

Assessment of Physico-Chemical Parameters of River Water of Subarnarekha Basin In and Around Jharkhand Area.

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ABSTRACT:

The present investigation is aimed at assessing the current physico-chemical characteristics along the Subarnarekha river in Jharkhand and Odisha. Eight samples were collected along the stretches of Subarnarekha basin during the period (Water Year) June-2012 to May-2013 on the first working day of every month. Various physico-chemical parameters like pH, TDS, EC, DO, BOD, Total Hardness, Total alkalinity, sodium, potassium, calcium, magnesium etc. were analysed. The study reveals that most of the parameters were found within permissible limits recommended by WHO and Indian Council of Medical Research (ICMR).

Key Words : Physico-chemical parameters, TDS, EC, DO, BOD, Total Hardness

INTRODUCTION:

The Subarnarekha is one of the longest east flowing inter-state rivers. It originates near Nagri village in Ranchi district of Jharkhand at an elevation of 600 m. The total length of the river is about 395 km. The principal tributaries of the river are Kanchi, Kharkai and Karkari. The basin lies between North latitudes of 21°33' to 23°32' and East longitudes of 85°09' to 87°27' situated in the North-East corner of peninsular India. It is bound in the North-West by the Chhotanagpur plateau, in the South-West by Brahmani basin, in the south by Burhabalanga basin and in the South-East by the Bay of Bengal [1].

As water is the basic need of the habitants, its safeness must be studied before use. The present study aims at detecting the quality of water in respect of physico-chemical and bacteriological parameters. The possible number of such parameters necessary to completely specify the quality of water are very large. Although in rural areas of developing countries, the great majority of water quality problems are related to bacteriological or other biological contamination, a significant number of very serious problems may occur as a result of physical and chemical contamination of water resources. With rapid industrialization and urbanization, the ground water pollution is increasing rapidly. Unlike the surface water pollution, its pollution is much difficult but once polluted restoration is difficult and long term [3].

Effect of poor water quality on human health was noted for the first time in 1854 by John Snow, when he traced the outbreak of cholera epidemic in London to the Thames river water which was grossly polluted with raw sewage. Since then the science of water quality progressed. In the third world countries 80% of all diseases are directly related to poor drinking water and insanitary conditions.

The physico-chemical quality of river water is very important from the health point of view. Thus, constant monitoring of river water quality is needed so as to record any alteration in quality and outbreak of health disorders. The present study reports on the river water quality of eight different stations of Subarnarekha basin as given below.

Sample Code	Name of the station	River/Tributary	State	District	Latitude	Longitude
S ₁	Muri	Subarnarekha	Jharkhand	Ranchi	22°48'56"	86°12'47"
S ₂	Adityapur	Kharkai	Jharkhand	Purb Sighbhum	22°47'29"	86°10'06"
S ₃	Kulpatanga	Kharkai	Jharkhand	Dumka	86°06'10"	22°49'04"
S ₄	Jamshedpur	Subarnarekha	Jharkhand	Purb Sighbhum	22°47'00"	86°12'00"
S ₅	Baridhi Nalla	Subarnarekha	Jharkhand	Paschim Singhbhum	86°14'33"	22°49'05"
S ₆	Ghats hila	Subarnarekha	Jharkhand	Purb Sighbhum	22°34'49"	86°20'08"
S ₇	Ghats hila Road Bridge	Subarnarekha	Jharkhand	do	22°35'15"	86°27'12"
S ₈	Jamsholaghat	Subarnarekha	Jharkhand		22°13'08"	86°43'00"

MATERIAL AND METHOD:

Water samples were collected every month, from June 2012 to May 2013 from eight different stations as mentioned below, in clean and dry polythene bottles. The water samples were collected and preserved for testing of various parameters at 10° C throughout the period of chemical analysis. The water samples were grouped under following categories:

- S₁ = Subarnarekha at Muri
- S₂ = Kharkai at Adityapur
- S₃ = Kharkai at Kulpatanga
- S₄ = Subarnarekha at Jamshedpur
- S₅ = Baridhi Nallah
- S₆ = Subarnarekha at Ghatshila
- S₇ = Subarnarekha at Ghatshila Road Bridge
- S₈ = Subarnarekha at Jamsholaghat

The water samples were analysed in the laboratory using standard methods. The parameters analysed are pH, turbidity, total dissolved solids(TDS), total hardness, electrical conductivity, total alkalinity, sodium(Na), potassium(K), dissolved oxygen(DO), biochemical oxygen demand (BOD) and bacteriological parameter.

pH and dissolved oxygen of the samples were analysed immediately after collection. The average, minimum, and maximum values for various physico-chemical parameters were listed in Table-12.

RESULT AND DISCUSSION:

Temperature is an important factor to influence the physico-chemical parameters and the biological reaction in water. Higher values of temperature accelerate the chemical reaction and reduce the solubility of gases and DO. In the present study temperature varied from 22°C to 35°C.

pH LEVEL:

The pH of most raw water sources lies within the range of 6.5-8.5^[3]. All the 96 water samples are found to have pH value within the limit. But some samples have excess pH value. The average pH value ranges from 7.3 to 8.7. The surface water of Subarnarekha at Muri has higher pH than the water from other sources, Table-1.

ELECTRICAL CONDUCTIVITY:

Pure water is a poor conductor of electricity. Acid, bases and salts in water make it relatively good conductor of electricity. With increased air pollution, the acid rain also adds to the conductivity of surface water. Greater is the conductivity greater anions and cations in the water and greater is the dissolved matter (electrolyte) in it. Electrical conductivity used as basic index in judging the suitability of water for potable properties. Water having electrical conductance upto 20 mhos is considered to be suitable for irrigation. The EC values are quite high ranging from 230 ms/cm to 700 ms/cm but within the permissible limit, Table-2.

TOTAL HARDNESS:

Water hardness is the traditional measure of capacity of water to react with soap, hard water requiring a considerable amount of soap to produce lather. Scaling of hot water pipes, boilers and other household appliances is

due to hard water. In fresh water, the principal hardness causing ions are calcium and magnesium; the ions strontium, iron, barium and manganese also contribute to some extent. It is expressed as an equivalent concentration of calcium carbonate. The permissible limit of hardness as calcium carbonate is 300 mg/l^[2]. Our investigation shows all the water samples are much below the permissible limit. The total hardness is considered taking presence of calcium and magnesium ion in water samples, Table-3.

TOTAL ALKALINITY:

Alkalinity is not a pollutant. It is a total measure of the substances in water that have acid neutralising capacity. Alkalinity indicates a solution's power to react with acid and buffer its p^H – that is the power to restrict its p^H from changing. It is due to salts of weak acids and bicarbonates and is estimated in terms of an equivalent amount of calcium carbonate. No permissive and excessive values of total alkalinity are given by WHO and ICMR. But according to USPHS, the value of total alkalinity as CaCO₃ is 120 mg/l. The alkalinity has no known adverse effect on health, some evidence has been given to indicate its role in heart disease^[9]. Desirable limit is 200 mg/l according to drinking water specifications IS (1992). But in study area, it is within the permissible limit, Table-4.

TOTAL DISSOLVED SOLID:

Total dissolved solid at a given temperature is the material residue left in the vessel after evaporation of a filtered sample and subsequent drying in an oven. TDS contains different kinds of nutrients and have been proved to be a very useful parameter. A sudden rise in TDS content can often indicate pollution by an extraneous source. Excess amount of TDS may disturb ecological balance and causes imbalance in osmotic regulation and suffocation in aquatic fauna even in presence of fair amount of dissolved oxygen^[4].

Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supply and normally less palatable and may induce an unfavourable physiological reaction in the transient consumer. In the present investigation, it is seen that TDS value of S₂, S₃, S₅ were slightly exceed the permissible limit, but water samples of other sources are within the safe limit of TDS value, Table-5. The increased TDS value in these samples may be due to the salt water intrusion as per town's proximity to Bay of Bengal [1].

SODIUM AND POTASSIUM:

Sodium is the chief cation in the extra cellular fluid. About 50% of body sodium is present in the bone, 40% in the extra cellular fluid and the remaining (10%) in the soft tissues. Whereas potassium is the principal intracellular cation. It is equally important in the extra cellular fluid for specific function such as influencing cardiac muscle activity [5].

According to European economic community the limit for sodium is 200mg/l and for potassium is 10mg/l of drinking water. The study reveals the value of potassium content in the water samples of S₅ are above the maximum permissible limit, Table-7.

DISSOLVED OXYGEN:

Dissolved oxygen is one of the most important parameters of water quality assessment and reflects the physical and biological processes prevailing in the water and show metabolic balance. A high DO level in a community water supply is good because it makes drinking water taste better. However, high DO levels speed up corrosion in water pipes. For diverse fish population the DO level must ranges from 4-9 mg/l. However, according to European Economic Community the standard value of DO is 5mg/l of drinking water. Except S₅ all samples were contains more DO values because of domestic sewage effluents and dumping of garbage,Table-8. This causes microbiological contamination consuming the DO [6].

BIOCHEMICAL OXYGEN DEMAND :

The degree of microbially mediated oxygen consumption in water is known as biochemical oxygen demand. This parameter is commonly measured by the quantity of oxygen utilized by suitable micro-organisms during 5 days period at 20°C . It is not a pollutant but an indicator to what extent the water is polluted. Its value 6.0 mg/l or more in water body is said to be polluted. Present study reveals that S₁,S₂,S₅ samples contain more BOD values in some months,Table-9.Overall the river water is not suitable for drinking purpose[7].

CONCLUSION :

Present study reveals that the physico-chemical parameters are within maximum permissible limit except the some samples in TDS, DO,BOD. Thus river water is not potable. Therefore, pre-treatment of water should be done for safe use of human being and animals[8].Monthly variational figures are also shown. As a whole, the present investigation reveals that Subarnarekha river water gets contaminated from various sources of natural as well as anthropogenic origin, which badly needs purification for safe use of dependent inhabitants.

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TABLE – 1 Concentration of pH in water samples

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	8.4	7.6	8.1	7.7	7.4	7.4	7.6	7.5
Jul,2012	7.7	7.8	7.9	7.7	7.5	7.4	7.6	7.3
Aug,2012	7.9	7.7	7.7	7.5	7.4	7.4	7.5	7.3
Sep,2012	7.6	8.0	7.8	7.5	7.0	6.2	7.4	7.2
Oct,2012	7.6	7.9	8.0	7.7	7.7	7.7	7.6	7.7
Nov,2012	7.3	7.5	7.4	7.6	7.0	7.3	7.5	7.8
Dec,2012	7.7	7.5	7.4	7.1	7.2	7.7	7.6	7.5
Jan,2013	7.4	7.3	7.6	7.3	6.9	7.9	7.7	8.0
Feb,2013	8.0	7.6	8.1	7.5	7.4	8.4	8.5	8.0
Mar,2013	7.9	7.4	8.0	7.6	7.5	7.4	7.8	7.3
Apr,2013	8.7	7.3	7.9	7.4	7.2	7.7	8.1	7.8
May,2013	8.0	7.3	7.9	7.3	7.4	8.0	7.9	7.6
Mean	7.85	7.57	7.8	7.49	7.3	7.5	7.7	7.5

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -3
Concentration of Total hardness in water samples, in mg/l

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	80	181	84	84	177	104	93	96
Jul,2012	92	76	60	80	103	68	80	84
Aug,2012	178	68	72	84	217	76	109	132
Sep,2012	101	76	93	109	208	32	89	73
Oct,2012	84	105	105	85	97	56	89	92
Nov,2012	84	117	96	81	201	84	149	112
Dec,2012	93	125	121	125	113	76	133	84
Jan,2013	93	129	117	89	101	72	100	72
Feb,2013	84	141	119	56	185	80	105	102
Mar,2013	77	138	117	57	188	67	102	76
Apr,2013	86	225	136	76	201	60	114	112

May,2013	64	161	101	76	80	32	88	86
Mean	93	161.91	101.75	83.5	155.91	67.25	104.25	93.41

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -4
Concentration of Total alkalinity in water samples, in mg/l.

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	152	135	130	163	85	107	107	86
Jul,2012	130	68	62	85	118	62	68	84
Aug,2012	85	68	79	79	192	90	79	72
Sep,2012	68	113	101	62	184	62	62	102
Oct,2012	85	113	113	85	90	90	85	88
Nov,2012	79	175	113	124	156	96	175	92
Dec,2012	75	141	158	124	118	107	124	112
Jan,2013	65	118	124	85	85	101	96	102
Feb,2013	80	141	130	85	186	80	96	91
Mar,2013	81	140	121	85	155	39	95	86
Apr,2013	180	152	141	93	96	101	101	132
May,2013	192	152	135	96	90	101	96	76
Mean	106	126.33	117.25	97.16	129.58	86.33	98.66	93.58

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -5
Concentration of Calcium in water samples, in mg/l.

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	22	55	32	32	50	30	24	22
Jul,2012	32	24	21	22	21	27	30	21
Aug,2012	19	14	18	22	67	30	22	22
Sep,2012	27	18	24	24	63	13	22	28
Oct,2012	22	22	27	19	26	22	19	20
Nov,2012	26	26	34	14	63	34	38	34
Dec,2012	22	27	22	29	26	30	32	28

Jan,2013	22	30	24	21	24	29	29	20
Feb,2013	22	34	27	16	51	32	29	26
Mar,2013	21	33	26	16	52	27	28	18
Apr,2013	26	58	31	21	63	24	32	31
May,2013	19	35	21	22	21	13	27	26
Mean	23.33	31.33	25.58	21.5	43.91	25.91	27.66	24.66

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -6
Concentration of Magnesium in water samples, in mg/l.

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	5.8	10.7	1.0	1.0	12.6	6.8	7.8	6.2
Jul,2012	2.9	3.9	1.9	5.8	12.0	6.8	1.0	1.6
Aug,2012	31.1	7.8	6.8	6.8	11.7	10.7	12.6	10.6
Sep,2012	7.8	7.8	7.8	11.7	12.1	2.9	7.8	6.5
Oct,2012	6.8	11.7	8.8	8.8	7.8	6.8	9.7	8.2
Nov,2012	4.9	12.6	2.9	10.7	10.6	17.5	12.6	9.4
Dec,2012	8.8	13.6	15.6	12.6	11.7	13.6	12.6	8.8
Jan,2013	8.8	12.6	13.6	8.8	9.7	6.8	6.8	9.2
Feb,2013	6.8	13.6	12.6	3.9	13.6	7.8	7.8	8.2
Mar,2013	5.8	13.6	12.6	4.0	13.8	7.8	7.8	7.1
Apr,2013	5.1	19.4	14.1	5.6	10.3	5.8	8.1	5.8
May,2013	3.9	17.5	11.7	4.9	6.8	14.6	4.9	6.8
Mean	8.2	12.06	9.11	7.05	11.05	9.1	8.29	7.36

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -7
Concentration of Total Dissolved Solid in water samples, in mg/l.

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	286	487.5	214.5	162.5	650	169	234	228
Jul,2012	279.5	143	143	149.5	520	175.5	195	196

Aug,2012	162.5	111.15	108.5	13.65	559	169	175.5	178
Sep,2012	162.5	143	149.5	130	253.5	143	143	138
Oct,2012	149.5	169	162.5	130	149.5	143	149.5	162
Nov,2012	149.5	169	149.5	175.5	208	92.95	273	281
Dec,2012	208	188.5	182	195	195	260	260	253
Jan,2013	143	214.5	175.5	156	169	208	214.5	188
Feb,2013	156	279.5	182	162.5	520	221	214.5	125.5
Mar,2013	175.5	318.5	1885.	175.5	754	572	292.5	218
Apr,2013	305.5	650.65	234	156	520	221	156	148
May,2013	455	474.5	240.5	169	175.5	253.5	253.5	242
Mean	219.37	279.06	318.8	147.9	389.45	218.99	213.41	196.45

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -8
Concentration of Sodium in water samples, in mg/l.

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	48	46.2	17.5	10.5	56.3	19.8	20.3	18.6
Jul,2012	43.6	10.3	7.9	10.5	11.3	10.9	10.9	12.4
Aug,2012	11.8	5.7	5.6	6.6	36.4	7.2	7.2	8.2
Sep,2012	11.5	5.6	5.4	6.5	35.3	7.2	7.4	7.9
Oct,2012	11.4	3.8	5.2	6.2	32.4	7.2	7.6	8.2
Nov,2012	16.6	19.8	14.3	11.9	36.5	22.8	21.6	14.6
Dec,2012	19.5	16.5	13.7	16.2	16.0	25.4	19.8	20.3
Jan,2013	16.7	19.4	14.8	12.9	15.6	22.0	21.4	18.6
Feb,2013	17.2	26.2	14.9	14.1	57.1	24.4	22.9	20.6
Mar,2013	16.8	25.2	15.1	14.2	95.8	33.5	21.9	18.4
Apr,2013	68.8	21.3	16.3	15.6	21.0	35.2	18.0	16.4
May,2013	90.3	46.2	20.7	12.1	13.6	22.7	22.9	20.1
Mean	31.01	20.51	12.61	11.44	35.6	19.85	16.82	15.35

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -9
Concentration of Potassium in water samples, in mg/l.

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	4.4	8.3	2.1	2.0	34.9	4.3	4.5	4.1
Jul,2012	4.8	2.4	1.7	2.7	3.2	3.5	3.5	3.2
Aug,2012	2.1	1.0	1.0	1.7	26.2	2.1	2.1	1.6
Sep,2012	2.3	1.0	1.4	1.6	24.2	1.8	2.5	2.2
Oct,2012	2.1	1.8	1.0	1.4	21.2	2.1	2.2	1.8
Nov,2012	3.5	2.4	1.4	2.6	21.1	4.7	5.3	4.8
Dec,2012	2.8	1.7	1.3	2.8	2.8	7.1	5.6	5.4
Jan,2013	3.4	2.8	1.3	2.4	4.2	5.7	5.5	4.2
Feb,2013	3.5	3.0	1.2	2.5	37.2	6.0	5.3	5.1
Mar,2013	2.5	2.5	1.2	2.6	67.9	9.2	5.2	4.2
Apr,2013	4.6	2.1	1.8	3.1	1.7	9.7	4.1	4.0
May,2013	5.5	6.1	2.1	2.0	2.4	6.6	6.3	6.1
Mean	3.45	2.92	1.45	2.28	20.58	5.23	4.34	3.89

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -10 **Concentration of Dissolved oxygen in water samples, in mg/l.**

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	6.6	2.0	5.4	5.4	0.0	5.5	5.6	5.3
Jul,2012	1.6	6.0	6.0	6.8	2.8	5.4	5.8	5.2
Aug,2012	6.6	5.8	5.4	4.8	0.0	4.4	5.2	6.2
Sep,2012	7.0	6.8	6.4	6.0	3.0	6.2	6.0	5.8
Oct,2012	6.0	6.2	8.1	7.0	6.6	6.2	6.4	6.6
Nov,2012	7.6	7.9	7.4	5.0	7.6	8.3	8.3	5.4
Dec,2012	7.9	8.9	8.3	6.0	7.6	10.3	8.5	6.1
Jan,2013	7.9	7.0	7.0	7.2	6.0	8.3	7.9	5.8
Feb,2013	7.9	6.2	7.9	6.4	4.0	7.9	10.1	5.6
Mar,2013	6.8	3.2	7.0	6.4	0.0	2.8	6.4	6.1

Apr,2013	6.8	5.8	6.8	6.2	0.0	6.8	8.5	6.4
May,2013	6.0	7.0	5.4	4.8	1.2	5.4	4.8	5.8
Mean	6.55	6.06	6.75	6.00	3.23	6.45	6.90	5.85

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

TABLE -11
Concentration of BOD in water samples, in mg/l.

Months	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
Jun,2012	2.2	39.6	1.2	2.2	59.8	0.7	0.4	0.4
Jul,2012	19.9	1.8	1.0	1.0	19.9	0.8	1.2	0.6
Aug,2012	0.4	0.6	0.4	0.8	60.0	1.4	1.2	0.4
Sep,2012	1.2	1.2	0.8	2.0	40.0	0.6	0.2	0.6
Oct,2012	0.4	0.4	1.8	0.4	0.8	0.4	0.8	0.8
Nov,2012	0.6	0.8	0.6	0.8	2.0	1.4	1.0	1.2
Dec,2012	0.6	1.6	1.8	1.2	1.6	0.6	0.6	0.6
Jan,2013	0.2	2.0	0.1	0.6	1.8	0.6	0.2	0.2
Feb,2013	0.4	3.0	0.6	0.8	1.6	0.4	2.0	0.4
Mar,2013	0.4	0.4	0.4	1.0	0.4	0.8	0.4	0.2
Apr,2013	2.6	0.4	1.0	2.0	20.0	1.2	3.0	1.2
May,2013	0.4	2.0	1.0	0.3	0.4	0.6	0.6	0.4
Mean	2.44	4.48	0.89	1.09	17.35	0.79	0.96	0.58

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

Table No : 12 , Physico-chemical Characters of river water

Parameters	C a t e g o r i e s								
	S ₁			S ₂			S ₃		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
pH	7.3	8.7	7.85	7.3	8.0	7.57	7.4	8.1	7.80
Electrical conductivity	230	700	337.5	171	1001	429.3	167	370	271.4
Total hardness	64	178	93	68	181	161.91	60	121	101.75
Total alkalinity	68	192	106	68	175	126.3	62	141	117.25
Calcium	19	32	23.33	14	55	31.33	18	34	25.58
Magnesium	2.9	31.1	8.2	3.9	19.4	12.06	1.0	15.6	9.11

TDS	143	455	219.37	143	650.65	279.06	143	1185	318.8
Sodium	11.4	90.3	31.01	3.8	46.2	20.51	5.2	20.7	12.61
Potassium	2.1	5.5	3.45	1.0	8.3	2.92	1.0	2.1	1.45
DO	1.6	7.9	6.55	2.0	8.9	6.06	5.4	8.3	6.75
BOD	0.2	19.9	2.44	0.4	39.6	4.48	0.1	1.8	0.89

Parameters	S ₄			S ₅			S ₆		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
pH	7.1	7.7	7.49	6.9	7.5	7.30	6.2	8.4	7.50
Electrical conductivity	200	300	243.3	230	1160	599	143	880	336.9
Total hardness	56	125	83.5	80	217	155.91	44	157	67.25
Total alkalinity	62	163	97.16	85	192	129.58	39	107	86.33
Calcium	14	32	21.5	21	67	43.91	13	34	25.91
Magnesium	1.0	12.6	7.05	6.8	13.8	11.05	2.9	17.5	9.1
TDS	130	195	147.9	149.5	754	389.45	92.95	572	218.99
Sodium	6.2	16.6	11.44	11.3	95.8	35.6	7.2	35.2	19.85
Potassium	1.4	3.1	2.28	1.7	67.9	20.58	1.8	9.7	5.23
DO	4.8	7.0	6.00	0.0	7.6	3.23	2.8	10.3	6.45
BOD	0.3	2.2	1.09	0.4	59.8	17.35	0.4	1.4	0.79

Table No : 12 Cont....

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Parameters	S ₇			S ₈		
	Min	Max	Mean	Min	Max	Mean
pH	7.4	8.5	7.70	7.2	8.0	7.50
Electrical conductivity	220	420	328.4	200	410	295
Total hardness	80	149	104.25	72	132	93.41
Total alkalinity	62	175	98.66	72	132	98.58
Calcium	19	38	27.66	18	34	24.66
Magnesium	1.0	12.6	8.29	1.6	10.6	7.36
TDS	143	292.5	213.41	148	253	196.45
Sodium	7.2	22.9	16.82	7.9	20.6	15.35
Potassium	2.1	6.3	4.34	1.6	6.1	3.89
DO	4.8	10.1	6.9	5.2	6.6	5.85
BOD	0.2	3.0	0.96	0.2	1.2	0.58

*. Electrical conductivity in micromho/cm and others in mg/l except turbidity and pH.

S₁= Subarnarekha at Muri ,S₂ = Kharkai at Adityapur, S₃= Kharkai at Kulpatanga, S₄= Subarnarekha at Jamshedpur,S₅= Baridhi Nallah, S₆=Subarnarekha at Ghatshila, S₇=Subarnarekha at Ghatshila Road Bridge S₈= Subarnarekha at Jamsholaghat

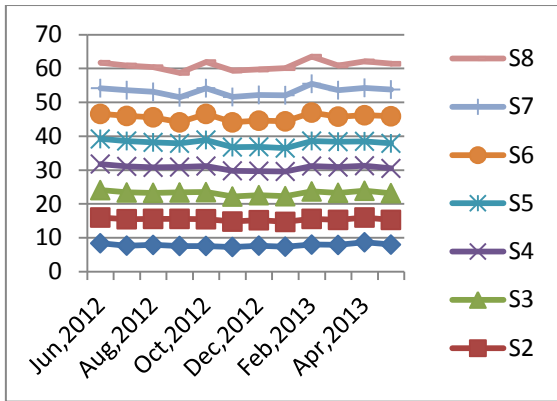


Fig-1 Concentration of pH in water samples

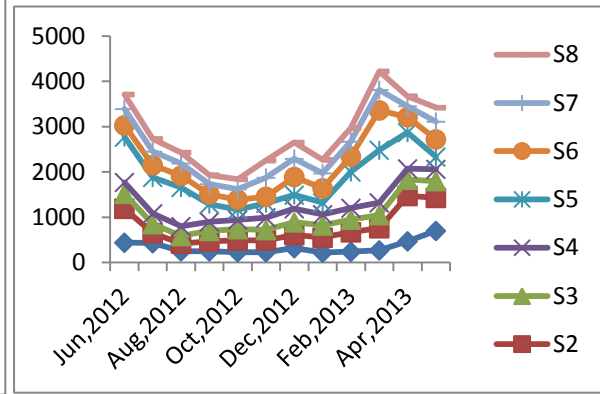


Fig-2 EEC in water samples, in micromho/cm

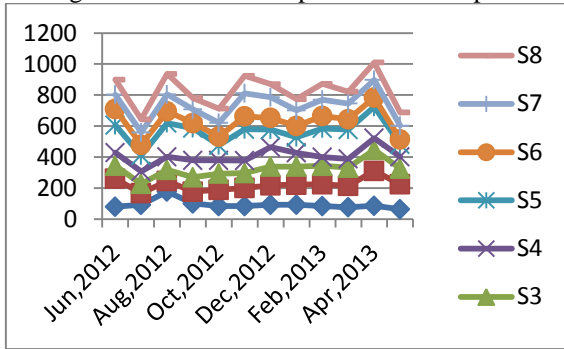


Fig-3 Concentration of Total hardness in water samples

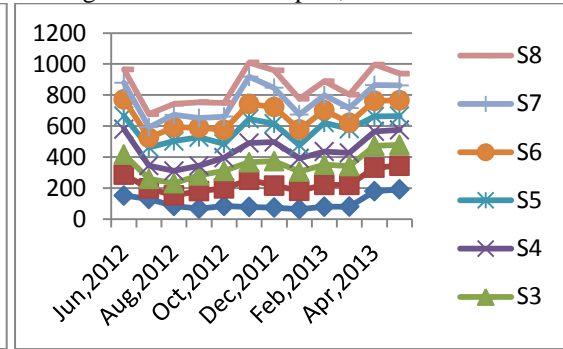


Fig-4 Concentration of Total alkalinity in water samples

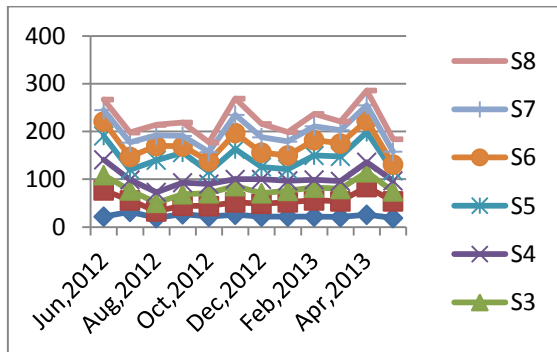


Fig-5 Concentration of Calcium in water samples

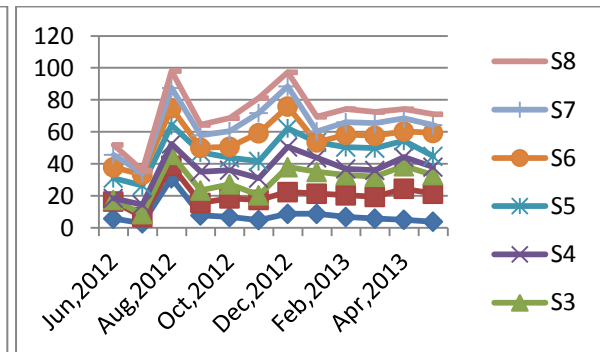


Fig-6 Concentration of Magnesium in water samples

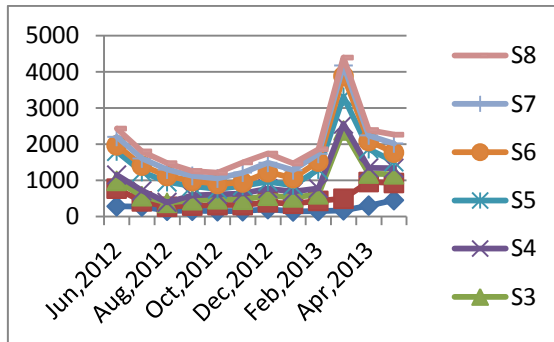


Fig-7 Concentration of Dissolved Solid in water samples

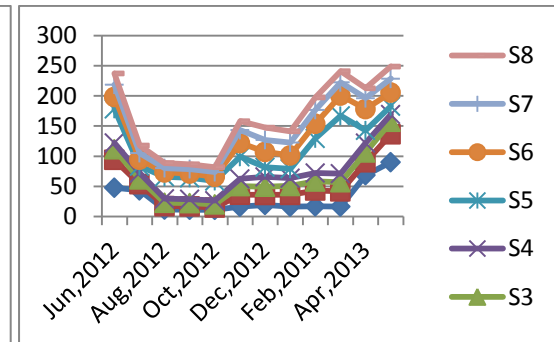


Fig-8 Concentration of Sodium in water samples

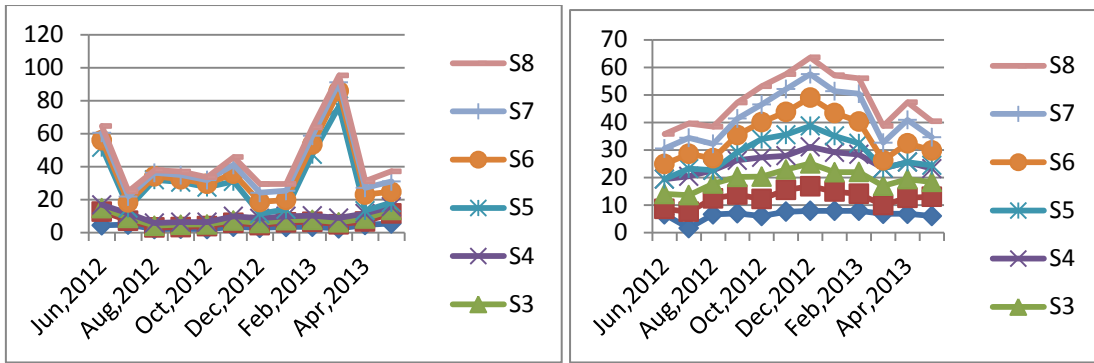


Fig-9 Concentration of Potassium in water samples Fig-10 Concentration of Dissolved oxygen in water samples

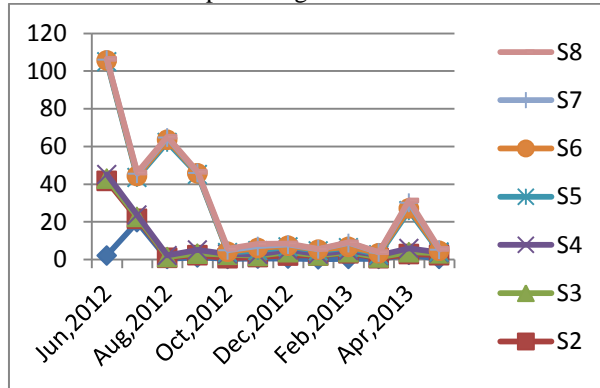


Fig-11 Concentration of BOD in water samples