1035	0.7	1899	68	19	48	19	310	489	20
4	4	8.3	1790	1.25	887	49	17	20	15	180	587	92
5	5	7.65	1360	1	897	190	24	79	18	188	587	98
6	6	7.36	1093	0.07	947	256	18	68	10	190	368	48
7	7	7.45	1135	0.8	877	49	17	61	9	299.8	489	79
8	8	7.7	1383	0.84	917	87	14	60	27	191	587	65
9	9	7.88	1477	0.9	980	68	16	87	24	197	289	12
10	10	7.4	693	0.87	1070	94	15	83	21	199.7	287	11
11	11	7.85	589	0.62	600	148	12	82	10	190	498	26
12	12	8.1	716	1.2	1084	152	19.1	76	14	260	587	89
13	13	7.4	690	0.9	1500	149	23	82	19	198	478	24
14	14	7.3	860	1.3	1325	149	26	26	18	299	698	59
15	15	7.34	985	0.7	987.9	178	24	24	10	287	365	57
16	16	7.7	731	0.2	1198	168	17	28	21	259	298	48
17	17	7.5	270	0.5	1700	216	12	49	26	249	278	35
18	18	8.7	1245	0.8	1203.5	209	18	59	20	287	609	16
19	19	7.55	851	0.7	692	187	14	87	9	264	698	20

20	20	7.9	849	0.9	987	165	10	41	15	249	489	13
21	21	7.46	879	0.6	1458	159	16	49	14	268	586	19
22	22	7.32	1700	0.7	1275	187	12	40	12	239	349	58
23	23	7.15	2010	0.9	1368	150	23	39	21	213	287	79
24	24	7.59	1520	1.2	975	144	24	71	29	265	259	42
25	25	7.36	1890	1.7	819.5	187	19	20	23	298	629	89
26	26	8.2	1489	1.7	928.6	62	14.2	29	24	320	426	26
27	27	6.6	698	1.5	988.6	67	19.02	51	18	298	267	35
28	28	8.1	978	1.52	749.9	69	12.5	43	17	278	419	36
29	29	8.2	1260	1.52	1279	97	17.8	29	16	269	439	48

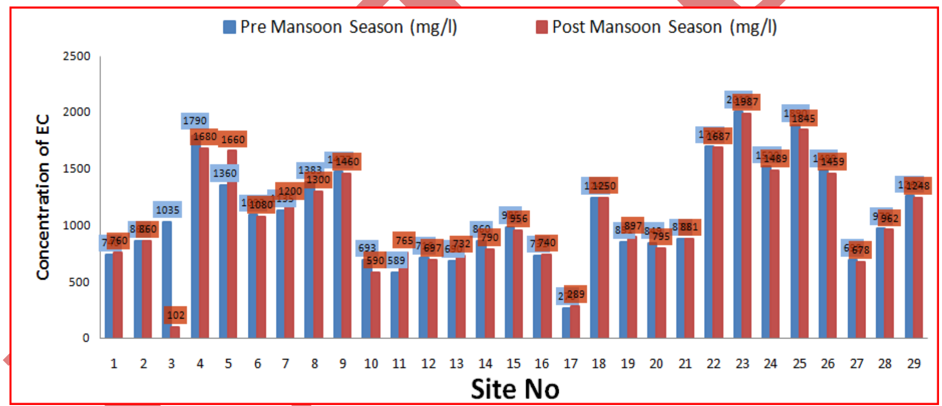
Table No.6. Physico-chemical analysis of ground water in Kasari river basin area during Post monsoon season.

Sr. No.	Site No.	PH	EC μS/cm	F	TDS	Cations				Anions		
						Ca	Mg	Na	K	Cl	HCO_3	SO_4
1	1	7.4	760	0.61	1200	57	18	31	19	178	289	62
2	2	7.5	860	0.87	1032	85	12	31	14	298	665	95
3	3	7.4	102	0.72	1900	89	17	41	21	325	480	22
4	4	7.3	1680	1.2	848	51	16	29	14	189	589	99
5	5	7.5	1660	1.2	889	180	27	68	19	178	588	98
6	6	7.5	1080	0.7	979	250	15	79	13	156	379	49
7	7	7.3	1200	0.88	880	49	13	64	10	290	478	81
8	8	7.3	1300	0.87	917	98	12	61	27	195	565	71
9	9	7.5	1460	1	9965	87	21	89	21	203	278	19
10	10	7.2	590	0.79	1012	91	19	79	23	199	298	17
11	11	7.3	765	0.66	690	151	14	81	14	189	497	28
12	12	7.6	697	1.1	1089	159	19	71	19	259	589	88
13	13	7.6	732	0.91	1465	145	21	79	17	193	465	29
14	14	7.5	790	1.31	1315	151	21	21	16	287	695	62
15	15	7.3	956	0.79	986	165	19	19	10	285	367	61
16	16	7.3	740	0.21	1112	156	19	22	20	259	305	46
17	17	6.9	289	0.52	1659	205	21	49	26	248	287	39
18	18	7.1	1250	0.82	1203	202	19	51	21	289	621	18
19	19	7.1	897	0.71	689	179	17	81	10	269	598	29
20	20	7.6	795	0.9	998	160	17	39	11	259	478	17
21	21	7.5	881	0.63	1456	148	12	51	13	262	565	19
22	22	7.5	1687	0.72	1226	169	13	38	12	248	348	51
23	23	7.4	1987	0.91	1348	152	21	41	2	232	289	84
24	24	7.9	1489	1.21	965	139	21	77	19	245	262	40

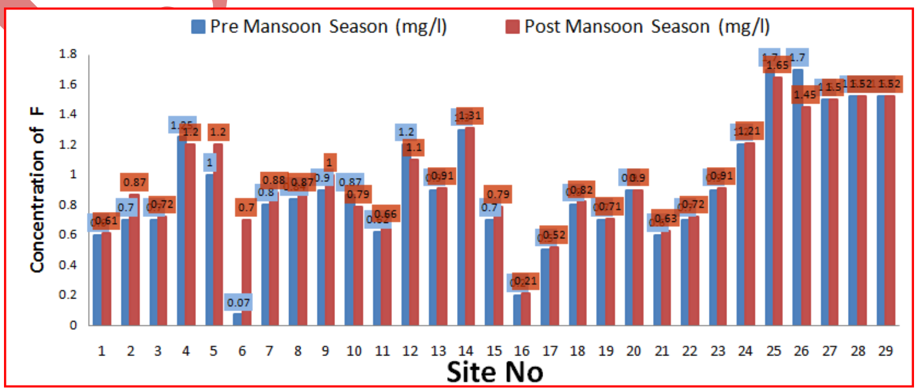
25	25	7.8	1845	1.65	8145	181	17	29	21	278	635	21
26	26	7.4	1459	1.45	928.6	67	14	38	21	329	435	21
27	27	7.4	678	1.5	988.6	65	19	54	21	287	256	39
28	28	7.3	962	1.52	749.9	67	12	41	20	298	429	37
29	29	7.1	1248	1.52	1245	99	17	39	19	260	449	50



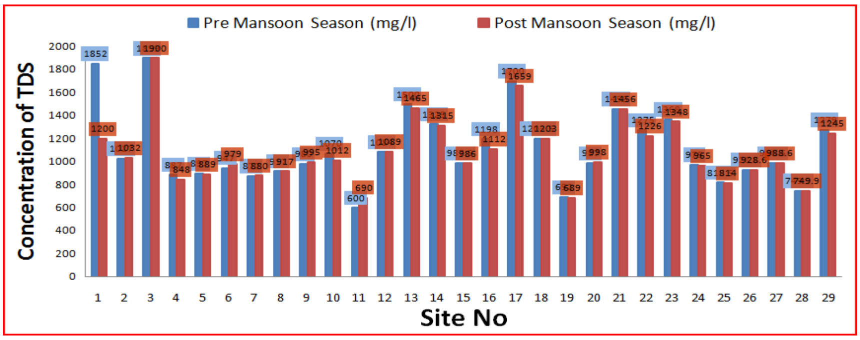
Graph No.1. Physico-chemical Data of PH



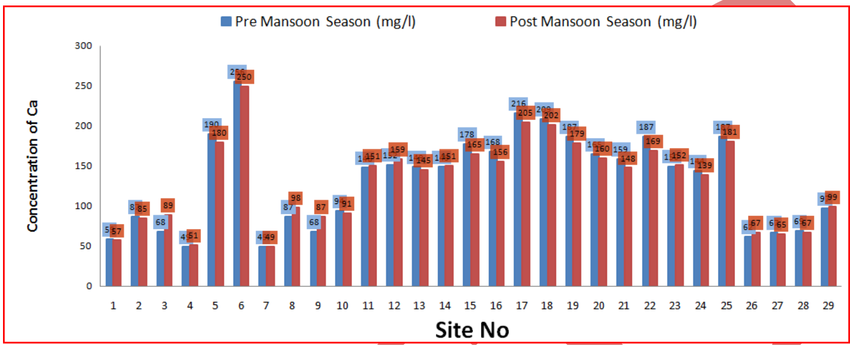
Graph No.2. Physico-chemical Data of EC



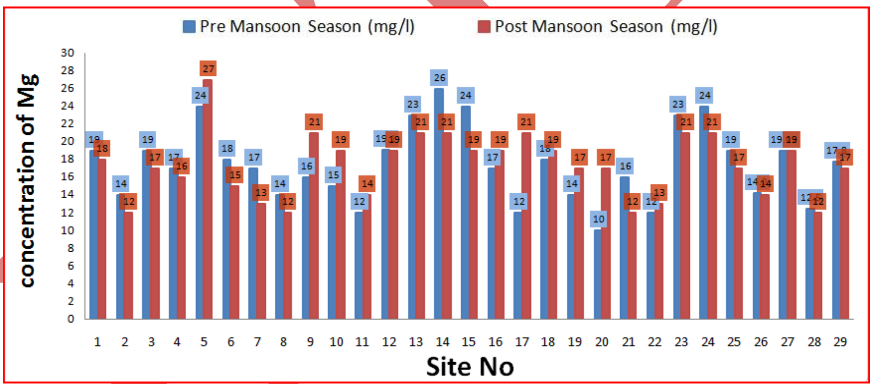
Graph No.3. Physico-chemical Data of F



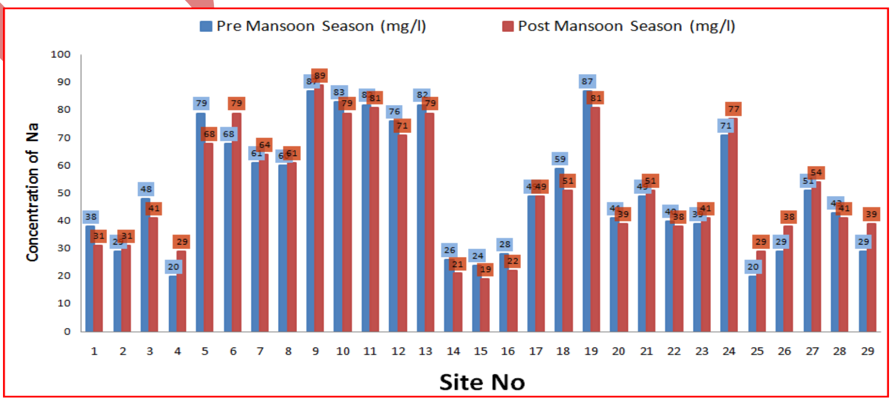
Graph No.4.Physico-chemical Data of TDS



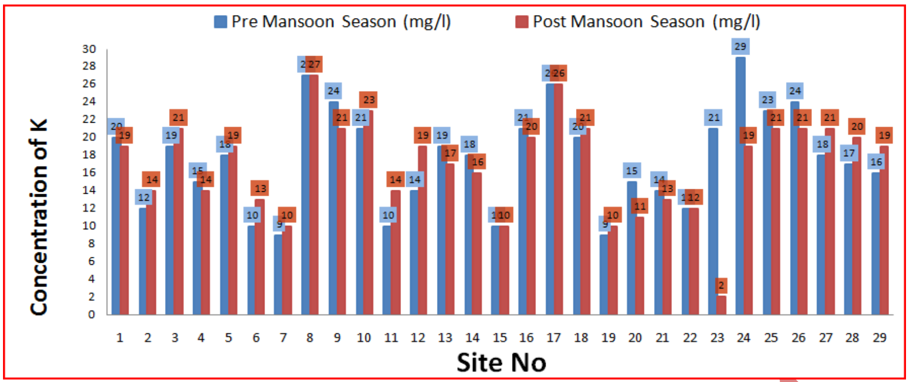
Graph No.5. Physico-chemical Data of Ca



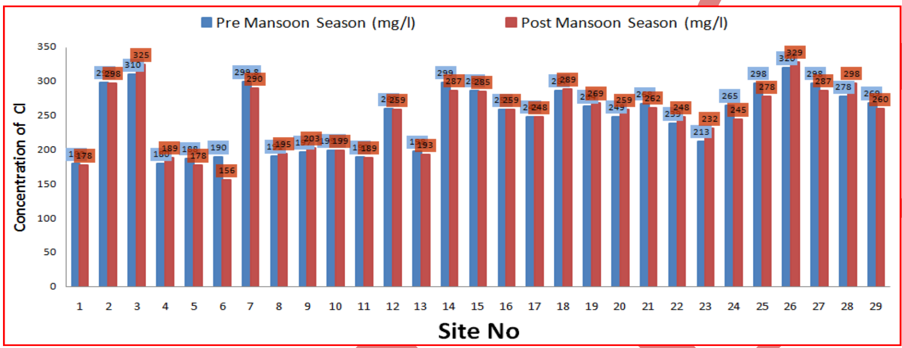
Graph No.6. Physico-chemical Data of Mg



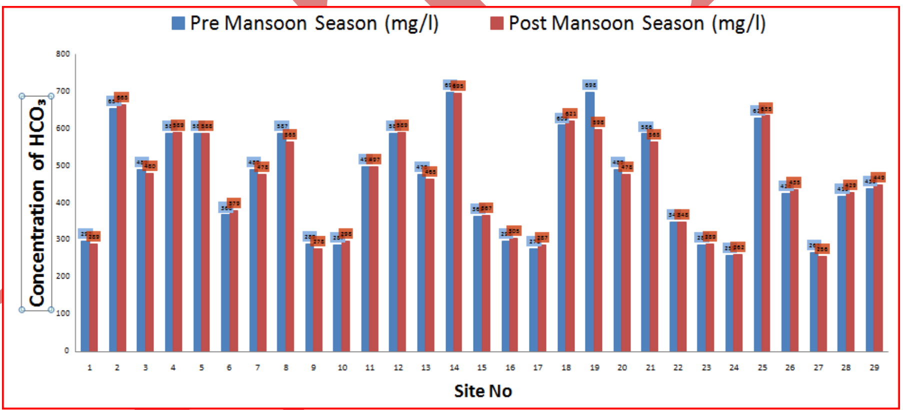
Graph No.7.Physico-chemical Data of Na



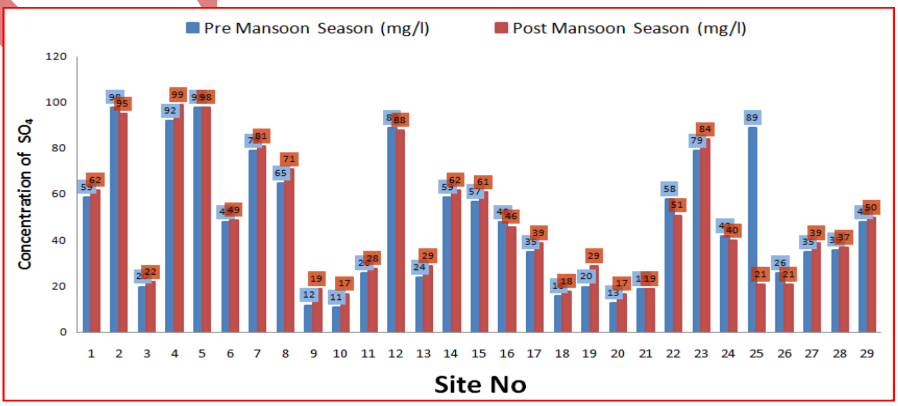
Graph No.8. Physico-chemical Data of K



Graph No.9.Physico-chemical Data of Cl



Graph No.10. Physico-chemical Data of HCO_3



Graph No.11. Physico-chemical Data of SO_4

IV. CONCLUSION

During study, samples were taken from different areas of Kasari River Basin Based on different parameter like PH, Temperature, Total Dissolved Solid, Alkalinity, Hardness, cations and anions analysis has been carried out. The parameter analysis is discussed above in detail and also showing variation in the form of graphically .

REFERENCES

Journal Papers:

[1] A. Kaushik and C. P. Kaushik, Perspectives in Environmental Studies, *New Age International Publishers, 21, 4-21 (2006)*

[2] Sudhkar M. R and Mamatha, P. (2004) Water quality in sustainable water management, *Current science, vol.87(7).*

[3] Sujatha M., Gopalskrishnayya A. Satyanarayana T., Assesment of ground water quality in rural areas of Vijayawada, A.P. 2012, Vol. 2, 645-648.

[4] Zafar, A.R.: Limnology of Hussain Sagar lake, *Hyderbad. Phykos., 5, 115-126 (1966)*

[5] Richards L.A (1954) "Diagnosis and Improvement of Saline and Alkali Soils" *Agriculture Handbook 60, Department of Agricultural, Washington DC, US, 160p.*

[6] Amadi, PA Ofoegbu C.O & Morrison T.,(1989) Hydrogeochemical Assessment of Groundwater Quality in parts of the Niger Delta, Nigeria. Environmental Geol. *Water Science, 14(3)195 –202*

[7] Schroeder. H. A.: Relations between hardness of water and death rates from certain chronic and degenerative diseases in the United States, *J. Chron disease, 1960, 12:586-591*

[8] Suryanarayana, K.: Effect of groundwater quality on health hazards in parts of eastern ghats. *Indian J. Environ. Protec., 15(7), 497-500. (1995).*

[9] Wicox, L. V.: Classification and use of irrigation waters, US Department of Agriculture, Washington Dc, *1995, p-19*

Books

[10] G. S. Birdie and J. S. Birdie., Water Supply and Sanitary Engineering, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 6,33-60 (1998)

[11] CGWB (2009), http://cgwb.gov.in/ District_Profile/ Maharashtra/Chandrapur.pdf.

[12] APHA, AWWA and WPCF: Standard methods for the examination of water and waste water. 19th Ed., APHA New York, (1995).

[13] Bureau of Indian standards: BIS- 10500: 1991 Analyses of water and wastewater, BIS, Institution, Now Delhi (1991).

[14]WHO(Nov.2004)Water,Sanitation and Hygiene. World Health Organization,

Proceedings Papers

[15]Morphometric Analysis of Kasari River Basin, Kolhapur District, Maharashtra, India. National Conference on Emerging Trends in Engineering, Technology & Architecture 25 Jan.2014.pp. 335-339