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Study and Interpretation of Physico-Chemical Characteristic of Kerwa Dam Water Quality in Bhopal City (India)

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ABSTRACT : Bhopal is the capital of the state of Madhya Pradesh which is undergoing fast rate of urban development and industrialization with the increase in population growth. This has brought about an adverse impact on the available precious water resources. The Kerwa dam is a used as a source of irrigation and drinking water and as a sink for domestic and agricultural waste water.The present study was conducted to assess the physicochemical variation in water of Kerwa dam at Bhopal. An assessment of various physicochemicalcharacteristics of water such as pH, temperature, DO, Hardness, Phosphate, Sulphate, Nitrate, and COD was carriedfor a period of one yearin (Nov. 2010-Oct. 2011) atfive sites of dam to know the pollution status. In the present study all the parameters such as TDS, pH, alkalinity, total hardness, chloride, Sulphate, nitrate, and fluoride were found to be with in the permissible limits, while COD and faecal coliform count was found to be beyond the limit in all the samples. Thus, this water body is not suitable for drinking purpose, so possible remedial method should be adopted for this water resource. As the TDS and EC values are within the limit therefore the water of this dam can be used for irrigation purpose.Statistical analysis among various physicochemical parameters was also carried out. Total hardness shows positive correlation with chloride, sulphate, and nitrate.

Keywords: Water quality, correlation, nutrients, variation, physicochemical.

I. INTRODUCTION

Dams are important multi-usage components, such as sources of drinking water, irrigation, fishery and energy production [1]. In recent years both the Anthropogenic influences such as urban, industrial and agricultural activities have increased exploitation of water resources as well as natural processes such as precipitation inputs, erosion, weathering of crustal materials, degradation of surface waters and rendering the water bodies unsuitable for both primary and secondary use [2, 3]. The quality of water is described by its physical, chemical and microbiological characteristics [4]. Runoff water and discharge of sewage into dams are two common ways through which various nutrients enter the aquatic ecosystems resulting in water pollution. Kerwa dam is located in Bhopal district 10 miles away from the origin of river Kerwa near Mandosi village. Its water is used to provide irrigational facilities for 3240 hectares of agricultural land in Huzur tehsil of Bhopal district of Madhya Pradesh. The catchments area of the dam is around 34.5 Sq. km. The Dam water is a major source of water in agriculture for the nearby villages in Bhopal city but since long the Kerwa dam has been subjected to severe pressure and abuse owing to the fast pace of urban and industrial growth of the city. In present study physicochemical variation and water quality evaluation in Kerwa dam water was carried out to evaluate the pollution status and variation in physicochemical parameters of water at ten different sites.

II. MATETIALS AND MATHODS

Study area: Bhopal district is located in Madhya Pradesh at 23°15'N Latitudeand longitude 77°25'E longitude and has an altitude of 550/600 meters above sea level. The city has multiple requirements of water for its use in industries, irrigation, drinking and pisciculture. Kerwa dam is located in Bhopal district 10 miles away from the origin of river Kerwa near Mandosi village with a spread area of 50 km. Its water is used to provide irrigational facilities for 3240 hectares of agricultural land in Huzur tehsil of Bhopal district of Madhya Pradesh. The catchments area of the dam is around 34.5 Sqkm. for present study ten sites at study areas have been selected.

Sampling: The water samples for physicochemical analysis were collected from 5 sites of Kerwa at monthly interval from November 2009 to October 2010. The sampling was done in morning hours and the surface water samples were collected in pre-cleaned two litre polythene bottles with necessary precautions [6]. The parameters such as pH, temperature and dissolved oxygen were analysed in the field. The concentration of DO was measured using Azide-modification Winkler method. For analysis of Chemical Oxygen Demand (COD), the pH of the water was lowered to 2.0 by adding H_2SO_4 and brought to laboratory for further analysis. The other physicochemical parameters such as chloride, phosphate, sulphate, nitrate, BOD and COD (Chemical Oxygen Demand) and coli form were analysed in Laboratory as per the standard methods of [7, 8].

III. RESULTS AND DISCUSSION

Water Analysis

The variations of physicochemical parameters of water on monthly basis at five sites are depicted in Fig. 1-13 along with mean values and standard deviations are summarized in Table 1.

The temperature has direct effect on certain chemical and biological activities of the organism in aquatic media. The surface water temperature of study sites ranged between 14.4°C to 22.5°C (Fig. 1). The temperature showed an increase from the month of Feburery till the onset of summer season in June and gradual decrease from the rainy season (August) to the post-monsoon month. The rise in temperature could be due to the fact that in winter photoperiod was shorter and less intense than summer [9].

The pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. In the present study the mean values of pH at ten sites of dam water ranged between 7.7-7.9 and which were in accordance with the prescribed limit of 6.5-8.5 [10]. The dam water showed alkaline pH in the range of 7.6 to 8.3 (Fig. 2). The present result corroborated withthe findings of Shah A.N. [5] where the pH was found in the range 7.60-8.50 in Kharicut canal.

The DO and TDS of the water showed a highly positive correlation in dam water (r = 0.8465). Both the parameters are indicators of good quality water indicatingthe various favourable conditions for high primary and secondary production. Dissolved oxygen (DO) is very crucial for the survival of aquatic organisms and is also used to evaluate the degree of freshness of a river [2]. DO in the river water showed marked variation at different sites. The DO value was ranged from 7.4 mg/l to 8.4 mg/lin the months of November to October respectively. DO shows a less correlation with temperature (r = 0.1501) which proves that at high temperature thedissolution of oxygen decreases in water. Dissolved oxygen showed a significantly negative correlation with almost all the parameters at five sites of dam. Thus, Dissolved Oxygen can serve as a singleuseful index of water quality as withthe increase in value of other physicochemical parameters the concentration of DO decreases.

In most fresh waters, total hardness is mainly imparted by the calcium and magnesium ions, which apart from sulphate, chloride and nitrate are found in combination with carbonates and bicarbonates. In the present study total hardness showed higher values in pre-monsoonseason due to reduced inflow and evaporation followed by monsoon and post monsoon. The average values of total hardness in river water *i.e.* S-1, S-2, S-3 S-4, S-5 varied from 96.3 mg/ l to100.1 mg/l (Fig. 4) which is in accordance with prescribed values of drinking water standards (300 and 500 mg/l) [10, 13]. The hardness of water depends upon the dissolve salts present in the water [14]. These high values in water could be attributed to leaching from soilwhich contains dissolved cations and anions. Total hardness shows a positive correlation with conductivity (r = 0.8356), pH (r = 0.9806) and TDS (r = 0.8913) respectively.

Chloride occurs naturally in all type of waters. High concentration of chloride is considered to be the indicators of pollution due to organic wastes of animal or industrial origin. High values of chloride are troublesome in irrigation water and also harmful to aquatic life [17]. The mean value of chloride varied between 15.08 mg/l to 15.45 mg/l in dam water with maximum value of 20 in June 2011 and lowest value of 10 mg/l in the month of Dec respectively (Fig. 6). It is positively correlated with temperature (r = 0.308). High values of Chloride in summer months may be associated with high temperature which enhances the evaporation, reducing the volumeof water thus resulting in the high concentration of salts. Chloride also gets added to waters fromthe discharge of agricultural waste or contamination with sewage [19, 20]. Chloride is significant correlation with conductivity (r = 0.8442) and hardness (r = 0.9710).

Solids refer to matter suspended or dissolved in water or waste water. Waters with highdissolved solids are of inferior palatability. In the present study the mean value of total solid sranged from 142.5.15 to 144.9 mg/l (Fig. 2). In this study the primary sources for TDS level in water are agricultural runoff and leachingof soil contamination. TDS is significantly positive correlation with conductivity, pH, hardness chloride and sulphate.

The mean concentration of sulphate was found in the range of 17.83 to 20.08 mg/l (Fig. 9) which is within the range of prescribed drinking water standards (200 mg/l) [10, 13]. The lower values of sulphate recorded could be because sulphate easily precipitates and settles tothe bottom sediment of the river [22]. Sulphate exhibits positive correlation with temperature, pH,conductivity, nitrate, chloride, total hardness at five dam sites. Apositive correlation between sulphate and chloride suggests that they are from similar sources [15].

Nitrate shows negative correlation with turbidity and positive correlation with phosphate, sulphate, EC, TDS, and temperature in all 5 sites of dam. The mean concentration of nitrate ranged between 3.6-4.2 mg/l (Fig. 10). The spatial and temporal variationin nitrates represents the final product of the biological oxidation of ammonia [23]. Nitrate show comparatively high valuesin summer due to increased rate of evaporation and in monsoon which might have been because of surface run offf rom farms and storm water run off in to the river during early rain [22]. The elevated levels of nitrogen can cause eutrophication which is observed in many shallow patches near the bank ofriver [24]. Decrease in flow velocity also contributes to Eutrophication [25].

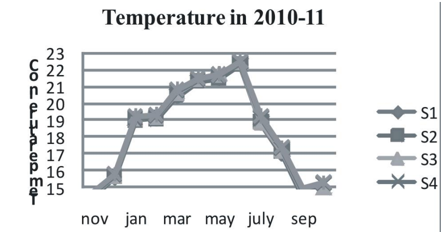
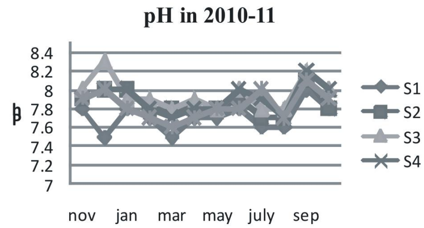


Fig.1



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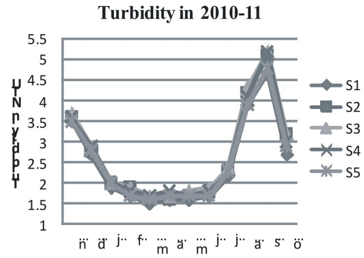

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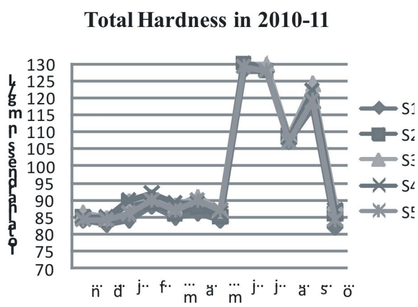

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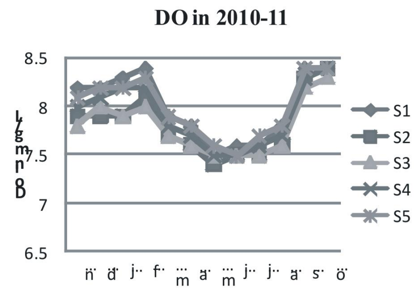

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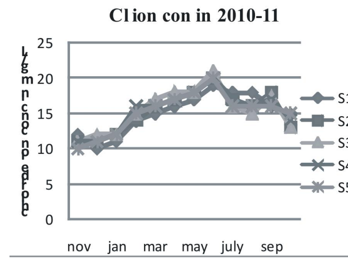

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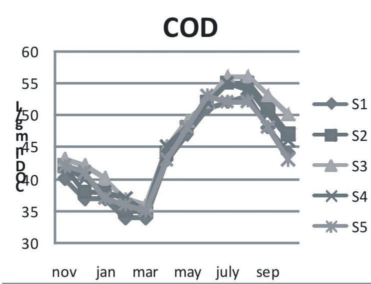

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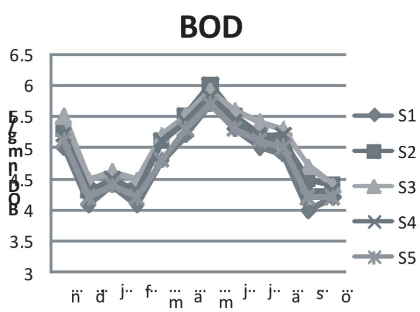

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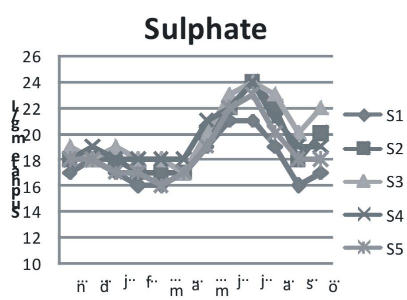

Fig.9

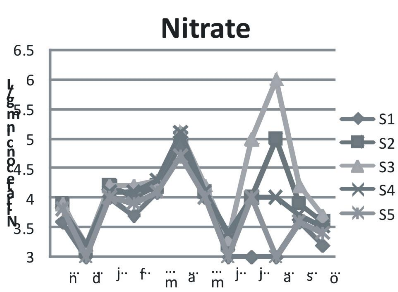

Fig.10

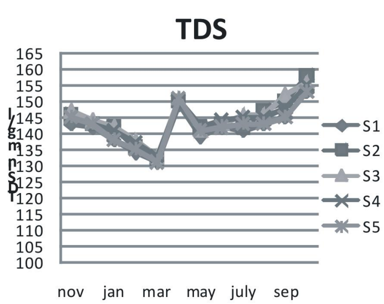

Fig.11

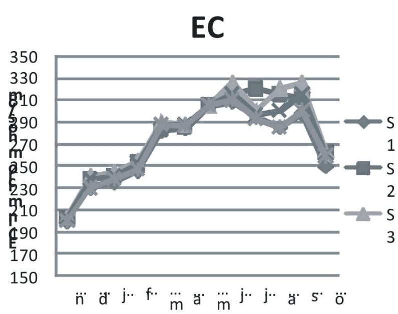

Fig.12

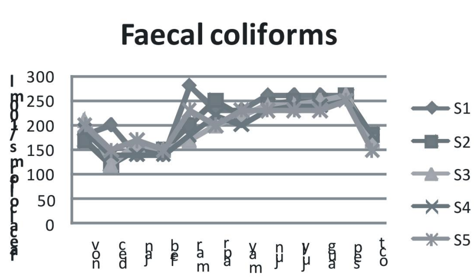

Fig.13

Table 1: Average values of physicochemical parameters at five sampling sites with Standard deviation. Values are in mg/l except for pH and Temperature. (Mean Standard Deviation).

S. No.	Parameter	S1	S2	S3	S4	S5
1.	Temperature	18.2±2.9	18.2±2.9	18.3±2.8	18.4±2.8	18.5±2.8
2.	pH	7.7±0.14	7.8±0.12	7.9±0.16	7.9±0.14	7.8±0.15
3.	Turbidity	2.47±1.05	2.65±1.15	2.72±1.15	2.65±1.13	2.55±1.05
4.	Total hardness	96.33±18.3	98.08±17.9	100.16±18.3	99.33±17.85	97.91±17.7
5	EC	267.9±34.6	277.6±38.0	279.7±38.5	275.0±35.5	270.0±34.6
6	TDS	141.6±5.9	144.2±6.7	144.9±6.2	144.0±5.7	142.5±6.0
7	DO	8.0±0.34	7.8±0.32	7.8±0.27	7.9±0.32	8.0±0.31
8	BOD	4.7±0.55	4.9±0.56	5.0±0.51	4.9±0.54	4.7±0.53
9	COD	43.3±6.9	45.0±7.4	46.5±7.0	45.1±6.8	44.1±6.3
10	Nitrate	3.6±0.63	4.0±0.56	4.2±0.78	3.9±0.49	3.7±0.52
11	Sulphate	17.8±1.8	19.2±2.3	20.0±2.3	19.58±1.9	18.58±2.1
12	chloride	15.0±2.8	15.2±2.9	15.4±3.0	15.4±2.8	15.1±2.8
13	Faecal coliform	218.3±49.1	203.3±48.3	199.1±44.8	195.8±41.0	201.6±37.3

Table 3: Correlation matrix among various physicochemical parameters in Kerwa dam water

Parameters	Temp	Turb	EC	pH	TDS	TH	Cl^-	SO_4^-	NO_3^-	DO	BOD	COD
Temp	1	−0.7112	0.0136	0.4809	0.1232	0.4639	0.3085	0.2985	0.0625	0.1501	0.0553	0.2283
Turbidity		1	−0.929	−0.9331	−0.9619	−0.8581	−0.851	−0.935	−0.851	0.8466	−0.8799	−0.8455
EC			1	0.8747	0.9903	0.8356	0.8442	0.9374	0.9754	−0.978	0.9893	0.9377
pH				1	0.9245	0.9807	0.9313	0.9779	0.8925	−0.765	0.8927	0.9459
TDS					1	0.8914	0.8984	0.973	0.968	−0.94	0.9799	0.9519
TH						1	0.9711	0.9711	0.8864	−0.711	0.8711	0.952
Chloride							1	0.965	0.8831	−0.722	0.8656	0.9297
Sulphate								1	0.9484	−0.845	0.9473	0.9736
Nitrate									1	−0.942	0.9965	0.983
DO										1	−0.962	−0.8709
BOD											1	0.9723
COD												1

2: Table showing values of physicochemical parameters at five sampling sites of Kerwa dam in 2010-11.

Parameter	station	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct
TEMPE													
	S1	14.4	15.6	19	19.1	20.4	21.3	21.5	22.3	18.8	17	14.4	14.7
	S2	14.5	15.6	19	19.1	20.5	21.3	21.5	22.3	18.9	17.1	14.5	14.8
	S3	14.6	15.7	19.1	19.2	20.6	21.4	21.7	22.4	18.9	17.2	14.7	15
	S4	14.7	15.7	19.1	19.2	20.7	21.4	21.6	22.4	19.1	17.3	14.8	15.2
	S5	14.8	15.8	19.2	19.3	20.8	21.5	21.7	22.5	19.2	17.4	14.9	15.3
pH													
	S1	7.8	7.5	7.8	7.7	7.5	7.7	7.7	7.8	7.6	7.6	8	7.8
	S2	7.9	8	8	7.8	7.8	7.8	7.8	7.9	7.7	7.7	8.1	7.8
	S3	8	8.3	7.9	7.9	7.8	7.9	7.8	8	7.8	7.8	8.2	8
	S4	7.9	8	8	7.8	7.7	7.8	7.8	8	7.9	7.7	8.2	8
	S5	7.9	8	7.8	7.7	7.6	7.7	7.8	7.8	8	7.7	8.1	7.9
TURBIDITY													
	S1	3.5	2.7	1.9	1.7	1.5	1.6	1.6	1.7	2.2	3.9	4.7	2.7
	S2	3.6	2.8	2	1.9	1.6	1.6	1.7	1.8	2.3	4.2	5.1	3.2
	S3	3.7	2.9	2	1.9	1.7	1.7	1.8	1.9	2.4	4.3	5.2	3.2
	S4	3.6	2.9	2	1.8	1.7	1.8	1.7	1.8	2.3	4.1	5.2	3

S5 3.5 2.8 2 1.7 S1 8.2 8.2 8.3 8.4
1.61.7 1.7 1.7 2.3 3.9 4.8 7.97.8 7.5 7.6 7.6 7.8 8.4
2.9 8.4

TH

S2 7.9 7.9 7.9 8.1
S1 84 83 84 88 85 7.77.6 7.4 7.5 7.5 7.6 8.3
86 84 128 128 107 117 82 8.4
S2 85 84 89 89 86 S3 7.8 8 7.9 8
88 85 130 128 109 118 86 7.77.6 7.5 7.5 7.5 7.6 8.2
S3 86 85 90 91 88 8.3
91 87 132 130 109 124 89 S4 8 8.1 8.2 8.2
S4 85 85 90 92 89 7.87.7 7.5 7.5 7.6 7.7 8.3
89 86 131 128 108 122 87 8.4
S5 84 84 86 90 87 S5 8.1 8.2 8.2 8.3
90 87 129 128 107 119 84 7.97.8 7.6 7.5 7.7 7.8 8.4
8.4

DO

CHLORIDE												
	S1	12	10	11	14	15	16	17	19	18	18	16	15
	S2	11	11	12	14	16	17	18	20	17	16	18	13
	S3	11	12	12	15	17	18	18	21	16	15	17.5	13
	S4	11	11	12	16	16	17	18	20	17	16	17	14
	S5	10	11	12	15	16	17	18	20	16	16	16	15
COD													
	S1	40	37	37	34	34	43	47	51	52	53	48	44
	S2	42	38	38	35	35	44	48	52	55	55	51	47
	S3	43	42	40	37	36	45	49	52	56	56	53	50
	S4	42	40	38	37	35	45	48	52	55	54	50	46
	S5	42	41	37	36	35	43	48	53	52	52	48	43
BOD													
	S1	5	4.1	4.4	4.1	4.8	5.2	5.7	5.3	5	4.9	4	4.2
	S2	5.3	4.3	4.5	4.3	5.1	5.5	6	5.5	5.2	5.1	4.5	4.4
	S3	5.5	4.5	4.6	4.5	5.2	5.5	5.9	5.6	5.4	5.3	4.7	4.4
	S4	5.2	4.3	4.5	4.3	5.1	5.4	5.8	5.4	5.2	5.2	4.3	4.3
	S5	5.1	4.2	4.4	4.2	4.8	5.3	5.7	5.3	5.1	5	4.2	4.2
SULPHATE													
	S1	17	18	17	16	16	17	19	21	21	19	16	17
	S2	18	18	18	17	17	17	20	22	24	22	18	20
	S3	19	18	19	18	18	17	20	23	24	23	20	22
	S4	18	19	18	18	18	18	21	22	24	21	19	19
	S5	18	18	17	17	16	17	19	22	23	20	18	18

Parameter	*station*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*July*	*Aug*	*Sep*	*Oct*
NITRATE													
	S1	3.6	3	4	3.7	4.1	5.1	4	3	3	3	3.6	3.2
	S2	3.9	3.1	4.2	4	4.2	4.9	4.1	3.2	4	5	3.9	3.6
	S3	3.9	3.2	4.2	4.2	4.3	5.1	4.2	3.3	5	6	4.2	3.7
	S4	3.8	3.2	4.1	4.1	4.3	5.1	4.1	3.4	4	4	3.7	3.5
	S5	3.8	3	4	3.9	4.1	4.7	4	3	4	3	3.6	3.4
TDS													
	S1	143	142	138	134	131	149	139	142	141	143	145	153
	S2	146	143	142	136	132	150	142	143	142	147	150	158
	S3	147	144	142	138	133	151	141	143	146	146	152	156
	S4	145	143	141	137	133	150	142	144	145	145	148	155
	S5	145	143	138	135	131	151	141	142	143	143	145	153
EC													
	S1	200	230	235	245	282	284	304	308	295	285	297	250
	S2	203	238	241	253	283	285	305	315	320	315	312	262
	S3	204	240	244	254	290	287	304	325	300	320	325	264

	S4	203	238	241	252	287	288	305	315	296	300	315	261
	S5	200	230	238	247	288	286	305	310	293	285	300	259
F. coli													
	S1	180	200	140	140	280	230	230	260	260	260	260	180
	S2	170	120	150	150	200	250	220	240	250	250	260	180
	S3	210	120	160	150	170	200	220	240	240	250	260	170
	S4	190	140	140	140	180	220	200	230	240	240	250	180
	S5	200	150	170	150	230	200	230	230	230	230	250	150

The Chemical oxygen demand is a measure of oxygen equivalent to the organic matter content of the water susceptible to oxidation and thus is an index of organic pollution in river [16]. In the present study value of COD was the highest 56 mg/l at S-3 in July and August and the lowest at S-1 i.e.34 mg/l in February and March which is beyond the drinking water standards (10 mg/l) [10]. The observed COD values were ranged from 34-56 mg/l (Fig. 7). The discharge of highly oxidized chemicals from different sewage serves as the main cause for high value of COD. The COD shows negative correlation with DO which shows that with the increase in COD or pollution load the DO level get decreased in dam water.

In the present study the observed BOD values were ranged from 4.7 mg/l to 5.09 mg/l at five sampling sites. The results indicate that the water body had suffered deterioration and degradation due to continuous discharge of partially treated effluent [27].

Faecal coliform test is one of the most important biological parameter in drinking waterquality. The microbiological quality of river is controlled by human activities. In urban areas faecal micro-organisms are mainly brought to aquatic environments through the discharge of domestic waste water and some industrial waste waters [28]. According to WHO the number ofFaecal coliform in 100 ml of water should be zero. In present study the values of FC/100 ml varied between 140 to 260/100ml at five sites of dam which makes water of inferior quality. The faecalcontamination of water by slums located along the dam side might be the reason of higher valuesin the present study.

IV. CONCLUSION

Various physicochemical parameters in studied lakes showed distinct, temporal and spatial variations throughout study period.The present study leads to following conclusions:

1. Data indicate that pH, alkalinity, hardness, nitrate, fluoride, chloride and BOD were found to be within WHO and BIS permissible limits for drinking water.

2. In present study the value of COD is well above the WHO permissible limit for all the samples. As COD is measures of water quality that reflect the degree of organic matter pollution of a water body. Therefore this water can be used for drinking purpose only after suitable treatment of water. It reveals high pollution load due to the discharge of partially treated effluent with high oxidizing matter in dam was found to be the point source of pollution and needs to be treated completely before its use for any human intended purpose.

3. The higher number of faecal coliforms at study area exceed the water quality criteria given by WHO make it unsuitable for drinking purpose, so it should be used only after proper primary treatment

4. The TDS and electrical conductivity values of the water sample are within the WHO and BIS permissible limits. Therefore the water of Kerwa dam is suitable for irrigation purpose.

5. The correlation coefficient among the various physicochemical parameters showed highest positive correlation between Electrical Conductivity and TDS and highest negative correlation between EC and DO. Since other parameters and their functions can be explained by using these conditions, utilization of such methodology will thus greatly facilitate the task of rapid monitoring of the status of pollution of water economically and this is the most important part of any pollution.

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