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Water Quality Assessment in Relation to Trophic Status of the Rana Pratap Sagar Dam and the Chambal River (Rajasthan) India

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Abstract:

The present investigation deals with the limnobiotic status of the Rana Pratap Sagar dam (lentic water bodies) and the Chambal river (lotic water bodies) from winter, 2008 to monsoon, 2009 (season wise for two years). Physico-chemical parameters in Rana Pratap Sagar dam (RPS) and Chambal river *I.e.* temperature, conductivity, depth of visibility, total dissolved solid, chlorides, total alkalinity, total hardness, nitrate, phosphate, silicate and primary productivity were observed. RPS dam and the Chambal river were well within the permissible limits for drinking water recommended by WHO and Indian Standard parameters for public water supply, fish culture as well as irrigation. Moderate fauna of total 30 forms of phytoplankton (40%, chlorophyceae), 18 forms of zooplankton (38.88%, rotifers) and 22 forms of benthos (27.27%, gasropods) were reported in RPS dam whereas in the Chambal river total 26 forms of phytoplankton (44%, chlorophyceae), 21 forms of zooplankton (33.33%, rotifers) and 23 forms of benthos (26.08%, gastropods) were identified. On the basis of productivity the RPS dam showed eutrophic characteristics as compared to the Chambal river which was showed mesotrophic nature.

Keywords: Benthos, Chambal river, Physico-chemical parameters, Phytoplankton, Rana Pratap Sagar dam, Zooplankton

1. Introduction:

The Chambal river is a tributary of the Yamuna river in central India, and forms part of the greater Gangetic drainage system. The river flows north-northeast through Madhya Pradesh, running for a time through Rajasthan, then forming the boundary between Rajasthan and Madhya Pradesh before turning southeast to join the Yamuna in Uttar Pradesh state (Jain *et al.,* 2007). The Rana Pratap Sagar dam has been constructed on the river Chambal at Rawatbhata Kota (Rajasthan) India which is well known for fish production as well as energy and irrigation. Limnological study of any lentic and lotic water bodies is basic in understanding the trophic dynamic of water bodies and they are the requirement of drinking, domestic, agricultural and industrial uses (Hulyal and Kaliwa, 2008). Water is one of the basic needs for all living things either mankind or all forms of life. The distribution and abundance of organisms are determined by physical and chemical habitats created in the water bodies (Thibert, 1994). Water temperature, alkalinity, TDS, conductivity, total hardness and pH have direct influence on the fish species richness whereas chlorides, turbidity, altitude, water current have been found to be negatively correlated with the fish species richness (Johal *et al.,* 2000).

Plankters are considered as an index of fertility and the landings of fish are directly proportional to the quantity of plankton (Chidambaram and Menon, 1945). Plankton is the most sensitive floating community which is being the first target of water pollution, thus any undesirable change in aquatic ecosystem affects diversity as well as biomass of this community. The major taxonomic groups Cyanophyceae, Chlorophyceae, Bacillariophyceae and Desmidisceae represented phytoplankton community and zooplankton community represented by Protozoa, Rotifera and two subclasses of Crustacea i.e. Cladocera and Copepoda. The river Chambal also exhibits similar condition harbouring a good planktonic flora. In India, Verma and Mohanty (2000), Saha *et al.,* (2000); Dwivedi and Pandey (2002); Khanna and Singh (2002) and Kiran *et al.,* (2002) made notable investigations as regards to phytoplankton. The status of phytoplankton in Rajasthan water were studied by Baghela *et al.,* (2007) and Sharma (2009; 2011). Another group of plankton such as zooplankton are heterogeneous assemblage of free floating microscopic animals. Among limnological parameters temperature, pH, dissolved oxygen and nutrients are known to control the production, composition and distribution of zooplankton (Bais and Agarwal, 1995).

Benthos comprise of those organisms living in or on sediments of water bodies. Liebmann (1942) claims that microscopic benthic organisms are true bio-indicators of pollution. Excellent works on Benthos have been done by notable workers viz. Mishra and Prasad (1997); Kumar *et al.,* (2006); Manoharan *et al.,* (2011). The present study enlightens that the seasonal variation of limnological parameters along with their interrelationship is important for checking the water quality for public water supply and fish production also. The present study also provides trophic status in biological point of view as well as the productive nature of the Rana Pratap Sagar dam and the Chambal river.

2. Materials and methods

2.1. Study sites

The Rana Pratap Sagar dam is the biggest reservoir which is constructed on the river Chambal at Rawatbhata Kota (Rajasthan) India (Fig. 1). It has water spread and catchment areas of 220 sq km and 27,840 sq km, respectively with gross and live storage of 2.3 mcft and 1.27 mcft respectively. The latitude, longitude and altitude of RPS dam is 24°55' 07.89" N 75°35' 04.83" E and 345.64 meter, msl respectively (Fig. 1). As the Chambal river flows first in northern direction in Madhya Pradesh for a length of about 346 km and then in north-east direction for a length of 225 km through Rajasthan, it creates a well integrated drainage system where the drainage channel forms the Dendritic pattern. The vast alluvial plains resulting from this drainage system has been highly dissected into gullies and ravines. Chambal river lies between latitudes 22° 27' N and 27° 20' N and longitudes 73° 20' E and 79° 15' E and height about 308.15 meter, msl (Fig. 1).

2.2. Water samples collection and analysis

To assess the water quality, the samples were collected from the fish landing station taken through boat in The Rana Pratap Sagar dam and near of chuliya fall at The Chambal river. Minimum two stations (both samples mix in each other) were marked in each water body for seasonal study. Seasonal sampling was made during winter, summer and monsoon for the years of 2008 and 2009. Field data like temperature, depth of visibility, pH, dissolved oxygen, water colour and total dissolved solid (TDS) were measured at the time of sampling. Air and water temperatures were measured using a thermometer (modal LCD portable digital multistem of -50^{o}C to 150^{o}C). Conductivity was estimated through Systronic' directed reading conductivity meter (308). Depth of visibility, pH, total dissolved solid (TDS) and dissolved oxygen was measured by the Sacchi disc method, digital pH meter (HANNA-pHep), digital (Hold) TDS meter and method as given by Ellis *et al.,* (1948). For the analysis of chloride, total alkalinity, hardness, phosphate and silicate, surface water samples were collected in clean polyethylene bottles from the sampling site and brought to the laboratory for analysis followed by APHA (1998) method. Primary production was estimate using by light and dark bottle method (Gaarder and Gran, 1927).

2.3. Collection and analysis of plankton and benthos

For plankton sampling, 50 liters of water was filtered through Henson's standard plankton net/25 no. bolting silk net. The samples collected were preserved in 70% alcohol on the spot. The samples were then brought into the laboratory for detailed examination. The aquatic insects and other benthic life were collected enclosing one square meter of stream bottom with square-meshed cloth. The bottom stones, gravel and sand were upturned to dislodge the aquatic life. Each animal was then brush picked and preserved in 5% formalin. To identify phytoplankton, zooplankton and benthos, the information was sought from the following references, Ward and Whipple (1992) and Edmondson (1992).For statically analysis simple correlation coefficient (r) was made for describing physico- chemical characteristics.

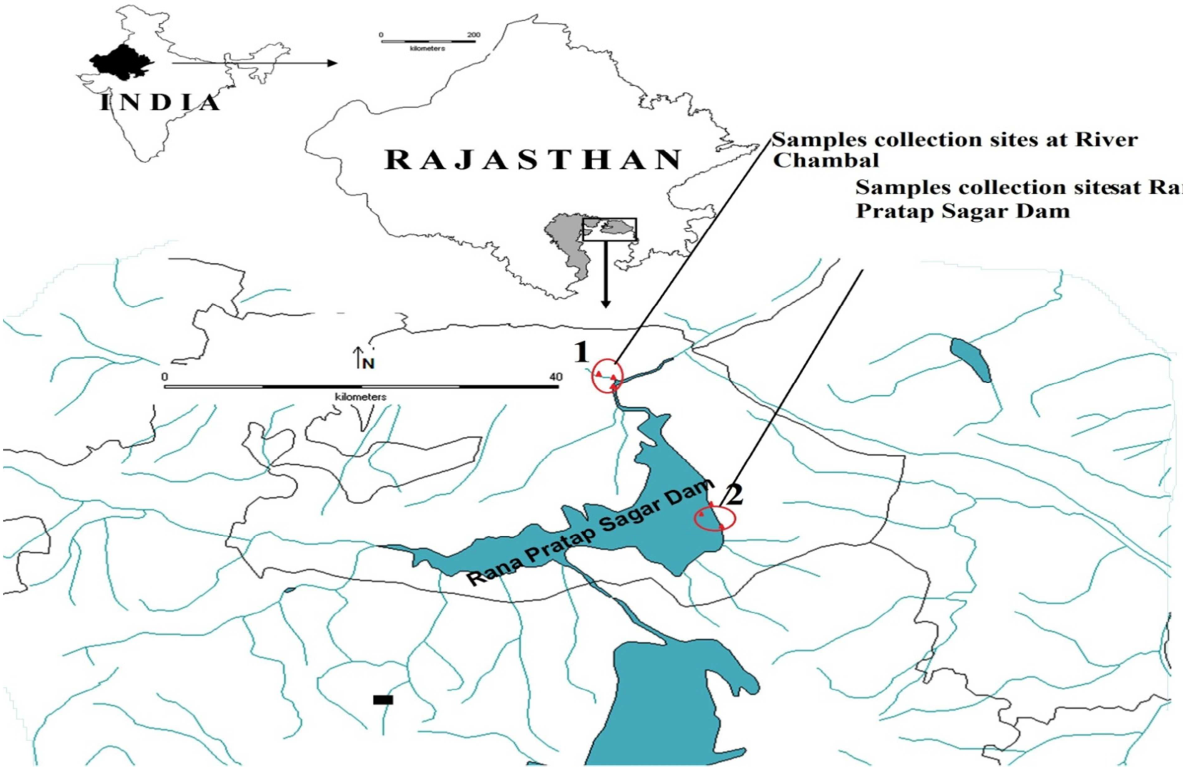

Fig. 1 Map showing sample collection sites for the research work.

3. Results and Discussion:

The physico-chemical characteristics provide a fair idea of the water quality in water bodies (Saksena *et al.,* 2008).

3.1. Physico-chemical analysis

The results and discussion of physico-chemical parameters and planktonic fauna of Chambal and Rana Pratap Sagar (RPS) dam are summarized in Table 1-4 and shown Figure 2-17. Temperature is a major factor, which governs chemical reactions and biological processes in a water body. In the present finding range of variation in air and water temperature at the site of the RPS dam (25.4-36.4, 19.6-28.4°C) and the Chambal river (25-36.4, 20.1-28.1°C) was similar to minimum and maximum mean value of air and water temperature 30.78 ± 4.91°C, 24.28 ± 3.68°C at the RPS dam and 30.83 ± 4.84°C, 24.46 ± 3.51°C in the Chambal river. Each species survive at an optimum temperature. Saksena *et al.,* (2008) and Sharma *et al.,* (2011) reported similar findings. Air and water temperature showed negative correlation with conductivity (r= -0.4442, -0.3016 at RPS dam and r= -0.3348, -0.1693 in Chambal river), depth of visibility (r= -0.2065, -0.3898 in RPS dam and r= -0.4664, -0.6007) and Gross primary production (r= - 0.7115, -0.8477 in the RPS and r= -0.9110, -0.09545 in Chambal river). Conductivity is a better index to measure trophic status of a water body; oligotrophic waters are characterized by poor electrical conductance, which shows lesser number of free ions, responsible for limiting effect on productivity. The monsoon season of 2009 showed the highest value of 231.6 µS/cm of conductance at the RPS dam and lowest value of 170.0 µS/cm was observed in summer 2009 in the Chambal river (Fig. 4). Saksena *et al.,* (2008) reported highest value of conductance of 884 µS/cm at the Chambal river. Conductivity showed positive correlation with TDS, dissolve oxygen and GPP at both water bodies whereas negative correlation showed with pH, hardness and nitrates (Table 2, 3).

Light penetration into a water body is influenced by turbidity and the extent of light penetration determines depth of euphotic zone in a water body. The depth of visibility gives first hand information regarding water quality (Sharma *et al.,* 2000). In the present study, the depth of visibility varied between a minimum in the monsoon of 146.3 cm to a maximum in winter of 191.0 at RPS dam, 163.0 cm to

204.0 cm in the Chambal river (Fig. 5). The depth of visibility showed a positive correlation with chloride, total hardness and primary productivity whereas negative relation with nitrate and phosphate (Table 2, 3). However, Sharma *et al.,* (2007) noted a positive relationship of visibility with GPP and NPP and negative correlation with chloride and nitrate. The depth of visibility showed a positive correlation with dissolved oxygen on the Chambal river and negative relation at the RPS dam.

In both water bodies (RPS dam and Chambal river) TDS ranged between 102 mg/l to 139 mg/l with the lowest reading in the summer of 2009 and higher during 2008 monsoon. In these water bodies TDS varied between 105.2 mg/l to 139 mg/l at the RPS dam with minimum and maximum mean values of 120.73 ± 13.72 mg/l and 102 mg/l to 133 mg/l in the Chambal river with mean values of 114.66 ± 11.2 mg/l. A high content of dissolved solids elevates the density of water and influences osmoregulation of freshwater organisms (Mishra and Saksena, 1993). During the study period water in these two bodies remained alkaline wherein values of pH fluctuated between 7.7 to 8.4 at the RPS dam with minimum and maximum mean values of 8.06 ± 0.25 and 7.7 to 8.2 in the river Chambal with mean values of 7.93 ± 0.18. Ranu (2001) observed pH between 7.1 and 9.9 in the Bandi river system. Seasonal variation revealed that during monsoon and winter, pH was low which was mainly attributed to addition of rain water, whereas during summer it was high. pH was found to have a positive correlation with alkalinity, hardness, chloride, nitrate, phosphate, and silicate at both water bodies (Table 2,3).

As depicted in the Tables 1 and Fig. 8, chloride concentration varied between 0.0170 mg/l to 0.329 mg/l at RPS dam (0.18 ± 0.10 mg/l), 0.00921 mg/l to 0.0228 mg/l (0.15 ± 0.0053 mg/l) in the river Chambal. Saksena *et al.,* (2008) reported a range of chloride between 15.62-80.94 at the Chambal river in years of 2003-04. Sinha (1988) opined that chloride content indicates domestic as well as industrial pollution. During the present study, chloride content showed positive correlation with temperature, pH, alkalinity, total hardness, nitrate, phosphate and productivity in both water bodies whereas, it has negative correlation (Table 2, 3) with dissolved oxygen (r= -0.6163), TDS (r= -0.7651) and electrical conductance (r= - 0.7653) at the RPS dam but in case of the Chambal river phosphate (r= - 0.5295) and nitrate (r= - 0.2418) shows the negative relation. Total alkalinity varied between a minimum of 80.1 mg/l recorded in Chambal river in monsoon and a maximum of 117 mg/l recorded in the RPS dam in summer season (Fig. 9). The minimum values of total alkalinity were observed during the monsoon months, the values increased during summer. Trivedy and Goel (1986) opined that alkalinity in itself is not harmful to human beings, however, waters with less than 100 mg/l alkalinity is desirable for domestic use. Total alkalinity showed a positive relationship with pH, total hardness, chloride, nitrate, phosphate, silicate and respiration in the RPS dam whereas in the Chambal river respiration shows the negative relation with alkalinity (r= - 0.1658).

Total hardness ranged between 122 mg/l to 203 mg/l (both RPS dam and Chambal river) during this investigation. The total hardness was high during summer, which gradually decreased in winter, the minimum values were found during monsoon season (Fig. 10). Waters with hardness up to 75 mg/l is termed soft waters while the waters with a hardness of more than 300 mg/l are considered hard. Saksena *et al.,* (2008) shows ranged between 42- 140 mg/l at the Chambal river during the study periods (2003-2004).Oxygen pressure in aquatic systems is temporally and spatially more variable than in air, and oxygen availability is therefore recognized as a key factor in aquatic ecology, affecting organism performance, community structure and local richness (Wetzel, 2001 and Kalff, 2002). The highest oxygen value of 8.2 mg/l was observed in winter season of 2008 and 2009 in the Chambal river (7.73 ± 0.51 mg/l), whereas, lowest oxygen value of 6.6 mg/l was observed in summer 2009 in RPS dam (7.43 ± 0.58 mg/l) (Fig. 11). The solubility of atmospheric oxygen in freshwater ranges from 14.0 mg/l at 0°C to about 7 mg/l at 35°C under one atmospheric pressure. The dissolved oxygen has an inverse correlation with total alkalinity (Pillai *et al.,* 1999).

Nitrates are important nutrients governed by geological conditions, organic load and rate of mineralization in water body. Nitrate is the highest oxidized form of nitrogen (Goldman and Horne, 1983). Nitrate plays an important role in the process of eutrophication and is enriched by domestic sewage and agricultural runoff coming from catchment area of the lake. High concentration of nitrate beyond 40 ppm is toxic (Gill *et al.,* 1984).

The lowest of 0.2251 mg/l value of nitrate in winter 2009 and a high of 0.4276 mg/l at summer 2008 were observed in the Chambal river (0.32 ± 0.078 mg/l). A clear trend can be seen with high nitrate content during summer which declines in winter and monsoon seasons (Fig. 12). This may be due to pouring in of the fertilizers from the catchment area. Phosphates are essential nutrients, which are known to contribute in the process of eutrophication when these are present in excessive concentration. In the present study maximum orthophosphate content of 0.5809 mg/l was observed during monsoon, 2009 at the RPS dam (0.38 ± 0.082 mg/l), whereas the minimum value of 0.237 mg/l was observed in winter season, 2009 in the Chambal river (0.42 ± 0.13 mg/l) (Fig. 13). Saksena *et al.,* (2008) reported lowest value (0.004 mg/l) in September and the highest value (0.050 mg/l) in October at the Chambal river. Higher values of phosphates in summer may be on account of reduced volume of water due to evaporation, the increased density of biota, which produces metabolic wastes, high water temperature and higher biodegradation releasing this nutrient from the sediment. In the present investigation, phosphate shows positive correlation with pH, chloride, total alkalinity, total hardness and nitrate but negative with conductivity and depth of visibility in both water bodies. Phosphate is positively related to TDS (r= -0.1548) in the Chambal river and negatively (r= -1428) in the RPS dam (Table 2, 3).

In the present investigation the RPS dam and the Chambal river showed the value of silicates ranged between 4.908mg/l to 5.771 mg/l (Table 1). The RPS dam showed silicate values to vary between 4.908 mg/l to 5.763 mg/l (5.30 ± 0.32 mg/l), the river Chambal between 5.079 mg/l to 5.771 mg/l (5.39 ± 0.28 mg/l) (Fig.14). It does not occur in nature as a free element. All the water bodies did not show increases in silicate values in summer as seen by Nair *et al.,* (1988). Russel Hunter (1970) classified water bodies on the basis of their productivity as Ultrologotrophic, Oligotrophic, Mesotrophic, Eutrophic and Hypereutrophic having a mean primary production range <50, 50-300, 250-1000, >1000 mg/m2/day respectively . The Chambal river since its impoundment in 1970 is in a continuous process of eutrophication. The same is with Rana Pratap Sagar dam, owing to its recent impoundment, it harbours poor planktonic flora and fauna thus is less productive. During the present investigation the value of NPP varied between 125 mgc/m2/hr to 187.5 mgc/m2/hr (153.64 ± 25.032 mgc/m2/hr) at RPS dam, 62.5 mgc/m2/hr to 135.41 mgc/m2/hr (101.56 ± 27.11 mgc/m2/hr) in the river Chambal. The GPP indicated variation between 218.75 mgc/m2/hr to 312.0 mgc/m2/hr with minimum and maximum mean value of 260.33 ± 36.39 mgc/m2/hr at RPS dam, 125 mgc/m2/hr to 270.83 mgc/m2/hr (180.51 ± 54.71 mgc/m2/hr) in the river Chambal. During the present study high primary productivity in winter months were recorded at the RPS dam as compare to the river Chambal. Sharma *et al.,* (2008) found out seasonal average value of the GPP 0.362, 0.449 and 0.285 gC/m3/hr for winter, summer and monsoon in the RPS dam.

Table 1 Analysis of physico-chemical parameters of the RPS dam and the Chambal river

Parameters	RPS Dam			Chambal river		
	Range of variation		Mean and SD	Range of variation		Mean and SD
	Min.	Max.		Min.	Max.	
Air Temperature (°C)	25.4	36.7	30.78 ± 4.91	25.0	36.4	30.83 ± 4.84
Water Temp. (°C)	19.6	28.4	24.28 ± 3.68	20.1	28.1	24.46 ± 3.51
Conductivity (μS/cm)	175.3	231.6	201.2 ± 22.87	170.0	221.6	191.08 ± 18.35
Depth of Visibility (cm)	146.3	191	171.63 ± 19.26	163.0	204.0	184.83 ± 15.36
Total Dissolved Solids (mg/l)	105.2	139	120.73 ± 13.72	102	133	114.66 ± 11.02
pH	7.7	8.4	8.06 ± 0.25	7.7	8.2	7.93 ± 0.18
Chlorides (mg/l)	0.017	0.329	0.18 ± 0.10	0.0092	0.022	0.015 ± 0.0053
Total Alkalinity (mg/l)	90	117	103.23 ± 10.64	80.1	110	95.06 ± 11.67
Total Hardness (mg/l)	122	167	148.83 ± 15.76	180	203	192 ± 8.60
Dissolved Oxygen (mg/l)	6.6	7.82	7.43 ± 0.58	7.0	8.2	7.73 ± 0.51
Nitrates (mg/l)	0.2279	0.3663	0.29 ± 0.055	0.225	0.427	0.32 ± 0.078
Phosphates (mg/l)	0.2752	0.4885	0.38 ± 0.082	0.237	0.58	0.42 ± 0.13
Silicates (mg/l)	4.9089	5.7632	5.30 ± 0.32	5.144	5.771	5.39 ± 0.28
GPP (mgc/m2/hr)	218.75	312	260.33 ± 36.39	125	270.83	180.51 ± 54.71
NPP (mgc/m2/hr)	125	187.5	153.64 ± 25.032	62.5	135.41	101.56 ± 27.11
Respiration (mgc/m2/hr)	78.125	156.25	118.75 ± 30.93	46.87	135.42s	80.64 ± 31.06

Fig. 2 : Air Temperature (ºC)

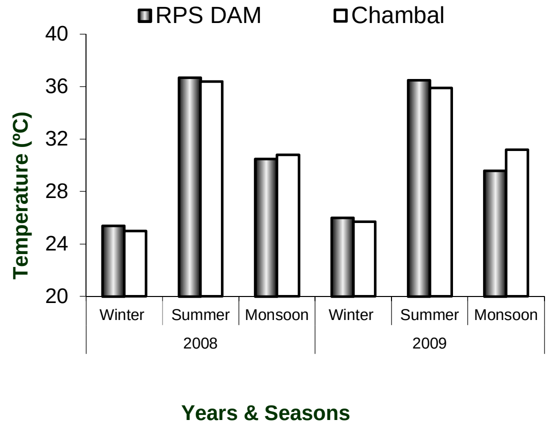

Fig. 3: Water Temperature (ºC)

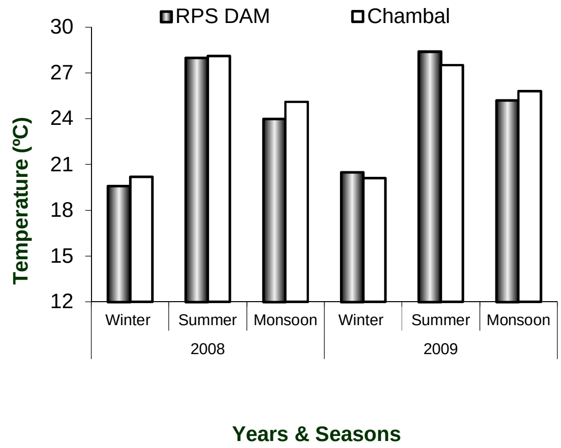

Fig. 4 : Conductivity

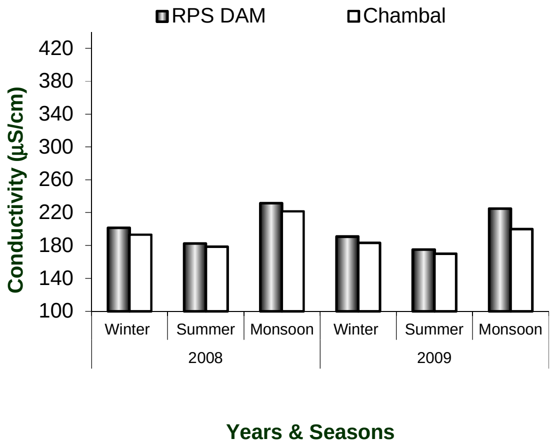

Fig. 5 : Depth of Visibility

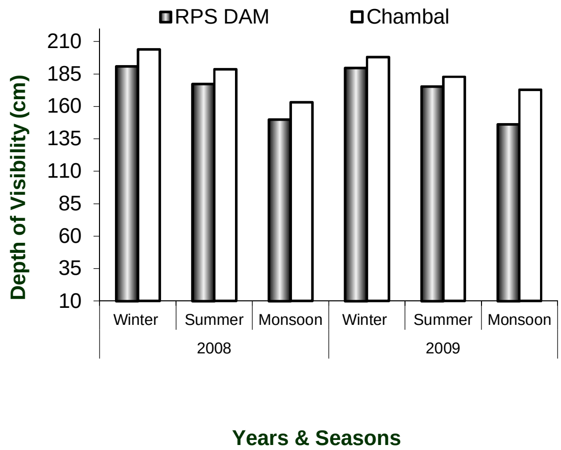

Fig. 6 : Total Dissolved Solids

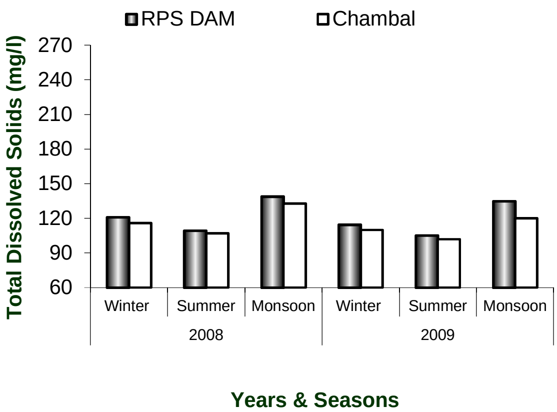

Fig. 7 : pH

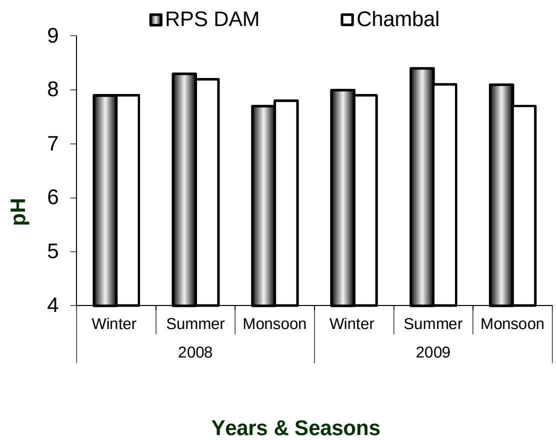

Fig. 8 : Chlorides

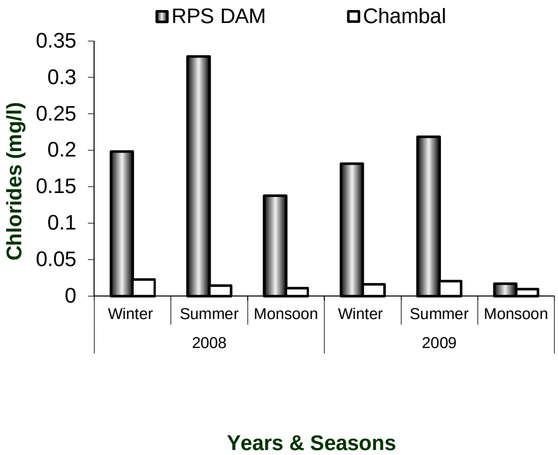

Fig. 9 : Total Alkalinity

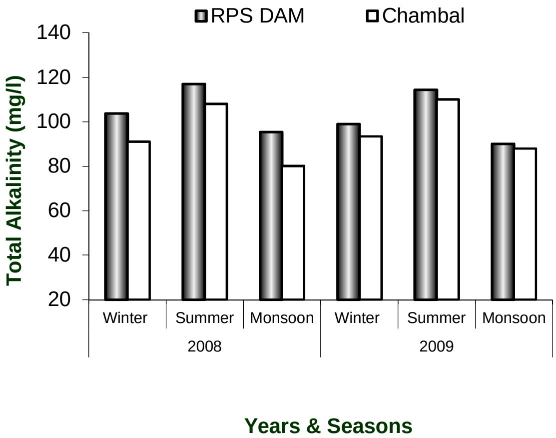

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Fig. 10 : Total Hardness

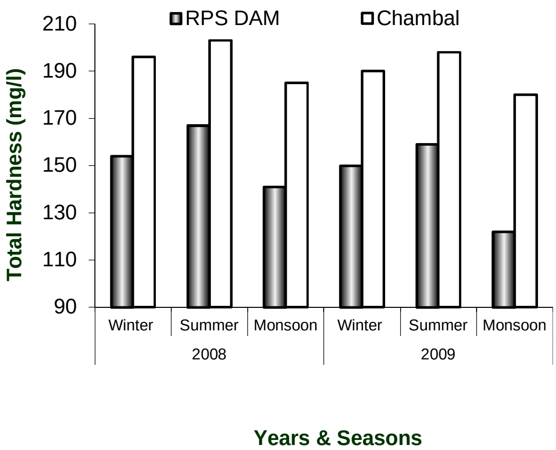

Fig. 11 : Dissolved Oxygen

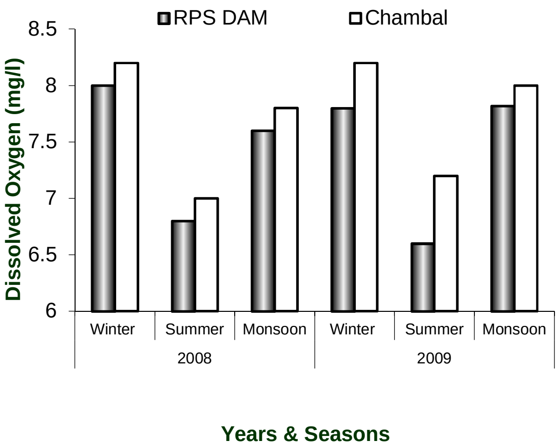

Fig. 12 : Nitrates

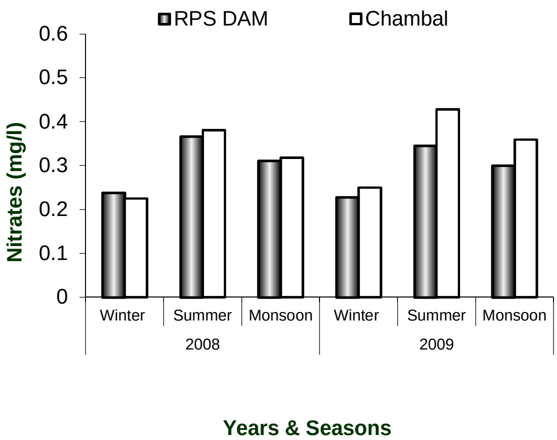

Fig. 13 : Orhthophosphates

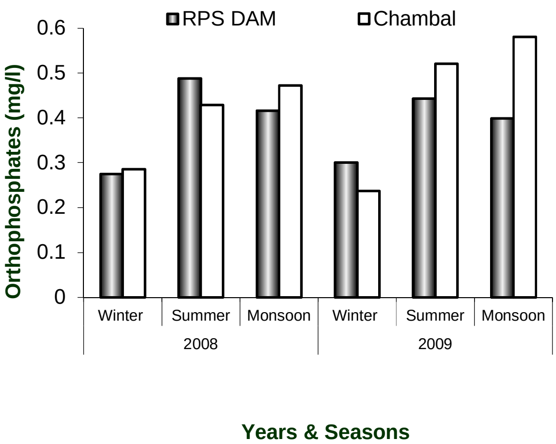

Fig. 14 : Silicates

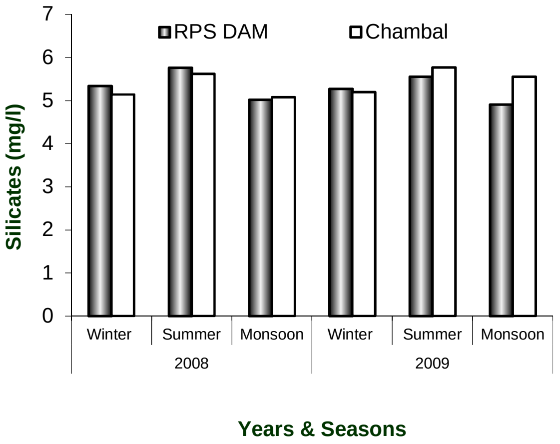

Fig. 15 : GPP

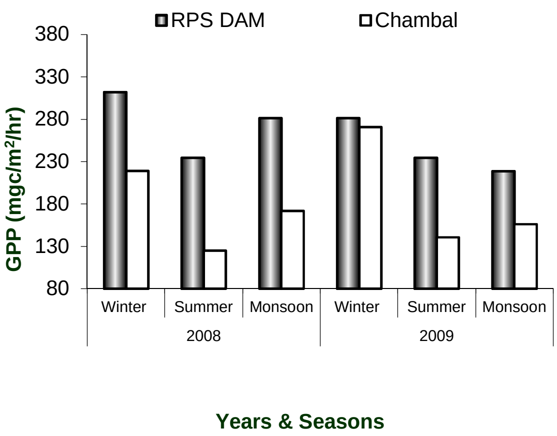

Fig. 16 : NPP

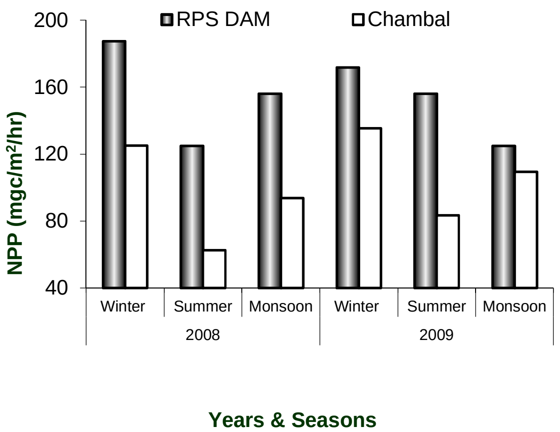

Fig. 17 : Respiration

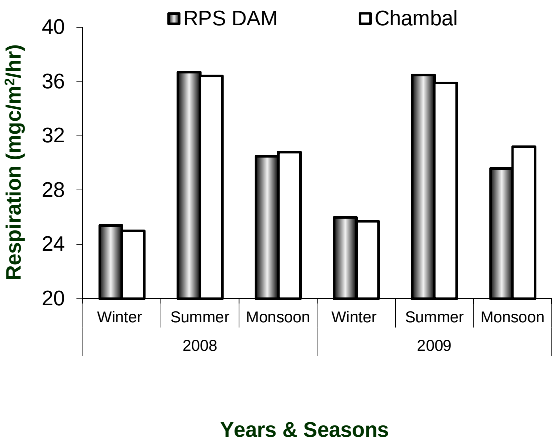

Fig. (2-17)- Physico-chemical characteristics of the RPS dam and the Chambal river.

3.2. Plankton

As depicted in Table 4 the phytoplanktonic community of the RPS dam was represented by seven groups viz. Myxophyceae (16.66%), Chlorophyceae (40%), Xanthophyceae (6.66%), Bacillariophyceae (23.33%), Euglenophyceae (3.33%), Dinophyceae (6.66%) and Chrysophyceae (3.33%). Total 30 forms were identified, out of these 5 belonged to Myxophyceae, 12 to Chlorophyceae, 2 to Xanthophyceae, 7 to Bacillariophyceae, 1 to Euglenophyceae, 2 to Dinophyceae and 1 to Chrysophyceae. Sharma *et al.,* (2008) reported 82 forms of phytoplanktons during the study.

The zooplankton in the Rana Pratap Sagar dam are enlisted in the Table 5 with their classification. The reservoir's zooplankton community was represented by four groups viz. Rotifera (38.88%), Ostracoda (11.11%), Cladoceran (33.33%) and Copepoda (16.66%). Total 18 forms were identified, out of these 7 belonged to Rotifera, 2 to Ostracoda, 6 to Cladocera and 3 to Copepoda. Sharma *et al.,* (2008) reported 63 forms of zooplankton during the study. As depicted in Table 4 the phytoplanktonic community of the river Chambal was represented by six groups viz. Myxophyceae (20%), Chlorophyceae (44%), Xanthophyceae (4%), Bacillariophyceae (20%), Euglenophyceae (8%) and Chrysophyceae (4%).

A total of 25 forms was identified out of which 5 belonged to Myxophyceae, 11 Chlorophyceae, 1 to Xanthophyceae, 5 to Bacillariophyceae, 2 to Euglenophyceae and 1 to Chrysophyceae. The zooplankton community of the river Chambal is enlisted in the Table 5. It comprises of five groups viz. Protozoans (19.04%), Rotifera (33.33%), Ostracoda (9.52%), Cladocera (19.04%), and Copepoda (19.04%). Total 21 forms were found out, out of which 4 belonged to the Protozoa, 7 belonged to Rotifera, 2 to Ostracoda, 4 to Cladocera and 4 to Copepoda.

Table 4 Phytoplanktons inhabiting the Rana Pratap Sagar and the Chambal river

The RanaPratapSagar			**The Chambal river**		
Myxophyceae (Blue-green algae)	**Chlorophyceae**	**Xanthophyceae**	**Myxophyceae (Blue-green algae)**	**Chlorophyceae**	**Xanthophyceae**
Oscillatoria sp.	*Pediastrum sp.*	*Trobonema sp.*	*Oscillatoria sp.*	*Volvox sp.*	*Trobonema sp.*
Microcystis sp.	*Scenedesmus sp.*	*Botryococcus sp.*	*Microcystis sp.*	*Oedogonium sp.*	**Bacillariophyceae (Diatoms)**
Phormidium sp.	*Closterium sp.*	**Bacillariophyceae (Diatoms)**	*Phormidium sp.*	*Spirogyra sp.*	*Melosira sp.*
Nostoc sp.	*Euastrum sp.*	*Melosira sp.*	Nostoc sp.	*Ulothrix sp.*	*Nitzschia sp.*
Anabaena sp.	*Cosmarium sp.*	*Nitzschia sp.*	Anabaena sp.	*Chlorella sp.*	*Cyclotella sp.*
Euglenophyceae	*Panium sp.*	*Ophephora sp.*	**Euglenophyceae**	*Pediastrum sp.*	*Pinnularia sp.*
Euglena sp.	*Ulothrix sp.*	*Cymbella sp.*	*Euglena sp.*	*Scenedesmus sp.*	*Tabellaria sp.*
Dinophyceae	*Ankistrodurmus sp.*	*Cyclotella sp.*	*Phacus sp.*	*Closterium sp.*	**Chrysophyceae**
Ceratium sp.	*Chlorella sp.*	*Synedra sp.*		*Cosmarium sp.*	*Chromulina sp.*
Gymnodium sp.	*Volvox sp.*	*Navicula sp.*		*Panium sp.*	
Chrysophyceae	*Oedogonium sp.*			*Chlorella sp.*	
Chromulina sp.	*Spirogyra sp.*				

Table 5 Zooplankton inhabiting the Rana Pratap Sagar and the Chambal river

The RanaPratapSagar			**The Chambal river**		
Rotifera	**Ostracoda**	**Cladocerans**	**Protozoans**	**Rotifera**	**Ostracoda**
Brachionus sp.	*Cypris sp.*	*Daphnia sp.*	*Arcella sp.*	*Brachionus sp.*	*Cyprio sp.*
Keratella sp.	*Centrocypris sp.*	*Moina sp.*	*Difflugia sp.*	*Keratella sp.*	*Centrocypris sp.*
Lepadella sp.	**Copepoda**	*Ceriodaphnia sp.*	*Phacus sp.*	*Filina sp.*	**Copepoda**
Lecane sp.	*Mesocyclops sp.*	*Diaphanosoma sp.*	*Actinophrys sp.*	*Monostyla sp.*	*Rhinodiaptomus sp.*
Filina sp.	*Cyclops sp.*	*Pleurocus sp.*	**Cladocerans**	*Asplanca sp.*	*Cyclops sp.*
Mytilina sp.	*Rhinodiaptomus sp.*	*Nauplii sp.*	*Daphnia sp.*	*Mytilina sp.*	*Mesocyclops sp.*
Monostyla sp.			*Ceriodaphnia sp.*	*Lecane sp.*	*Heliodiaptomus sp.*
			Diaphanosoma sp.		
			Alona sp.		

Table 6 Benthos inhabiting the Rana Pratap Sagar and the Chambal river

The RanaPratapSagar				The Chambal river		
Oligocaeta	**Hirudinea**	**Gastropoda**		**Oligochaeta**	**Hirudinea**	**Gastropoda**
Tubifex sp.	*Hirudinaria sp.*	*Pila sp.*		*Chaetogaster sp.*	*Hirudinaria sp.*	*Pila sp.*
Chaetogaster sp.	**Ephemeroptera**	*Lymnaea sp.*		*Tubifex sp.*	**Ephemeroptera**	*Lymnaea sp.*
Nais sp.	*Cinygmula sp.*	*Planorbis sp.*		*Nais sp.*	*Ephemerella sp.*	*Planorbis sp.*
Lumbriculus sp.	*Leptophlebia sp.*	*Limax sp.*		*Limnodrilus sp.*	*Centroptilum sp.*	*Vivipara sp.*
Limnodrilus sp.	*Heptagenia sp.*	*Vivipara sp.*		**Diptera**	*Heptagenia sp.*	*Limax sp.*
Diptera	*Centroptilum sp.*	*Gyraulus sp.*		*Pentaneura sp.*	*Cinygmula sp.*	*Parathelpusa sp.*
Simulium sp.		**Bivalvia**		*Simulium sp.*	*Leptophlebiasp.*	**Coleoptera**
Chironomous sp.		*Unio sp.*		*Tabanus sp.*	**Bivalvia**	*Psephenus sp.*
Pentaneura sp.		*Lamellidens sp.*		*Antocha sp.*	*Unio sp.*	*Ectopria sp.*
Culex larva sp.						

Table 7 Comparison of physico-chemical parameters of the Rana Pratap Sagar dam and the Chambal river with that of Indian standards and WHO

S. No.	Parameters	Present study on the RPS dam	Present study on the Chambal river	IS-2296: 1974			WHO
				Public water supply	Fish culture	Irrigation	Limit
1.	Electrical conductivity (µS/ cm)	175.3 – 231.6	170 – 221.6	-	1000	-	-
2.	Total dissolved solids (mg/l)	105.2 - 139	102 - 133	500	-	2100.00	1000
3.	pH	7.7 – 8.4	7.7 – 8.2	6 - 9	6 – 9	5.50-9.00	6.5-8.5
4.	Dissolved oxygen (mg/l)	6.6 – 7.82	7.0 – 8.0	> 4	>3	-	-
5.	Total alkalinity (mg/l)	90 - 117	80.1 – 110	200 – 600 (IS-10500:1991)	-	-	-
6.	Total hardness (mg/1)	122 - 167	180 - 203	300 – 600 (IS-10500:1991)	-	-	500
7.	Chlorides (mg/l)	0.017- 0.329	0.0092 – 0.022	600	-	600	250
8.	Nitrates (mg/l)	0.2279-0.3663	0.225 – 0.427	50	-	-	10

Table 2: Statistical correlation matrix amongst different parameters at the RPS dam.

	Air Temperature (°C)	Water Temp. (°C)	Water Current	Conductivity (µS/cm)	Depth of Visibility (cm)	Total Dissolved Solids (mg/l)	pH	Chlorides (mg/l)	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Dissolved Oxygen (mg/l)	Nitrates (mg/l)	Phosphates (mg/l)	Silicates (mg/l)	GPP (mgc/m2/hr)	NPP (mgc/m2/hr)	Respiration (mgc/m2/hr)
Air Temperature (°C)	1.0000	0.968	-	-0.4442	-0.2065	-0.4440	0.7190	0.4759	0.6886	0.4285	-0.9556	0.9662	0.9377	0.5878	-0.7115	-0.6348	0.0283
Water Temp. (°C)		1.000	-	-0.3016	-0.3898	-0.3016	0.7159	0.2552	0.5130	0.2009	-0.8785	0.9649	0.9560	0.4049	-0.8477	-0.7592	-0.0937
Conductivity (µS/cm)				1.0000	-0.7445	1.0000	-0.7712	-0.7653	-0.8655	-0.8256	0.6588	-0.2168	-0.1429	-0.8962	0.1494	-0.1048	0.2276
Depth of Visibility (cm)					1.0000	-0.7444	0.2130	0.6536	0.5460	0.7337	-0.0479	-0.4042	-0.4832	0.6481	0.4927	0.6210	-0.0104
Total Dissolved Solids (mg/l)						1.0000	-0.7715	-0.7651	-0.8653	-0.8253	0.6586	-0.2166	-0.1428	-0.8961	0.1499	-0.1043	0.2278
pH							1.0000	0.4123	0.6939	0.4258	-0.7808	0.5781	0.5268	0.6721	-0.7189	-0.4513	-0.4382
Chlorides (mg/l)								1.0000	0.9117	0.9793	-0.6163	0.3463	0.2777	0.9464	0.1086	0.0824	0.4339
Total Alkalinity (mg/l)									1.0000	0.9254	-0.8197	0.5403	0.4389	0.9787	-0.1666	-0.0512	0.1186
Total Hardness (mg/l)										1.0000	-0.6107	0.2675	0.1798	0.9453	0.1770	0.2283	0.2934
Dissolved Oxygen (mg/l)											1.0000	-0.8501	-0.8059	-0.7315	0.5836	0.4240	0.0632
Nitrates (mg/l)												1.0000	0.9821	0.4306	-0.7257	-0.7381	0.1476
Phosphates (mg/l)													1.0000	0.3440	-0.7665	-0.8078	0.1739
Silicates (mg/l)														1.0000	-0.1150	-0.0314	0.1725
GPP															1.0000	0.8896	0.3377
NPP																1.0000	-0.0883
Respiration																	1.0000

Table 3: Statistical correlation matrix amongst different parameters at the Chambal river.

	Air Temperature (°C)	Water Temp. (°C)	Water Current (cm/sec)	Conductivity (µS/cm)	Depth of Visibility (cm)	Total Dissolved Solids (mg/l)	pH	Chlorides (mg/l)	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Dissolved Oxygen (mg/l)	Nitrates (mg/l)	Phosphates (mg/l)	Silicates (mg/l)	GPP (mgc/m2/hr)	NPP (mgc/m2/hr)	Respiration (mgc/m2/hr)
Air Temperature (°C)	1.0000	0.9793	-	-0.3348	-0.4665	-0.3349	0.5799	-0.2182	0.6276	0.3573	-0.9446	0.9590	0.7190	0.8161	-0.9110	-0.9405	-0.7160
Water Temp. (°C)		1.0000	-	-0.1693	-0.6007	-0.1696	0.4174	-0.3626	0.4758	0.1943	-0.8714	0.9537	0.8279	0.7680	-0.9545	-0.9219	-0.8200
Conductivity (µS/cm)				1.0000	-0.5926	1.0000	-0.7542	-0.5881	-0.928	-0.713	0.4734	-0.339	0.1555	-0.680	0.0897	0.2024	-0.0917
Depth of Visibility (cm)					1.0000	-0.5923	0.3680	0.7746	0.3649	0.5676	0.2237	-0.528	-0.798	-0.107	0.5442	0.4163	0.5845
Total Dissolved Solids (mg/l)						1.0000	-0.7537	-0.5878	-0.928	-0.7130	0.4732	-0.340	0.1548	-0.681	0.0900	0.2022	-0.0911
pH							1.0000	0.4948	0.8971	0.9490	-0.8043	0.4250	-0.117	0.5339	-0.3704	-0.6397	-0.0385
Chlorides (mg/l)								1.0000	0.4803	0.6877	-0.0204	-0.241	-0.529	0.0302	0.2719	0.1771	0.3799
Total Alkalinity (mg/l)									1.0000	0.8116	-0.7611	0.5818	0.0703	0.7992	-0.4108	-0.5459	-0.1658
Total Hardness (mg/l)										1.0000	-0.6303	0.1861	-0.305	0.3602	-0.2223	-0.4734	0.0642
Dissolved Oxygen (mg/l)											1.0000	-0.837	-0.466	-0.744	0.8131	0.9523	0.5351
Nitrates (mg/l)												1.0000	0.8209	0.8749	-0.8696	-0.8142	-0.7367
Phosphates (mg/l)													1.0000	0.6090	-0.8312	-0.5858	-0.9026
Silicates (mg/l)														1.0000	-0.7097	-0.6277	-0.6171
GPP															1.0000	0.9067	0.9221
NPP																1.0000	0.6811
Respiration																	1.0000

3.3. Benthic fauna

The benthic community of Rana Pratap Sagar is listed in the Table 6. It comprises *Tubifex sp., Chaetogaster sp., Nais sp., Lumbriculus sp.* and *Limnodrilus sp*. of the class Oligocheta (22.72%); *Pila sp., Lymnaea sp., Planorbis sp., Limax sp., Vivipara sp.* and *Gyraulus sp.* of the class Gastropoda (27.27%); *Unio sp.* and *Lamellidens sp.* of Bivalvia (9.90%); *Simulium sp., Chironomous sp., Pentaneura sp.* and *Culex larva sp.* of Diptera (18.18%); *Cinygmula sp., Leptophlebia sp., Heptagenia sp.* and *Centroptilum sp.* of Ephemeroptera (18.11%) and *Hirudinaria sp.* of Hirudinea class (4.54%). The presence of *Limnodrillush offmeisteri* is regarded as the bioindicator of pollution (Brinkhurst, 1963). Mohammad (1979) and Singh *et al.,* (2002) also collected *Limnodrillus sp.* and *Tubifex sp*. from mildly and highly polluted waters. The benthic community of the river Chambal is enlisted in the Table 6. It comprises of *Chaetogaster sp., Tubifex sp., Nais sp.* and *Limnodrilus sp.* of class Oligochaeta (17.39%); *Hirudinaria sp.* of Hirudinea (4.34%); *Pila sp., Lymnaea sp., Planorbis sp., Vivipara sp., Limax sp.* and *Parathelpusa sp.* of the class Gastropoda (26.8%); *Unio sp.* of Bivalvia (4.34%); *Pentaneura sp., Simulium sp., Tabanus sp.* and *Antocha sp.* of Diptera (17.39%); *Ephemerella sp., Centroptilum sp., Heptagenia sp., Cinygmula sp.* and *Leptophlebia sp.* of Ephemeroptera (21.73%) and *Psephenus sp.* and *Ectopria sp.* of Coleoptera (8.69%).

4. Conclusion:

In the aforementioned work physico-chemical parameters of water bodies *viz* pH, TDS, hardness, total alkalinity, depth of visibility, chloride, phosphate, silicate and nitrates of the water samples analyzed from the samples drawn from the RPS dam and the Chambal river were well within the permissible limits for drinking water recommended by WHO (1984) and Indian Standard limits (Table 7). Phytoplankton, zooplankton and benthic fauna were present in moderate condition furthermore steps are required to conserve the flora and fauna. The RPS dam and the Chambal river were also found suitable for irrigation without further treatment.

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References:

1) APHA. (1998): Standard methods for the examination of water and wastewater. 20th edition Am. Public Health Assoc. Washington, D.C.
2) Arunachalam, M., Nair, M.K.C., Vijverberg, J. and Suryanarayanan, H. (1991): Substrate selection and seasonal variation in densities of invertebrates in stream pools of a tropical river. *Hydrobiologia*, 213: 141-148.
3) Baghela, B.S., Sharma, M.S., Sharma, V., Malara, H. and Sharma, R. (2007): Studies on composition of zooplanktonic fauna in relation to salinity changes. Proceedings Taal 2007, 12th World Lake Conference.
4) Brinkhurst, R.O. (1963): Taxonomic studies on the Tubificids (Annelida, Oligochaeta). *Int. Rev. GesamtemHydrobiol. Syst. Beih.,* 2: 7-89.
5) Burton, T.M. and Sivaramakrishanan, K.G. (1993): Composition of the insect community in the streams of the Silent Valley National Park in Southern India. *Trop. Ecol.,* 34: 1-16.
6) Chidambaram, K. and Menon, M.D. (1945): The correlation of the west coast (Malawar and Canara) fisheries with plankton and certain oceanographical factors. *Proceedings of the Indian Acadmy of Science*, B22: 355-367.
7) Dwivedi, B.K. and Pandey, G.C. (2002): Physico-chemical factors and algal diversity of two ponds (GirijaKund and Maqubara Pond) Faizabad, India. *Pollut. Res.,* 21(3): 361-370.
8) Edmondson, W.T. (1992): Freshwater biology. Second Eds., John Wiley and Sons. Inc., New York. pp 1248.
9) Ellis, M.M., Westfall, B.A. and Ellis, M.O. (1948): Determination of water quality. Fish and Wild life Service, United States Department of the interior. pp 122.
10) Gaarder, T. and Grann, H.H. (1927): Production of plankton in Ostofiard Rapp. *Proc. Verb. Cous. Pern. Int. Frplor.,* 42: 9-48.
11) Gilli, G., Corrao, G. and Favilli, S. (1984): Concentrations of nitrate in drinking water and incidence of gastric carcinomas, first descriptive study of the Piermente Region. *Italy Sci. Total Env.,* 34: 34-57.

12) Goldman, C.R. and Horne. (1983): Limnology. McGraw Hill International Book Company. I.S.E., pp 464.
13) Hulyal, S.B. and Kaliwal, B.B. (2008): Water quality assessment of AlmattiReservior of Bijapur (Karnataka State, India) with special reference to Zooplankton. *Env. Mon. Assess.,* 139: 299-306, DOI 10.1007/s10661-007-9.
14) Jain, S.K., Pushpendra, K., Agarwal., V. and Singh, P. (2007): Hydrology and water resources of India- Volume 57 of Water science and technology library - Tributaries of Yamuna river. Springer, pp 350.
15) Johal, M.S., Tandon, K.K., Rawal, Y.K., Tyor, A.K., Banyal, H.S. and Rumana, H.S. (2000): Species richness of fish in relation to environmental factors. *Curr. Sci.,* 80(4): 499-501.
16) Khanna, D.R., and Singh, S. (2002): Pond fish ecology and economics. Daya Publ. House. Delhi., pp86.
17) Kiran, B.R., Kumara, V., Shanmukh, D. and Puttaiah, E.T. (2002): Phytoplanktonic composition in Jannapura Pond, Near Bhadravathi town (Karnataka). *Geobios.,* 29 (2-3): 89-92.
18) Kulshrestha, S.K., Adholia, U.N. and Bhatnagar, A. (1992): Zooplankton community of river chambal and its tributaries with special reference to industrial pollution. *Intern. J. Environ. Stud.,* 40: 207-216.
19) Kumar, A., Qureshi, T.A. and Alka, P. (2006): Biodiversity assessment of macroinvertebretes in RanjitSagar reservoir, Jammu, J&K, India. *J. Aqu. Biol.,* 21(2): 39-44.
20) Manoharan, J., Varadharajan, D., Thilagavathi, B. and Priyadharsini, S. (2011): Biodiversity and abundance of benthos along the South East Coast of India. *Adv. Appl. Sci. Res.,* 2 (6): 554-562.
21) Mishra, M.K. and Prasad, S. (1997): Production of molluscs in a tropical wetland of North Bihar. *J. Freshwat. Biol.,* 9(3, 4): 122-124.
22) Mishra, S.R. and Saksena, D.N. (1993): Planktonic fauna in relation to physico-chemical characteristics of Gauri tank at Bhind, M.P. India. Advanus in limnology Narendra Publishing House. New Delhi, pp. 57-61.
23) MohmadMurad, B.M. (1979): Annual cycle of some cladocerans in a polluted stream. *Environ. Hoth.,* 8(1): 6-35.
24) Nair, M.S.R., Seth, O.N. and Mishra, K.D. (1988): Limnological studies on a village pond, India (Vidisha). Physico-chemical characteristics, Past, Present and Future of Bhopal Lakes. Proc. Nat. Symp.
25) Neera, S., Garima, H. and Rama, S. (2009): A study of physico-chemical characteristics of lakes around Jaipur. India. *J. Env. Biol.,* 30(5): 889-894.
26) Pathak, J.K. and Bhatt S.D. (1993): Physico-chemical characteristics of three major riverine water bodies in the uplands of Kumaun, central Himalaya. In, Singh, H.R. (Ed.) Advances in Limnology, Narendra Publishing House. Delhi., pp 145-168.
27) Pillai, A., Pandy, P. and Shukla, A. (1999): Physico-chemical studies of drinkinge water of Durg Municipality. *Pollut. Res.,* 18(1): 49-51.
28) Rajagopal, T., Thangamani, A. and Archunan, G. (2010): Comparison of physico-chemical parameters and phytoplankton species diversity of two perennial ponds in Sattur area, Tamil Nadu. *J. Env. Biol.,* 31(5): 787-794.
29) Ranu. (2001): Studies on toxicity of textile effluents to fresh water zooplankton. Ph.D. thesis, MLSU, Udaipur (Raj.) India.
30) Russel-Hunter, W.D. (1970): Aquatic productivity. Macmillin London., pp 3.
31) Saha, S.B., Bhattacharya, S.B. and Choudhary, A. (2000): Diversity of phytoplankton of a sewage polluted brakish water tidal ecosystems. *J. Env. Biol.,* 21(1): 9-14.
32) Saksena, D.N., Garg, R.K. and Rao, R.J. (2008): Water quality and pollution status of Chambal river in National Chambal sanctuary, Madhya Pradesh. *J. Env. Biol.,* 29(5): 701-710.
33) Shailendra, S., Vibha, J., Sushama, K. and Singhvi, M.S. (2010): Biodiversity And Abundance Of Benthic Macroinvertebrates Commiunity Of Kishanpura Lake, Indore (M.P.) India. *Poll. Res.,* 2(10): 57-67.
34) Sharma, M.S. and Durve, V.S. (1985). Morphological distribution and behavioural patterns of zooplankton in Rajasthan water. *J .Anim. Morphol. Physiol.,* 321(2): 161-170.
35) Sharma, M.S., Sharma, L.L. and Durve, V.S., (1984): Eutrophication of lake Pichhola in Udaipur, Rajasthan. *Poll. Res.,* 3(2): 39-44.

36) Sharma, M.S., Sumitra, M., Sharma, V., Malara, H. and Sharma, R. (2007): Eutropication process in an urban lake system of Udaipur. Nat. Symp. Limnol., pp 31.
37) Sharma, R., Sharma, V., Sharma, M.S., Verma, B.K., Modi, R. and Gaur, K.S. (2011): Studies on Limnological Characteristic, Planktonic Diversity and Fishes (Species) in Lake Pichhola, Udaipur, Rajasthan (India). *Uni. J. Env. Res. Technol.,* 1(3): 274-285.
38) Sharma, V., Sharma, R., Malara, H. and Sharma, M.S (2009): Zooplanktonic diversity and trophic status of Mahi dam in relation to physico – Chemical characteristics of its water. *Poll. Res.,* 28(4): 571–576.
39) Sharma, V., Verma, B.K. and Sharma M.S. (2012): Zooplanktonic Fauna in Relation to Physico-Chemical Characteristics in Madar Tank, Udaipur, Rajasthan, India. *Int. Res. J. Env. Sci.,* 1(3): 5-10.
40) Sharma, V., verma, B.K., Sharma, M.S. and Gaur, K.S. (2012): A report on the freshwater Cladocera (Crustacea, Branchiopoda) of south Rajasthan (India). *Int. J. Env. Sci.,* 3(1): 276-296.
41) Singh, B.K., Singh, S.K. and Singh, B.B. (2002): Distribution and Seasonal abundance of Benthicmacroinvertebrate in the 'Bisarsarovar' – a Pond of Gaya. *Bihar J. Env. Zool.,* 16(2): 139-150.
42) Sinha, M.P. (1988): Effect of waste disposal on water quality of river Damodar in Bihar. Physico-chemical characteristics. In Ecology and Pollution in Indian rivers (Ed. R.K. Trivedi). pp. 216-246.
43) Sivaramakrishanan, K.G., Venkataraman, K., Sridhar, S. and Marimuthu, S. (1995): Spatial patterns of benthic macro-invertebrate distributions along River Kaveri and its tributaries (India). *Int. J. Ecol. Env. Sci.,* 21: 141-161.
44) Smita, Jain. (2009): Assessment of water quality at the three Stations of Chambal River. *Int. J. Env. Sci.,* 3(2): 881-884.
45) Thibert, S. (1994): Exportations naturelles of anthropiquos des ion majeurset des elements nutritifsdans le bassn de la Seine. These de doctorate de l' Univ-de Paris VI., pp204.
46) Trivedi, R.K. and Goel, P.K. (1986): Chemical and biological methods for water pollution studies. Environmental Publication, Karad. India, pp. 1-171.
47) Verma, J.P. and Mohanty, R.C. (2000): Bioindicators of some rural water bodies of Puri district, Orissa. The fifth Indian Fisheries Forum, CIFA, Kausalyaganga, Bhubaneshwar, India.
48) Verma, P.C., Sharma, L.L. and Hegde, A.G. (2008): Aquatic Biodiversity of RanaPratapSagar Lake. Proceedings Taal 2007, 12th World Lake Conference., pp1967-1970.
49) Verma, P.K. and Munshi, D. (1987): Plankton community structure of Badua reservoir, Bhagalpur (India). *Trop. Ecol.,* 28: 200-207.
50) Ward, H.B. and Whipple, G.C. (1992): Fresh water biology (second edition, Edmondson, W.T.) Int. Books Periodicals supply service, New Delhi.
51) Wetzel, R.G. (2001): Limnology, Lake and river ecosystems. Academic Press, New York.
52) WHO. (1984). Guidelines of Drinking Water Quality in Health Criteria and Other Supporting Information. pp 336.