

## COMPARATIVE ANALYSIS OF WATER QUALITY OF DIFFERENT GHATS OF PUSHKAR LAKE FOR TWO DECADES

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### ABSTRACT

Pushkar Lake situated in the pilgrim town of Pushkar has been the main source of livelihood for the residents of this town. It is facing multifold pressure due to domestic and agricultural discharge, intermixing of storm and sewage water and congestion of areas in and around the lake. Different ghats of the lake exhibited variations in physicochemical parameters through a period of two decades. The temperature of water varied between 15°-41° during 1989-1990 and has reached a range of 15° to 42° during 2009-10. The average pH values for 1989-90 were 7.2-7.9, 2000-01 was 7.7-7.96 and 2009-10 was 7.5-7.8. Values in lake water varied from 0.32 µmhos/cm in 1989-1990, in 2000-01 EC was 0.42 to 0.44 µmhos/cm and in 2009-10 was 0.37-0.44 µmhos/cm. Similarly total alkalinity was also found to increase from 104 mg/L in 1989-90, 135 in 2000-01 to 140 mg/L in 2009-10. Sodium levels were found to be as high as 50 mg/L during 2009-10 from 36 mg/L in 1989-90. Potassium level on Gau ghat and Saptarishi ghat was found to be 9.0 mg/L and 9.1mg/L during 2009-10. The Biological oxygen demand (BOD) had also been found to increase from 3.7 in 1989-90 to 4.8 mg/L in 2009-10. The amount of chlorides also increased from 16 mg/L in 1989-90, 70 in 2000-01 to 50 mg/L in 2009-10. The amount of Sulphate was found to increase from 32.9mg/L to 50.1 mg/L. Phosphate levels were found to be as high as 1.20 mg/L in 2009-10 from 0.02 mg/L in 1989-90. Dissolved oxygen was also found to be declining from in 1989-90, 4.8 in 2000-01 to 4.70 mg/L in 2009-2010. The Biological oxygen demand (BOD) has also been found to increase from 3.7- 4.4 in 1989-90, 4.2- 4.7 in 2000-01 to 4.7-5.4 mg/L in 2009-10. The fluoride levels were found to increase from 0.04 in 1989-90, 0.35 in 2000-01 to .040 in 2009-10. Besides pesticide residues were also found in trace amounts in the water samples. Most of the parameters were found to be slightly higher than the IS permissible-limit (IS-10500:1991).

### INTRODUCTION

Almost 70% of the water in India has become polluted due to discharge of domestic sewage and industrial effluents into natural water source such as rivers, streams and lakes (Sangu and Sharma 1987). The lakes and reservoirs all over the country are in varying degrees of environmental degradation (Reddy and Char 2004). The Pushkar Lake is one such pilgrim lake which is central to all tourist activities in the town of Pushkar. A variety of environmental goods and services provided by lakes make them vulnerable to human demand. Society's demands for economic gains have contributed to the deterioration of water quality and aesthetic value of lakes (Ranade 2008). Sustainability of Pushkar is by and large dependant on the lake. The improper management of water systems may cause serious problems in availability and quality of water (Subba Rao and Subba Rao 1995). In our country 70% of the water is seriously polluted and 75% of illness

and 80% of the child mortality is attributed to water pollution. The healthy nature of underground water has also altered. Hence special care is needed to conserve the lake and exercise development controls on buildings in the vicinity of the lake. The study was undertaken to signify the actual state of water quality at Pushkar and uncover the causes for its deterioration.

### Study Area

Rajasthan because of its rich historical, cultural and environmental heritage coupled with various fairs and festivals has become a favorite destination for tourists all over the world. One out of every three tourists visits Rajasthan. Pushkar is situated 12km northwest of Ajmer. It is located at a latitude of 26°27' North and longitude 74°37' east at an elevation of 530m above sea level. Pushkar lies on the eastern fringe of the Thar Desert. The town is saucer shaped with the Pushkar Lake as the centre of the saucer. The soil

and topography of the town is predominantly sandy with very low water retention capacity. The climate of the town is semiarid with dry and hot summer and cool winter. The catchment area of Pushkar Lake is 1,124 ha and the lake area is 12 ha. The depth is approx. 8.3m with a water holding capacity of 79,287 cu.m. The main economic driver of the town is tourism which promotes the other key industries. Pushkar being predominantly pilgrimage town, temples have been the main source of livelihood for centuries. The satisfaction of tourism requirements must not be prejudicial to the social and economic interests of the population in the tourist areas, to the environment or above all to natural resources which are fundamental attractions of tourism.

## MATERIALS AND METHODS

Water samples were collected from three ghats of Pushkar Lake. Out of 52 Ghats only four ghats which were primarily used were studied. Three Ghats namely Gau Ghat, Brahma Ghat and Saptarishi Ghat are used for bathing whereas Jaipur Ghat is used for dispersion of ashes.

The water samples were collected for a period of 12 months starting from January 2009 to December 2009. The earlier data for 1989-1990, 1999-2000 was the report presented to Parliamentary Committee by Department of Environment (2003). The parameters included temperature, pH, conductivity, dissolved oxygen (D.O), biological oxygen demand (B.O.D.), alkalinity, total Hardness, sulphates, chlorides, fluoride, phosphate, potassium. All the collected water samples were analyzed within 24 hrs. Samples were collected in triplicate from each site during the four quarters of the year using PET bottles as per standard procedures. The collected samples were stored at 4°C. The samples were analyzed for a number of physicochemical parameters by standard methods given in APHA (1998).

## RESULTS AND DISCUSSION

Temperature plays an important role in the physical and chemical characteristics of Pushkar Lake. It seems to have a pronounced effect on the rate of CO<sub>2</sub> fixation by phytoplankton (primary productivity). In addition, temperature affects bacterial activities which are responsible in the decomposition of organic matter for nutrient cycling as well as solubility and liberation of dissolved gases like O<sub>2</sub>, CO<sub>2</sub>, and NH<sub>3</sub> etc. The temperature of water varied little during 1989-1990 (15°-41°C) and 2009-10 (15°-42° C) (Table 1,2).

The pH levels had been found to continuously increase from 7.2 to 7.9 and finally as 7.8 (Table 1,2). The reason for the alkalinity may be due to mixing up of the alkaline chemicals, soap and detergents etc. produced due to commercial, agricultural and residential activities. H<sup>+</sup> ion concentration values ranging from 7.8 to 8.7 are suitable for aquatic organisms (Klien 1973). On the other side the pH value of water according to Target Water Quality Range (TWQR) for domestic use is 6.0 to 9.0 (Mishra and Yadav 1978). The desirable limit of pH recommended by IS is 6.5-8.5. In general, it can be concluded that the pH value of Pushkar Lake lies within the permissible range.

Similarly values of E.C., total alkalinity, chlorides, sulphates, phosphate, sodium, potassium and BOD increased with time suggesting degradation in water quality of the lake (Table 1,2). The alkalinity in the water is due to salts of carbonates, bicarbonates, nitrate, silicates and phosphates along with the hydroxyl ions in the free state. The permissible limit of alkalinity in the water samples is 200-600 mgL<sup>-1</sup> (IS) while for chloride content in the water is 250-1000 mgL<sup>-1</sup> (IS). The National River Water Quality (NRWQ) standard range is 45-155 mg/L (Singh et al. 2000). The average NRWQ standard range for sulphates is 200 mg/L. The permissible limit of fluoride content in the water is 1.0-1.5 ppm (IS). The fluoride levels were found low (0.35- 0.4ppm) throughout the study period.

The low oxygen level was recorded during summer due to its demand for decomposition of organic matter. There is a very strong negative significant relationship between DO and water temperature. Free O<sub>2</sub> (DO) is the single most important gas for aquatic organisms. When the aquatic organisms are exposed to less than 2 mg/L free O<sub>2</sub> for few days, it may kill most biota in the aquatic system (Goel et al. 1980). Dissolved oxygen was also found to be declining from 5.2 in 1989-90, 4.8 in 2000-01 to 4.70 mg/L in 2009-2010. Pesticide residues were also found in trace amounts in the water samples as shown in Table 3.

The data reveal that only eight pairs of physicochemical parameters (x and y) show high degree of positive correlation (>0.90) (Table 4). On the other hand low negative correlation value of 'r' ranged between potassium and temperature (-0.000) as well as total alkalinity and pH (-0.944). The study revealed that correlation of BOD with pH, temperature and DO and Na with pH, DO, BOD, sulphates and Fluoride was highly significant.

Table 1. Physico-chemical characteristics of water in Pushkar Lake.

Parameter	Jaipur Ghat		Gau Ghat		Brahma Ghat		Saptarishi Ghat	
	Average 1989-90	Average 2000-01	Average 1989-90	Average 2000-01	Average 1989-90	Average 2000-01	Average 1989-90	Average 2000-01
Temp. (Range)	15°-40°	15°-32°	16°--40°	15°-40°	15°-41°	16°-42°	15°-40°	15°-34°
pH	7.2	7.96	7.9	7.96	7.4	7.7	7.2	7.8
DO	5.38	5.35	5.35	5.45	5.21	5.13	5.2	4.88
BOD	4.4	4.5	4.4	4.2	3.85	4.2	3.7	4.7
Total	120	135	110	130	104	150	120	125
Alkalinity								
Chlorides	16	61	20	70	24	62	20	60
Sulphate	32.9	39.20	32.2	46.40	33.4	46.4	50.2	49.9
Fluoride	0.04	.22	.07	.34	.04	.35	0.32	.20
Phosphate	.02	.20	.02	.19	.25	.35	1.20	.30
Sodium	38	37	36	36	36	37	38	36
Potassium	3.8	3.1	3.8	2.4	2.9	2.6	8.7	4.8
Conductivity	.32	.42	.37	.42	0.25	.42	0.34	.41

Table 2. Physico-chemical characteristics of water of Pushkar Lake

Parameter	Jaipur Ghat	Gau Ghat	Brahma Ghat	Saptarishi Ghat
	Average 2009-10	Average 2009-10	Average 2009-10	Average 2009-10
Temperature (Range)	15°-42°	15°-41°	15°-42°	16°-41°
pH	7.5±0.05	7.8±0.26	7.7±0.06	7.6±0.14
Dissolved Oxygen	4.8±0.28	4.98±0.06	4.78±0.23	4.7±0.19
BOD	4.8±0.32	5.4±0.17	4.82±0.31	4.7±0.09
Total	140±0.09	120±0.20	120±0.11	130±0.20
Alkalinity				
Chlorides	50±0.02	50±0.08	40±0.16	45±0.04
Sulphate	33.5±0.10	35.10±0.13	51.4±0.19	6.0±0.11
Fluoride	0.4±0.44	0.4±0.18	0.40±0.17	0.38±0.28
Phosphate	1.20±0.15	1.0±0.17	1.25±0.10	1.20±0.25
Sodium	40±0.14	50±0.16	45±0.32	40±0.18
Potassium	9.1±0.33	9.0±0.31	8.8±0.52	9.1±0.20
Conductivity	0.37±0.24	0.44±0.14	0.44±0.26	0.44±0.23

Except pH, EC ( $\mu\text{mhos/cm}$ ) and temperature ( $^{\circ}\text{C}$ ), all values are in mg/L

Table 3. Pesticide Residue (mg/L ) in water of Pushkar Lake

	Total BHC	Aldrin	Dieldrin	Total DDT
Bharatpur Ghat	6.50	NT	NT	NT
Jaipur Ghat	8.41	NT	7.80	2.53
Gau Ghat	8.40	NT	5.66	1.76

Source: Pushkar Municipal Board

Table 4. Pearson correlation matrix between various water quality parameters

	pH	Temp	DO	BOD	TA	Cl	S	Fl	P	Na	K	Cond
pH	1.000											
Temp	-0.775	1.000										
DO	0.677	-0.931	1.000									
BOD	0.780	-0.986	0.975	1.000								
TA	-0.944	0.522	-0.427	-0.537	1.000							
Cl	-0.135	-0.522	0.545	0.493	0.455	1.000						
S	0.344	-0.127	0.420	0.285	-0.398	-0.264	1.000					
Fl	0.258	-0.333	0.649	0.483	-0.174	0.174	0.903	1.000				
P	-0.640	0.977	-0.884	-0.942	0.353	-0.667	0.044	-0.225	1.000			
Na	0.944	-0.870	0.869	0.910	-0.818	0.091	0.501	0.522	-0.746	1.000		
K	-0.548	-0.000	-0.120	-0.104	0.739	-0.793	-0.471	-0.213	-0.492	1.000		
Cond	0.775	-0.333	0.085	0.273	-0.870	-0.522	-0.071	-0.333	-0.225	0.522	-0.471	1.000



PUSHKAR LAKE

## CONCLUSION

Congestion of areas in and around the lake has obstructed natural drainage into the lake. Water quality in the lake has been deteriorating continuously primarily due to uncontrolled flow of sewage and waste water and disposal of solid waste in the catchment drains. Regular offerings of flower and bone ash have caused the water quality to deteriorate further. Excessive siltation is reducing carrying capacity of the lake resulting in its shrinkage. During the last ten years the maximum level has gone down to 4.6m. This not only disappoints the pilgrims but also affects the water quality.

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