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Evaluation of Physico-chemical Parameters of Kolar River Water Samples with reference to Pearson's Correlation Coefficient

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Abstract:

The present study has evaluate water quality assessment on the basis of physico-chemical analysis such as Temperature, Conductivity (EC), Total Dissolved Solids (TDS), Turbidity (Turb) , Hydrogen Ion Concentration (pH), Chloride (Cl-), Free Co_2, Total Alkalinity (TA), Dissolved Oxygen (DO), Biochemical oxygen demand, Phosphate PO_4, Nitrate NO_3 etc., using advance statistical method. There is a Pearson's Correlation Coefficient relationship between physico-chemical which shows that one variable actually causes changes in another variable. Samples were collected from Kolar River at Saoner region District Nagpur, during June 2011 to May 2012. The results proved to be a useful mean for rapid monitoring of water quality with the help of systematic calculations of correlation coefficient between water parameters with the help of Salstate2 offline software.

Key words – Evaluate, Water quality parameters, Advance, Pearson's Correlation coefficient, Salstate2.

Introduction

Water will be the main agenda and it is only the main source of economy in 22nd century (Ingale *et al.,* 2016). The total environment is a complex unit, of which water is an essential component for the survival of living beings (Bobdey *et al.,* 2009). Water is an essential requirement for life and has been put to miscellaneous expenditures composed with human and domestic consumption, industry, drinking, irrigation, agricultural and aquaculture and it is also a basic requirement for nourishing a high quality of life for economic and social development (Ingale *et al.,* 2015). The study of extraneous water parameters influenced each other and also the sediment parameter study also very significant for perception of metabolic events in aquatic ecosystem as well as superintends the abundance and distribution of the flora and fauna (Bobdey *et al.,* 2014). Activities of human alter water shed and interfere with the natural processes of wetland due to addition of domestic sewage nutrient increases moreover and industrial effluents falling into natural water bodies change the quality of water and lead to eutrophication (Dhote and Dixit 2010).

Materials and Methods:

Kolar river to the center of the town of Saoner (Savner). It continues southeast past the town of Patansavangi and receives it major tributary, the Chandrabhaga Nadi, from the right (west) at 21°19′24″N 79°01′11″E. Continuing southeast it enters the Kanhan river from the right at the village of Tola, 21°14′58″N 79°09′29″E Coordinates: 21°14′58″N 79°09′29″E, just above the town of Kamptee. The entire course of the river is in Nagpur district.

A total of twelve hydrobilogical parameters of water viz., temperature, conductivity, turbidity, total dissolved solid, hydrogen Ion concentration (pH), free CO2, total alkalinity, chloride, dissolved oxygen, biochemical oxygen demand, phosphates and nitrate were determined of the samples collected from all five stations (S1, S2, S3, S4, and S5) on water of river Kolar. Physico-chemical parameters were measured in the field by using portable ELIKO makes a digital water analysis kit. Other parameters were analysed by the standard methods (APHA 1985). Pearson's correlation coefficients were calculated for the determination of relationships between different types of physico-chemical parameters by using Salstate2 offline software.

Observations and Results: The statistical result with respect to Mean and SD values of parameters are summarized in below tables. Graphical seasonal variation of physico-chemical parameters are represented in figures with correlation matrix.

Table 1: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S1" 2011-2012.

Year:- June 2011 to May 2012					
	Parameters	**Monsoon**	**Winter**	**Summer**	**Annual Average**
1	**Water Temperature**	24.17±0.943	20.47±2.09	26.5±2.52	26.91±2.750
2	**Conductivity**	341.5±15.52	267.25±44.5	381.25±14.1	330.0±57.86
3	**Total Dissolved Solid**	230.75±7.63	204.0±13.73	208.25±6.75	214.3±14.37
4	**Turbidity**	27.075±1.11	15.11±2.202	19.68±1.806	20.62±6.037
5	**pH**	7.33±0.15	8.325±0.189	7.98±0.092	7.87±0.505

	Year:- June 2011 to May 2012				
	Parameters	**Monsoon**	**Winter**	**Summer**	**Annual Average**
6	**Chloride**	46.6 ± 0.66	58.23±3.46	62.27±0.17	55.7±9.47
7	**Free CO_2**	1.013±0.165	1.387±0.062	1.83±0.29	1.41±0.413
8	**Total alkalinity**	81.5±11.25	145.25±7.14	111.5±8.81	114.08±31.89
9	**Dissolved oxygen**	8.6±0.69	11.42±1.059	7.52±0.457	9.18±2.01
10	**B. O. D.**	7.35±0.45	6.87±0.411	10.82±1.004	8.35±2.15
11	**Phosphate**	0.043±0.006	0.059±0.006	0.069±0.003	0.057±0.013
12	**Nitrate**	0.015±0.017	0.020±0.001	0.024±0.002	0.019±0.004

Table 2: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S2" 2011-2012.

	Year:- June 2011 to May 2012				
	Parameters	**Monsoon**	**Winter**	**Summer**	**Annual Average**
1	**Water Temperature**	24.57±0.842	19.1±0.959	26.6±2.36	27.5±3.060
2	**Conductivity**	368.25±14.38	295.75±28.05	385.0±65.89	349.66±47.43
3	**Total Dissolved Solid**	367.25±24.45	233.5±19.53	289.0±49.81	296.58±67.19
4	**Turbidity**	41.78±4.026	24.25±2.00	29.4±2.48	31.80±9.007
5	**pH**	7.75±0.238	8.125±0.263	7.6±0.216	7.83±0.270
6	**Chloride**	49.01±0.321	66.87±2.15	74.19±1.91	63.36±12.95
7	**Free CO_2**	1.625±0.074	2.25±0.072	3.275±0.144	2.38±0.833
8	**Total alkalinity**	115.75±21.01	191.25±14.15	152.5±9.32	153.2±37.75
9	**Dissolved oxygen**	7.98±0.865	10.97±0.639	6.5±1.098	8.483±2.280
10	**B. O. D.**	9.95±0.387	8.83±1.18	15.05±1.87	11.275±3.317
11	**Phosphate**	0.053±0.012	0.080±0.004	0.092±0.005	0.075±0.019
12	**Nitrate**	0.019±0.0014	0.023±0.001	0.031±0.005	0.024±0.006

Table 3: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S3" 2011-2012.

	Year: June 2011 to May 2012				
	Parameters	**Monsoon**	**Winter**	**Summer**	**Annual Average**
1	**Water Temperature**	24.52±0.822	20.25±1.32	26.72±2.71	27.25±2.980
2	**Conductivity**	358.25±22.09	270.75±43.78	365.25±64.69	331.42±52.65
3	**Total Dissolved Solid**	359.0±31.51	223.0±23.45	273.75±46.87	285.25±68.72
4	**Turbidity**	40.013±3.080	21.67±1.28	25.35±2.42	29.01±9.70
5	**pH**	7.8±0.294	8.23±0.298	7.6±0.141	7.88±0.319
6	**Chloride**	45.1075±1.64	61.70±1.63	64.53±0.64	57.11±10.49
7	**Free CO_2**	1.47±0.239	2.025±0.165	3.013±0.503	2.17±0.779
8	**Total alkalinity**	111.5±20.15	179±9.96	139.25±8.95	143.25±33.92
9	**Dissolved oxygen**	7.73±0.377	9.45±0.7188	6.2±0.683	7.79±1.62
10	**B. O. D.**	9.98±0.505	8.75±1.25	14.675±1.927	11.13±3.127
11	**Phosphate**	0.047±0.009	0.069±0.004	0.078±0.003	0.065±0.016
12	**Nitrate**	0.019±0.0008	0.024±0.003	0.030±0.002	0.024±0.005

Table 4: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S4" 2011-2012.

	Year:- June 2011 to May 2012				
	Parameters	**Monsoon**	**Winter**	**Summer**	**Annual Average**
1	**Water Temperature**	24.72±0.822	21.25±1.32	26.82±2.69	26.84±2.793
2	**Conductivity**	369.5±13.79	285.75±28.05	382.75±64.23	346.0±52.59
3	**Total Dissolved Solid**	357.25±24.45	227.5±27.34	279.0±49.81	287.92±65.33
4	**Turbidity**	37.98±3.34	22.2±0.98	26.48±3.19	28.89±8.16
5	**pH**	7.8±0.294	8.225±0.299	7.6±0.141	7.87±0.319
6	**Chloride**	47.55±1.91	60.21±1.97	68.48±0.60	58.75±10.54
7	**Free CO_2**	1.5±0.182	1.87±0.104	2.9±0.449	2.091±0.724
8	**Total alkalinity**	112.75±22.69	186.75±10.21	146.75±5.73	148.75±37.04
9	**D.O**	7.35±0.580	9.75±1.04	6.175±0.629	7.76±1.82
10	**B. O. D.**	9.425±0.403	8.35±1.11	13.85±1.873	10.54±2.91
11	**Phosphate**	0.040±0.0017	0.06±0.007	0.075±0.005	0.059±0.016
12	**Nitrate**	0.0195±0.001	0.023±0.002	0.028±0.002	0.024±0.004

Table 5: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S5" 2011-2012.

Year:- June 2011 to May 2012					
	Parameters	**Monsoon**	**Winter**	**Summer**	**Annual Average**
1	**Water Temperature**	24.75±0.818	21.25±1.32	27.1±2.96	27.36±2.730
2	**Conductivity**	354.25±23.51	255.25±16.1	366.75±52.5	325.42±61.08
3	**Total Dissolved Solid**	331.5±31.38	207.5±7.54	257.5±41.10	265.5±62.38
4	**Turbidity**	37.61±2.98	20.72±1.57	24.5±2.27	27.61±8.86
5	**pH**	7.45±0.580	8.125±0.298	7.5±0.141	7.69±0.376
6	**Chloride**	47.92±2.11	59.24±0.44	67.53±0.82	58.23±9.84
7	**Free CO_2**	1.23±0.184	1.64±0.075	2.54±0.537	1.8±0.671
8	**Total alkalinity**	91.0±8.52	153.5±8.26	122.5±9.33	122.3 ±31.25
9	**D.O**	7.8±0.828	10.13±1.173	6.93±1.37	8.28±1.65
10	**B. O. D.**	8.85±0.443	7.4±0.547	11.52±1.18	9.26±2.09
11	**Phosphate**	0.047±0.011	0.066±0.002	0.071±0.003	0.061±0.013
12	**Nitrate**	0.015±0.002	0.020±0.001	0.026±0.001	0.020±0.005

Table no. 6: Pearson's Correlation of coefficient Physico-chemical parameters of water in Kolar river 2011-2012.

Sr. No.	**Parameters**	**W.T**	**Cond**	**T.D.S**	**Tur**	**pH**	**Chl**	**F.CO_2**	**TA**	**D.O.**	**B.O.D**	**PO_4**	**NO_3**
1	**W. Temp.**	1											
2	**Conductivity**	0.031	1										
3	**TDS**	0.47	0.61	1									
4	**Turbidity**	0.60	0.59	0.98	1								
5	**pH**	**-0.51**	0.42	**-0.01**	**-0.12**	1							
6	**Chloride**	0.63	0.77	0.70	0.79	**-0.14**	1						
7	**Free Co_2**	0.52	0.69	0.97	0.96	0.14	0.77	1					
8	**T. alkalinity**	0.26	0.83	0.91	0.88	0.35	0.71	0.95	1				
9	**D.O**	**-0.05**	**-0.23**	**-0.80**	**-0.70**	**-0.049**	**-0.15**	**-0.66**	**-0.66**	**1**			
10	**B.O.D**	0.43	0.65	0.93	0.91	0.29	0.65	0.97	0.96	**-0.70**	1		
11	**Phosphate**	0.81	0.56	0.66	0.75	**-0.007**	0.87	0.80	0.67	**-0.11**	0.74	1	
12	**Nitrate**	0.20	0.72	0.90	0.83	0.43	0.56	0.93	0.98	**-0.75**	0.97	0.59	1

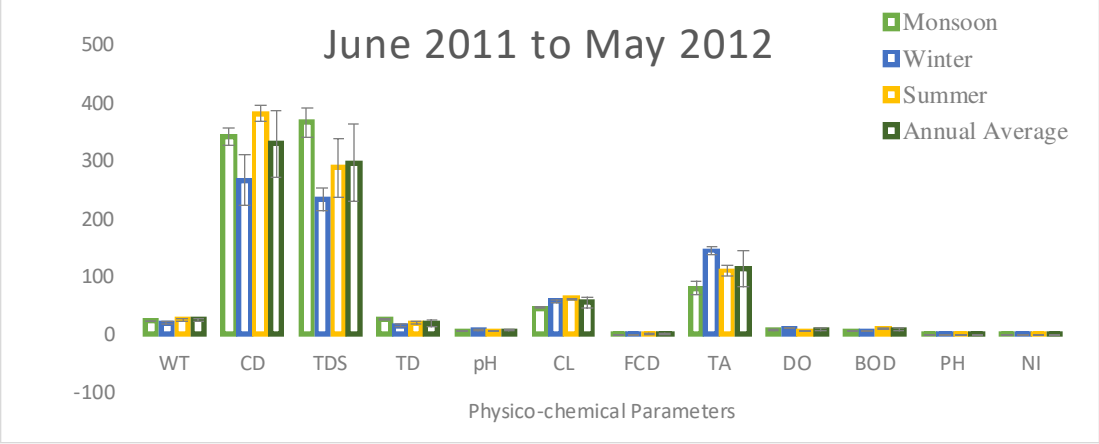

Figure no. 1: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S1" 2011-2012 (WT - Water Temperature, CD – Conductivity, TDS - Total dissolved solid, TD – Turbidity, pH, CL – Chloride, FCD - Free carbon dioxide, TA - Total alkalinity, DO - Dissolved oxygen, BOD - Biochemical oxygen demand, PH – Phosphate and NI – Nitrate).

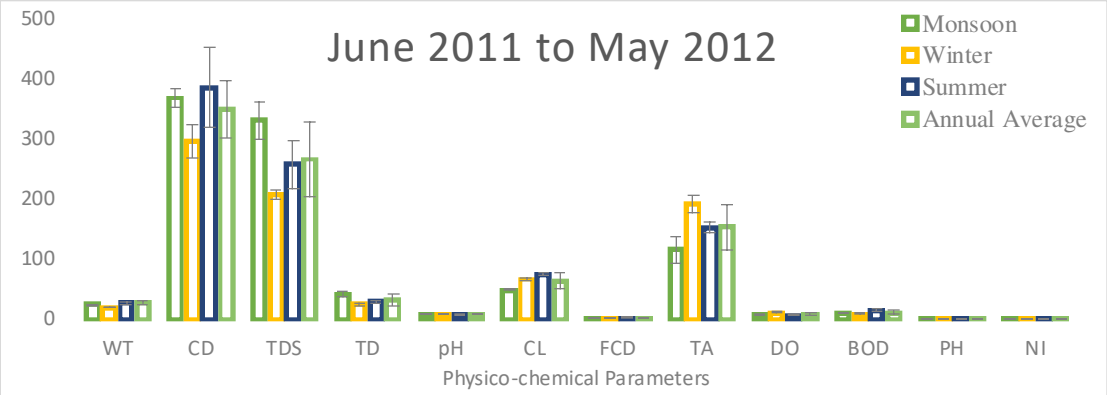

Figure no. 2: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S2" 2011-2012 (WT - Water Temperature, CD – Conductivity, TDS - Total dissolved solid, TD – Turbidity, pH, CL – Chloride, FCD - Free carbon dioxide, TA - Total alkalinity, DO - Dissolved oxygen, BOD - Biochemical oxygen demand, PH – Phosphate and NI – Nitrate).

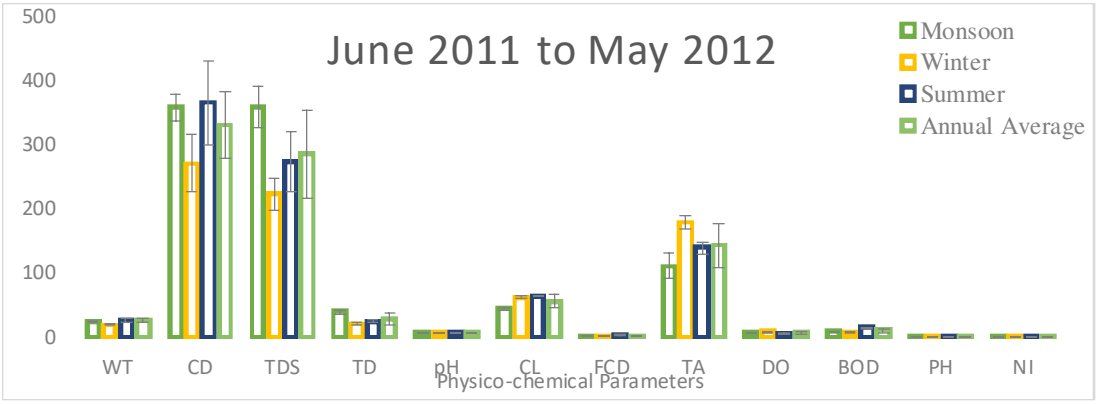

Figure no. 3: Seasonal average mean values of physico-chemical parameters of water in Kolar river station "S3" 2011-2012 (WT - Water Temperature, CD – Conductivity, TDS - Total dissolved solid, TD – Turbidity, pH, CL – Chloride, FCD - Free carbon dioxide, TA - Total alkalinity, DO - Dissolved oxygen, BOD - Biochemical oxygen demand, PH – Phosphate and NI – Nitrate).

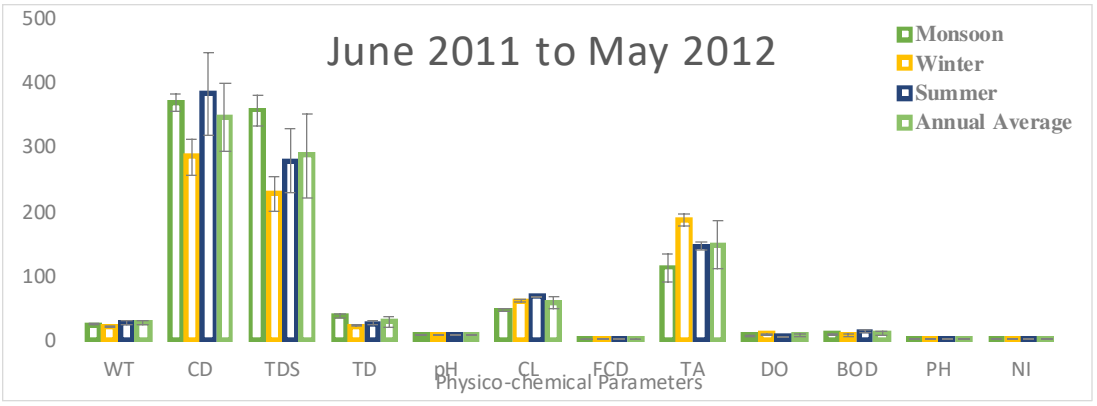

Figure no. 4: Seasonal average values of physico-chemical parameters of water in Kolar river station "S4" 2011-2012 (WT - Water Temperature, CD – Conductivity, TDS - Total dissolved solid, TD – Turbidity, pH, CL – Chloride, FCD - Free carbon dioxide, TA - Total alkalinity, DO - Dissolved oxygen, BOD - Biochemical oxygen demand, PH – Phosphate and NI – Nitrate).

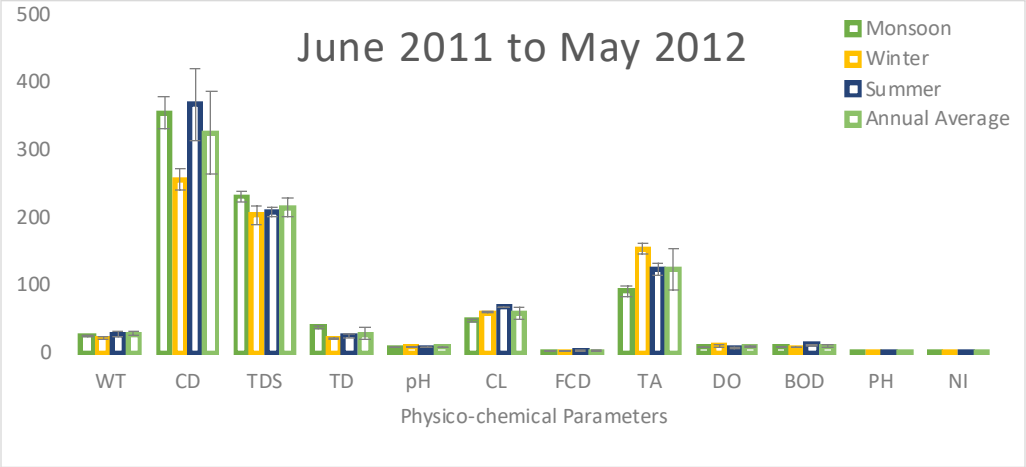

Figure no. 5: Seasonal average mean values of physico-chemical Parameters of water in Kolar river station "S5" 2011-2012 (WT - Water Temperature, CD – Conductivity, TDS - Total dissolved solid, TD – Turbidity, pH, CL – Chloride, FCD - Free carbon dioxide, TA - Total alkalinity, DO - Dissolved oxygen, BOD - Biochemical oxygen demand, PH – Phosphate and NI – Nitrate).

Discussion:

A. Water Temperature:

During the study period, maximum water temperature recorded during summer season and minimum during the winter season. At station S-1 there is less temperature of water at this station has been recorded as compared to the downstream. Similarly, Sunkad (2013) observed from the Malaprabha river of Krishna basin, Kolhe and Shinde (2014), Kalshetty *et al.,* (2014) from river Tungabhadra, at Harihar, District Davanagere, Karnataka State, India.

It is evident from the present study that, the temperature of Kolar river water increases from upstream station to downstream stations with the increasing load of organic pollutants. Similar value recorded by (Malviya and Dwivedi, 2015).

The present study indicates that the correlation coefficient of water temperature show positive relationship with electrical conductivity and chloride analogous findings reported by Tripathi *et al.,* (2014).

B. Conductivity (µmho/cm)

During the present study, conductivity of river water increases during the summer and decreases during winter season. The highest concentration of wastes and domestic activities and less flow of river during summer is responsible for the increase of ionic contents in water and conductivity. Similar results were reported by Rewatkar *et al.,* (2015) in river Kathani, Gadchiroli (M.S.). This may be due to higher chlorides and total dissolved solid contents in river water during summer. Analogous findings by Singh *et al.,* (2016).

The study period spread over one year shows that the values of river water have a regular and gradual increases in conductivity from upstream station S-1 to downstream station S-5, in all seasons. These results were supported by Lena and Maneemegalai, (2015) in Varahanadhi River. There was a positive correlation between conductivity and TDS of the water samples (Sujitha *et al.,* 2012) and negative correlation of conductivity with dissolved oxygen (Kadarshahib and Selvakumar 2014).

C. Turbidity (NTU)

The maximum turbidity recorded during the monsoon season and minimum during winter and summer season. This may be due to the more addition of municipal and decomposed sewage during rainy season. Regular cloth washing and mass bathing adds soaps and detergents at station S-3, S-4 and S-5. The impact of municipal sewage from station S-2 is observed at station S-3, due to decomposed sewage from station S-2 that reaches at station S-3 and S-4 before it complete assimilation in river water. These findings are in line with those Giri and Singh (2013) in river Wang Chhu and Gunasekar and Isaac (2015) in river Sone at Bihar.

The downstream station S-3 shows maximum values due to heavy load of pollutants. These observations are similar with those of Bobdey (2002) in river Wainganga Kar *et al.,* (2010) in Mahanadi river water in and around Hirakud, Orissa. Turbidity showed negative correlation with DO (Jinal and Vaghani 2015).

D. Total dissolved solids (Mg/L)

In the present investigation, the maximum value of total dissolved solid noted during the rainy season followed by summer, while it was minimum during winter season. Similar results

were found out by Tomar *et al.,* (2016) from Kali River.

In addition to sewage discharged, addition of crematory ashes and religious wastes are responsible for the maximum values at station S-3 and decaying cow dung from agricultural farming mixes into the river basins at stations S-4 and S-5. However, the abundance of phytoplanktons in river water during winter and their assimilation of carbonates and bicarbonates may be the cause of reduction of TDS values. The present findings supports with the work of Khadse *et al.,* (2008) from river Kanhan.

The concentration of dissolved solids gradually increases from upstream station S-1 to downstream station S-5. Analogous findings Shukla *et al.,* (2015) from Shivnath river in Durg District (Chhattisgarh). The TDS showed significant positive correlation with Chloride, EC, Nitrate and Phosphate (Khatoon *et al.,* 2013).

E. Hydrogen Ion Concentration (pH)

According to present study, the pH increases in winter season. This may be due to municipal sewage and domestic wastes in river water. However increase of carbonates and bicarbonates concentration in the river water, rises the values of pH in winter season. Similar line results in accordance with the present study of Bobdey, (2014) in river Wainganga, and Selakoti and Rao (2015) from Kosi river.

During winter season and summer season at upstream station S-1, the deposited soil sediments of alkaline earth carbonates maintains the alkaline nature of water. At stations S-2, S-3, S-4 and S-5 the impact of pollution can be determined from the maximum value of pH. Khan and Nath (2014) have recorded maximum mean pH value at Upstream in river Ganges at Mirzapur in Uttar Pradesh, India. pH was positively correlated with conductivity (Jinal and Vaghani 2015).

F. Free carbondioxide (Mg/l)

During the present investigation, the concentration of carbon dioxide is maximum during the summer and minimum during rainy season. Chandanshive (2013) in river Mula Mutha at Pune and Sarwade and Kamble, (2014) in river Krishna, Sangli Maharashtra, have recorded similar findings.

At upstream station S-1, the less concentration of CO_2 has been recorded. It may be due to active photosynthesis activities by aquatic flora within the period of intense sunlight, in summer. This intern accelerates the assimilation of CO_2 by phytoplanktons. Increasing load of population at station S-2, S-3, S-4 and S-5 resulted in to increase in concentration of sewage and waste with turbidity. Analogous findings reported by Mahajan and Kalwale (2015) in river Tapti. The slight decline in values during winter may be due to abundance of phytoplanktons in the moderate flow of river. The findings of present study are in accordance with Deshmukh (2015) from river Pravara. Free carbondioxide positively correlated with pH (Andem *et al.,* 2012).

G. Total alkalinity (Mg/L)

Total alkalinity in Kolar river water varies with seasons. Maximum values of alkalinity recorded in the winter and minimum in the rainy season. The value of alkalinity increases with increasing load of pollutants in the river water. These findings tally with those of Jha (2015) in river Kamla.

The sewage and domestic wastes are the source of organic matter at downstream stations S-2, S-3, S-4 and S-5. Decomposition of organic matter by microbes leads in to formation of CO_2 in river water, which intern increase the concentration of carbonates and bicarbonates salts. Similar findings have been reported by Selakoti and Rao (2015) in Kosi river at Almora province from central Himalaya, India. Total alkalinity showing positive correlation with pH ()

H. Chloride (Mg/L)

Sampling of water during the period of study showed that maximum concentration of chlorides during summer and winter season. Minimum values were obtained during rainy season. These findings are in accordance with the findings of Datar (2014) recorded maximum chloride values during summer season. Chloride concentration in river water is lower in the rainy season. This may be due to the dilution of pollutants in more quantity of water in river. Mostly the cattle washing activities at station S-5 during rainy season and winter may affects the chloride level at these station in addition to the other sources of pollutants Rout *et al.,* (2016) in Mahanadi river have recorded the findings correlating with the results of the present study. Correlation coefficient of chloride shows negative relationship with dissolved oxygen and nitrate. Similar findings reported by Tambekar *et al.,* (2013) in river Wardha.

I. Dissolved oxygen (Mg/L)

It is concluded that dissolved oxygen in Kolar river water varies from season to season. Maximum concentrations of DO observed in the winter and minimum during the summer season. The investigation showed the inverse relationship between DO and temperature by Trivedi *et al.,* (2014) in Kolar River, Saoner, (M.S.), India.

During the summer season decrease of values at station S-2 is due to municipal sewage. At station

S-3, it may be due to cremation and partially diluted organic pollutants from station S-2 and the human activities at station in the river stream. The watermelon fields in the river basin cover the area around station S-2 and S-3. The mixing of decaying cow dung in stream increases the organic pollution. The similar observations were recorded by Shinde and Somaiya (2015) in river Godavari.

The DO showed significant and negative correlation with BOD, TDS, chloride, conductivity, nitrate, phosphate. Findings Analogous with Usharani *et al.,* (2010) from Noyyal River and ground water quality of Perur, India.

J. Biochemical oxygen demand (Mg/L)

Analysis of Kolar river water during the study period reveals that, the microorganism requires more oxygen for stabilizing the biodegradable organic wastes, during summer season. At station S-1 there is no significant source of pollutants, however, the present organic bottom sediments and rise in water temperature increases the value of biochemical oxygen demand as also have been reported by Kushram (2016) in Narmada river water at Dindori (M.P.) India.

At station S-2 and S-4 increased biodegradable organic material, from sewage, decaying cow dung from farming in river basin, may be responsible for increased values of biochemical oxygen demand. At station S-2, S-4 and S-5, discharge of temple wastes and cremation waste at station S-3 contributes the most of biodegradable organic matter in the river. At downstream increasing load pollutants has resulted in to higher values of BOD. The result of the present study are in accordance with Gupta *et al.,* (2014) in river Ken.

The BOD showed significant and positive correlation with TDS, Chloride, EC, Nitrate and Phosphate. Similar findings by (Khatoon *et al.,* 2013).

K. Phosphates (Mg/L)

Present study of Kolar river water reveals that, the concentration of phosphate recorded maximum during the summer season followed by winter season, while minimum during the rainy season. The present study is in accordance with Cieśliński and Olszewska, (2012) in Kopalińskie Lake, Emad.

The domestic activities of the population near by the bank of river results in to increase in the percentage of phosphates in water. In river basin farming and use of cow dung as manure by farmers during summer season polluted the river and constitute the major source of phosphates in river water at station S-2, S-4 and S-5. The similar findings reported by Bhandarkar and Bhandarkar (2013) in some freshwater lotic ecosystems in Gadchiroli District Maharashtra and Tomar *et al.,* (2016).

L. Nitrate (Mg/L)

On the basis of results recorded during the present investigation it can be concluded that, the maximum values were obtained in the summer followed by winter season. The maximum value at station S-2, S3, S4, and S-5 respectively, variation in to the values of nitrates may be due to the varying quantity of pollutants the many sources of organic pollutants lead to increase in the values of nitrates. While in the rainy season, concentration of nitrates became lower. These findings are in accordance with Muniyan and Ambedkar (2011), Giri and Singh (2013) and Nagarsekar *et al.,* (2014). The Nitrate showed positive correlation with phosphate (Khatoon *et al.,* 2014).

Conclusion:-

From the above study, it is concluded that the Kolar river is facing moderate pollution at downstream stations. The water is not suitable for drinking purpose but it can be uses for agricultural activities and recreational purposes. The DO and pH are negatively correlated with most of the water parameters. Finally, it can be concluded that the correlation studies Kolar river water quality parameters have great significance in the study of water resources. This study has revealed the facts that all the physico-chemical parameters of drinking water in Kolar river are correlated in some or the other ways. The study could be more improved by studying river water quality movement in the near future. Hence, recommendation for necessary action by the local government should be undertaken to protect this natural river: 1. Prevention of pollution all the station 2. Prohibiting of solid wastes disposal and domestic waste near the river 3. Awareness and restriction policy about open defecation.

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