International Research Journal of Biological Sciences _____ ISSN 2278-3202
Vol. **2(3),** 76-79, March **(2013)** *Int. Res. J. Biological Sci.*

Limnological profile of Chenani Hydroelectric Reservoir, its connecting channel and River Tawi in Udhampur district of J&K, India

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Available online at: www.isca.in
Received 6th February 2013, revised 9th February 2013, accepted 25th February 2013

Abstract

In the present study, Physico-chemical conditions of Chenani hydroelectric reservoir, its connecting channels and feeder river Tawi were studied from 10 September 2011 to 10 August 2012, with an objective to generate data of their water quality parameters. Chenani hydroelectric reservoir is situated at 32°57' 45.49' N to 75°10' 46.93'E, having dimension of 750×150×22 feet with a capacity of 15Mw. Water analysis was done for the physico-chemical parameters viz. air temperature, water temperature, transparency, pH, DO, FCO_2, carbonates, bicarbonates, chloride, calcium, magnesium, sulphates, phosphates and nitrates. Water remains alkaline throughout the study period in all these water bodies and value of its pH ranged between 8.1 to 8.9. Parameters viz. transparency, Dissolved oxygen, bicarbonates, calcium and magnesium showed seasonal fluctuations with an increases from monsoon (September) to Winter (February) where as values of FCO_2, chloride, phosphate, sulphate and nitrate show decline in same seasons in all the stations.

Keywords: Physico-chemical parameters, reservoir, river Tawi, fluctuation.

Introduction

Water is a prime natural resource, a basic human need and a precious natural asset. It is indeed required in all aspects of life and health for drinking, cooking, bathing, food production, energy generation, maintenance of environment and sustenance of life and development. The contamination and pollution of water is of great concern in the world for the developing countries like India. Needless to mention, that any kind of pollution of water can further aggravate the conditions prevailing and thus affect the biotic potential of the water body. In this age of industrial revolution, pollution of an aquatic ecosystem is a common problem. It is well known that changing climate due to human interference affects the distribution of animals in the aquatic habitat and if the individuals are not able to sustain such variations, they are eventually eliminated.

Ill planned management and disposal of sewage, industrial waste, agricultural runoff and other human and animal waste in rivers, lakes and reservoirs are continuously deteriorating their water quality and influencing their animal resources to greater extent[1]. Keeping the above highlighted facts in view, it is desired to investigate the trophic status of river Tawi in the vicinity of Chenani hydroelectric reservoir immediately. Chenani hydroelectric power house is situated at a distance of 15km from Udhampur district near Chenani town in J&K state. The water supply is generally provided from the river Tawi through an artificial channel of 9 km. These findings would go a long way in generating data of deteriorating aquatic conditions and thus ensure long life of these ecosystems for providing desirable water quality for drinking, swimming, irrigation and for fish production. Such findings shall be of great importance to environmentalists and planners who aim to maintain and protect the water quality and biota.

Material and Methods

Chenani hydroelectric reservoir is situated at 32°57' 45.49' N to 75°10' 46.93'E, having dimension of 750×150×22 feet. In the present study seven stations viz. 1, 2, 3, 4, 5, 6 and 7 were selected, out of which stations 1, 2, 3 and 4 lies in the reservoir (stations 1 and 2 at the inlet whereas stations 3 and 4 are situated near the outlet). Stations 5 and 6 were situated in the canal (station 5 at about 4 km away from reservoir and station 6 at 5 km beyond station 5 towards feeding section of river Tawi) and station 7 was situated at river Tawi.

Water samples were collected once every month from these stations and estimated for physico-chemical parameters like water temperature, air temperature, transparency, pH, dissolved oxygen, free carbon dioxide, carbonates, bicarbonates, calcium, magnesium, chloride, sulphates, nitrates and phosphates by standard methods of APHA[2].

Results and Discussion

The minima and maxima of various physico-chemical parameters and their mean variations during the study period were given in the table 1 and table 2 respectively. During the present study average monthly temperature of air fluctuated between a minimum of 16.5^{0}C (Dec.) to maximum of 37^{0}C (June) in all the stations. Water temperature followed atmospheric temperature and fluctuated between 9.5^{0}C (Dec.) to 24^{0}C (June). Maximum value of both air and water temperature

in the month of June may be attributed to the increased photoperiod and longer day length whereas minima acquired in December may be due to shorter photoperiod and shorter day length. Further atmospheric temperature of an area also depends upon its altitudinal and longitudinal location[3-5]. The high temperature of surface water in summer depends upon the volume of water which remains in contact with air and sunlight[6]. During the present study period, the value of Secchi transparency ranged between 42 cm (Aug.) to 431 cm (Sept.) showed the water bodies were Oligotrophic with high drinking water qualities. High values of transparency of 425cm (Sept. 2011) during summer was due to pre monsoon period with settled silt, clay, mud and less suspended organic matter while low value of transparency in August 2012 was due to mud, silt and debris in water brought by rain water in monsoon season.

pH of water remain alkaline throughout the year and ranged between 8.1 (Jan.) to 8.9 (June). Similar results were also recorded[7,8]. The low pH in winter due to heavy rainfall and dilution effect[9,10]. High pH in summer was because of utilization of bicarbonate and carbonate buffer system[11]. High value of pH may results due to waste discharge, microbial decomposition of organic matter in the water body and sewage discharge by surrounding human population[12,13]. Dissolved oxygen showed an increase with the decline in water temperature and its values ranged between 4.75 mgl-1 (Sept.) to 9.60 mgl-1 (Jan.). The high concentration of dissolved oxygen recorded during December was due to increased solubility of gases in water at low temperature and favourable conditions for higher rate of photosynthesis[14-16]. Whereas low concentration of dissolved oxygen during summer may be due to the high temperature and process of decomposition of organic matter involving the utilization of oxygen[17,18]. Free carbon dioxide bear inverse relationship with dissolved oxygen and its value increased in summer season while decreased in winter. The value of FCO2 ranged between 1.20 mgl-1 (Feb.) to 6.29 mgl-1 (Sept.). High concentration of FCO2 during the warmer period may be due to the decomposition of organic matter, utilizing dissolved oxygen and liberating carbon dioxide. Carbonates (CO3) were totally absent in all the study sites, further evinces the opcit postulates. Bicarbonates were present in the permissible limit and ranged between 82.0 mgl-1 (Sept.) to 150.4 mgl-1 (Feb.). In the present study, during the observation period, the values of chloride fluctuated between 2.89 mgl-1 (Feb.) to 22.99 mgl-1 (Sept.). The higher concentration recorded during summer may be due to animal, agricultural and sewage runoff during rain and higher evaporation rate[19,20]. Further its value is quite less than the permissible limit as given by WHO as shown in table 3.

The value of Ca^{2+} fluctuated during the study period between a range of 26.20 mgl-1 (Aug.) to 89.25 mgl-1 (Jan.). This indicated low values in summer and high in winter season. The maxima in winter was due to its great solubility at low temperature[21]. Similarly Mg^{2+} concentration showed its maxima during winter and minima during summer and its value ranged between 19.91 mgl-1 (Aug.) to 102.13 mgl-1 (Dec.). Winter rise in concentration of Mg^{2+} had also been reported[22- 25].

Table-1
Showing range in variation of physico-chemical parameters in 7 stations during study period of Sept. 2011 to Aug. 2012

Parameter	Unit	Station 1		Station 2		Station 3		Station 4		Station 5		Station 6		Station 7	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Air temp.	^{0}C	16.5 Dec.	37 June	16.5 Dec.	37 June	16.5 Dec.	37 June	16.5 Dec.	37 June	16.5 Dec.	37 June)	16.5 Dec.	37 June	16.5 Dec.	37 June
Water temp.	^{0}C	9.5 Dec.	24 June	9.5 Dec.	24 June	9.5 Dec.	24 June	9.7 Dec.	24 June	9.7 Dec.	24 June	9.7 Dec.	24 June	9.5 Dec.	24 June
Turbidity	cm	44 Aug.	431 Sept.	45 Aug.	425 Sept.	43 Aug.	426 Sept.	44 Aug.	425 Sept.	45 Aug.	430 Sep.	45.0 Aug.	429 Sep.	45.0 Aug.	423 Sep.
pH		8.1 Jan.	8.7 June	8.2 Jan.	8.6 June	8.2 Oct.	8.7 Jun.	8.1 Jan.	8.9 Nov.	8.1 Jan.	8.7 June	8.1 Jan.	8.7 June	8.2 Jan.	8.5 Oct.
Free CO_2	mg/l	1.20 Feb.	6.29 Sept.	1.23 Feb.	6.21 Sept.	1.25 Feb.	6.16 Sept.	1.27 Feb.	6.23 Sept.	1.23 Feb.	6.18 Sep.	1.27 Feb.	6.19 Sept.	1.27 Feb.	6.23 Sep.
DO	mg/l	4.87 Sept.	9.39 Jan.	4.82 Sept.	9.58 Jan.	4.78 Sept.	9.57 Jan.	4.81 Sep.	9.58 Jan.	4.84 Sept.	9.58 Jan.	4.86 Sept.	9.58 Jan.	4.75 Sep.	9.60 Jan.
CO_3	mg/l	00	00	00	00	00	00	00	00	00	00	00	00	00	00
HCO_3	mg/l	82.0 Sept.	145.6 Apr.	88.0 Sept.	149.8 Feb.	86.0 Sept.	150.4 Feb.	82.0 Sep.	147.2 Feb.	90.0 Sept.	148.2 Apr.	82.0 Sept.	145.4 Aug.	86.0 Sept.	146.4 April
Cl^-	mg/l	3.09 Feb.	20.99 Sept.	4.09 Feb.	22.99 Sept.	4.59 Feb.	20.99 Sept.	3.89 Feb.	22.09 Sep.	3.79 Feb.	24.26 Sept.	3.099 Feb.	20.99 Sept.	2.89 Feb.	22.09 Sept.
Ca^{2+}	mg/l	26.20 Jan.	88.2 Aug.	26.46 Jan.	86.10 July	27.25 Mar.	89.25 Aug.	44.1 Oct.	87.9 Aug.	42.0 Oct.	87.78 Aug.	46.20 Oct.	87.57 Aug.	42.0 Oct.	86.73 Aug.
Mg^{2+}	mg/l	20.50 Aug.	96.69 Dec.	20.36 Aug.	102.1 Dec.	19.91 Aug.	101.2 Dec.	20.41 Aug.	95.64 Dec.	20.86 Aug.	98.90 Dec.	21.12 Aug.	96.69 Dec.	20.72 July	96.85 Dec.
Sulphate	mg/l	0.023 June	0.170 Nov.	0.021 June	0.190 Oct.	0.012 Sept.	0.121 Nov.	0.015 Mar	0.136 Sept.	0.019 May.	0.16 Oct.	0.017 May	0.19 Oct.	0.014 July	0.170 Oct.
Phosphate	mg/l	0.107 Sept.	0.316 Aug.	0.107 Sept.	0.319 Aug.	0.111Sept.	0.311 Aug.	0.104 Jan.	0.280 Aug.	0.104 Jan.	0.291 Aug.	0.107 Sept.	0.301 Aug.	0.109 June	0.300 Aug.
Nitrate	mg/l	0.119 Apr.	0.291 Aug.	0.109 Feb.	0.283 Aug.	0.087 Feb.	0.290 Aug.	0.102 Feb.	0.292 Aug.	0.099 Apr.	0.261 Aug.	0.093 Feb.	0.241 Oct.	0.086 Feb.	0.269 Aug.

Table-2
Mean and standard deviation in the physico-chemical parameters of Reservoir, Channel and river Tawi during Sept. (2011) to Aug. (2012)

Parameters	Units	Reservoir (St 1, 2, 3 and 4)	Channel (St 5 and 6)	River Tawi (7)
Air temp.	^{0}C	27.79 ± 6.89	27.80 ± 6.88	27.80 ± 6.88
Water temp.	^{0}C	17.55 ± 5.75	17.44 ± 5.79	17.41 ± 5.83
Transparency	cm	209.23 ± 110.42	211.16 ± 110.64	210.58 ± 109.38
pH		8.40 ± 0.165	8.39 ± 0.189	8.36 ± 0.102
Dissolved O2	mg/l	7.76 ± 1.65	7.76 ± 1.64	7.76 ± 1.65
Free CO2	mg/l	3.93 ± 1.57	3.93 ± 1.57	3.95 ± 1.57
Carbonates	mg/l	00	00	00
Bicarbonates	mg/l	120.91 ± 20.25	120.26 ± 19.17	118.78 ± 20.35
Chloride	mg/l	8.38 ± 3.96	8.65 ± 4.93	8.12 ± 4.47
Calcium	mg/l	66.53 ± 17.42	70.42 ± 12.06	69.44 ± 12.31
Magnesium	mg/l	56.77 ± 22.60	57.13 ± 23.01	56.92 ± 22.53
Sulphate	mg/l	0.079 ± 0.053	0.077 ± 0.052	0.078 ± 0.051
Nitrate	mg/l	0.164 ± 0.059	0.157 ± 0.047	0.155 ± 0.052
phosphate	mg/l	0.170 ± 0.053	0.158 ± 0.051	0.161 ± 0.051

Table-3
Summary Analysed Parameters and WHO Guideline Levels

S.No.	Parameters	Units	Minimum	Maximum	WHO level	ICMR levels
1	Temperature	^{0}C	9.5	24	.	.
2	Turbidity	Cm/ NTU	43	430	29.3- >54.7	5 NTU
3	pH	-	8.1	8.9	6.5- 9.2	7.0- 8.5
4	DO	mg/l	4.75	9.60	4.0	-
5	FCO_2	mg/l	1.20	6.29	-	-
6	HCO_3	mg/l	82.0	150.4	-	-
7	Cl^-	mg/l	2.89	22.99	250- 600	200
8	Ca^{2+}	mg/l	26.20	89.25	100	75
9	Mg^{2+}	mg/l	19.91	102.2	30-150	50
10	NO_3^-	mg/l	0.086	0.292	10-45	20
11	SO_4^{-2}	mg/l	0.012	0.170	200-400	200
12	PO_4	mg/l	0.104	0.319	>0.5	-

The value of sulphates, phosphates and nitrates do not Varied in uniform manner and their values ranged between 0.012 mgl-1 (Sept.) to 0.190 mgl-1 (Oct.), 0.104 mgl-1 (Jan.) to 0.319 mgl-1 (Aug.) and 0.086 mgl-1 (Feb.) to 0.291 mgl-1 (Aug.) respectively. Further their concentrations increases during monsoon season because of animal and agricultural runoff. Basic nutrients like sulphates, phosphates and nitrates, determine the productivity of the water body indicated that any amount in the excess of 0.5ppm of phosphate is an indicator of pollution[26].

Conclusion

In this study, it was found that physico-chemical parameters of chenani hydroelectric reservoir, its connecting channel and river Tawi are under the permissible limit as given WHO and ICMR indicates that these water bodies are productive and suitable for fish culture, irrigation, domestic and drinking purpose.

Acknowledgements

I am highly thankful to CSIR, Delhi for financial assistance as junior research fellow and Head of department of Zoology Prof. K. K. Sharma for his valuable guidance.

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