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Assessment of seasonal changes in water quality of river Panchganga

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Abstract

Day by day aquatic ecosystem develops as challenging environment for sustainability of aquatic flora and fauna, due to unstability created by continuously changing water quality. Deterioration of water quality by natural and anthropogenic activities was continued, since beginning of human development. Now days, water quality is continuously rendering throughout the world and becomes a serious threat resulting scarcity of valued freshwater utilized for variety of purposes. Panchganga river is considered as one of the important river in Maharashtra, India. Rapidly declining water quality of river Panchganga was monitored for the period of March 2011 to February 2013. During investigation, various physicochemical parameters at different monitoring sites were assessed and interpreted statistically. Average results along with seasonal alterations in the physicochemical parameters at different monitoring sites confirmed average water quality of river Panchganga. However, noted as continuously polluting river due to discharge of tremendous amount of pollutants from nearby industries along with domestic sewage.

INTRODUCTION

Water is vital resource for sustainable development of life. Earth contains enormous amount of water, however percentage of potable water found very less. The amount of potable water for well being of human life is only 1%. South Asiatic countries have 2800 kms of freshwater resources including 1880 kms of river flow [1]. Due to unequal geographical distribution of freshwater resources, the scarcity of freshwater is seen in some of the region.

Major freshwater resources include rivers, reservoirs, lakes, streams etc. Among these resources, rivers have immense important due to their major role in hydrological cycle. River water circulates throughout the land area, during the flow organic matters get dissolved in it, nutrients are replenished and waste material is carried away [2]. Water quality of river is result of multitude of physical, chemical and biological interactions. Rivers played vital role in establishment of community and were considered as dwelling place for thousands of aquatic animals. However, deterioration of water quality from aquatic bodies is matter of serious concern [3-6]. Today, most of the rivers in the world received sewage, domestic waste, industrial and agricultural effluents and became polluted [7]. Industrial revolution has significant cause's relating to aquatic pollution and has direct or indirect impact on floral and faunal incapacitation and total deterioration.

Man tried to cope with formed scenario and started advanced efforts to counteract with melody [8]. Numbers of parameters signifying the quality of waters in various aspects have been proposed. Regular monitoring of these parameters not only prevented diseases and hazards, but also checked water resources from being further pollution [9]. Water quality from river Panchganga, India has not much more studied and as a result now became issues of major concern due to continuous discharge of industrial, agricultural effluents and domestic sewage. This has resulted to loss of biodiversity along with spreading variety of diseases throughout the river basin. Hence, as mentioned by Bellingham (2012) [10], regular monitoring of water quality is necessary to identify the impairments and to step out preservations of natural water resources, which in turns improves the quality of total ecosystem.

Therefore, by taking in to account the above considerations, present investigation had been carried out in relation to monitor the water quality of river Panchganga.

MATERIAL AND METHODS

Study area:

Panchganga river originated at Prayag Chikhli, Kolhapur, Maharashtra, India 16º 31'N to 74 º 36' E. Panchganga river is union of five streams from different rivers viz. Kasari, Kumbhi, Tulsi, Bhogawati and Saraswati. River flows along the length of 81 km i.e. 30 miles, during which it continues as a large pattern until it reaches Kurundwad, where it joins with river Krishna.

Monitoring Sites:

In the present work, for pollution assessment five spots viz. S_1, S_2, S_3, S_4 and S_5 were selected as monitoring sites. S_1 and S_2 were at upstream, whereas, S_3, S_4 and S_5 were at downstream of the river. Latitude, longitude and names of monitoring sites with exact location were illustrated in the Fig.1.

Physicochemical Analysis:

Water samples from each of sites were collected monthly by applying standard methods, in the period of March 2011 to February 2013. Sampling was carried using one litter acid leached polythene bottle. Physical parameters as Temperature and pH of the water were measured in situe at every monitoring sites using thermometer and calibrated pH meter (Hanna, pocket pH meter). Total Solids (TS) and Total Dissolved Solids (TDS) were determined by Hach's gravetric method. Other chemical parameters as- Dissolved Oxygen (DO), (Wrinkler's idometric method), Total Hardness (TH), (EDTA method), Total Alkalinity (TA), (Simple titration method), Free Carbon Dioxide (CO_2), (Simple titration method),Inorganic Phosphate (IP),

Monitoring sites				
Code	Name	Longitude	Latitude	Elevation from Sea level
S_1	Prayag-Chikhli	16º 44' N	74 º 10' E	1780 ft.
S_2	Shivaji Bridge	16º 42' N	74 º 13' E	1786 ft.
S_3	Rukdi	16º 42' N	74 º 20' E	1770 ft.
S_4	Narsobawadi	16º 41' N	74 º 36' E	1754 ft.
S_5	Ichalkaranji	16º 41' N	74 º 35' E	1763 ft.

Fig. 1. Geography of the Study region.

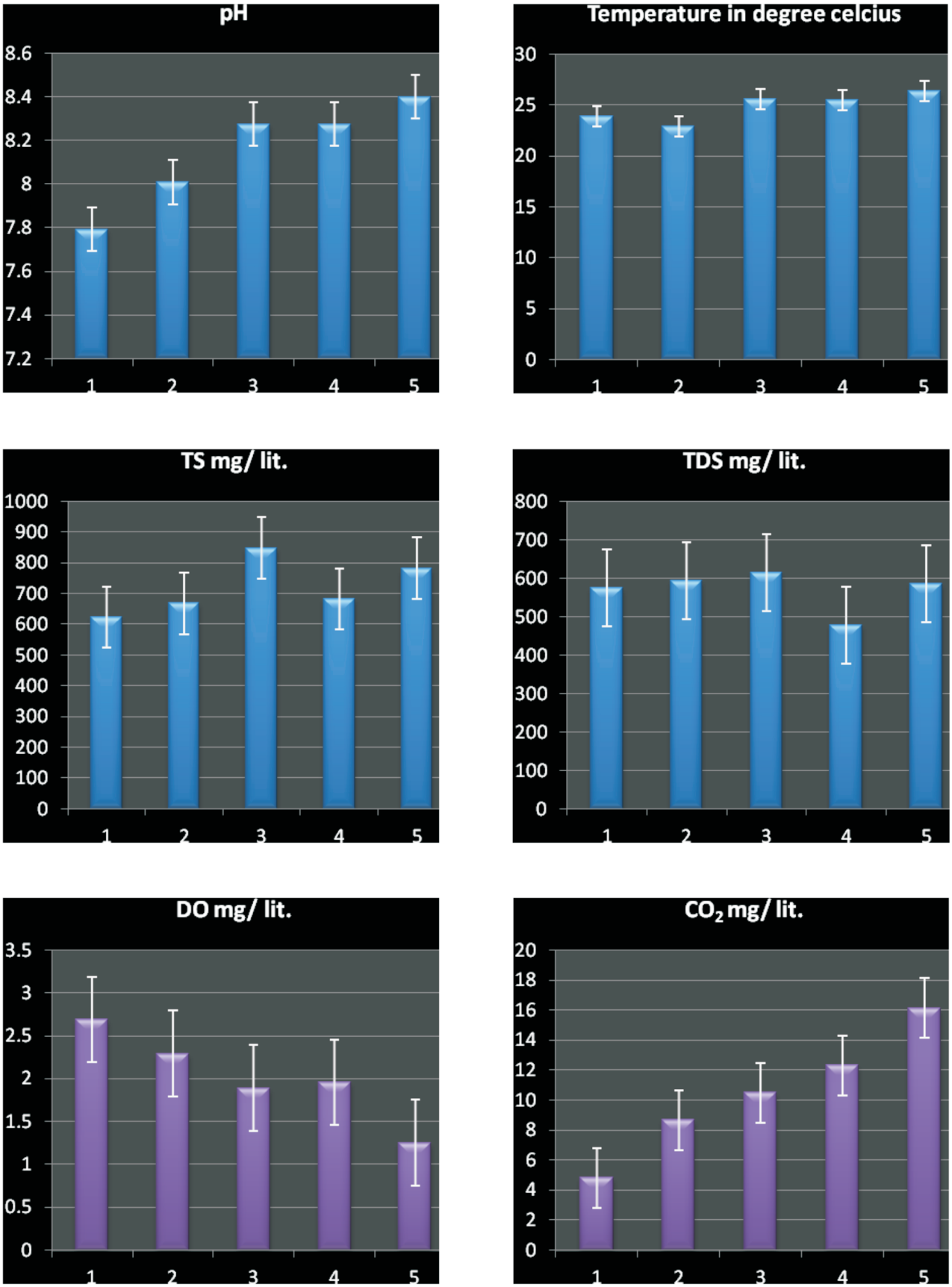


Fig. 2A) Physicochemical parameters 2011-2012.

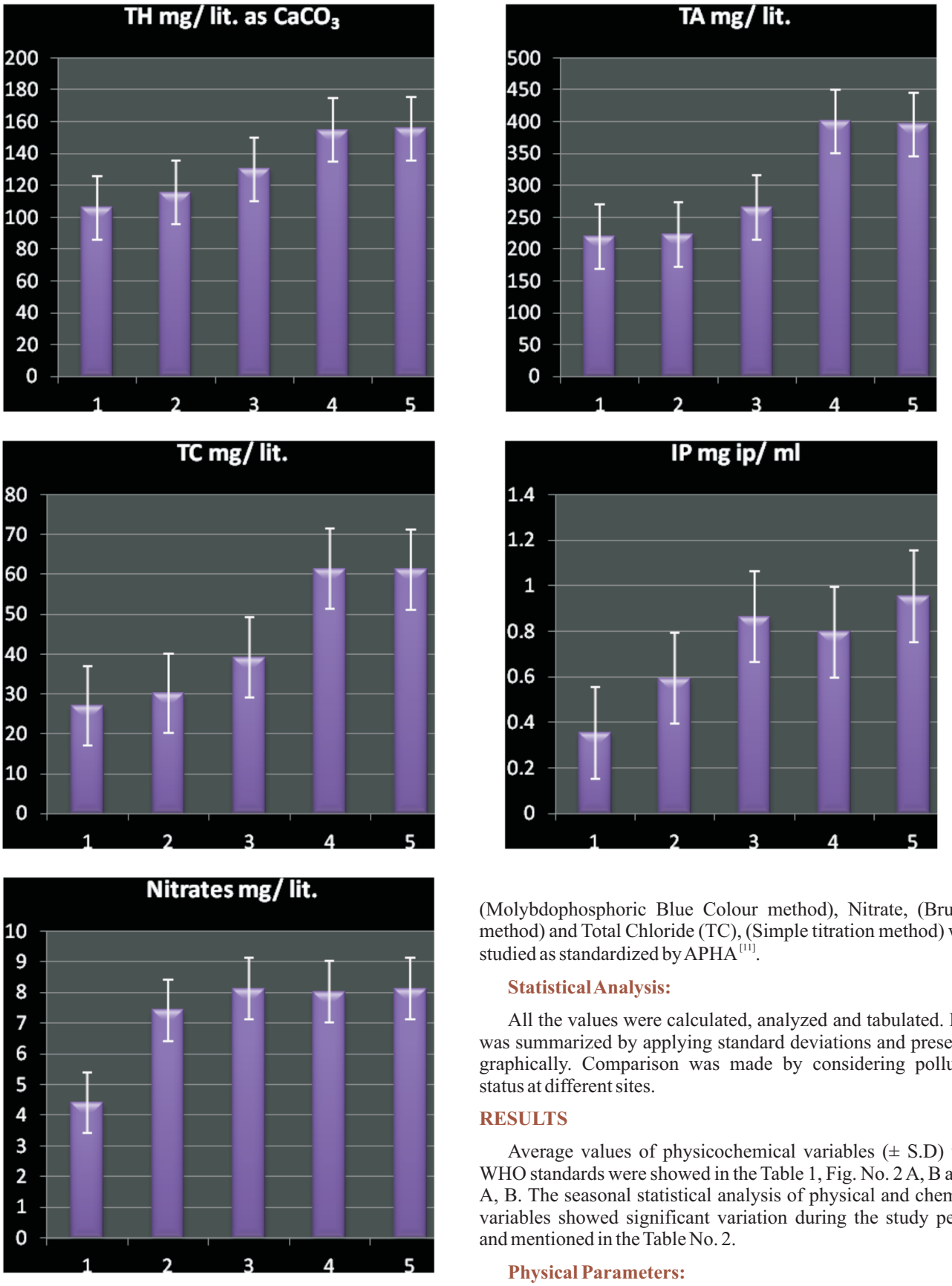


Fig. 2B) Physicochemical parameters 2011-2012.

(Molybdophosphoric Blue Colour method), Nitrate, (Brucine method) and Total Chloride (TC), (Simple titration method) were studied as standardized by APHA [11].

Statistical Analysis:

All the values were calculated, analyzed and tabulated. Data was summarized by applying standard deviations and presented graphically. Comparison was made by considering pollution status at different sites.

RESULTS

Average values of physicochemical variables (± S.D) with WHO standards were showed in the Table 1, Fig. No. 2 A, B and 3 A, B. The seasonal statistical analysis of physical and chemical variables showed significant variation during the study period and mentioned in the Table No. 2.

Physical Parameters:

pH: During the entire course of investigation the pH values represented alkaline nature of water and showed average alkaline pH range between 7.6 to 8.5. In seasonal comparison, minimum

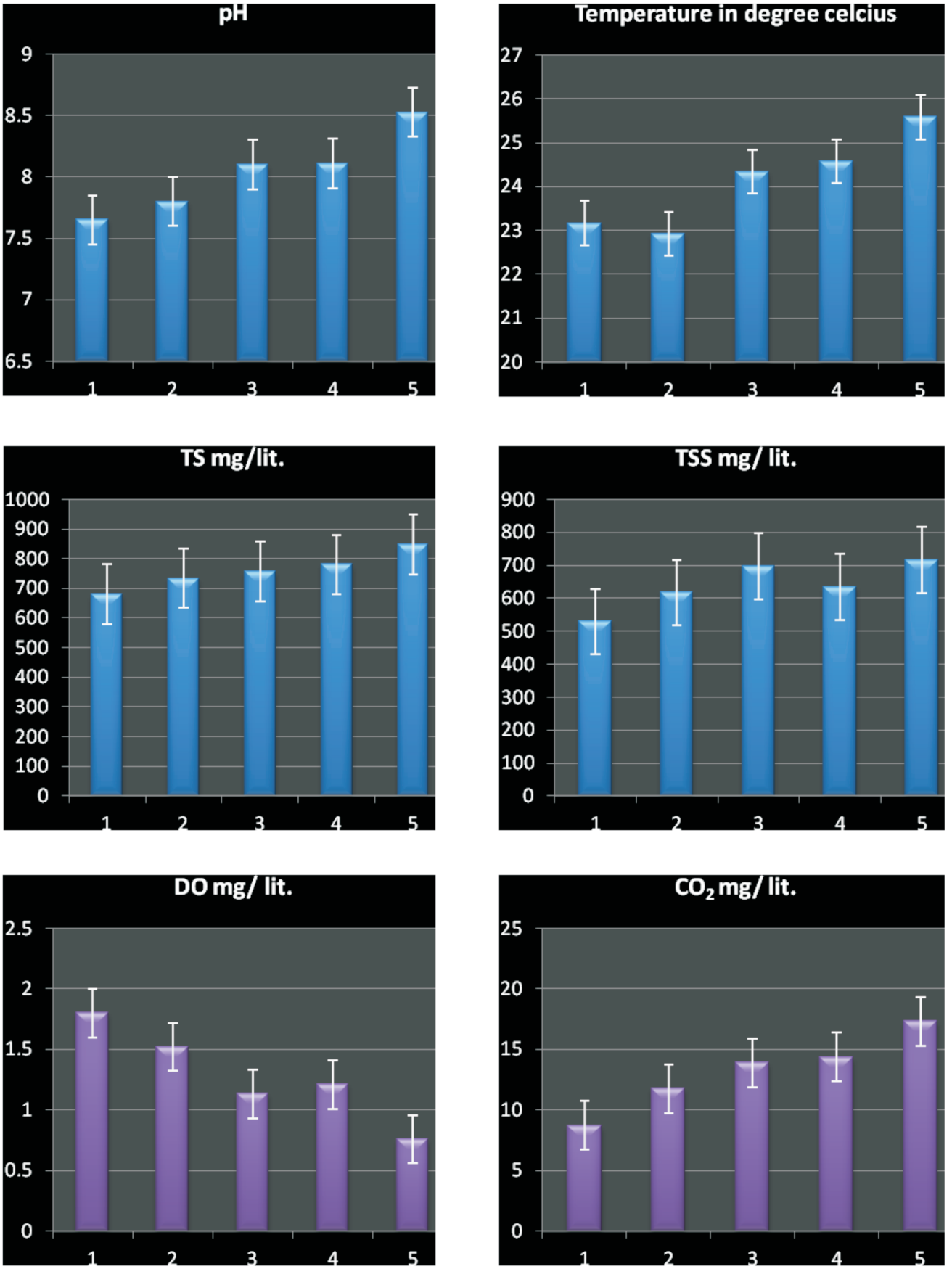
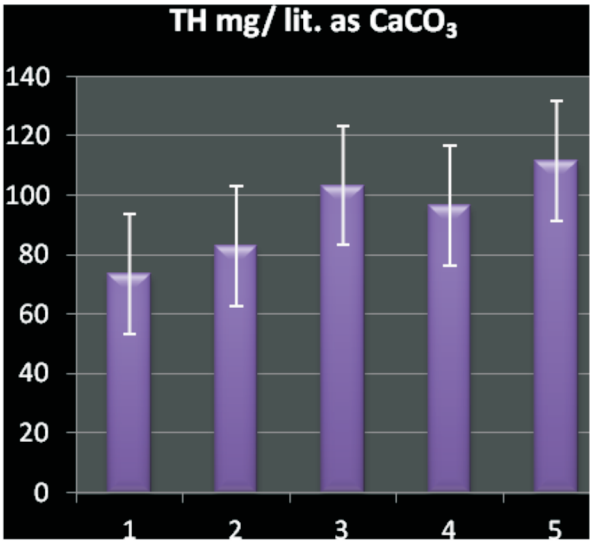
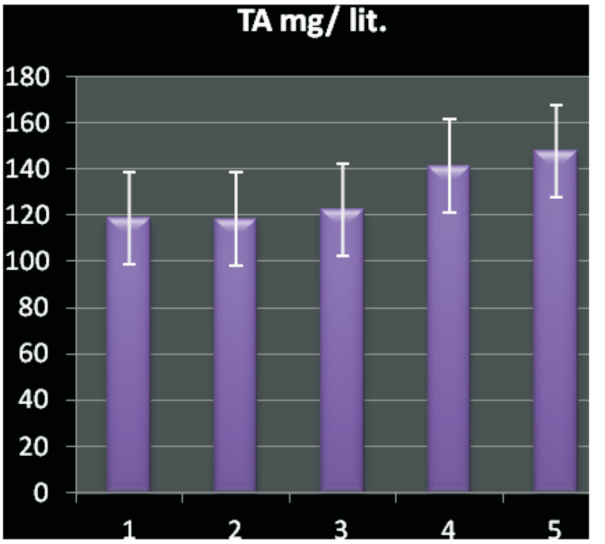
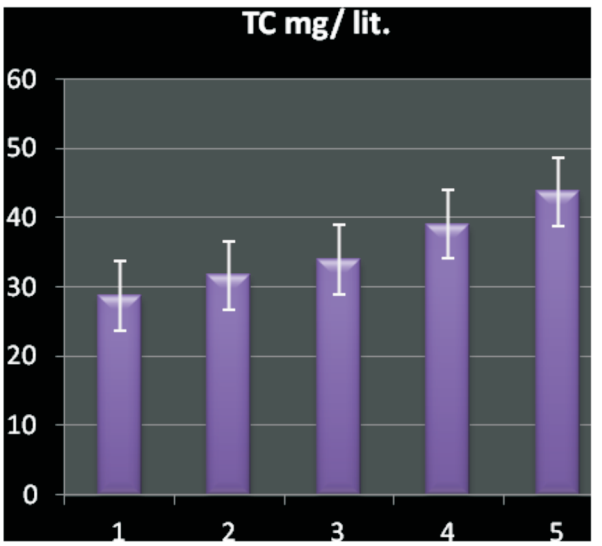
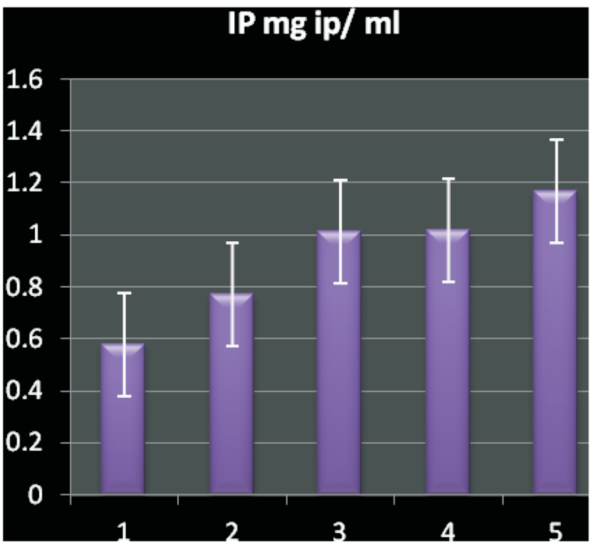


Fig. 3 A) Physicochemical parameters 2012-13.









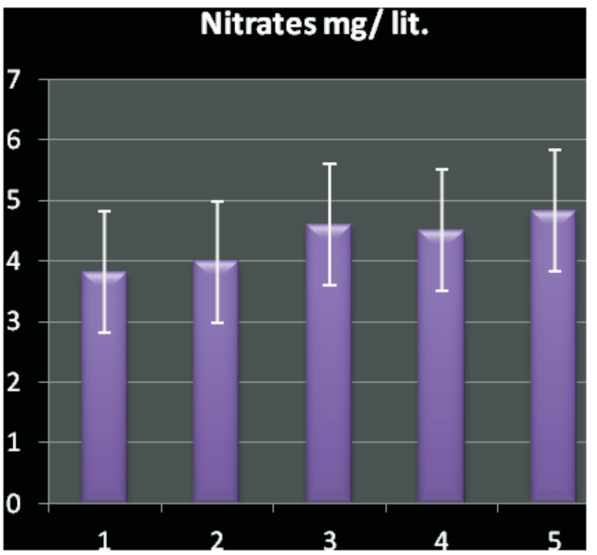


Fig. 3 B) Physicochemical parameters 2012-13.

pH of 7.4 was recorded at site S_1 during the rainy season, whereas maximum pH of 8.7 noted at site S_5 in summer season.

Temperature: The average range of fluctuation for temperature varied between 22ºC to 26ºC. The lowest temperature of 17ºC noted during winter at site S_2, whereas maximum of 28 ºC recorded from site S_3 and S_5 during summer season.

TS: The results noted for the average TS was in between 623 to 848 mg/lit. Seasonal fluctuation for TS was with minimum of 550 mg/lit. at site S_1 during summer and maximum of 845 mg/lit. at site S_5 during winter.

TDS: The concentration of TDS ranged between 478 to 715 mg/lit. The seasonal variation in TDS noted with minimum of 458 mg/lit. at site S_4 during summer to maximum of 750 mg/lit. at site S_4 during rainy season.

Chemical parameters:

DO: Concentration of DO was between 1.1 to 2.6 mg/lit. Substantial seasonal variations were recorded for the DO with

Table No.1 Physicochemical parameters with average variations during the period of 2011- 2013.

2011-2012						
Parameters	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**	**WHO standards**
pH	7.7916	8.0083	8.275	8.275	8.4	6.5-8.5
Temp. ° C	23.9166	22.9166	25.5833	25.5	26.375	< 40
TS mg/ lit.	623.3333	667.6666	847.6666	682.4444	782.333333	500
TDS mg/ lit.	574	594.333333	613	478.333333	586.333333	2000
DO mg/ lit.	2.6261	2.2686	1.9119	1.9916	1.2741	5-7
CO_2 mg/ lit.	4.8158	8.6525	10.4841	12.3141	16.1433	22
TH mg/ lit.	106	115.5	130.166667	154.666667	155.5	300
TA mg/ lit.	219.5833	222.9166	265.4166	400.4166	395.4166	200
TC mg/ lit.	27.0175	30.175	39.1683	61.3516	61.1783	200
IP mg/ lit.	0.3533	0.5933	0.8633	0.7958	0.9533	45
Nitrates mg/ lit.	4.4075	7.4175	8.1225	8.0175	8.125	45
2012-2013						
pH	7.65	7.8	8.1	8.1083	8.525	6.5-8.5
Temp. ° C	23.1666	22.9166	4.3333	24.5833	25.5833	< 40
TS mg/ lit.	680.6666	733.5833	757.1666	779.8333	848	500
TDS mg/ lit.	529.3333	617.3333	698	635.1666	715.25	2000
DO mg/ lit.	1.7991	1.52	1.1333	1.2091	0.7583	5-7
CO_2 mg/ lit.	8.73	11.7608	13.8966	14.3541	17.3083	22
TH mg/ lit.	73.5	82.9166	103.1666	96.5	111.5833	300
TA mg/ lit.	118.75	118.3	122.133333	141.25	147.625	200
TC mg/ lit.	28.6166	31.6283	33.9775	39.0366	43.69	200
IP mg/ lit.	0.5783	0.7691	1.0116	1.0166	1.1666	45
Nitrates mg/ lit.	3.8108	3.9908	4.6	4.5025	4.8316	45

minimum of 0.6 mg/lit. at site S_5 during winter to maximum of 3.31 mg/lit. at site S_1 during rainy season.

CO_2: Fluctuation in CO_2 noted with average range of 4.81 mg/lit to 17.30 mg/lit. Seasonally, significant alterations were found with minimum of 3.49 mg/lit. at site S_1 during rainy season to maximum of 21.22 mg/lit. at site S_5 during summer season.

TH: In the experimentation, TH ranged between 73.5 to 155 mg/lit. as $CaCO_3$. TH of river water showed seasonal variations with minimum concentration of 37 mg/lit. as $CaCO_3$ during rainy season at site S_1 to maximum of 202 mg/lit. as $CaCO_3$ at site S_5 during winter season.

TA: For TA average range of 118 to 400 mg/lit. recorded during experimentation. Seasonally it varied with minimum of 58.75 mg/lit. at site S_4 during rainy season to maximum of 577 mg/lit. at site S_5.

TC: TC value ranged in between 27 to 61 mg/lit. Seasonal alterations were noted with minimum of 11.36 mg/lit at site S_1 during rainy season to maximum of 96 mg/lit. at site S_5 during winter season.

IP: The results for IP was within range of 0.3 to 1.1 mg IP/ml.

Table No.2 Seasonal variation in physical parameters during the study period.
Legends : (M- Monitoring stations, S- Summer, R- Rainy, W- Winter).

2011-2012						2012-2013					
M	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**	**M**	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**
pH											
S	7.75	8.175	8.475	8.2	8.575	**S**	7.825	8.175	8.425	8.45	8.75
R	7.9	7.8	8.05	8.25	8.2	**R**	7.4	7.475	7.85	7.875	8.4
W	7.725	8.05	8.3	8.375	8.425	**W**	7.725	7.75	8.025	8	8.425
Temperature ^{o} C											
S	26.75	27.25	28	27.75	28.625	**S**	26.75	25.5	27	26.75	27.75
R	23	23.75	24.5	24.5	25.5	**R**	23.5	23.5	24.5	25	26
W	22	17.75	24.25	24.25	25	**W**	19.25	19.75	21.5	22	23
TS mg/lit.											
S	550	625	859	731	877	**S**	694	748.75	831.5	756.5	824
R	683	698	840	713	720	**R**	693	755	818	808	875
W	637	680	844	603.33	750	**W**	655	697	622	775	845
TDS mg/lit.											
S	505	522	570	458	550	**S**	587	648	705	585.5	725.7
R	595	636	643	489	567	**R**	538	685	737	710	750
W	622	625	626	488	642	**W**	463	519	652	610	670
DO mg/lit.											
S	3.015	2.1475	2.207	2.26	1.0025	**S**	1.882	1.5025	1.15	1.3275	0.775
R	3.317	2.965	1.907	1.655	1.3	**R**	1.807	1.505	1.3	1.25	0.9
W	1.545	1.6933	1.620	2.06	1.52	**W**	1.707	1.5525	0.95	1.05	0.6
CO_2 mg/lit.											
S	5.217	9.235	13.98	17.225	16.97	**S**	11.29	16.312	18.23	18.352	21.22
R	3.49	4.24	5.74	6.2375	13.48	**R**	8.66	11.482	13.977	15.225	18.72
W	5.74	12.482	11.73	13.48	17.97	**W**	6.24	7.4875	9.4825	9.485	11.98

TH mg/lit. as $CaCO_3$										
S	161	169.5	189	187	173	**S**	71.5	92.25	104.5	110.5	136.2
R	87.5	92.5	85	112.5	91.5	**R**	37	40	49	44	53
W	69.5	84.5	116.5	164.5	202	**W**	112	116.5	156	135	145.5
TA mg/lit. as $CaCO_3$										
S	173.7	183.7	231.25	301.25	303.75	**S**	147.5	160.25	165.5	206.25	215
R	186.2	181.2	205	295	305	**R**	62.5	61.25	63.75	58.75	73.75
W	298.7	303.7	360	605	577.5	**W**	146.2	133.4	137.15	158.75	154.1
TC mg/lit.										
S	29.93	37.985	54.31	67.45	57.155	**S**	31.18	35.955	38.325	51.582	56.88
R	17.75	19.17	20.59	26.98	29.465	**R**	11.36	14.555	16.0375	17.75	21.65
W	33.37	33.37	42.6	89.625	96.915	**W**	43.31	44.375	47.57	47.777	52.54
IP mg ip/ml										
S	0.26	0.38	0.79	0.6875	0.875	**S**	0.535	0.7675	0.835	0.93	0.897
R	0.28	0.74	0.86	0.84	0.88	**R**	0.96	1.2	1.64	1.64	2.06
W	0.52	0.66	0.94	0.86	1.105	**W**	0.24	0.34	0.56	0.48	0.542
Nitrates mg/lit.										
S	4.23	6.915	7.92	7.4025	8.46	**S**	4.0375	4.165	5.2575	5.0625	5.375
R	4.4	7.73	8.23	8.39	7.755	**R**	3.98	4.24	4.21	4.28	4.48
W	4.575	7.605	8.2275	8.265	8.16	**W**	3.4425	3.6375	4.365	4.125	4.65

Seasonal variations were observed with minimum of 0.24 mg IP/ml at site S_1 during winter to maximum of 2.06 mg IP/ml at site S_5 during rainy season.

Nitrates: In the present work, average nitrate concentrations ranged between 3.8 to 8.12 mg/lit. Seasonally minimum concentration of nitrate recorded as 3.44mg/lit. at site S_1 during winter, whereas maximum concentration noted as 8.46 mg/lit. at site S_5 during summer season.

DISCUSSION

During the entire course of investigation, physicochemical parameters were noted with significant differences. Parameters under the study had their impact on the biogeography of the Panchganga river, influencing water quality of the region. Hence, found most valued for the assessment of water quality. Specific pH affects the chemical reaction in aquatic bodies and thus rewarded as crucial factor in aquatic ecosystem [12-13]. For sustenance of aquatic life, the average range of pH required is 6.5 to 8.2. The result obtained at monitoring site S_5 exceeds desired concentration of pH as per WHO standards, which remarked it as the polluted area. Fluctuation in pH may be result of temperature variation, decomposition of organic matter and dilution of water through surface runoff as mentioned by Rajasegar (2003) [14]. Rich biodiversity of benthic flora and fauna also be the cause of alteration in pH, as their photosynthetic activities through bicarbonate degradation shifted the equilibrium towards alkalinity [15]. Similarly, temperature considered as immensely important factor, which has key role in biochemical interactions [16]. The average values obtained during investigation comply with WHO's desired standards of 25 ºC which represents the better water quality. Analysis of TS found as an important tool for the assessment of biological waste from the water sample. It get utilized in wastewater treatment plants, as it gives out level of turbidity, whereas TDS served as parameter for pollution indicator, because higher TDS resulted in excess ionic

concentration [17-18]. Values obtained for TS were above the standards, presenting high turbidity of water. However, determined values of TDS, depends upon rainfall, surface runoff and geographical characters of water area and were within the standards giving positive remark for palatability of water.

Content of dissolved Oxygen concentration in water considered as essential factor for better survivality of aquatic fauna in ecosystem. Atmospheric oxygen get easily dissolved in to the water, but tends to be less soluble at increased temperature, affecting ecological balance of aquatic community [19]. DO concentration level was below the standards which showed the higher organic activities at the region and found related to temperature and biological activities as previously noted by Chapman (1992) [20]. Concentration of free CO_2 gives direct evidences for polluting status of water. Excess concentration of CO_2 resulted from deoxygenation tends to enhance the water temperature, leading its direct impact over aquatic biota, hence considered as limiting factor [21]. At sampling station, S_5 concentration of CO_2 elevated up to maximum miscible limits, which gives alarming indication of the aquatic pollution and exhibited reverse pattern to that of DO. Total hardness calculated as measure of polyvalent cations or complex organic constituent's capacity of forming soap [22]. Hardness shows contents of cations like Ca+, Mg+ and Iron etc. with bicarbonates, sulphate, chlorides etc. [23]. Total hardness recorded were well below the WHO standards, which confirmed the suitability of water for variety of usages. The alkalinity of aquatic system determined the acid neutralizing capacities of water. It is basic property of water to withstand with solubility of varieties of organic and inorganic substances [24]. Alkalinity reflects due to composition of carbonates, bicarbonates and minerals [25]. The maximum values for TA noted above the standards, which may be b'coz of contamination and deposition of sewage and agricultural waste in the study region. Excess chloride in water gives salty taste to water and has laxative effects in organisms [26]. Hence, excess chloride content was considered as indicator of water pollution. Reasons behind these were dumping of agricultural waste, sewage and industrial waste in the system [27-28]. The values noted were below the permissible limits of WHO standards, representing moderate contamination of aquatic system.

IP is freely available in natural water bodies, but in very minute concentrations. Raw sewage is the source of IP and Nitrates in the water bodies [29]. Among them excess concentration of IP was due to discharge of fertilizers, pesticides, industrial waste etc., hence mentioned as pollution indicator. The observed values were below the standards, showing the average water quality. Organic pollution leads to excess amount of nitrates in water bodies, which presented as indicator of pollution [30]. Nitrate concentration above 45mg/lit resulted causing diseases as blue baby in children's [31]. The average nitrate content obtained was below the standards, representing less contamination aquatic system. Assessment of physicochemical parameters with seasonal variations noted as fascinating phemenon caused due to imbalanced process of mineralization and its consumption [32-33]. During the entire flow of the river Panchganga the monitoring site S_1 i.e. Prayag-Chikhli recorded as completely unpolluted, whereas monitoring sites S_2, S_3 and S_4 were found with average amount of pollution and noted as continuously polluting zone of the river. Monitoring site S_5 i.e. Ichalkaranji found densely polluted as physicochemical parameters at the site exceeded the miscible limits of WHO hence found unsuitable for domestic, agricultural and industrial utilization.

CONCLUSION

Analysis of the physicochemical parameters clearly indicated that, some monitoring sites from river Panchganga were lest polluted, but remarked as continuously polluting zone. The source of pollution may be direct discharge through numbers of drainage outlets, untreated effluents discharge, agricultural runoff, domestic activities etc. Huge discharge resulted in accumulation of heavy load of pollutants in the river. Result implicated that; currently aquatic system of the river is under threat, but not biologically dead. The increased pollution causes elimination of the aquatic fauna. Pollutants created burden on the planktonic, invertebrates and vertebrate's composition. Such stressed conditions causes enhancement of organic material by reduction of oxygen content through biodegradation with excess CO_2. Recorded conditions were not suitable for aquatic life form. So is the time to counteract with the trouble of pollution by taking necessary actions and precautionary measures for sustenance of water quality of river Panchganga, to retain it with diversity of flora and fauna for the balance of natural ecosystem.

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