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Water Quality Analysis of Back Water and Flow Water of Saradgi Barrage on Bhima River Karnataka

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Abstract: The present work is aimed at assessing the Physico-chemical characteristics of Back Water and Flow Water of Saradgi Barrage and the Water Quality Index (WQI) of both the water of Bhima River near Saradgi village of Taluka-District Kalaburgi, Karnataka State, India. Surface water samples were collected at two sampling points, S_1 upstream side of barrage saradgi, and S_2 downstream side of village saradgi. The samples are subjected for physico-chemical analysis and eleven parameters have been considered for study namely; pH, Total Dissolved Solids, Total Hardness, Chloride, Nitrate, Sulphate, DO, BOD, Alkalinity, Phosphate, Electrical Conductivity. The analysis reveals that as BOD is slightly more then the surface water of the area needs some degree of treatment before consumption and it also needs to be protected from the perils of contamination. As per WQI calculations both the waters i.e., Back water and Flow water were found to be excellent and fit for drinking.

Keywords: Bhima river water, Physicochemical analysis, water quality index, water quality standards.

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I. INTRODUCTION

Water is the prime constituent that supports human life as well as aquatic life. Water is also known as blue gold, and is one of the most precious natural resources and responsible for life on Earth, the evolution of life and development of human civilization could not have been possible without water. All great civilizations of the world therefore are evolved around rivers. Rapidly increasing population, indiscriminate urbanization and unplanned industrialization along the rivers as well as in the catchment areas have put tremendous stress on water resources and their quality. Indiscriminate discharge of industrial effluent in rivers has been a common phenomenon leading to sever depletion of water quality and aquatic life.

The organic waste, sludge and garbage dumping has reduced the carrying capacity of the river and hence a threat to marine life. After consumption of polluted water, the water pollutants will be, absorbed through the intestines, they can enter the blood stream, where their potential harmful effects are distributed throughout the body. Blood passes through all the body's organs and tissues, and can carry toxic substances as well as beneficial substances, such as oxygen, to cell and removes toxoides from the cell. Surface water pollution with chemical, physical and biological contaminants by anthropogenic activities is of great environmental attention all over the world. Surface water systems mainly mean the waters naturally open to atmosphere, for example rivers, lakes and reservoirs water. Rivers play an important role in a watershed for carrying off municipal and industrial wastewater and run-off from farm land, and are one of the most susceptible water bodies to pollutants. The constant discharges of domestic and industrial wastewater and seasonal surface run-off due to the climate all have a strong effect on the river discharge and water quality. However, rivers are the main water sources for domestic, industrial and agricultural irrigation purposes in a region, river water quality is one of important factors directly concerning with health of human and living beings. Therefore, it is imperative and important to have reliable information on characteristics of water quality for effective pollution control and water resource management. There is a great need to evaluate the river water quality. For the spatial variations in hydrochemistry of rivers, the usual method of water quality evaluation is to measure multiple parameters of pollutants in different monitoring stations at periodic times in a watershed with varying topographical conditions. Since, there is a complex data matrix with a large number of physico-chemical parameters to evaluate the water quality.River water contains a large number of dissolved chemical components of varying magnitude. The primary source of most dissolved ions is the mineral assemblages in rocks near the land surface but the chemical composition is likely to be greatly affected by the nature and amounts of wastes dumped into, as well as biotic and abiotic processes in the water body (APHA, 2005). However, the effect of pollutants on water composition may obscure the effect of other factors in most of the cases.

1.1 Bhima river

Bhima river originates near Bhimashankar temple in the Bhimashankar hills in Ambegaon Taluka on the western side of the western Ghats known as Sahyadgi in Pune district of Maharashtra. Bhima River is a major river in south India. It flows southeast for 861 km through Maharashtra, Karnataka and telangana states before confluence with the Krishna River at Kadlur (Raichur) in Karnataka.

1.2 Study area

Kalaburagi is a city in the Indian state of Karnataka, India. It is the administrative headquarters of the Kalaburagi district and a major city of north Karnataka region. Kalaburagi is 623 km north of the state capital of Bangalore and 220 km from Hyderabad. Previously it was the part of Hyderabad state, it was incorporated into a newly formed mysore state (now known as Karnataka) through the states reorganization act in 1956.

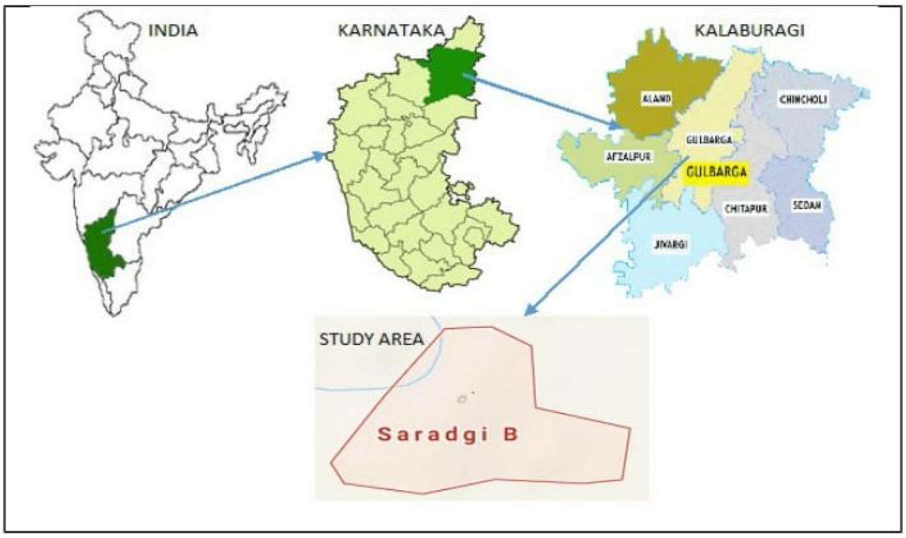

Fig.1.2.a. Location of Kalaburagi city map

The district is situated in north Karnataka between 76^0.04' and 77^0.42' east longitude, and 17^0.46' north latitude, covering an area of 10,951 km^2.
As per official census 2011, Kalaburagi had a population of 2,566,326 of which male and female were 1,301,755 and 1,264,571 respectively. Kalaburagi city is shown in map.1.2.a.

The proposed study area i.e., Bhima river near Saradagi dam is located nearly about 25 km away from the kalaburgi city. Under Gulbarga water supply scheme-III Stage, Bhima river as source with an implimentation of Bhima water supply scheme to Gulbarga city 11 MGD of water will be made available to the city taking in to consideration ultimate stage population of 3.30 lakhs censis during the year 2011 A.D. Map of saradgi barrage is shown in fig.1.2.b. and fig.1.2.c.

Fig.1.2.b. Google map of Saradgi Barage

At present daily 55 MLD of water supply to kalaburagi city, length of the barrage is 300 meters, capacity 300 mcft, Bed level of river is 374 meters, Highest flood level is 383.80 meters, extraordinary flood observed of about 386.50 meters on 16-10-1998 and 386.85 meters on 14-08-2006.

Fig.1.2.c. Saradgi Barrage of Bhima river

1.3 OBJECTIVES

1) Water quality analysis of Back water and Flow water.
2) Comparision of water quality using statistical methods.
3) To check the pollution status of the Back water and Flow water.
4) To carry out the water quality Index.

II. MATERIALS AND METHODOLOGY

2.1 Sampling

Water is collected during the time of peak hour at the point of conflux in a bottle, which is non contaminated and stored it in a cold storage at (4^0 c)**.** The samples were collected from February 01 2017 to May 16 2017 covering winter and summer seasons. All the grab samples are collected covering the barrage Back water and Flow water with a frequency of 15 times after a gap of every 8 days.

Two liters of water samples are collected from each sampling point and immediately transported to the laboratory for analysis. All the samples were tested in the laboratory to determine physico-chemical parameters such as pH, Electrical Conductivity (EC), Total Hardness (TH), Total Dissolved Solids (TDS), Chloride(Cl^-), Alkalinity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Nitrate (NO_3^-), Sulphate (SO_4^-), Phosphate (PO_4^{3-}).

2.2 Methods for Analysis

2.2.1 Correlation and Regression analysis

Co-variation of two independent magnitudes is known as correlation. If two variables x and y are related in such a way that increase or decrease in one of them corresponds to increase or decrease in the other, we say that the variables are positively correlated. Also if increase or decrease in one of them corresponds to decrease or increase in the other, the variables are said to be negatively correlated. The numerical measure of correlation between two variables x and y is known as coefficient of correlation. Regression is an estimation of one independent variable in terms of the other. If x and y are correlated, the best fitting straight line in the least square sense gives reasonably a good relation between x and y. The best fitting straight line of the form y = ax+b (x being the independent variable) is called the regression line of y on x and x = ay+b (y being the independent variable) is called the regression line of x on y.

2.2.2 Software Used

MINITAB 18 for statistical analysis.

2.3 Water Quality Index

Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of groundwater. WQI is defined as a rating reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of groundwater for human consumption.

III. RESULTS AND DISCUSSIONS

3.1 General

For sampling purpose we have selected two points such as Back Water and Flow water and the water quality results of 15 samples each covering the study area have been presented from the pre monsoon period
(a). Physico-chemical analysis
(b) Correlation and Regression analysis
(c) Water Quality Index (WQI)

3.2 Physico-Chemical Analysis:

Table 3.2.a: Characteristics of Back Water (BW)

No. of samples	pH	EC (u S/cm)	TDS (mg/L)	DO (mg/L)	BOD (mg/L)	TH (mg/L)	Cl^- (mg/L	Alkalinity (mg/L)	SO_4^{--} (mg/L)	PO_4^{3-} (mg/L)	NO_3^- (mg/L)
1.	8.12	356	235	6.82	2.81	260	97	275	49	0.15	3.8
2.	8.31	396	258	6.59	2.23	288	90	226	54	0.26	4.2
3.	8.25	464	302	6.91	2.45	240	95	290	44	0.45	4.4
4.	8.51	397	259	6.58	2.21	242	118	288	46	0.31	2.8
5.	8.41	488	318	6.82	2.44	298	108	186	58	0.28	3.9
6.	8.34	416	271	6.63	2.13	260	119	198	61	0.39	4.1
7	8.45	418	280	6.56	1.98	290	126	250	47	0.42	3.6
8	8.5	438	252	6.86	2.15	300	108	260	48	0.11	3.8
9	8.4	446	266	6.91	2.53	280	123	276	46	0.1	2.5
10	8.48	426	258	6.68	1.58	268	142	265	55	0.34	3.7
11	8.36	416	276	6.95	2.51	276	138	280	49	0.26	3.3
12	8.44	436	268	6.76	1.45	258	120	269	47	0.29	2.6
13	8.49	448	260	6.85	1.88	294	118	288	54	0.34	2.9
14	8.38	458	258	6.88	2.11	288	112	259	50	0.16	3.4
15	8.45	434	278	6.86	1.99	275	124	278	49	0.38	3.2
MAX	8.51	488	318	6.95	2.81	300	142	290	61	0.45	4.4
MIN	8.12	356	235	6.56	1.45	240	90	186	44	0.1	2.5
MEAN	8.38	428.29	270.11	6.77	2.16	273.94	115.88	256.70	50.70	0.28	3.47
SD	0.10	31.91	20.25	0.13	0.36	19.27	14.70	32.01	4.86	0.11	0.58
%CV	1.26	7.45	7.49	1.97	16.73	7.03	12.69	12.47	9.60	39.34	16.91
SUM	125.89	6437	4039	101.66	32.45	4117	1738	3888	757	4.24	52.2

Table 3.2.b: Characteristics of Flow Water (FW)

No. of samples	pH	EC (uS/cm)	TDS (mg/L)	DO (mg/L)	BOD (mg/L)	TH (mg/L)	Cl^- (mg/L)	Alkalinity (mg/L)	SO_4^{--} (mg/L)	PO_4^{3-} (mg/L)	NO_3^- (mg/L)
1.	8.3	398	259	6.58	2.2	276	99	220	46	0.27	0.23
2.	8.2	413	268	6.62	1.86	274	86	260	44	0.18	0.15
3.	8.4	390	253	6.59	1.89	258	89	228	58	0.16	0.19
4.	8.5	389	188	6.81	1.85	240	119	235	48	0.38	0.17
5.	8.1	427	278	6.65	1.58	268	107	198	57	0.07	0.26
6.	8.4	437	285	6.68	1.66	285	130	210	45	0.15	0.16
7.	8.2	438	286	6.75	1.56	258	108	226	48	0.14	0.18
8	8.15	398	258	6.61	1.48	280	106	208	45	0.04	0.11
9	8.13	422	269	6.72	1.55	259	112	220	46	0.05	0.13
10	8.14	384	286	6.56	1.46	264	119	216	43	0.03	0.23
11	8.16	389	277	6.81	1.98	266	109	206	42	0.12	0.18
12	8.18	412	305	6.66	1.64	252	120	214	44	0.18	0.12
13	8.12	411	268	6.56	1.55	274	116	218	48	0.14	0.16
14	8.15	396	288	6.64	1.92	263	114	212	46	0.02	0.19
15	8.17	388	276	6.62	1.47	272	113	219	49	0.04	0.22
MAX	8.5	438	305	6.81	2.2	285	130	260	58	0.38	0.26
MIN	8.1	384	188	6.56	1.46	240	86	198	42	0.02	0.11
MEAN	8.22	406.70	266.88	6.65	1.71	265.52	109.58	220.47	47.58	0.139	0.178
SD	0.121	18.24	26.348	0.082	0.224	11.60	11.63	14.54	4.605	0.098	0.043
%CV	1.476	4.486	9.872	1.234	13.100	4.372	10.614	6.598	9.677	70.950	24.107
SUM	123.3	6092	4044	99.86	25.65	3989	1647	3290	709	1.97	2.68

3.3 Correlations and Regression Analysis

3.3.1 Correlation of Back Water

In the present study the correlation coefficient between the parameters is computed. The degree of line of association between any two water quality parameters is measured by correlation coefficient which is represented in table 3.3.1. The highest positive correlation between different parameters was found out to be 0.702 i.e., between Total Dissolved Solids and Electric Conductivity and the highest negative correlation between different parameters was found out to be -0.767 i.e., between sulphate and alkalinity.

Table No 3.3.1: Correlation Coefficient of Various Parameters of Back Water

	pH	EC	TDS	DO	BOD	TH	Cl^-	alkalinity	SO_4^-	PO_4^{3-}	NO_3^-
pH	1.00										
EC	0.387	1.00									
TDS	0.079	**0.702**	1.00								
DO	-0.185	0.444	0.153	1.00							
BOD	-0.657	-0.195	0.078	0.349	1.00						
TH	0.320	0.328	0.028	0.147	-0.044	1.00					
Cl^-	0.572	0.076	0.005	-0.008	-0.450	0.032	1.00				
Alkalinity	0.068	-0.183	-0.367	0.366	-0.042	-0.363	0.190	1.00			
SO_4^-	0.018	0.084	0.111	-0.276	-0.138	0.310	0.057	-0.767	1.00		
PO_4^{3-}	0.112	0.119	0.509	-0.380	-0.365	-0.366	0.170	-0.057	0.155	1.00	
NO_3^-	-0.501	-0.041	0.239	-0.162	0.285	0.008	-0.496	-0.490	0.368	0.265	1.00

If the correlation coefficient is ≥0.67 there exists a relation between two parameters so TDS and EC are best correlated. For such parameters regression equations are computed and best fit line is drawn in figure 3.3.1

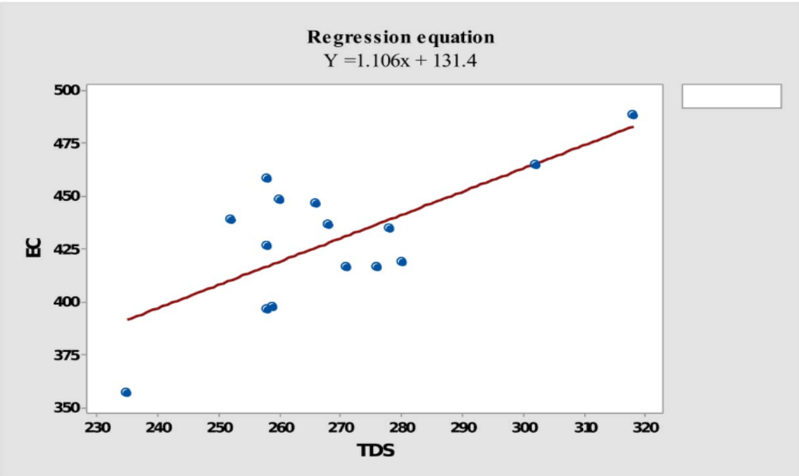

Figure 3.3.1: Regression Line for TDS v/s EC

3.3.2 Correlation of Flow Water

In the present study the correlation coefficient between the parameters is computed. The degree of line of association between any two water quality parameters is measured by correlation coefficient which is represented in table 3.3.2. The phosphate and pH are highly interrelated among themselves. The highest negative correlation between different parameters was found out to be -0.646 i.e., between Total dissolved solids and pH.

Table 3.3.2: Correlation Coefficient of Various Parameters of Flow Water

	pH	EC	TDS	DO	BOD	TH	Cl^-	alkalinity	SO_4^-	PO_4^{3-}	NO_3^-
pH	1.00										
EC	-0.104	1.00									
TDS	-0.646	0.358	1.00								
DO	0.267	0.174	-0.294	1.00							
BOD	0.440	-0.280	-0.283	0.151	1.00						
TH	-0.266	0.209	0.373	-0.503	-0.081	1.00					
Cl^-	0.018	0.160	0.150	0.252	-0.419	-0.081	1.00				
Alkalinity	0.348	0.056	0.383	0.005	0.247	-0.207	-0.516	1.00			
SO_4^-	0.191	0.091	0.219	0.175	0.037	-0.163	-0.343	-0.081	1.00		
PO_4^{3-}	**0.758**	0.037	0.657	0.327	0.551	-0.379	-0.087	0.469	0.024	1.00	
NO_3^-	-0.034	-0.196	0.034	-0.213	0.167	0.054	-0.100	-0.219	0.434	-0.075	1.00

If the correlation coefficient is ≥0.67 there exists a relation between two parameters so TDS and EC are best correlated. For such parameters regression equations are computed and best fit line is drawn in figure 3.3.2.

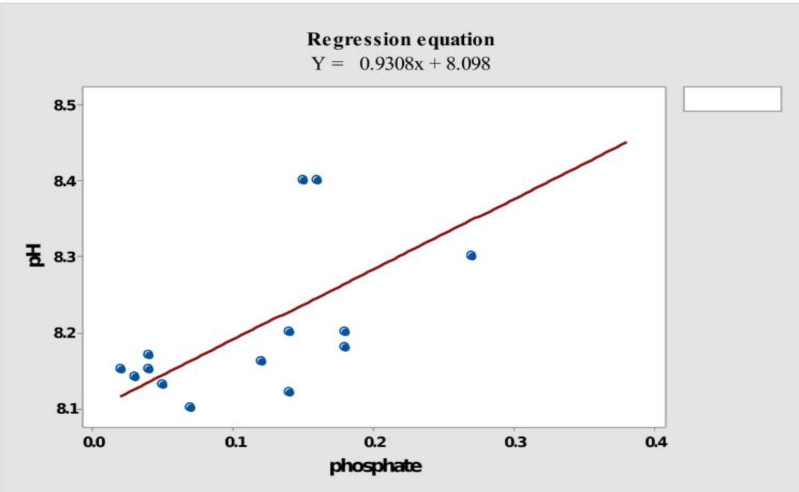

Figure 3.3.2 Regression Line for phosphate v/s pH

3.4 Comparison of Physico-chemical Characteristics of Back Water and Flow Water with BIS Standards

The estimated values of water quality parameters with regard to physico-chemical parameters prescribed by Bureau of Indian Standards (BIS)

Table 3.4: Comparison of Average Water Quality Parameters with Their BIS Standards (IS 10500:1991)

Parameters	Standards	Recommended Agency	Observed Values	
			BW	FW
pH	6.5-8.5	BIS	8.38	8.22
TH	300	BIS	273.94	265.2
SO_4^{-2}	150	BIS	50.70	47.58
D.O	5.0	BIS	6.77	6.65
NO_3^-	45	BIS	3.47	0.178
Chloride	250	BIS	115.88	109.58
TDS	500	BIS	270.11	266.88
Alkalinity	200	BIS	256.70	220.47

The comparison of estimated values with BIS standards shows that the water of the study area is as per standards.

3.5 Water Quality Index (WQI)

A water quality index (WQI) is a means by which water quality data is summarized for reporting to the public in a consistent manner. It is similar to the UV index or an air quality index, and it tells us, in simple terms, what the quality of drinking water is from a drinking water supply.

Table 3.5.1: Water Quality Index of Back water

Parameters	IS	Ci	Si	wi	Wi=wi/Σwi	Qi=(Ci/Si)*100	Sub Index (SI_i)=Wi*Qi
pH	6.5-8.5	8.51	8.5	4	0.138	100.12	13.81
TH	300-600	300	600	3	0.103	50.00	5.17
Alkalinity	200-600	290	600	3	0.103	48.33	5.00
Cl	250-1000	142	1000	3	0.103	14.20	1.47
BOD	0-5	2.81	5	4	0.138	56.20	7.75
TDS	500-2000	318	2000	4	0.138	15.90	2.19
SO4	200-400	61	400	4	0.138	15.25	2.10
NO3	45	4.4	45	4	0.138	9.78	1.35
Total				29			**38.85**

Water quality index

WQI = ΣSIi = 38.85

The water quality index of the samples is found out to be 38.85 which lies in **A** grade (table 3.5.1) Excellent quality of water.

Table 3.5.2: Water Quality Index of Flow water

Parameters	IS	Ci	Si	wi	Wi=wi/Σwi	Qi=(Ci/Si)*100	Sub Index (SI_i)=Wi*Qi
pH	6.5-8.5	8.5	8.5	4	0.138	100.00	13.79
TH	300-600	285	600	3	0.103	47.50	4.91
Alkalinity	200-600	260	600	3	0.103	43.33	4.48
Cl	250-1000	130	1000	3	0.103	13.00	1.34
BOD	0-5	2.2	5	4	0.138	44.00	6.07
TDS	500-2000	305	2000	4	0.138	15.25	2.10
SO4	200-400	58	400	4	0.138	14.50	2.00
NO3	45	0.26	45	4	0.138	0.58	0.08
Total				29			**34.79**

Water quality index

WQI = ΣSIi = 34.79

The water quality index of the samples is found out to be 34.79 which lies in **A** grade (table 3.5.2) Excellent quality of water. Application of water quality index WQI in this study has been found to be useful in assessing overall quality of water. This method is helpful to understand the quality water and also being useful tool in many ways in the field of water quality management.

IV. CONCLUSION

1) Both back water and flowing water of Bhima river are good in respect of physico-chemical characteristics.
2) Both back water and flowing water of Bhima river are with in the permisibble limits as per IS 10500:1991
3) Quality wise BOD is slightly on higher side, it may be due to contamination from other natural and anthropogenic sources.
4) As BOD is more, treatment is necessary before human consumption.
5) As per WQI both the waters fall under excellent category.

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