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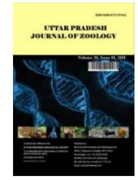

PRIMARY PRODUCTIVITY AND PHYSICO-CHEMICAL PARAMETERS OF CHIKKLINGDALLI WATER BODY

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author SHM designed study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JN and SGD managed the analysis of the study and author DSS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present study is carried out for estimation of primary productivity in relation to water quality of Chikklingadalli water body of Chinchollitaluk, Kalaburagi district, every month water samples were collected from the four different sampling sites of the water body from Feb 2016 to January 2018. Various water quality parameters including Atmospheric and water temperature, DO, Free CO_2, Total alkalinity, Total hardness, Chloride, Nitrate, TDS etc. were estimated, whereas correlation and coefficient between parameters were analyzed. During the study period all the values of the physico-chemical parameters are within the permissible limit. Primary productivity values were recorded highest during summer season and northeast monsoon season and lowest values recorded during the southwest monsoon season from study area. Data subjected to statistical analysis.

Keywords: Chikklingadalli water body; water quality; gross primary productivity; net primary productivity and community respiration.

1. INTRODUCTION

The ecosystem concept has been particularly useful and extensively employed in the study of aquatic primary productivity. Although we are able to measure primary productivity in terms of the carbon fixed, we are not yet able to measure the actual change in the oxidative state of newly fixed carbon.

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The fate of photosynthate as food for higher trophic levels is therefore dependent upon a considerable array of biological and environmental variables [1]. In recent decades, large inputs of nutrients have accelerated the eutrophication of many freshwater and coastal marine environments, resulting in phytoplankton blooms and even disruption of the structure and functioning of some biological communities [2,3,4,5]. However, seasonal variability of production in reservoirs and lakes with high water renewal rates is less evident than in lakes with low rates of water renewal, and the annual peaks in these rates are slightly delayed in reservoirs. According to Kimmel et al. [6], the photosynthetic production by phytoplankton in reservoirs varies almost insignificantly from that of natural lakes, presumably giving reservoirs a resilience or dynamic stability that enables them to return to their previous state after repeated perturbations.

Hence there is need for determination of various physical and chemical parameters of lake waters, in order to evaluate water quality for determining the extent of pollution. Phytoplankton is vital and important organisms which act as producer to the primary food supply in any aquatic ecosystem. These are also widely used as bio-indicators to monitor water quality, pollution and eutrophication [7]. The phytoplankton composition is affected by various environmental factors such as pH, temperature, salinity, turbidity, light and nutrients [8]. They are the initial biological components from which the energy is transferred to higher organisms through food chain [9].

2. MATERIALS AND METHODS

The samples were collected from Lingdalli (Chikklingdalli) water body. The Chikkalingdalli is perennial water body of the taluk and located at Lingdalli (Chikkalingdalli) village near Chincholi Taluk, which is 7 kms away from the Chincholli and 90 kms away from Kalaburagi City, which falls 77°28' 51" E longitudes and 17°26' 14" N latitude.

Physico-chemical Parameters: Every month water samples were collected from four sampling stations from study area from February 2016 to February 2018. Atmospheric and water temperature, pH and free CO_2 were measured in the field and samples collected for further analysis of physico-chemical parameters according to APHA [10] and Trivedi and Goel [11]. Physico-chemical characteristics and productivity were subjected to analysis using IBM SPSS (v20.0).

The four sets of light and dark

The four sets of light and dark bottles at four different stations in the Chikklingdalli water body were fixed in field, and after incubation period of 4 hrs. bottles were transferred to the laboratory [12]. The DO was determined (as earlier mentioned) in initial and after incubation (4 hr duration) in the light and dark bottle. The gross and net primary production and community respiration was estimated by using below formula.

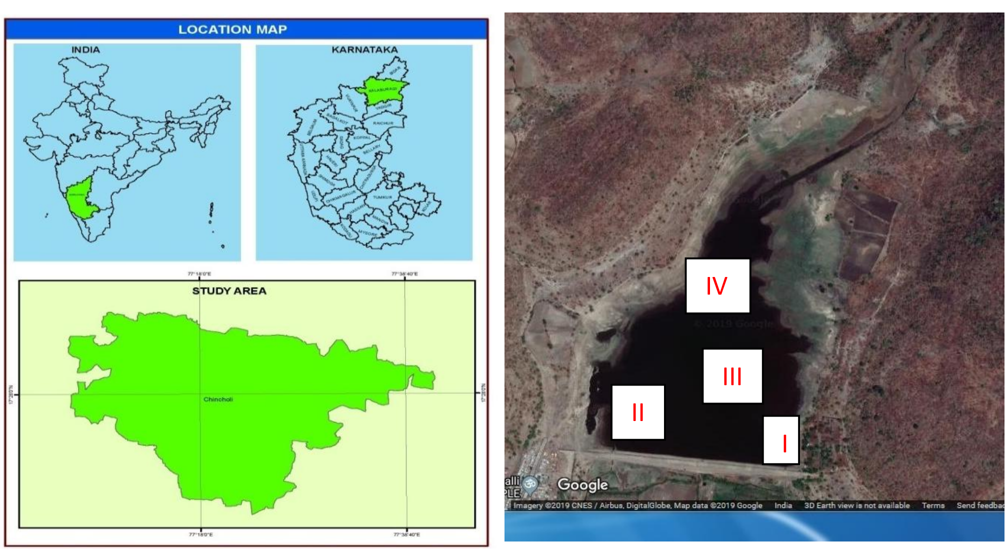

Fig. 1. Map Showing study area of Chikklingdalli water body

Gross Primary Production: $gC/m3/hr = \frac{DL-DD}{hr} X 0.375$

Net Primary production: $gC/m3/hr = \frac{DL-DI}{hr} X 0.375$

Community Respiration: $gC/m3/hr = \frac{DI-DD}{hr} X 0.375$

Where:

D_L = Dissolved Oxygen in light bottle in mg/l.
D_D = Dissolved oxygen in dark bottle in mg/l
D_I = Dissolved in initial bottle in mg/l.
hr. = Duration of exposure (incubation period) in hrs.
0.375 = Respiratory quotient

3. RESULTS AND DISCUSSION

In the present investigations all the mean data of water quality parameters obtained monthly basis during February 2016 to January 2018 is depicted in Table 1. Surface water temperature is an important factor in any aquatic environments affecting biological processes, in this study atmospheric temperature varied from highest 39.9°C in the May 2016 and 2017 lowest values recorded 22.7°C and 26.3°C November 2016 and 2017 respectively. The higher must be due to the presence of cloudy weather according to Uyeno, [13] long rains responsible for following temperature during south west monsoon and north east monsoon season. The highest water temperature of 31.4°C and 31.6°C recorded in the month of May 2016 and 2017 respectively. Similarly lowest values 19.5°C were recorded in December 2016 and 21.1°C in November 2017. Temperature fluctuation in water are influenced considerably by meteorological factors such as air temperature, humidity, winds and solar radiations. Munawar [14] reported direct relationship between bright sunshine and air temperature. Similar pattern of changes in the air and water temperature was reported by Sathe et al., [15].

pH of any aqueous system is suggestive of its acid-base equilibrium achieved by various dissolved compounds in it. pH of water is a master variable because many reactions that control water quality are pH dependent. The pH values ranged from 7.4 to 8.2 in the year 2016. Similarly 7.1 to 8.3 in the year 2017.

Maximum values observed during summer might be due to increased photosynthetic activity. The decrease in pH during monsoon may be due to greater inflow of water, while during winter could be due to decreased photosynthetic activity [16].

pH remained alkaline throughout the study period. Annual fluctuations are small indicating good buffering capacity. Higher pH is normally associated with photosynthetic activity in water [17]. The increase and decrease in summer and monsoon respectively have been reported from a number of lakes of Australia Ferell et al. [18] tropical India [19]. The high pH in summer observed in present investigations may be due to increased photosynthesis. The photosynthetic assimilation of dissolved inorganic carbon can increase pH [17]. Milind et al., (1987) have reported the similar results on seasonal variation of physic-chemical parameters in Perennial tank of Talsande, Maharashtra.

Alkalinity of water is its capacity to neutralize acids. Weathering of rocks is the potential source of it and it imparts buffering capacity to water, there by helps in stabilizing the pH of water. Though incidence of nitrates, borates, silicates contributes to alkalinity, it is primarily due to the presence of carbonates, bicarbonates and hydroxyl ions in free state in water. The influence of photosynthesis on pH is greater in low alkalinity waters because of their low buffering capacity. In the year 2016, total alkalinity was found to be maximum 362 mg/l in the month of May minimum 130 mg/l in the month of August. Similarly in the year 2017 maximum values were 342 mg/l in the month of May and minimum 165 mg/l in the month of September. The higher alkalinity in summer may be attributed to increased rate of decomposition, during which carbon dioxide is liberated which reacts with water to form HCO_3 increasing the total alkalinity in summer. The observed summer higher values compared to monsoon and winter seasons might have resulted from the effect of pH on the relative proportions of different forms (CO_2, HCO_3- and CO_3^{-2}) of inorganic carbon. Slightly higher values of alkalinity were observed during summer as was observed in case of pH. Similar type of observations were made by Harshey et al. [20], Kaur et al. [21], Manjare et al. [22], Simpi et al. [23], Lubal et al. [24], Hussain et al. [25], Pulugandi [26], Sreenivasalu et al. [27], Chalapathi et al. [16].

Dissolved oxygen (DO) is the prime important critical factor in natural waters both as regulator of metabolic processes of biota and as a vital indicator of water quality, ecological and trophic status of a reservoir. This is due to its importance as a respiratory gas, and its significant role in both chemical and biological reactions of an ecosystem. The values of dissolved oxygen varied from 4.2 mg/l in July to 9.8 mg/l in May in 2016 and 4.0 mg/l in September to 8.1 mg/l in the month of April 2017.

Table 1. Physico-chemical parameters of Chikklingdalli water body

Months	At. Temp °C	Water Temp°C	pH	(Alkalinity) mg/l.	DO mg/l.	Free CO_2	TDS mg/l.	Total Hardness mg/l.	Ca	Mg	Chloride mg/l.	NO^3 mg/l	SO^{-4} mg/l.	Fluoride mg/l.
Feb	35.6	28.7	7.9	305	7.2	0.9	276	316	142	98	98	25.7	22	0.9
Mar	36.3	29.9	8.0	328	9.8	0.9	286	292	156	146	146	24.4	18	0.9
April	38.1	31.3	8.1	358	9.2	1.2	242	380	166	124	124	12.6	12	0.8
May	39.9	31.4	8.2	362	8.8	1.5	225	348	168	120	120	13.4	14	0.8
June	36.6	30.6	7.5	193	5.6	1.9	234	264	120	76	76	29.6	18	0.6
July	32.7	28.1	7.4	158	4.2	1.5	210	286	124	88	88	38.5	28	0.4
Aug	31.4	28.5	7.6	130	4.8	0.6	182	254	108	66	66	28.5	30	0.4
Sept	30.2	26.3	7.6	151	4.9	0.5	152	188	112	58	58	24.3	32	0.5
Oct	30.8	26.5	7.6	282	4.6	0.6	120	152	88	72	72	19.6	36	0.5
Nov	23.3	21.2	7.8	290	5.8	0.4	132	166	92	76	76	18.6	32	0.6
Dec	22.7	19.5	8.0	275	5.9	0.8	104	196	106	45	96	25.0	18	0.6
Jan 2017	32.5	21.8	7.9	262	6.5	0.9	248	232	108	49	102	21.0	15	0.7
Feb	35.6	26.6	7.5	305	6.2	0.8	260	252	114	52	112	26.2	16	0.8
Mar	36.6	29.2	8.2	312	6.9	1.1	256	356	126	58	136	28.0	12	0.8
April	38.1	31.4	8.1	328	8.1	1.3	248	380	135	59	152	32.2	10	0.8
May	39.9	31.6	8.3	342	7.4	1.6	262	418	178	62	113	31.8	13	0.5
June	36.4	30.6	7.9	224	6.1	1.4	134	320	186	42	106	28.5	12	0.4
July	32.7	26.3	7.7	201	4.6	0.7	139	256	120	40	92	26.2	18	0.4
Aug	31.4	27.1	7.5	190	4.2	0.6	144	242	106	39	68	24.2	22	0.3
Sept	29.8	23.3	7.1	165	4.0	0.8	162	264	112	37	66	28.2	28	0.5
Oct	2701	22.1	7.5	196	5.2	0.9	142	190	103	36	88	24.0	30	0.5
Nov	26.3	21.5	7.3	236	5.1	0.8	123	185	101	34	82	22.2	32	0.5
Dec	23.1	19.5	7.7	265	6.5	0.8	228	228	118	52	92	26.5	28	0.8
Jan 2018	31.5	21.5	7.9	287	7.5	0.9	236	252	122	64	108	24.2	22	0.7

Average values are expressed in mg/l

From these findings it is seen that, highest dissolved oxygen concentrations were observed during summer. These highest values can be attributed to high rate of photosynthetic activity that might have resulted in the liberation of oxygen as a by-product. Lowest oxygen concentrations were observed in the month of November, then oxygen levels slightly increased and this might be due to cumulative effect of wind generated turbulence, resultant mixing coupled with rainfall during this period Chalapathi et al. [16].

Yet high dissolved oxygen values in summer and lower values in monsoon in Chikklingdalli dam served to emphasize the overriding influence exerted by factors (other than temperature) such as great abundance of photosynthesizing organisms. Ahemad and Krishnamoorthy [28] have recorded maximum recorded in summer and minimum in monsoon. Similar observations were made by Milind et al. [29], Gaur [30], Majagi et al. [31]. Contrary results were observed by Gonzolves [32] and Jain et al. [33]. Similar findings were observed by Kamble [34], Mathavan and Nimbirajan [35], Bhadja and Vaghela [36], Idowu et al. [37], Meshram [38], Basavaraj et al. [39], Sreenivasalu [27]. The total dissolved solids were highest 286 mg/l in March 2016 and 262 mg/l in May 2017 summer and monsoon season and lower values 104 mg/l in December 2016 and 123 mg/l in November 2017 in Northeast monsoon season. Carbon dioxide is particularly influential in regulating pH. Organic decomposition, respiration, photosynthesis, diffusion and run-off etc. brings about changes in the carbon dioxide concentrations of water. It is highly soluble in natural waters but is a minor constituent of the atmosphere and remains present in equilibrium concentration by giving an acidic reaction in water. Its low concentrations recorded in most of the times may be due to the alkaline nature of the water in both the reservoirs.

The maximum free carbon dioxide values 1.9 mg/l and 1.6 mg/l were observed in the month of June throughout the study period and minimum values of 0.4 mg/l and 0.4 were observed in June 2016 and July 2017. More or less higher values observed during monsoon and winter seasons can be attributed to decreased photosynthetic rates during these seasons besides decomposition of allochthonous organic matter that have entered in to the reservoir through runoff. Similar type of observations was made by Liathuamluaia et al. [40] recorded CO_2 levels ranging from 0 to 8.93 mg/l in case of Savitri reservoir. Saxena and Saksena [41] noticed free CO_2 in the range of 0 to 9.3 in Raipur reservoir.

The principle ions causing hardness in water are the divalent cations, especially calcium and magnesium in case of surface waters. Dissolution of limestone is the primary source of these ions in water. The total hardness values ranged from 380 mg/l in the month of April and minimum of 152 mg/l in the month of October 2016 and in 2017 highest values (418 mg/l) noticed in May and lowest (185 mg/l) in the month of November in 2016 and 2017 respectively. The highest values of calcium (168 mg/l) and magnesium (65 mg/l) were noticed in the month of May and Similarly in 2017 maximum values of calcium (186 mg/l) in June and magnesium (62 mg/l) in May of 2017 were found. Similarly lowest calcium and magnesium values observed 101 mg/l and 34 mg/l in the month of November 2017 respectively. Higher values of total hardness during summer season can be attributed to decrease in water volume and increased rate of evaporation. Tayyab et al. [42] have also recorded higher hardness in summer and lower in winter.

Chlorides occur naturally in waters. Discharge of sewage contributes to chlorides there by their concentration serves as an indicator of pollution by sewage. The highest chloride concentrations of 146 mg/l and 152 mg/l were recorded in the month of March and April of 2016 and 2017 respectively, similarly lowest of 55 mg/l and 66 mg/l in the month of September 2016 and 2017 respectively. Higher values of chlorides were observed during summer and monsoon samplings compared to winter. Higher values of summer could be attributed to high rate of evaporation, which might have resulted in increase in their concentration, while high values observed in monsoon samplings might be due to the entry of runoff including sewage from the catchment area.

Similar studies was made by Piska et al. [43], Jadoon et al. [44], Mohammad et al. [45]. Such condition was also observed by Swarnalatha and Rao [46] and reported raise of chlorides due to increased summer temperature and evapo-transpiration. The chloride concentration decreased steadily through winter and reached minimum in rainy season. The nitrate values varied from 18.6 mg.l in November to 38.5 mg/l July in 2016 and 22.2 mg/l in November to 32.2 mg/l in April 2017. Highest values of nitrate recorded during rainy season and lowest during winter season. Generally water bodies polluted by organic matter exhibit higher values of nitrates Kodarkar and Chandrashekara [47]. The prominent rise of NO^3 during rainy season seemed to be a common feature of Mc. Mc-Lachin [48] observed nitrate peak in early rainy season in lake Rao and Govind, [19] reported from Tungabhadra reservoir that nitrate was enriched when flood water entered in lake. Similarly nitrates were added in the form of surface run off from catchment area. The decrease of nitrate in winter and summer may be due to the photosynthetic activity of the algae and macrophytes. These observations are in agreement with that of Munawar, [14]. The sulpahte values were recorded maximum of 36 mg/l in October and minimum of 12 mg/l in April 2016. Likewise highest nitrate of 32 mg/l in November and lowest of 10 mg/l in April 2017.Sulphate was lower in monsoon and summer and higher in winter. Here all season, nitrate showed samples within permissible limit i.e<200 ppm. People unaccustomed to drinking water with elevated levels of sulphate can experience diarrhea and dehydration. Infants are often more sensitive.

Monthly variation of gross primary productivity of Chikklingdalli water body are presented in the Table 2 and Fig. 1.

Gross primary productivity of summer season of 2016 varied from 0.60 to 0.80 gC/m^3/hr at station I, 0.58 to 0.79 gC/m^3/hr at station II, 0.66 to 0.83 gC/m^3/hr at station III and 0.64 to 0.85 gC/m^3/hr at station IV respectively. During the same season of 2017, the values fluctuated from 0.58 to 0.73 gC/m^3/hr at station I, 0.59 gC/m^3/hr to 0.69 gC/m^3/hr at station II, 0.63 gC/m^3/hr to 0.72 gC/m^3/hr at station III and 0.63 gC/m^3/hr to 0.75 gC/m^3/hr at station IV respectively.

During the southwest monsoon season of 2016, the gross primary productivity fluctuated from 0.26 gC/m^3/hr to 0.39 gC/m^3/hr, 0.25 gC/m^3/hr to 0.42 gC/m^3/hr, 0.33 gC/m^3/hr to 0.45 gC/m^3/hr and 0.38 gC/m^3/hr to 0.47 gC/m^3/hr at station I, I, III and IV respectively. Similarly, during the same season of 2017, the values ranged from 0.32 gC/m^3/hr to 0.42 gC/m^3/hr at station I, 0.34 gC/m^3/hr to 0.41 gC/m^3/hrgC/m^3/hr at station II, 0.40 to 0.47 gC/m^3/hr at station III and 0.39 gC/m^3/hr to 0.49 gC/m^3/hr at station IV respectively.

Northeast monsoon season of 2016-17, the gross primary productivity values observed between 0.27 gC/m^3/hr to 0.46 gC/m^3/hr at station I, 0.26 gC/m^3/hr to 0.43 gC/m^3/hr at station II, 0.31 gC/m^3/hr to 0.48 gC/m^3/hr at station III and 0.34 gC/m^3/hr to 0.41 gC/m^3/hr at station IV respectively. However, during the same season of 2017-18, the values observed were from 0.39 gC/m^3/hr to 0.50 gC/m^3/hr at station I, 0.40 gC/m^3/hr to 0.53 gC/m^3/hr at station II, 0.41 gC/m^3/hr to 0.56 gC/m^3/hr at station III and 0.38 gC/m^3/hr to 0.53 gC/m^3/hr at station IV respectively.

Monthly variation of net primary productivity values recorded from February 2016 to January 2018 are presented in the Table 3.

Table 2. Monthly variation of gross primary productivity of (gC/m^3/hr) Chikklingdalli water body

Month	I	II	III	IV	Average
Feb. 2016	0.60	0.58	0.66	0.64	0.62
Mar. 2016	0.72	0.74	0.82	0.84	0.79
Apr. 2016	0.75	0.76	0.87	0.88	0.82
May 2016	0.80	0.79	0.83	0.85	0.82
Jun. 2016	0.31	0.26	0.33	0.38	0.32
Jul. 2016	0.39	0.42	0.43	0.47	0.43
Aug. 2016	0.37	0.32	0.41	0.46	0.39
Sep. 2016	0.26	0.25	0.45	0.42	0.39
Oct. 2016	0.27	0.26	0.38	0.37	0.32
Nov. 2016	0.32	0.32	0.31	0.34	0.32
Dec. 2016	0.43	0.41	0.42	0.42	0.42
Jan. 2017	0.46	0.43	0.48	0.51	0.47
Feb. 2017	0.61	0.60	0.66	0.69	0.64
Mar. 2017	0.73	0.69	0.71	0.75	0.72
Apr. 2017	0.66	0.63	0.72	0.71	0.68
May 2017	0.58	0.59	0.63	0.57	0.59
Jun. 2017	0.42	0.41	0.47	0.40	0.46
Jul. 2017	0.41	0.36	0.46	0.48	0.42
Aug. 2017	0.32	0.34	0.47	0.49	0.41
Sep. 2017	0.38	0.39	0.40	0.39	0.39
Oct. 2017	0.39	0.40	0.41	0.38	0.38
Nov. 2017	0.44	0.46	0.46	0.45	0.45
Dec. 2017	0.47	0.48	0.47	0.47	0.46
Jan. 2018	0.50	0.53	0.56	0.53	0.53

Net primary productivity of summer season of 2016 values recorded between 0.35 gC/m^3/hr to 0.45 gC/m^3/hr at station I, 0.35 gC/m^3/hr to 0.46 gC/m^3/hr at station II, 0.43 gC/m^3/hr to 0.47 gC/m^3/hr at station III and 0.42 gC/m^3/hr to 0.48 gC/m^3/hr at station IV respectively. Likewise, during the same season of 2017, values fluctuated from 0.28 gC/m^3/hr to 0.47 gC/m^3/hr at station I, 0.24 gC/m^3/hr to 0.48 gC/m^3/hr at station II, 0.34 gC/m^3/hr to 0.49 gC/m^3/hr at station III and 0.38 gC/m^3/hr to 0.52 gC/m^3/hr at station IV respectively.

During the southwest monsoon season of 2016, the values observed between 0.16 gC/m^3/hr to 0.41 gC/m^3/hr at station I, 0.15 gC/m^3/hr to 0.37 gC/m^3/hr at station II, 0.21 gC/m^3/hr to 0.36 gC/m^3/hr at station III and 0.25 gC/m^3/hr to 0.49 gC/m^3/hr at station IV respectively. However, during the same season of 2017, values fluctuated between 0.21 gC/m^3/hr to 0.48 gC/m^3/hr at station I, 0.24 gC/m^3/hr to 0.49 gC/m^3/hr at station II, 0.24 gC/m^3/hrto 0.45 gC/m^3/hr at station III and 0.30 to 0.46 at station IV respectively.

The northeast monsoon season of 2016-17, the concentration of net primary productivity observed from 0.29 gC/m^3/hr to 0.35 gC/m^3/hr at station I, 0.28 gC/m^3/hr to 0.34 gC/m^3/hr at station II, 0.30 gC/m^3/hr to 0.36 gC/m^3/hr at station III and 0.34 gC/m^3/hr to 0.40 gC/m^3/hr at station IV respectively. While, during the same season of 2017-18, the net primary productivity values recorded from 0.19 gC/m^3/hr to 0.32 gC/m^3/hr at station I, 0.21 gC/m^3/hr to 0.32 gC/m^3/hr at station II, 0.20 gC/m^3/hr to 0.37 gC/m^3/hr at station III and 0.28 gC/m^3/hr to 0.38 at station IV respectively.

Monthly variation of community respiration of Chikklingdalli water body presented in the Table 3.

Community respiration of summer season of 2016, the values observed from 0.9 gC/m^3/hr to 0.26 gC/m^3/hr at station I, 0.18 gC/m^3/hr to 0.23 gC/m^3/hr at station II. 0.26 gC/m^3/hr to 0.29 gC/m^3/hr at station III and 0.23 gC/m^3/hr to 0.31 gC/m^3/hr at station IV respectively. While during the same season of 2017, the values noticed between 0.11 gC/m^3/hr to 0.25 gC/m^3/hr at station I, 0.14 gC/m^3/hr to 0.23 gC/m^3/hr at station II, 0.16 gC/m^3/hr to 0.32 gC/m^3/hr at station III and 0.19 gC/m^3/hr to 0.31 gC/m^3/hr at station IV respectively.

Southwest monsoon season of 2016, the community respiration values noticed from 0.11 gC/m^3/hr to 0.23 gC/m^3/hr at station I, 0.09 gC/m^3/hr to 0.21 gC/m^3/hr at station II, 0.19 gC/m^3/hr to 0.27 gC/m^3/hr at station III and 0.19 gC/m^3/hr to 0.29 gC/m^3/hr at station IV respectively. However, community respiration values ranged from 0.15 gC/m^3/hr to 0.18 gC/m^3/hr at station I, 0.18 gC/m^3/hr to 0.21 gC/m^3/hr at station II, 0.19 gC/m^3/hr to 0.22 gC/m^3/hr at station III and 0.14 gC/m^3/hr to 0.23 gC/m^3/hr at station IV respectively.

Table 3. Monthly variation of net primary productivity (gC/m^3/hr) of Chikklingdalli water body

Month	I	II	III	IV	Average
Feb. 2016	0.37	0.36	0.43	0.42	0.39
Mar. 2016	0.38	0.35	0.42	0.45	0.40
Apr. 2016	0.35	0.42	0.45	0.48	0.45
May 2016	0.45	0.46	0.47	0.46	0.46
Jun. 2016	0.41	0.37	0.45	0.49	0.43
Jul. 2016	0.20	0.17	0.22	0.25	0.21
Aug. 2016	0.16	0.16	0.23	0.25	0.20
Sep. 2016	0.17	0.15	0.21	0.24	0.19
Oct. 2016	0.29	0.28	0.36	0.35	0.32
Nov. 2016	0.29	0.31	0.33	0.34	0.32
Dec. 2016	0.33	0.32	0.30	0.35	0.32
Jan. 2017	0.35	0.34	0.39	0.40	0.37
Feb. 2017	0.28	0.24	0.34	0.38	0.31
Mar. 2017	0.43	0.44	0.49	0.48	0.46
Apr. 2017	0.44	0.43	0.48	0.49	0.46
May 2017	0.47	0.48	0.49	0.52	0.49
Jun. 2017	0.48	0.49	0.45	0.46	0.47
Jul. 2017	0.32	0.33	0.30	0.30	0.31
Aug. 2017	0.29	0.28	0.26	0.30	0.28
Sep. 2017	0.21	0.24	0.33	0.30	0.27
Oct. 2017	0.19	0.21	0.27	0.25	0.23
Nov. 2017	0.21	0.22	0.29	0.28	0.25
Dec. 2017	0.28	0.23	0.20	0.21	0.24
Jan. 2018	0.33	0.32	0.37	0.38	0.35

The northwest monsoon season of 2016-17, the values of community respiration noticed from 0.14 gC/m^3/hr to 0.21 gC/m^3/hr at station I, 0.15 gC/m^3/hr to 0.20 gC/m^3/hr at station II, 0.18 gC/m^3/hr to 0.24 gC/m^3/hr at station III and 0.24 gC/m^3/hr to 0.27 gC/m^3/hr at station IV respectively. While, during the same season of 2017-18, the values fluctuated from 0.14 gC/m^3/hr to 0.21 gC/m^3/hr at station I, 0.15 gC/m^3/hr to 0.17 gC/m^3/hr at station II, 0.18 gC/m^3/hr to 0.24 gC/m^3/hr at station III and 0.22 gC/m^3/hr to 0.26 gC/m^3/hr at station IV respectively.

In aquatic ecosystems, autotrophs (algae, planktons, etc.) act as primary producers on which all the life forms depends [49]. To sustain a level of growth and respiration and to support a biological population, primary productivity is to be estimated [50]. The basis of ecosystem functioning is the biological production of autotrophs which is manipulated by primary productivity of a water body [51,52]. There is a main role of primary productivity in providing energy and organic matters to the entire biological community (Ahmed et al., 2005). Light (solar energy) and nutrients are the main limiting factors to primary production in an aquatic ecosystem [53,54], though distribution of phytoplankton (algae) are also affected by temperature and seasonal variations in light intensity [55].

Primary production studies are of paramount interest in understanding the effect of pollution on systems efficiency. High rates of production both in natural and cultural ecosystems occur when physico-chemical factors are favorable (Trivedi and Goel, 1985).

Primary production estimation is concerned with "evaluation of the capacity of an ecosystem to build up, at the expense of external energy (radiant and chemical) primary organic compounds for transportation and flow to a higher level trophic system ([10]. Phytoplanktons are vital and important organisms which act as producer to the primary food supply in any aquatic ecosystem. These are also widely used as bio-indicators to monitor water quality, pollution and eutrophication [7]. The phytoplankton composition is affected by various environmental factors such as pH, temperature, salinity, turbidity, light and nutrients [8]. They are the initial biological components from which the energy is transferred to higher organisms through food chain Tiwari and Chauhan [9]. Changes in physico-chemical parameters of ecosystems have a substantial impact on the species that live within them.

According to Kimmel et al. [6] the photosynthetic production by phytoplankton in reservoirs varies

Table 4. Monthly variation of community respiration (gC/m^3/hr) of Chikklingdalli water body

Months	S1	S2	S3	S4	Average
Feb. 2016	0.19	0.18	0.26	0.23	0.21
Mar. 2016	0.23	0.22	0.27	0.28	0.25
Apr. 2016	0.24	0.23	0.28	0.29	0.26
May 2016	0.26	0.22	0.29	0.31	0.27
Jun. 2016	0.23	0.21	0.27	029	0.25
Jul. 2016	0.14	0.13	0.23	0.22	0.18
Aug. 2016	0.11	0.09	0.19	0.21	0.15
Sep. 2016	0.12	0.13	0.21	0.19	0.16
Oct. 2016	0.14	0.20	0.18	0.24	0.19
Nov. 2016	0.20	0.17	0.23	0.22	0.20
Dec. 2016	0.18	0.15	0.24	0.27	0.21
Jan. 2017	0.21	0.19	0.23	0.25	0.22
Feb. 2017	0.22	0.19	0.24	0.27	0.23
Mar. 2017	0.25	0.22	0.27	0.28	0.26
Apr. 2017	0.24	0.23	0.32	0.31	0.28
May 2017	0.11	0.14	0.16	0.19	0.15
Jun. 2017	0.16	0.18	0.19	0.22	0.18
Jul. 2017	0.15	0.17	0.22	0.23	0.19
Aug. 2017	0.15	0.21	0.22	0.14	0.18
Sep. 2017	0.18	0.15	0.20	0.23	0.19
Oct. 2017	0.14	0.15	0.21	0.22	0.18
Nov. 2017	0.15	0.16	0.24	0.23	0.20
Dec. 2017	0.19	0.17	0.22	0.26	0.21
Jan. 2018	0.21	0.16	0.18	0.23	0.18

Table 5. Showing the correlations values

Parameters	Correlation values
Gross primary productivity	Atmospheric temperature ($P < 0.01$), water temperature ($P < 0.01$), pH ($P < 0.01$), dissolved oxygen ($P < 0.01$), total hardness ($P < 0.01$), calcium ($P < 0.01$) and net primary productivity ($P < 0.01$).
Net primary productivity	Atmospheric temperature ($P < 0.01$), pH ($P < 0.01$), total alkalinity ($P < 0.01$), dissolved oxygen ($P < 0.01$), gross primary productivity ($P < 0.01$), and copepod ($P < 0.01$).
Community respiration	pH ($P < 0.01$) total alkalinity ($P < 0.01$), dissolved oxygen ($P < 0.01$), carbon dioxide ($P < 0.01$), gross primary productivity ($P < 0.01$), net primary productivity ($P < 0.01$).

almost insignificantly from that of natural lakes, presumably giving reservoir a resilience or dynamic stability that enables them to return to their previous state after repeated perturbations. This characteristic is due to relatively high external nutrient loads in reservoir with low residence time. However, when turbidity is high and phytoplankton washout occurs during the rainy season in reservoirs with low residence times. The temporal variability in phytoplankton production can be significant [56]. However, seasonal variability of production in reservoir and lakes with high water renewal rates is less evident than in lakes with low rates of water renewal and the annual peaks in these rates are slightly delayed in reservoir.

In the present study the gross primary productivity was recorded highest during summer season and northeast monsoon season is mainly depending on the light penetration and the similar observations made by Sreenivasan [57], Saltro and Wright [58]. In the current investigation low productivity was observed during southwest monsoon season due to influx of the turbid water to the dam. There was an increase in gross and net production and it attained the peak during summer season. This could be due to more algae resulted due to maximum sunlight of summer season as well as high load of nutrients due to decomposition of accumulated metabolites towards end part of the crops and correlated values expressed (Table 5). Similar results were also reported by earlier worker [59] Pradeep [60].

Net primary productivity of Chikklingdalli ater body is followed a more or less similar trend of fluctuations in all four stations, exhibited an increasing trend towards northeast monsoon season and summer season with a distinct peaks. While, lower values of net primary productivity was observed during southwest monsoon season (Table 3).

In the present study community respiration was also followed a similar trend of oscillations in all four stations during the study period (Table 4). The higher values in increasing trend during northeast monsoon season and summer season and lower values during southwest monsoon season 2016 and 2017 respectively. Correlated values expressed (Table 5).

There is no dearth of literature regarding the primary production of standing crops to mention few, Reetu et al. [41] studied on comparative study of primary productivity in Yamuna River canal of different parts of Yamunanagar Haryana, India. The primary production in three reservoirs from Nilgiries and Ooty in Tamilnadu reported by Sreenivasan [61] and recorded high production values and opined that primary production correlated well with physic-chemical factors and biological parameters. Vijayraghavan [62] reported that the water temperature is important for limiting productivity. Although variations in the magnitude of solar radiation in surface water are low in equatorial and tropical regions, the penetration of light can be highly variable and can affect the modification pattern of productivity in aquatic environments [56]. Primary productivity and that low production in one of the pond could be due to excess of aquatic weeds reported by Murty et al. [63]. During the present study excessive growth of aquatic plants were noticed especially during north east monsoon season and summer season which could have caused increased trend in primary productivity during summer months. The findings are similar with the other workers like Vijaykumar [64], Anjinappa [65], Padmavathi et al [66] and Majagi [67]. The high primary productivity in the summer season is mainly depending on the light penetration. Similar results were noticed by Sreenivan (1967) and Saltro and Wright [58] Kusmlatha et al., [68].

Weather conditions have profound effect on the aquatic ecosystem. Rain and cloud covers were disrupting the important light for photosynthesis [69], alter the temperature and dilute the water chemistry [70]. Different weather conditions seem to be the major factor behind fluctuation of water quality parameters and primary production in Chikklingdalli water body. Light intensity and then photosynthesis process were significantly affected by dense cloud cover during mix weather conditions resulting in decreased of dissolved oxygen in surface water lake.

Phytoplankton biomass and productivity in Chikklingdalli water body was also closely depending on light availability and intensity. Primary productivity generally increases in conditions where the combination of available light and high nutrient concentrations are optimum. Therefore, it is most probable that the higher values of primary productivity observed during summer season may be due to combination of high concentration of nutrients, higher temperature, better light availability and higher photosynthesis [71].

The seasonal decline in light intensity during the southwest monsoon season weather conditions and northeast monsoon season is likely to be a controlling factor in depressing of primary production at all stations. In summer season, low cloud cover, better light availability and intensity together with low rainfall reduces the dilution factor resulting better phytoplankton productivity. It is possible that evaporation reduced certain volume of the water in water body, concentrating the nutrient and improving primary productivity.

The decline of primary production in the southwest monsoon season may be partly caused by the dilution of essential ions [72]. Rainfalls flushed nutrients from urban residential areas or from any other main sources into the lakes. The proportions of nutrient inside the lake from anthropogenic sources might fluctuate every time after rainfalls.

4. CONCLUSION

The results from this study indicated that the increased level of temperature led to increased water evaporation. Therefore present study suggests that the water temperature can positively correlated with water temperature, TDS, pH, total hardness. However further studies are required on the continuous monitoring of this Chikklingadalli waterbody. It could be concluded that all the physicochemical parameters of the Chikklingdalli water body are within the permissible limit. Good for drinking, agricultural and other purposes. The Present study provides better understanding about the effect of water quality on primary productivity. Water quality of water body impacted principally by weather conditions, consequently, biological process of phytoplankton have changed during seasons but it is not eutrophic.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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