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Water Quality Assessment of PushkarSarovar, a Sacred Pond in Ajmer District, Rajasthan (India)

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ABSTRACT

PushkarSarovar, is one of the important religious water bodies in where, every year an international cattle fair is organized on *KartikPurnima*. Holy bath at PushkarSarovar is most sanctifying event for Hindu community but such mass bathing can definitely deteriorate the water quality. A significant difference in physico-chemical properties was observed with difference in pilgrim load throughout the year. This load was found positively associated with increase in values of EC, pH, TDS, turbidity, alkalinity, chloride, BOD, phosphate etc. In addition microbial fauna was also found flourishing after the nutrient entry during mass bathing. Pilgrims load was found negatively associated with dissolved oxygen in water, which found decreased after massive bathing.

KEYWORDS: *PushkarSarovar, Mass bathing, Pilgrim, Water quality, Phosphate, Coliform*

Introduction

India is known to have community-managed conservation plans to protect various natural resources such as forests, water bodies etc. These natural resources set carrying capacity of the land. In arid Rajasthan, many water bodies were declared holy to conserve them by preventing negligence, non-judicious use and encroachment. PushkarSarovar, the *Teerth Raj,* is one of the important religious water bodies in Rajasthan with over 500 temples in and around the town. Every year an international cattle fair is organized at Pushkar on *KartikPurnima*. Thousands of devotees visit the Sarovar and take holy bath and worship the Sarovar and nearby *Brahma Temple* almost throughout the year but during the *KartikSnan* and other religiously important day, the frequency and intensity of such activities increase. Many devotees also offer flowers, flour pallets, and millet to the fishes roaming in the pond even after restriction. Holy bath at PushkarSarovar is most sanctifying event for Hindu community (Lal 1996). But such mass bathing can definitely deteriorate the water quality. Also many devotees also carry skin diseases and other which create health risk for other pilgrims. Obviously in last few decades, increased anthropogenic meddling, change in community perception, paralyzed management and disregard to socio-cultural values lead to nutrient enrichment or eutrophication (Edmondson 1991).

Study area

PushkarSarovar is a perennial natural pond, situated in Pushkar town of Ajmer district (Rajasthan, India) at 26^{0}29'14''N, 74^{0}33'15''E with surface elevation of 530 m above mean sea level. It lies on eastern fringe of Thar Desert in semi-arid climate with dry and hot summer. The prevailing wind direction is South-west to North-east. There is average rainfall of 400 to 600 mm in short monsoon season. Occasional rainfall is received in months of January and February due to western disturbances. The soil bed is sandy with low water retention capacity. The Pushkar town has 21,626 inhabitants as per census 2011. Tourism is the main economic activity of the town. Pushkar town has a steady base load of 1,25,000 domestic tourists per month with increasing trend.

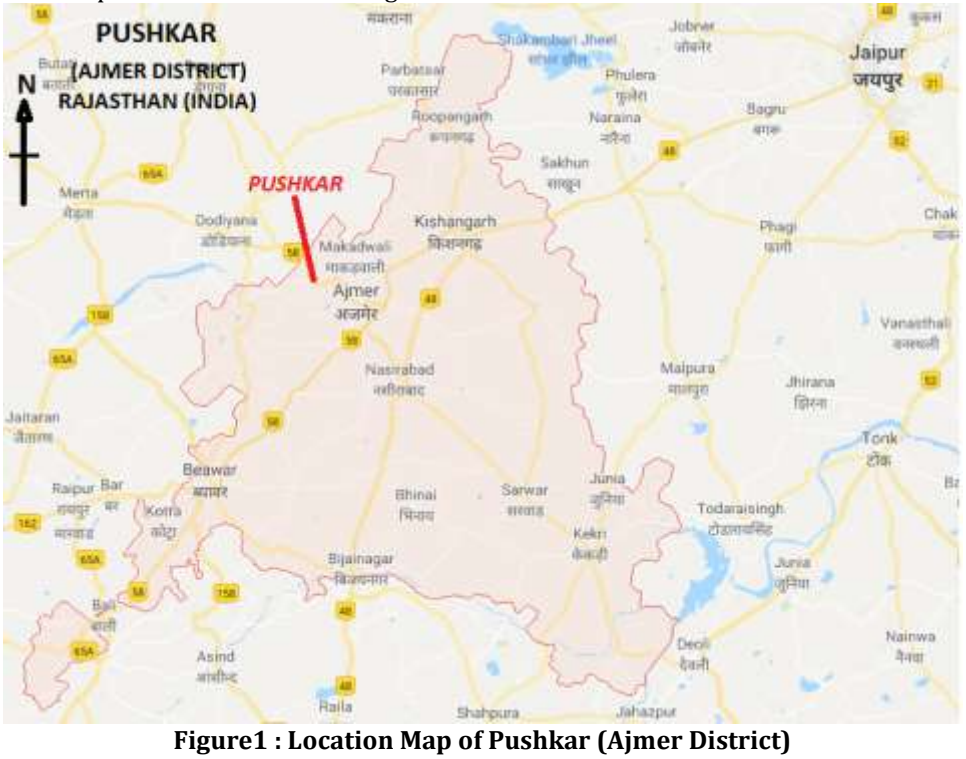


Figure1 : Location Map of Pushkar (Ajmer District)

PushkarSarovar is irregular elliptical stagnant water pond supported by primary inflow from Luni River. This pond with an area of 5 km^2 is fed by small streams originated from the Aravalli hills, constituting a vast catchment area of more than 22 km^2. The average depth of the pond is around 08 meter however depth varies considerably between the rainy season and summer season.. The Sarovar is surrounded by 52 Ghats (series of bathing steps with temples, *dharmashalas,* house of *Purohit, Samadhies*and changing rom) except its southern edge where water inflows from catchment area. Some of the important and old Ghats are *Brahma Ghat, Gau-Ghat,*and*Varah-Ghat.*

Figure 2: Bird Eye View of PushkarSarovar

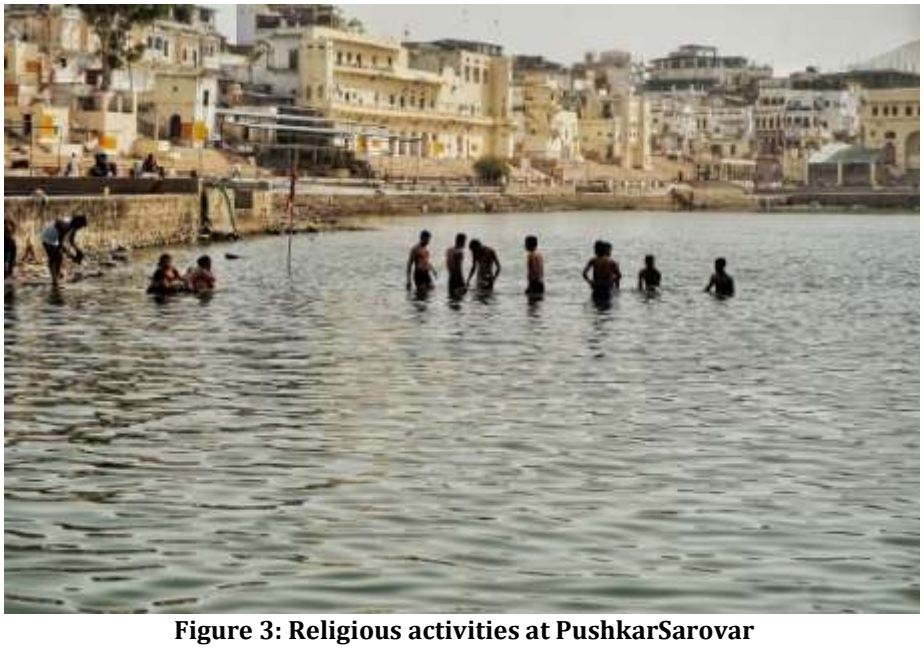


Figure 3: Religious activities at PushkarSarovar

Material and methods

The water samples were collected at six Ghats, namely *Jaipur Ghat, Nagar PalikaGhat, Brahma Ghat, Gau-Ghat, Saptrishi-Ghat,* at monthly interval. *In situ* parameters like temperature, pH and EC were measures on spot by thermometric

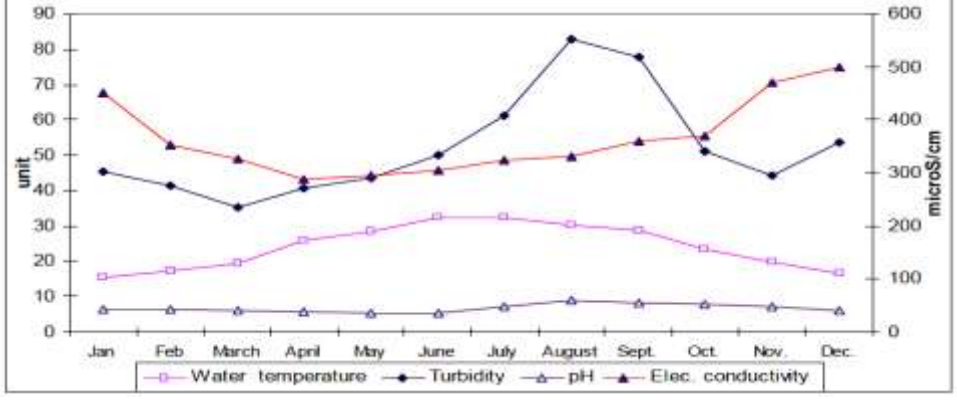
and potentiometric method, respectively. Water sample was collected from 5 cm below surface, avoiding bubbling, in non-reactive borosilicate Glass bottle (BOD Bottle) for Dissolved Oxygen analysis. His sample was immediately fixed as per Wrinkler method. For other parameters, water samples, from various Ghats, were collected in 2-liter PET containers and brought to laboratory after putting them at 4^0C temperature. In laboratory various parameters including Turbidity, Alkalinity, Hardness, Chlorides, Nitrate, Total Dissolved Solids, BOD (5-day), Phosphate and bacterial parameters (faecal Coliforms, total coliforms, faecal streptococci) were studied as per standard procedures published by National Environmental Engineering Research Institute (NEERI 1988) and the American Public Health Association (APHA 1998).

Results and Discussion

This study has shown a significant difference in physico-chemical properties with difference in pilgrim load. The monthly variation from January to December in water quality parameters and pilgrim load are represented in graph 1 to 4. All the physicochemical parameters were taken in mg/l except for pH. Similarly microbial parameters are taken in MPN per decilitre.

Water temperature plays an important role in dynamics of water body, affecting various physicochemical properties like alkalinity, dissolution of gases particularly oxygen, carbon dioxide, carbonate-bicarbonate equilibrium, toxicity, increase in metabolic rate and physiological reactions of microbial fauna (Semwal and Akolkar 2006). Water temperature does not influence significantly by pilgrim load and fluctuation in it reflects seasonal trend. The water temperature was found in the range of 15.65 to 32.5 ^{0}C.

Graph 1: Monthly physicochemical profile of Sarovar



Turbidity, an expression of optical property of water, depends on light scattering by particulate matter in the water. Therefore it is found associated with amount of Total Dissolved Solids (TDS) in water (Stepane*et al*. 1959). The turbidity was found higher than the permissible limit, throughout the duration of investigation. It was found much higher (53.61 NTU) in the month of December due to massive influx of pilgrims in the month for holy bath during Pushkar Fair (Anantnarayan*et al.* 2018). The credit for higher values (61.25 to 82.69 NTU) during

monsoon season, July to September, goes to the runoff water from hills and agricultural fields, while it was found markedly high (50.21 NTU) in June due to decrease in water level. High turbidity was also reported by Deepa*et al.* 1998 among wetlands of Bangalore due to anthropogenic stress.

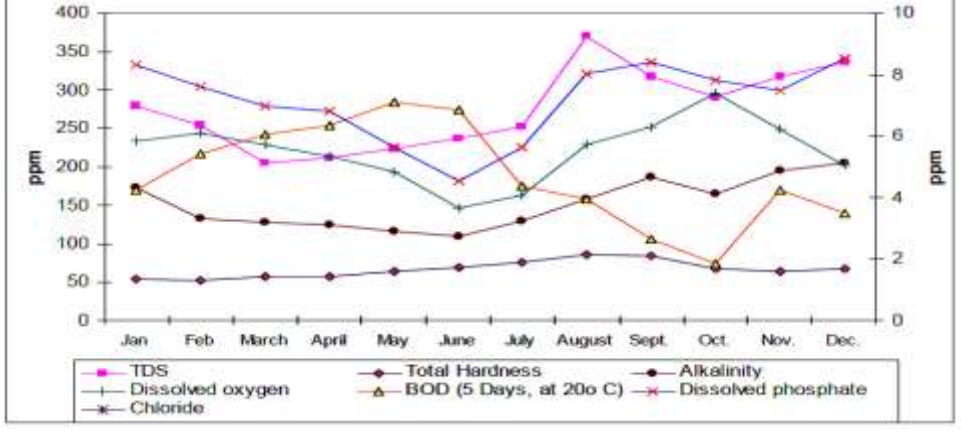
pH of the water is governed by the ionic equilibrium in the water (Fakayode 2005). It was found well associated with the pilgrim load. Acidic character of pH (6.12) was recorded during massive bathing in month of December. However higher pH in monsoon (8.85 in August) and acidic condition in summer (5.34 in June) are due to inflow of alkaline runoff water and due to decrease in water level respectively.

In addition to pH, electrical conductivity (EC) was also found associated with pilgrim load, majority of which takes bath. The EC depends on the total concentration, mobility, valence, and the temperature of the ionic solution (APHA 1998). Alike with turbidity, it was also found higher, diverted from the natural seasonal trend of changes, in November and December (471.3 to 499.8 microS/cm).

Total Dissolved Solids (TDS), show general characteristic of water which influences alkalinity, turbidity, EC, pH. More than 500 mg/l of TDS is not considered desirable for drinking (Jain, 2002). It was found significantly associated with pilgrims load at the Sarovar. It was found higher in December (336.8 mg/l), away from its usual seasonal trend. This higher value may be contributed by massive bathing. Chaurasia and Kamran (1994) also reported increase in TDS during mass bathing in river Mandakini during AshwameghaYagna in April 1994. TDS values were also high in monsoon (369 mg/l in August).

Alkalinity, chloride and total hardness were also found higher in December during and just after Pushkar Fair. High values of total alkalinity may be attributed to the increase in organic decomposition during which CO_2 is liberated (Anderson 1993.). High value of Alkalinity (204.63 mg/l) during Pushkar Fair found support from this fact. Chloride concentration in water indicates the presence of organic waste in water, primarily of animal origin (Thresh *et al*. 1949). It was found higher in monsoon season (63.21 mg/l) but surprisingly it was not very high during the Fair (34.26 mg/l).

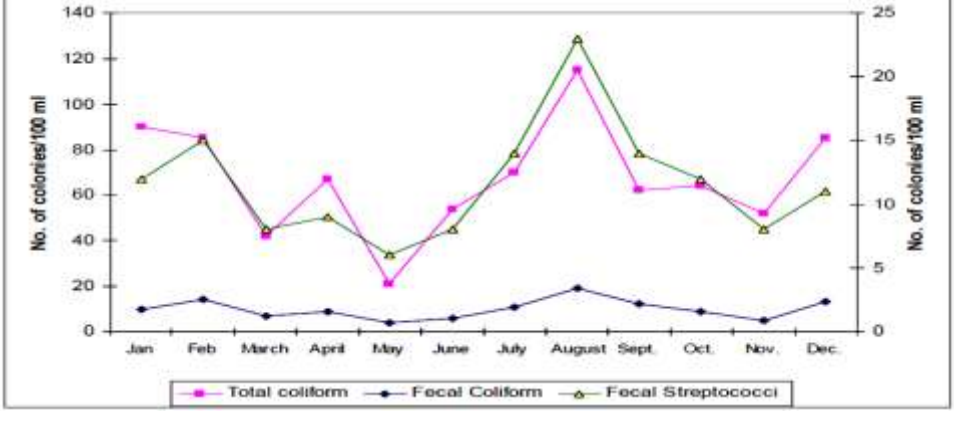
Graph 2: Monthly physicochemical profile of Sarovar



The phosphate was emerged as a serious problem regarding water quality as it was found many time higher than the permissible limit due to dumping of cremation wastes rich in phosphate throughout the year. It was ranged from 4.52 mg/l to 8.52 mg/l. It showed significant relation with pilgrim load. Panda and Patel (1996) also observed similar trend in phosphate when analyzed impact of dead body cremation waste on the water quality of river Saryu at Ayodhya.

Dissolves Oxygen (DO) and Biological Oxygen Demand are the parameters that found correlated with temperature and nutrient status of the water, which facilitate growth of microorganisms and thus high oxygen consumption (Sahu*et al*. 2000). DO was found below the desirable limit throughout the year, but the decrease was more pronounced during December (5.04 mg/l), despite of higher solubility in water. This may be contributed by to the use of detergents and availability of nutrients in plenty during mass bathing event. DO was, so, found associated with pilgrim load at Sarovar. Pandey and Sundaram (2002) and Chaturvedi*et al.* (2003) also found decreased dissolved oxygen in river Ganges in their studies where religious activities were pronounced. Bhatnagar and Sangwan (2009) found similar situation at Brahmasarovar, Kurukshetra. Biological oxygen demand gives an idea of quantity of biodegradable organic substances present in water, which is subjected to aerobic decomposition of microorganism. Thus, it provides a direct measurement of state of pollution (Singh *et al.* 1999). BOD was reported higher during May (7.09 mg/l) and least during October (1.84 mg/l). Dhanapakiam*et al.* (1999), Singh *et al.* (1999), Sharma *et al.* (2000), Pandey and Sundaram (2002) and Sudhakar and Mamatha (2004) have reported high BOD in case of contamination of water resources by biological and organic pollutants. The present study draws support from the findings of these workers. Nitrate was found around 1 mg/l throughout the year much less than the permissible limit.

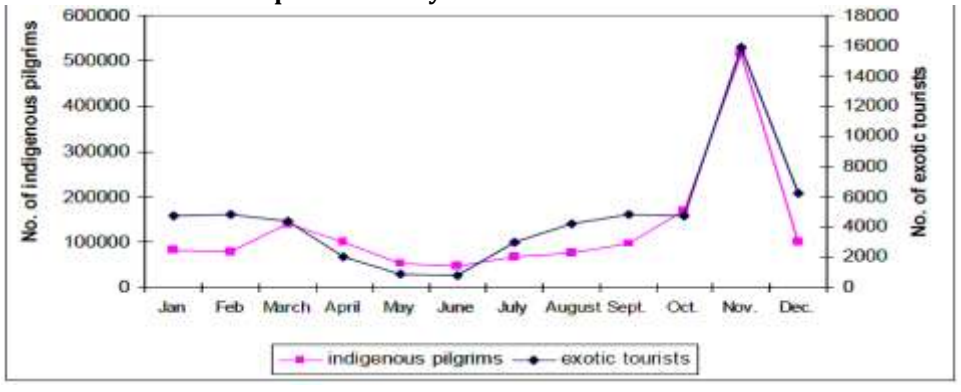
Graph 3: Monthly variations in the microbial characteristics of Sarovar



Total coliform, fecal coliform and fecal streptococci were present in water throughout the year, which can result in health problems because there presence indicates presence of other harmful bacteria in water. All the microbial parameters exhibited similar trends. They were found much higher in the monsoon season and in December after mass bathing. Maximum 85 MPN per deciliter were found during

and just after Pushkar Fair. Results of present studies are in close conformity to the findings of Annapoorani and Lakshmanpurmalsamy (1989); Ramanibai (1997), Bhadra*et al.* (2003), and Satapathy (2016) who noticed heavy bacterial contamination in similar situations.

Graph 4: Monthly tourist load at Pushkar



The faecal coliforms are used as an indicator of human enteric pathogen for many years. It is well established that E. coli is not limited to humans but also exists in the intestine of many warm-blooded animals (Orskov and Orskov, 1981). Mohapatra*et al.* (1992) examined the presence of faecal coliforms as indicators of faecal pollution in various water bodies. 13 MPN per deciliter of faecal coliform were found during December.Overall mass bathing causes a significant change in water quality, which may represent a health hazard to the users (Sinha*et al.* 1991 and Kulshrestha and Sharma 2006).

Conclusion

PushkarSarovar is one of the most sacred pilgrimages in India. But constant pilgrims load, particularly mass bathing, resulted in increase in nutrient and ionic level of the water. This load was found positively associated with increase in values of EC, pH, TDS, turbidity, alkalinity, chloride, BOD, phosphate etc. In addition microbial fauna was also found flourishing after the nutrient entry during mass bathing. Pilgrims load was found negatively associated with dissolved oxygen in water, which found decreased after massive bathing.

By the present study it can be summarized that the PushkarSarovar is under relentless pressure of pilgrims. If this situation is not managed properly, it may result in increase in nutrient status of the pond, paving path for eutrophication. Therefore serious efforts are necessary, particularly by community, to conserve this natural water resource.

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