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RESEARCH ARTICLE

PHYSICO – CHEMICAL PROFILE OF KANGSABATI RESERVOIR, WEST BENGAL, INDIA

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Manuscript Info *Abstract*

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The recent investigation deals with the assessment of water quality of Kangsabati reservoir during the study period March, 2010 – February, 2012. Statistical analyses have been carried out by calculating correlation coefficients among several parameters. The observed values of various physico-chemical parameters of water samples were tallied with desirable, permissible, acceptable range – recommended by WHO, FAO, BIS, NRAC, SRAC, ICAR guideline whichever is properly applicable for the purpose of irrigation, pisciculture and drinking. It is found that strong positive correlation builds a network among air and water temperature; dissolved oxygen and transparency; hardness with Calcium, Magnesium and phosphate; salinity and chloride; photic depth and transparency; free CO_2 and conductivity. A highly negative correlation was found among water temperature with dissolved oxygen and phosphate; total inorganic nitrogen and P^H; photic depth with phosphate and hardness; phosphate and transparency. All the physico-chemical parameters of Kangsabati Reservoir are within the acceptable limit set by above mentioned organizations except conductivity value which recorded to be low .

Introduction

Water is the most prime abiotic factor which support life in this world. Particularly the physico - chemical properties of water governs the life of aquatic organisms living in it. Any change in the water quality has direct influence on biotic communities where different species of flora and fauna exhibit great variations in their responses to the alter environment (Watson and John, 2003). The ranges of different parameters determine the quality of water body. On tallying these parameters with desirable and acceptable limit recommended by several reputed organizations like WHO (World Health Organization), BIS (Bureau of Indian Standards), SRAC (Southern Regional Aquaculture Center), NRAC (Northeastern Regional Aquaculture Center), ICAR(Indian Council of Agricultural Research) NEH Region Tripura Centre, FAO (Food and Agricultural Organization) document etc, we can conclude whether the water is favourable for pisciculture, eligible for irrigation, drinking purpose or not and can also get an idea about the trophic status of the water bodies.

. Several workers like Kumar et al (2006), Saksena et al (2008), Garg et al (2009), Sharma et al (2010), Basu et al (2010), Kumar and Sinha (2010), Rajashekar et al (2012), Salih et al (2013), Brindha and Elango (2013), Dutta and Patra (2013), Agale, M. C. and Patel, N. G. (2013), Nakkaew, S., Pekkoh, J. and Peerapornpisal, Y. (2013) and Gopalakrishna et al (2014) have studied on various fields such as physico – chemical parameters of

water and correlation among them, assessment of water quality, seasonal variation, trophic status, impact on planktonic community, fisheries activity etc. in fresh water bodies.

The present study we have made an attempt to analyze the monthly variation of physico - chemical parameters of Kangsabati Reservoir from March, 2010 to February, 2012 with an comparative statistical correlation.

II MATERIALS AND METHODS :

Kangsabati Reservoir ($22^0$55' 16.53" N - $23^0$2' 30.41"N latitude and $86^0$37' 55.30"E - $86^0$47' 23.35"E longitude) is located in the Mukutmanipur region of the Bankura District, W.B. . It has a total catchment area of 3625 sq. km . It covers an total irrigable area of 340752 ha. during Kharif season and 60704 ha. during Rabi season . In addition to irrigation this reservoir has a great potential of pisciculture which can alleviate the economic condition of the local people . It is also the source of drinking water in the region . This large reservoir (According to Sugunan, 1995) has been inaugurated in the year 1965 – 1966.

Subsurface water samples were collected at the last week of each month in clean plastic air tight bottles at three stations viz. Sadarghat, Aparajitaghat and Peerlessghat (Fig. – 1) called by local people during the study period in between 8 A.M - 9.30 A.M. For Dissolved Oxygen(D.O.) analysis, water sample was collected in clean 100 ml bottles of glass. Water and air temperature were measured by hydro thermometer and minimum-maximum thermometer respectively; pH by digital pH meter (Cystronics Model – 335) ; conductivity by conductivity meter (Labtronics model – LT 16); DO by Winkler's method; photic depth by Secchi disc method; free CO_2, alkalinity, chloride, salinity, phosphorus, total inorganic nitrogen, calcium, magnesium and hardness were measured following APHA (2008). Rainfall data of the concerned period was recorded and supplied by the Office of the Sub divisional Officer, Kangsabati left bank subdivision no. II, Mukutmanipur, W.B. Observed and experimented results were compared with the recommended standard of WHO, BIS, NRAC, SRAC, ICAR, FAO as and where applicable.

The Pearson Correlation matrix(r) between several physicochemical parameterhas been done using Microsoft Excel (2007) to correlate among these parameters.

III RESULT AND DISCUSSION :

Figure 1: Open view of Kangsabati Reservoir

Figure 2 : Side view of Kangsabati Reservoir

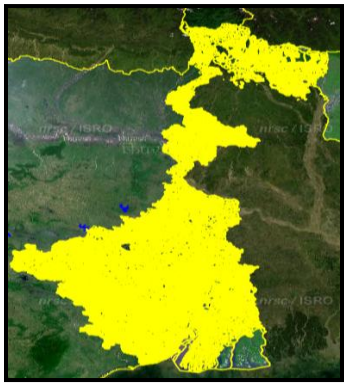

Figure 3 – Map of West Bengal

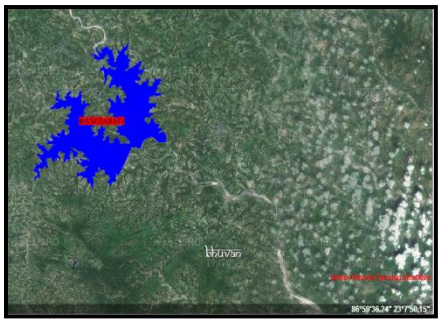

Figure 4 – Sattelite image of Kangsabati Reservoir (Blue shaded area)

AIR TEMPERATURE: The abiotic factor, temperature have several biological and physical impacts on organisms. Minimum air temperature was recorded was 25.0^0C in winter month and maximum 36.83^0C [Table - 1] in summer month. Similar result has been reported by Yadav et al, 2013. It is positively correlated with water temperature (r = 0.785), hardness (r = 0.329), chloride (r = 0.201), salinity (r = 0.197), phosphate (r = 0.244) etc. [Table – 2].

WATER TEMPERATURE: The water temperature of Kangsabati Reservoir varies with climatic condition, sun light penetration, depth etc. Water temperature ranged between 18.33^0C and 30.86^0C in the month of winter and summer season respectively during the study period. Such type of result have also been observed by Sonawane, 2011 in Sukhana river, Maharastra, India. Strong positive correlation of water temperature have been found with hardness and phosphate which is in accordance with Lianthuamluaia et al, 2013 in Savitri Reservoir, Maharastra. It showed negative correlation with dissolved oxygen (r = -0.527), transparency (r= -0.326), photic depth (r = -0.332) and free CO_2 (r = -0.314) [Table – 2]. Strong negative correlation between water temperature and dissolved oxygen has also been observed by Das, 2000 in some Andhra Pradesh reservoirs.The mean value of water temperature support fisheries activity [Table – 1].

TRANSPARENCY : The higher value of transparency was recorded to be 308.5 cm found in the winter month and lower value was 33.02 cm [Table – 1] in the month of rainy season. The result corroborates with the report of Saksena et al, 2008 in Chambal river. Transparency showed marked positive correlation with photic depth, P^H, D.O., and negative correlation with hardness, total inorganic nitrogen, PO_4 [Table – 2]. This result was confirmed by the observation of Sharma et al, 2010 in Gundolavlake.

CONDUCTIVITY : Electrical conductivity value marked through lower reading 11.95 µmho/cm and higher reading 28.39 µmho/cm [Table - 1]. The value was far low against recognized organization. So, conductivity value is less satisfactory for irrigation and pisciculture. It is positively correlated with air temperature, phosphate, transparency, P^H [Table – 2] . Positive correlation with P^H (r = 0.108) and chloride(r = 0.089) has also been reported by Garg et al, 2009 and Wiatkowski, 2011 respectively.

P^H : The P^H value fluctuated in between 6.50 to 8.59 [Table – 1]. Positive correlation has been observed with dissolved oxygen, chloride, salinity and alkalinity but correlation analysis indicates that P^H has no strong negative correlation with total inorganic nitrogen and phosphate [Table – 2]. The output results supported the investigation of Madhab Borah et al (2011). The mean P^H value strongly recommends not only for pisciculture but also irrigation and drinking purpose.

DISSOLVED OXYGEN (DO) : The life candle of aquatic organisms depend on dissolved oxygen which governs to lead the aquatic life fruitfully. D.O. value ranged from 7.2 to 12.4 mg/l . It was noted minimum value in summer month and maximum value in winter month [Table – 1]. It is positively correlated with P^H (also reported by Dash et al, 2006), transparency and photic depth, free CO_2 where as negatively correlated with water temperature (also reported by Islam, 2007) [Table – 2]. The mean value of DO indicated that it was finely acceptable for irrigation, pisciculture and drinking (I-P-D) purpose.

ALKALINITY : The lowest alkalinity value was analyzed in the month of winter i.e. 40.67 mg/l while highest value was 94.0 mg/l in the month of summer [Table – 1]. Similar result has been recorded by Elayaraj and Selvaraju, 2014. It showed markedly positive correlation (r = 0.263) with P^H (also reported by Sharma Riddhi et al, 2011) and negative correlation with total inorganic nitrogen, PO_4 [Table - 2]. The observed value had permitted for such stated (I-P-D) purpose.

CHLORIDE : Chloride in Kangsabati reservoir varied from 32.66 mg/l to 305.30 mg/l. [Table – 1].The findings were very satisfactory as it remained within the permissible limit. Chloride had strong positive correlation with salinity (r = 0.999), conductivity, Mg and water temperature. Similar observation regarding conductivity and water temperature were made by NaseemaKhatoon et al, 2013 and A.S.C. Sharma et al, 2013 respectively. The negative correlation with phosphate was observed which expressed positive influence on most of the parameters [Table – 2]. In every cases chloride content level was allowed to perform the estimated area of I-P-D.

SALINITY : Maximum salinity i.e. 0.57 ppt was recorded in the month of June, 2010 where as minimum value was 0.088 ppt recorded in May, 2011. It made positive relation with chloride and P^H . Similar result had been registered by P. Lilly Florence et al, 2012. According to NRAC for fresh water fish culture less than 0.5 ppt saline water is required. The value has been found to be within proper range.

PHOSPHATE(PO_4): The amount of phosphate exhibited wide fluctuation throughout the study period. Maximum value was 0.199 mg/l in August, 2011 and minimum value was 0.003 mg/l in April, 2011[Table – 1]. It built positive correlation strongly with hardness (r = 0.724), temperature, total inorganic nitrogen and negative correlation with DO, photic depth, transparency, salinity. Similar relationship between Phosphate and hardness has also been reported by Ramarao and Ramdas, 2009. The phosphate value in the study site is favourable for irrigation and pisciculture.

TOTAL INORGANIC NITROGEN : Total inorganic nitrogen comprises ammoniacal nitrogen, nitrate and nitrite nitrogen. The amount of total inorganic nitrogen varied from 0.25 mg/l to 2.46 mg/l [Table - 1]. It revealed strongly positive correlation with phosphate (r = 0.488) which was supported by G.V. Trevisan and Forsberg, 2007. It was major negative correlation with P^H (r = -0.717). It possessed the flexibility as well as acceptable limit for irrigation, pisciculture, drinking purpose.

CALCIUM (Ca) : The recorded calcium value fluctuate in between 18.63 mg/l and 51.21 mg/l. The highest mean value was 31.75 mg/l [Table – 1]. It displayed positive correlation with hardness (r = 0.647), chloride (r = 0.089), phosphate (r = 0.498), total inorganic nitrogen(r = 0.242) and strictly negative correlation with transparency (r = -0.256), P^H (r = -0.340) [Table – 2]. Positive correlation of Ca with hardness was firmly speech by Okomoda, V. T. et al, 2014. The calcium value is suitable for irrigation, pisciculture and drinking purpose as per recommended range [Table - 1].

MAGNESIUM (Mg): In the present study, the Magnesium content was detected with higher concentration 55.40 mg/l during summer season and lower concentration 9.28 mg/l in winter season. The highest mean value of Mg was 19.63mg/l [Table – 1]. It bridged positive correlation with chloride, temperature, hardness and P^H (r = 0.203). Positive correlation with P^H was also found by Kumari, 2014. It made negative correlation with transparency (r = - 0.209), DO (r = - 0.230), total inorganic nitrogen (r = - 0.009) has been reported by Bhandari et al, 2008. The information proves that the water in the reservoir has no objection for drinking and irrigation purpose.

HARDNESS : Hardness varied from 99.80 mg/l to 195.36 mg/l. It approved positive correlation with temperature, PO_4, total inorganic nitrogen [Table – 2]. Lianthuamluaia et al, 2013 also opined the same. Its value stood in between preferable limit for irrigation and piscicultutre [Table – 1]. In this connection it is to be mentioned that hardness value as per IS – 10500 is 200 mg/l in maximum for drinking purpose. On the other hand, according to ICAR guideline, 30 – 150 mg/l is required for fresh water pisciculture.

PHOTIC DEPTH : Light penetration depth i.e. photic depth expressed range from 29.63 cm to 287.00 cm (Table - 1). It enlightened extreme positive correlation with transparency (r = 0.995), DO (r = 0.773), free CO_2 (r = 0.437) and negative correlation with phosphate (r = - 0.475), hardness (r = - 0.496). Positive correlation with free CO_2 had also been informed by Rodrigues et al, 2002.

FREE CO_2 : Free CO_2 range exposed variability from 1.0 mg/l to 9.66 mg/l [Table – 1]. NRAC experimentally determined that the free CO_2 have no harmful effect on fish culture when its concentration remains less than 10 mg/l. The result is within the limit. It showed good positive correlation with transparency (r = 0.459), conductivity (r = 0.415), D. O. (r = 0.432) and photic depth (r = 0.437). Free CO_2 exhibit highly negative correlation with water temperature (r = - 0.314). Basu, Roy and Barik (2010) observed the same in Kamal Sayer lake, Burdwan, West Bengal.

.**RAINFALL :**Rainfall can regulate the value of different parameters. The annual mean values of rainfall were 70.80 mm and 72.02 mm in both the year respectively. It showed positive correlation with PO_4(r =0.510), Ca(r =0.128), Mg (r =0.328), hardness (r =0.482), total inorganic nitrogen (r =0.298) and negative correlation with transparency (r = - 0.370), photic depth (r = - 0.390), D.O.(r = - 0.405), P^H (r = - 0.377) [Table – 2].

CONCLUSION :

Correlation coefficient analysis of the water quality parameters demonstrates clearly the type and degree of relationship among them. Different parameters varied, which navigate the parameters to be monitored for management. Among 17 parameters an appreciable strong positive correlations have been recorded with air temperature and water temperature, DO and transparency, hardness and phosphate, salinity and chloride, photic depth and transparency where as highly negative correlation with water temperature and D.O., total inorganic nitrogen and P^H. Conductivity value has been found to be very poor for irrigation and pisciculture. Otherwise P^H, D.O., Ca, alkalinity, chloride, hardness, salinity, free CO_2 ranges is well compared with the permissible as well as acceptable limit recommended by WHO, FAO, BIS, NRAC, SRAC, ICAR guideline (which ever applicable), we conclude and confirm about its suitability for drinking, irrigation and pisciculture programme. The observations logically proved that the reservoir water facilitates multiple activity.

DO range referred to as good water quality but values of transparency (According to Vollenweider, 1968), total phosphorus (According to Wetzel, 2001; Lee et al, 1981), total inorganic nitrogen (Vollenweider, 1968) clearly state that the Kangsabati Reservoir is oligotrophic water body which is slightly inclined towards eutrophication. The trophic status of this reservoir alerts to conserve and manage it in scientific approach properly. Minor treatment may be required for phosphorus and nitrogenous content. Submerged macrophytes can be removed by mechanical help or through culture of grass carp like fishes.

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TABLE- 1 : RANGES OF PHYSICO-CHEMICAL PARAMETERS AND THEIR ELIGIBILITY FOR DRINKING, IRRIGATION AND PISCICULTURE PURPOSE DURING THE STUDY PERIOD FROM MARCH, 2010 – FEBRUARY, 2012.

	March,2010 – Feb,2011			March,2011- Feb,2012					
PARAMETERS (UNIT)	**MIN.**	**MAX.**	**MEAN**	**MIN.**	**MAX.**	**MEAN**	**D.W.(WHO/BIS) LIMIT**	**IRRIGATION (FAO/BIS)**	**PISCICULTURE (ICAR)**
A.T. (^{0}C)	25.00 Dec.	36.83 April	33.31	26.00 Dec.	35.33 March	31.06		0 – 3 ds/m	
W.T. (^{0}C)	18.33 Dec.	30.86 Sept.	27.70	22.00 Dec.	30.83 Aug.	27.02			Sp. dependent 24-30 usually
Transparency (cm)	40.83 May	308.5 Feb.	169.73	33.02 July	271.33 Sept	153.88			Species dependent
Conductivity (µmho/cm)	11.95 Dec.	28.39 Jan.	14.16	12.72 Nov.	18.24 May	14.9		Below1500µmho/cm-low class BIS:11624-1986	
P^H	7.32 Mar.	8.45 Dec.	7.69	6.50 July	8.59 April	7.28	6.5 – 8.5 IS-10500	6.5 – 8.4	6.5 – 9.0 SRAC
Dissolved Oxygen (mg/l)	7.2 April	12.00 Nov.	9.61	7.5 June	12.4 March	9.47	>4		>4 – 5 NRAC
Alkalinity (mg/l)	40.67 Sept.	94.0 May	68.27	41.00 July	88.00 Dec.	67.74	200 max. IS-10500		50 – 150 SRAC
Chloride (mg/l)	110.9 Feb.	305.30 June	168.93	32.66 May	223.66 Feb.	104.73	250 Max. IS-10500	0-30 me/l	>100 SRAC
Salinity (ppt)	0.22 Feb.	0.57 June	0.326	0.088 May	0.432 Feb.	0.217			<0.5 – 1.0 for Fresh water Fish. NRAC
Phosphate (mg/l)	0.014 Mar.	0.199 Aug.	0.074	0.003 Apr.	0.184 July	0.073		0 – 2	0.005 – 0.5 SRAC
Total inorganic nitrogen(mg/l)	0.50 May	1.96 Aug.	1.072	0.25 March	2.46 Oct.	1.42	NH_3 0.5 Max.,$NO_3$45 Max.	NH_3 0-5 NO_3 0-10	NH_3 0.1 Max. NO_3 0.1-4.5 $NO_2$0.005-0.5 ICAR Tripura
Ca (mg/l)	18.63 Jan.	51.21 Nov.	31.75	10.85 April	41.33 July	24.38	75 Max. IS-10500	0 – 20me/l	>20 SRAC
Mg (mg/l)	10.35 Nov.	55.40 June	19.63	9.28 Dec.	34.32 Aug.	16.77	30 Max. IS-10500	0 – 5 me/l	
Hardness (mg/l)	112.62 Jan.	195.36 Aug.	148.18	99.80 Nov.	194.83 Aug	131.77	200 Max. IS-10500		30 – 180 ICAR
Photic depth (cm)	32.66 My	287.00 Feb.	153.81	29.63 July	245.33 Sept	142.66			
Free CO_2 (mg/l)	3.33 July	9.66 Jan.	4.88	1.0 Apr.	6.0 Feb.	3.80			<10 NRAC
Rainfall (mm)	0.00 Feb.	213.60 Aug	70.80	0.00 Dec.	428.4 June	119.46			

Table - 2 : Pearson Correlation matrix(r) between several physico-chemical parameters of Kangsabati Reservoir

	Air Temp.	*Water Temp.*	*Transparency*	*Conductivity*	*PH*	*D.O.*	*Alkalinity*	*Chloride*	*Phosphate*	*T.I.N*	*Hardness*	*Ca*	*Mg*	*Salinity*	*Free CO_2*	*Photic depth*	*Rainfall*
Air Temp.																	
Water Temp.	0.785676	1															
Transparency	-0.21753	-0.32671	1														
Conductivity	0.25133	-0.07115	-0.13679	1													
PH	0.047033	-0.06811	0.322489	0.108033	1												
D.O.	-0.39665	-0.52739	0.781926	-0.28812	0.323713	1											
Alkalinity	-0.07621	0.123281	0.044281	-0.07836	0.263816	-0.08049	1										
Chloride	0.201029	0.166106	0.169457	0.089266	0.328054	0.014637	0.070214	1									
Phosphate	0.244136	0.323787	-0.46901	0.041088	-0.38855	-0.45461	-0.28887	-0.36688	1								
T.I.N	-0.10379	0.079387	-0.12964	-0.23528	-0.71792	-0.1315	-0.21204	-0.17188	0.512349	1							
Hardness	0.329701	0.358892	-0.47765	-0.04391	-0.11106	-0.32183	-0.18647	-0.02542	0.724462	0.255652	1						
Ca	0.122883	0.052915	-0.25655	-0.16616	-0.34021	-0.10253	-0.13469	0.089999	0.498892	0.242794	0.647461	1					
Mg	0.341434	0.428575	-0.20917	0.110676	0.203407	-0.23045	0.078122	0.353557	0.114639	-0.00955	0.552233	0.143983	1				
Salinity	0.197126	0.164255	0.163617	0.086077	0.321282	0.013018	0.06886	0.999465	-0.37615	-0.16728	-0.03527	0.078041	0.348799	1			
Free CO_2	0.046434	-0.31469	0.459696	0.415143	0.060276	0.432809	-0.16535	0.04858	-0.14144	-0.14223	-0.14443	0.083684	-0.13092	0.037408	1		
Photic depth	-0.23873	-0.3323	0.995497	-0.15728	0.266946	0.77369	0.059299	0.159659	-0.46124	-0.07192	-0.49701	-0.24472	-0.23041	0.154172	0.437615	1	
Rainfall	0.327444	0.39793	-0.37025	0.086105	-0.37773	-0.4054	-0.21136	-0.23567	0.510775	0.298604	0.482368	0.128036	0.328907	-0.23462	-0.1492	-0.39004	1

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