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Assessment of the Water Quality Standard of Brahmani River in terms of Physico-Chemical Parameters

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Abstract: The present investigation is aimed at assessing the current water quality standard along the stretch of Brahmani river in terms of physico-chemical parameters. In the selected study area the River Brahmani is receiving a considerable amount of industrial wastes and witnessing a considerable amount of human and agricultural activities .Fourteen samples were collected along the entire stretches of the river basin during the period from January-2013 to December-2013 on the first working day of every month. Various physico-chemical parameters like pH,, EC, Total Hardness, Total alkalinity sodium, potassium, calcium, magnessium, nitrate sulphate D.O.,B.O.D. etc. were analysed. The present study indicates that the water quality of Brahmani River is well within tolerance limit taking the physico-chemical parameters in to considerations.

Key Words: Brahmani River, Physico-chemical parameters, pH ,EC, Total Hardness, D.O,B.O.D.

I. Introduction

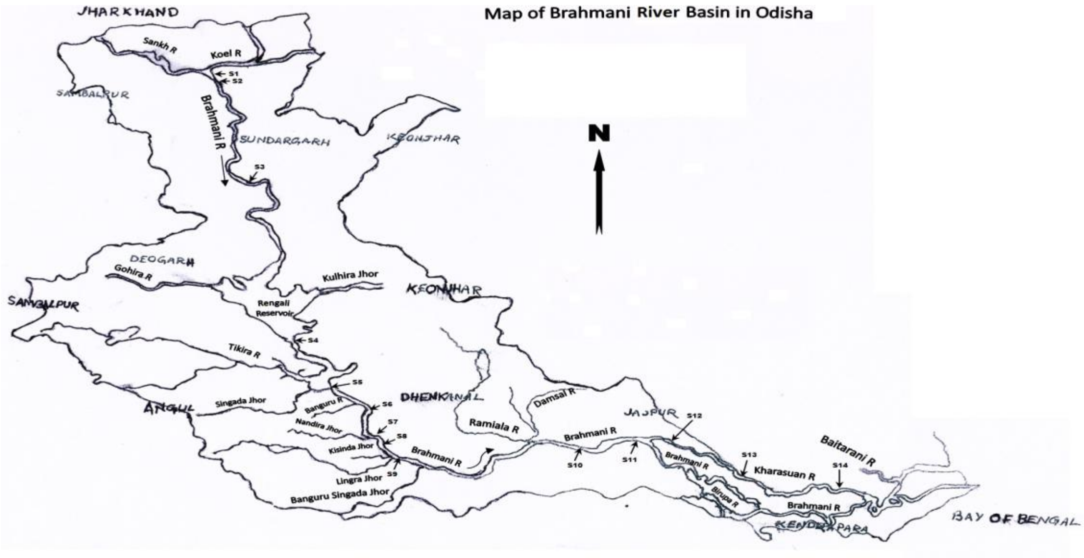
As water is the basic need of the habitants , its safeness must be studied before use. The present study aims at detecting the quality of water across the Brahmani River in respect of physico-chemical and bacteriological parameters. Although in rural areas of developing countries, the great majority of water quality problems are related to bacteriological and other biological contaminations, a significant number of very serious problems may also occur as a result of physico-chemical impairity of water resources.[8] With rapid industrialization and urbanization, the river water pollution is increasing rapidly. Effect of poor water quality on human health was noted for the first time in 1854 by John Snow, when he traced the out break of cholera epidemic in London to the Thames river water which was grossly polluted with raw sewage. Since then the science of water quality monitoring progressed. In the third world countries 80% of all diseases are directly related to poor drinking water and insanitary conditions. As water is one of the most basic needs of the habitants , its safeness must be studied before use. 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 out break of health disorders. The present study reports on the river water quality of fourteen different stations of Brahmani basin as given below. The present study aims at detecting the quality of water in respect of physico_chemical parameters Studies. The possible number of such parameters necessary to completely specify the quality of water are very large.However at present fourteen parameters are considered to characterize the Brahmani River water.

II. Study Area

The River Brahmani, the second largest river of Odisha is one of the major peninsular river systems in India. The confluence of the rivers Koel and Sankh at Vedvyasa near Rourkela in the district of Sundargarh gives rise to the river Brahmani. It travels southward through the districts of Sundargarh, Deogarh, Angul, Dhenkanal, Jajpur, and Kendrapara finally flowing into Bay of Bengal. After Kabatabandha, it divides into two rivers namely Brahmani and Kharasrota(Kharasuan). The major flow of water goes into Kharasrota. After covering a few kilometres, the river Birupa joins Brahmani and it flows onwards in the name of Brahmani though its major portion of water comes from the river Birupa. The study area covers 14 major sampling points starting from Vedvyasa to Garhgarhi Ghat. In this stretch, the river Brahmani is joined by several drains and streams carrying industrial effluents, city wastages, mining residues etc. along with a number of tributaries. Kabatabandha is the eleventh sampling point and the next three sampling points downstream are in the river Kharasrota such as Jokadia, Hasinipur and Garhgarhi Ghat. The sampling stations are selected mainly

Sample Code	Name of the station	River/ Tributary	State	District	Description of the location
S_1	Panposh	Brahmani	Odisha	Sundergarh	Confluence of Koel and Snkh to form Brahmani
S_2	Tarkera	Brahmani	Odisha	do	Mixing point of Rourkela Steel Plant Effluent with Brahmani
S_3	Gomlai	Brahmani	Odisha	do	About 50 km down stream of Rorkela
S_4	Rengali	Brahmani	Odisha	Angul	About 0.5 km down stream of Rengali Dam

S_5	Samal	Brahmani	Odisha	do	About 0.5 km down stream of Samal Barrage
S_6	Talcher	Brahmani	Odisha	do	About 5 km upstream of the Nalco effluent confluence with Brahmani
S_7	Durgapur	Brahmani	Odisha	Dhenkanal	0.2 km down stream of the confluence of Nalco effluent with Brahmani
S_8	Kamalanga	Brahmani	Odisha	do	1.5 km down stream of the confluence of Nalco effluent with Brahmani
S_9	Bido	Brahmani	Odisha	do	0.5 km down stream of the confluence of Bhusan effluent with Brahmani
S_{10}	Nilakanthapur	Brahmani	Odisha	do	Carries human habitation by its side
S_{11}	Kabatabandha	Brahmani	Odisha	Jajpur	Before the bifurcation of Brahmani to form Kharasrota
S_{12}	Jokodia	Kharasrota	Odisha	do	0.5 km down stream of confluence of Kalinganagar effluent with Kharasrota
S_{13}	Hasinpur	Kharasrota	Odisha	do	Before the bifurcation of the river Kharasrota
S_{14}	Gargar Ghat	Kharasrota	Odisha	Kendrapara	Kharasrota after covering a large human and agricultural landscape.



III. Materials And Methods:

Water samples were collected every month, from January 2013 to Dec 2013 from fourteen different stations as mentioned in the above table, in clean and dry polythene bottles.The water samples were collected and preserved for testing of various parameters at 10^{o} C throughout the period of chemical analysis.

The water samples were analysed in the Mayurbhanj Chemical Laboratory, Department of Chemistry,Ravenshaw University,Cuttack using standard methods(APHA 2005). The pH and Dissolved Oxygen of water samples were measured immediately after sampling at the field itself. Samples were subjected to filtration before chemical analysis. The determination of TDS was done by gravimetric process while the total hardness was carried out by EDTA complexometric titration method (APHA 2005).The Winkler's alkali iodide-azide method was followed for the estimation of DO and BOD. Nitrate was determined colorimetric procedure (APHA 2005)[2]. Faecal coliform population was analysed by MPN /100 ml method by growing on M-FC medium at temperature 44.5^{0} C and counted after 48 hours.

IV. Results 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^{o}C to 35^{o}C.

pH LEVEL: The pH of most raw water sources lies within the range of 6.5-8.5[3]. All the 168 water samples are found to have pH value well within the tolerance limit. The average pH value ranges from 7.06 to 8.36. Panposh recorded the maximum pH value 8.36 and Rengal the minimum pH value 7.06.

ELECTRICAL CONDUCTIVITY: Pure water is a poor conductor of electricity. Presence of acids , 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 is used as a basic index in judging the suitability of water for potable properties. Present studies revealed that all the samples recorded conductivity values well within the tolerance limit prescribed by ICMR and WHO. Tarkera recorded te highest conductivity value 500 μ mho/cm. It may be due to the impact of Rourkela Steel Plant Effluent. The minimum conductivity value 146 μ mho/cm is recorded at Talcher. Tolerance limit for conductivity in drinking water is 2300 μ mho/cm

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. 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. Its permissible limit is 75 to 200 mg/l. Maximum value was recorded 62.09 at Tarkera and minimum value 8.38 at Gomlai.

TOTAL ALKALINITY: Alkalinity is not a pollutant. It is a total measure of the substances in water that have acid nutralising capacity. Alkalinity indicates the power of a solution to react with acid and buffer its pH , that is the power to restrict its pH from changing.[5] 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, ISI and ICMR.[6] But according to USPHS, the value of total alkalinity as $CaCO_3$ is 120 mg/l. The average value of total alkalinity in the different sources of water samples of the present observation ranges from 21.08 at Rengali to 145.91 mg/l at Tarkera. The minimum average alkalinity value is recorded at Samal whereas the maximum average value is at Tarkera indicating that the river water has better buffering capacity going down of the stream and is important for fish and aquatic life. It is also less vulnerable to acid rain. The alkalinity has no known adverse effect on health, some evidence has been given to indicate its role in heart disease [9].

TOTAL DISSOLVED SOLIDS: 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[5].

Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supply and normaly less palatable and may induce an unfavourable physiological reaction in the transient consumer. In the present investigation, it is seen that TDS value of most of the water samples are well within the permissible limit except at Tarkera Effluent Nallah. The increased TDS value in the lower stretches of the river may be due to the salt water intrusion due to the proximity 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[10]. 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 mean value of sodium and potassium content in the water samples are well within the permissible limit along the entire stretch of Brahmani River.

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 river water sample is good because it makes the water better from drinking as well bathing point of view and friendly for aquatic lives. However, high DO levels speed up corrosion in water pipes. For diverse fish population the DO level must ranges from 4-9 mg/l. The river water of Brahmani is good fishing water. However, according to Europian Economic Community the standard value of DO is 5mg/l of drinking water. The average DO values of water samples from the river ranges from 5.83 mg/l to 7.33 mg/l (Table-5).

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^oC . 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 the mean value of BOD of the Brahmani River is 4.72 mg/l at Tarkera which is the highest average value whereas that of the remaining sampling stations ranges from from 0.19 mg/l to 1.97 mg/l. The BOD of Mahanadi, the biggest river of Odisha is of high mean value, 11.2 mg/l [2] at Mahanadi-Atharabanki and Mahanadi sea confluence [7]. Thus, the Brahmani river water is less polluted from B.O.D. point of view.than Mahanadi.

BACTERIOLOGICAL PARAMETER : Pathogenic bacteria present in water are responsible for causing water borne diseases like cholera, typhoid, dysentry (bacillary and amoebic) etc. The bacteriological analysis of water is essential to determine its potability for drinking. The bacteriological analysis carried out were most probable number (MPN) of total coliform and faecal coliform . Presence of coliform bacteria is undesirable for human consumption. Generally the coliform bacteria is observed in raw water samples. When the water comes in contact with sewage, coliform bacteria are observed. Occurrence of faecal coliform is more significant than total coliforms. According to WHO, E.Coliform should be absent and if coliform counts were found in no case it should exceed 10/100 ml[4]. The bacteriological analysis was done for all the samples during the year and found that the presence of Faecal Colliform was alarmingly high in Brahmani River particularly at Panposh.It is mainly due to the near by peoples defecate in open places along the river bank and other human activities across the river stretch is very high. The upper stretch of the river at Rourkela has a high MPN count ,which is minimum at Rengali Samal stretch and again increases down stream.

V. Conclusion

The present study reveals that the water quality of Brahmani River is quite safe as compared to the physico-chemical parameters point of view at present.However due to increased industrial and human activities along its bank a constant monitoring of the water quality of the river is a must to maintain the river water quality.

VI. Applications

The present study is usefl in ascertaining the water quality of Brahmani River along its entire stretch for its potability for industrial, agricultural and human use.

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Table:1

Name of the Sampling Station	pH			Conductivity in µ mho/cm			Sulphate(SO_4^{--}) in mg/l		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Panposh-S_1	8.36	7.16	7.59	240	118	173.8	11.00	3.00	7.33
Tarkera-S_2	7.92	7.18	7.48	500	200	366.7	65.00	17.16	37.6
Gomlai-S_3	7.95	7.42	7.70	260	88	178.6	32.44	4.64	15.46
Rengali-S_4	8.05	7.06	7.55	148	83	119.7	11.52	3.76	7.14
Samal-S_5	7.96	7.14	7.63	157	98	126	17.52	4.36	9.00
Talcher-S_6	7.93	7.41	7.67	146	103	128.3	12.16	4.28	8.20
Durgapur-S_7	8.01	7.38	7.71	420	123	280.5	59.04	10.08	34.82
Kamalanga-S_8	8.10	7.42	7.75	260	115	191.9	43.28	7.12	22.53
Bido-S_9	8.17	7.43	7.80	380	145	267.7	56.16	7.20	26.49
Nilakanthapur-S_{10}	8.23	7.35	7.82	162	114	134	12.24	5.0	8.28
Kabatabandha-S_{11}	7.92	7.42	7.70	158	126	142.3	12.96	3.92	9.07
Jokdia-S_{12}	8.04	7.17	7.71	188	104	148.8	18.88	3.76	10.49
Hasinpur-S_{13}	8.01	7.39	7.70	152	112	132.9	12.12	2.76	8.18
Gadagadi-S_{14}	8.13	7.10	7.77	155	121	139.3	15.84	5.4	8.85

Table:2

Name of the Sampling Station	Nitrate(NO_3^-) in mg/l			Chloride(Cl^-) in mg/l			Bicarbonate(HCO_3^-) in mg/l		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Panposh-S_1	4.56	0.62	2.13	19.5	7.56	13.32	101.02	37.75	69.33
Tarkera-S_2	63.64	7.62	30.37	39	18.89	28.01	145.91	36.89	91.58
Gomlai-S_3	8.33	1.64	3.92	24.82	7.56	14.32	84.18	26.35	58.84
Rengali-S_4	4.65	1.06	2.02	14.18	5.67	9.10	60.39	21.08	45.02
Samal-S_5	4.12	0.97	1.94	14.18	5.67	9.86	56.12	26.35	45.00
Talcher-S_6	3.85	0.80	1.80	14.18	5.67	10.62	61.73	26.35	46.36
Durgapur-S_7	9.88	1.37	2.63	33.68	7.56	22.88	123.46	42.16	80.50
Kamalanga-S_8	8.15	1.33	2.52	21.28	5.67	13.02	84.18	42.16	63.16
Bido-S_9	5.98	0.75	2.83	37.23	10.64	20.92	120.78	47.43	86.23
Nilakanthapur-S_{10}	2.79	0.53	1.71	13.22	7.10	10.07	67.34	36.89	50.89
Kabatabandha-S_{11}	3.23	0.97	1.96	15.96	7.56	12.20	67.34	42.16	50.87

Jokdia-S_{12}	5.05	1.11	2.51	17.00	7.56	12.02	78.56	31.62	52.75
Hasinpur-S_{13}	3.63	1.02	2.13	15.11	7.56	9.91	67.34	36.89	50.44
Gadagadi-S_{14}	4.96	1.24	2.36	17.00	7.10	11.30	61.73	31.62	50.46

Table:3

Name of the Sampling Station	Calcium(Ca^{++}) in mg/l			Magnessium(Mg^{++}) in mg/l			Faecal Coliform MPN/100ml		
	Max	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**
Panposh-S_1	25.65	9.60	17.37	9.72	2.92	6.40	7000	790	2741
Tarkera-S_2	41.68	19.24	30.06	20.41	4.86	11.50	54000	5400	18367
Gomlai-S_3	22.44	6.41	15.50	12.64	1.94	7.05	3500	170	1313
Rengali-S_4	17.64	8.02	12.42	5.83	2.92	4.13	2700	70	803
Samal-S_5	14.43	9.62	12.29	6.8	2.92	4.13	3500	210	1141
Talcher-S_6	16.03	9.62	12.56	4.86	2.92	4.21	4300	630	1580
Durgapur-S_7	36.87	11.22	26.45	14.58	2.92	9.23	22000	1300	5342
Kamalanga-S_8	25.65	11.22	19.24	11.66	3.89	6.97	28000	1100	6317
Bido-S_9	38.47	11.22	24.85	15.55	4.86	10.13	24000	1300	5400
Nilakanthapur-S_{10}	17.64	9.62	13.36	6.80	2.92	4.86	4300	240	1484
Kabatabandha-S_{11}	19.24	11.22	13.76	6.80	2.92	4.78	7000	280	2083
Jokdia-S_{12}	17.64	8.02	13.90	7.78	2.92	5.18	15000	940	3970
Hasinpur-S_{13}	17.64	11.22	14.16	5.83	2.92	4.54	4300	220	1206
Gadagadi-S_{14}	17.64	9.62	13.63	6.80	1.94	4.29	7000	430	1937

Table:4

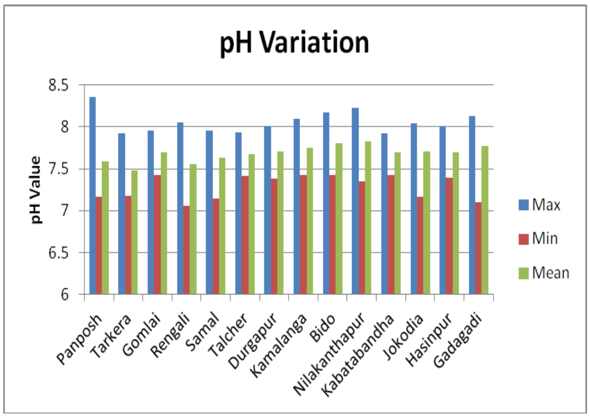
Name of the Sampling Station	Sodium(Na^+) in mg/l			Potassium(K^+) in mg/l			Total Solids		
	Max	**Min**	**Max**	**Max**	**Min**	**Max**	**Max**	**Min**	**Mean**
Panposh-S_1	8.7	3.5	2.4	0.6	1.5	5.95	303	140	197.8
Tarkera-S_2	28.8	5.9	8.0	2.3	5.73	17.98	594	250	392
Gomlai-S_3	13.6	3.1	5.0	0.5	2.23	7.38	392	121	210.9
Rengali-S_4	6.4	2.5	1.9	0.3	1.34	3.91	410	100	160.5
Samal-S_5	6.7	3.0	2.9	0.5	1.89	4.98	350	116	177.7
Talcher-S_6	7.2	3.7	2.0	0.5	1.4	4.73	342	106	167
Durgapur-S_7	19.8	5.1	6.8	0.8	3.42	12.24	348	132	260.3
Kamalanga-S_8	8.6	4.2	3.8	0.8	2.14	6.38	385	124	267.9
Bido-S_9	17.5	5.5	4.6	1.0	2.64	10.19	348	129	253.2
Nilakanthapur-S_{10}	7.4	3.2	2.3	0.6	1.43	4.53	504	116	192.3
Kabatabandha-S_{11}	7.4	3.2	2.7	0.5	1.57	5.63	593	118	196.9
Jokdia-S_{12}	8.3	3.9	3.1	0.4	1.69	5.69	450	120	183.2
Hasinpur-S_{13}	5.5	3.2	2.1	0.6	1.35	4.18	620	109	183

Gadagadi-S_{14}	7.5	4.6	2.8	1.4	1.88	6.01	412	146	197.6

Table:5

Name of the Sampling Station	D.O. in mg/l			B.O.D. in mg/l		
	Max	**Min**	**Max**	**Max**	**Min**	**Max**
Panposh-S_1	8.46	6.16	7.33	1.5	0.37	0.8
Tarkera-S_2	7.86	4.44	5.83	4.72	1.97	3.01
Gomlai-S_3	8.26	5.78	6.91	1.54	0.38	0.72
Rengali-S_4	8.65	6.37	7.17	1.88	0.38	0.75
Samal-S_5	8.46	5.79	7.01	1.12	0.56	0.74
Talcher-S_6	8.06	6.36	7.13	1.88	0.19	0.54
Durgapur-S_7	7.32	5.40	6.61	1.50	0.38	0.72
Kamalanga-S_8	7.33	5.98	6.80	1.88	0.19	0.83
Bido-S_9	7.69	6.18	6.82	1.31	0.38	0.81
Nilakanthapur-S_{10}	8.07	6.56	7.21	0.94	0.19	0.51
Kabatabandha-S_{11}	7.88	6.10	6.97	1.35	0.39	0.66
Jokdia-S_{12}	7.88	5.98	6.79	1.54	0.56	0.85
Hasinpur-S_{13}	8.06	6.18	7.13	1.16	0.38	0.54
Gadagadi-S_{14}	7.67	6.18	7.05	1.35	0.59	0.88

Figure-1:



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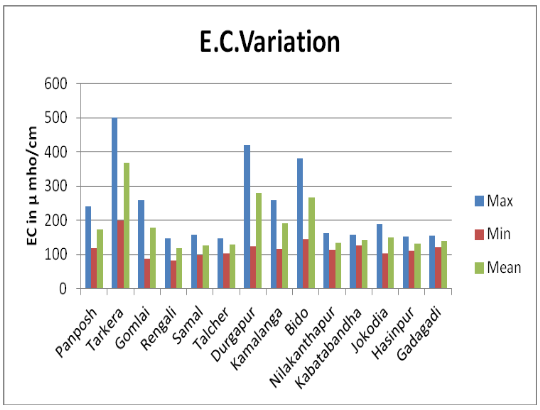

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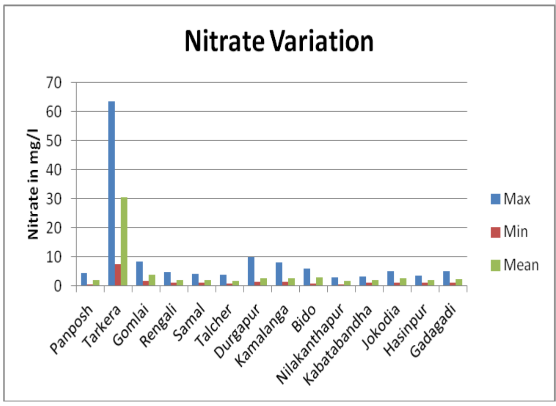

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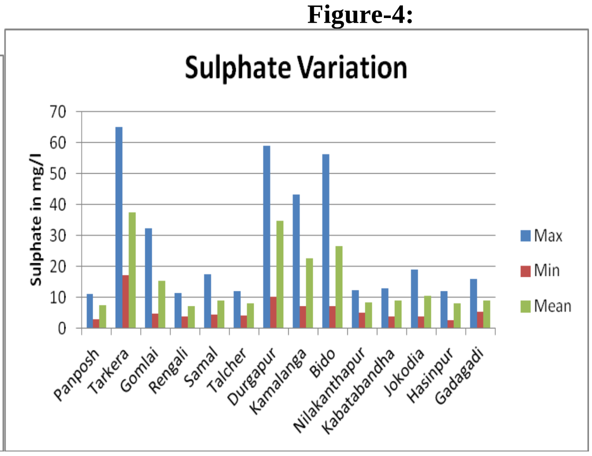
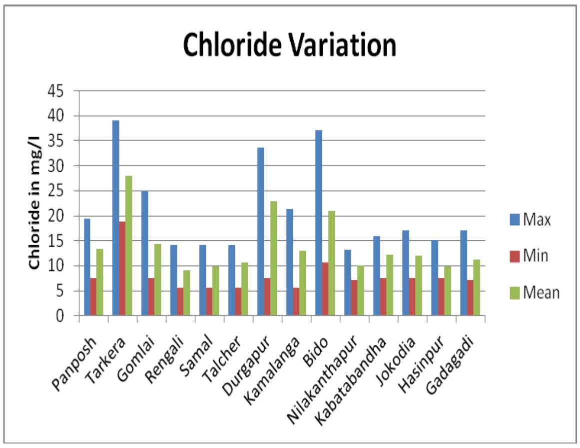


Figure-5:

Figure-6:



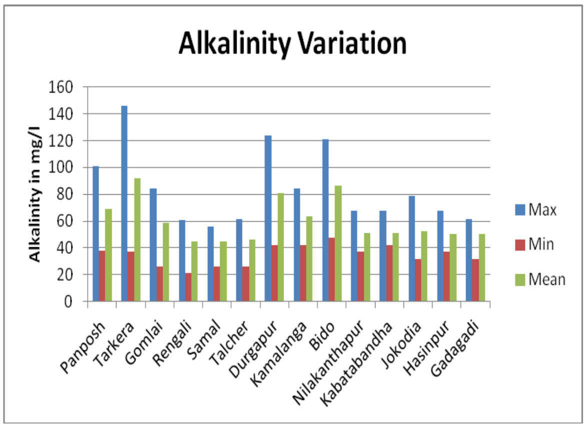
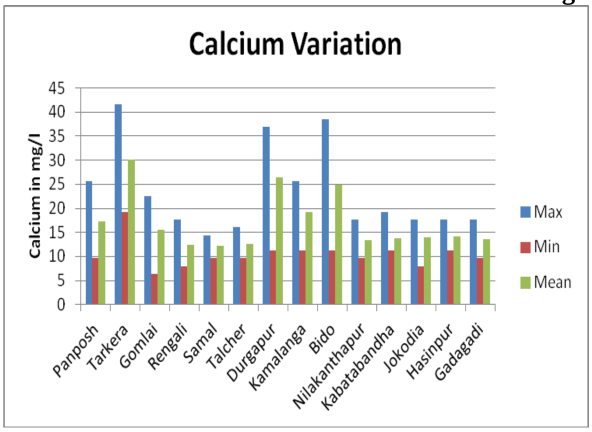
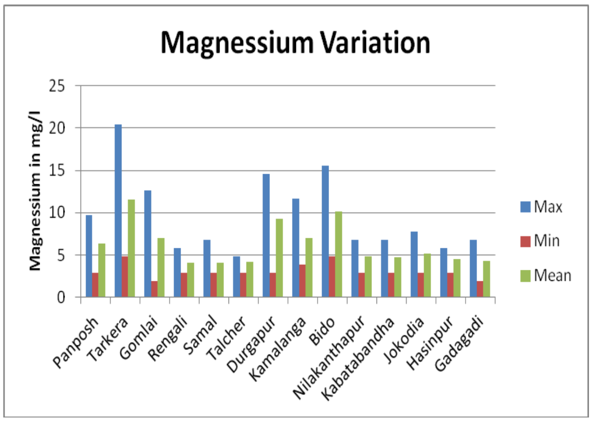


Figure-7:

Figure-8:





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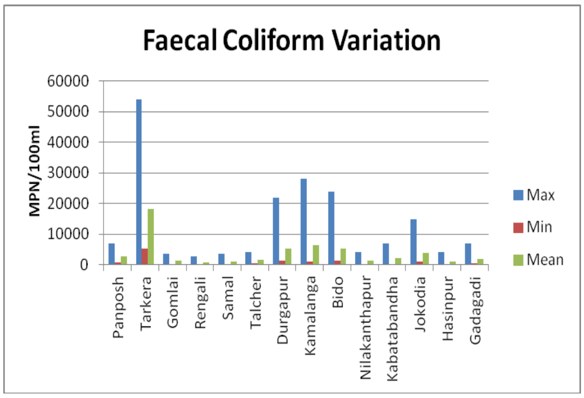

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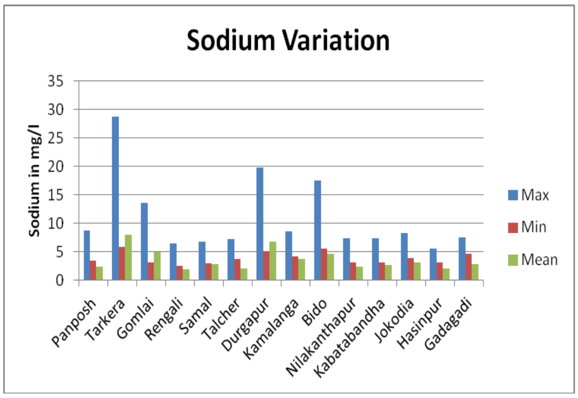

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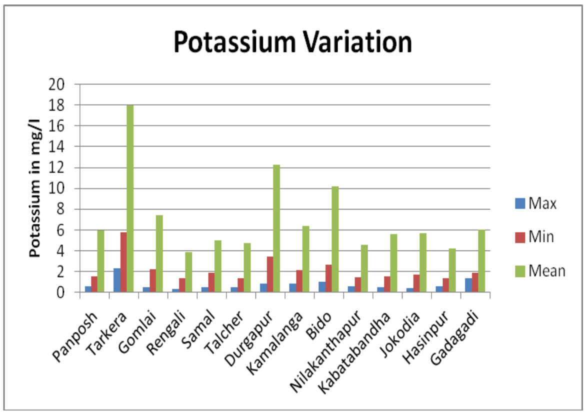

Figure-12:

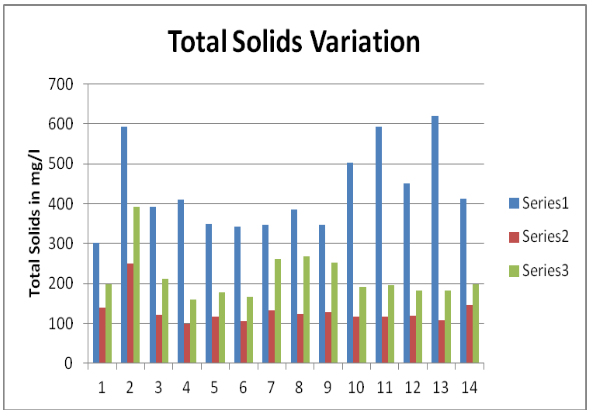

Figure-13:

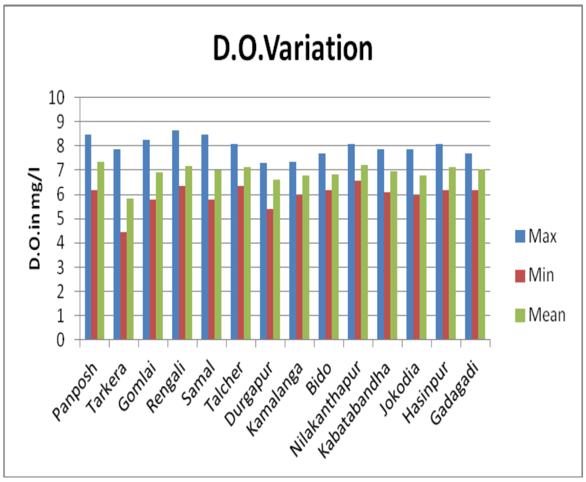

Figure-14: