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PRESERVING PILGRIMAGE SITES: COMPREHENSIVE ANALYSIS OF ECOLOGICAL SUSTAINABILITY OF PUSHKAR LAKE

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ABSTRACT

Lakes are particularly noteworthy because they combine a number of characteristics, incorporating elements that are not only functional but also historical, cultural, social, administrative, and physical in order to create a tourist destination that is conveniently placed and conveniently located. Residents in dry and semi-arid areas rely heavily on lakes and reservoirs as their primary source of water supply at the moment. Over the course of the last several decades, there has been a growing concern over the interaction of humans and bodies of water. Pushkar Lake is a vital component of all of the tourist offers that the town of Pushkar has to offer. The biochemical oxygen demand (BOD), alkalinity, water hardness, chlorine, fluoride, and nitrate levels in the lake are increased as a result of the fact that millions of people bathe in the lake practically throughout the whole year and participate in various religious activities. Using the protocols that are considered conventional, samples were collected in PET bottles. It was for this purpose that Horton's Water Quality Index (WQI) was established. It measures the quality of drinking water. Each and every analytical technique adhered to the procedures that were defined in the APHA, which gave the recommendations. According to the findings of this research, the water in Pushkar Lake has a pH that is somewhat alkaline.

Keywords: *Pushkar Lake, Pilgrimage, Ecological*

INTRODUCTION

Because of the fast population expansion that has contributed to the contamination of water bodies from pesticides and fertilizers carried by home, industrial, and agricultural runoff, there has been a growing concern in recent decades over the way in which people interact with water systems. Different lakes and reservoirs around the country are experiencing varying degrees of environmental degradation at different points in time. Among the most significant contributors to water pollution are the burial of dead individuals, the disposal of solid waste, littering in both rural and urban areas, and swimming in public places. Changes in the physicochemical environment, which are brought about by hydrological variables such as precipitation, water loss from high heat indices, and human disturbances, have a direct influence on the biotic component of the water body. These changes are brought about by the water body. The biotic component of the body of water is the outcome of these alterations as they have occurred.

A large number of persons are of the opinion that the Water Quality Index (WQI) is among the most effective instruments for alerting concerned citizens and decision-makers about the quality of the water present. The Water Quality Index (WQI) is a measure that may be used to determine the broad condition of the water at a particular location and moment in time. The quality of water that is accessible for human consumption is evaluated and controlled using this measure, which has become an essential parameter in recent years. Many different kinds of organisms, such as bacteria, viruses, and protozoa, are known to be passive carriers in water.

These organisms have the potential to cause a wide variety of ailments in people. Indicator organisms in water are now considered to be the best faecal indicator bacterium for monitoring faecal pollution in drinking water regulations and recommendations on a global scale. It is believed that the presence of indicator organisms in water is one of the most important factors in identifying health problems that are caused by pathogens.

A sample of one hundred milliliters should not reveal any measurable levels of indicator organisms in drinking water, according to the World Health Organization (WHO). Since humans are mostly to blame for these environmental issues, there has been an increase in human activity in the catchment region, which has had an effect on the natural processes that occur inside many water systems. This has put the development and survival of biotic communities in jeopardy. The Pushkar Lake is an example of a pilgrim lake that had a vital role in the development of the tourist sector in the town of Pushkar. One of the reasons why the water quality of lakes and the visual beauty of lakes are deteriorating is because of the demands of society to increase their financial benefit. For the most part, Pushkar is dependent on the lake for its survival.

One of the most significant challenges in Pushkar is the implementation of sustainable development. This causes an increase in the levels of nitrate, fluoride, magnesium, chlorine, alkalinity, and biological oxygen demand (BOD) in the lake water, as well as other components, since millions of people bathe in the lake and engage in a variety of religious activities virtually throughout the whole year. As a result, study has been conducted on the physicochemical properties of the water in Pushkar Lake. This research has been conducted with the consideration of the lake's remarkable scenic value, as well as the impact the water has on the health of pilgrims and even the local inhabitants, who utilize it often for a range of domestic uses. It is particularly crucial to conduct this study because of the growing relevance of human activities on this lake and the threats that these activities represent to the lake's capacity to survive in the long run. The current analysis was conducted with the purpose of determining the physicochemical properties of Pushkar Lake and making recommendations on appropriate restoration procedures.

OBJECTIVES

To study ecological sustainability of Pushkar lake.

RESEARCH METHDOLOGY

Due to the fact that these human activities and environmental stresses have exceeded the carrying capacity of Pushkar Lake, the water quality has degraded to the point that it is no longer acceptable for any purpose. A conclusion has been reached about the examination of the physicochemical features for the purpose of conservation and management. Within the scope of this inquiry, the religious, economic, and social value of the lake was taken into consideration, in addition to the influence that the water had on the health of the local community. The location of Pushkar Lake is displayed on a satellite map, as may be seen in Figure 1. 100 Samples of water were taken from four different locations throughout the months of April and September of 2019. Table I provides a breakdown of the techniques and parameters.

The D.O. and B.O.D. levels of the water were determined by fixing samples of water at the points of interest. Within a single day of their collection, each and every water sample was carried out for analysis. For the purpose of collecting samples in PET bottles, conventional procedures were used. Every analytical procedure was

carried out in accordance with the standard protocols, as stated by the standard methodologies that were given. The Water Quality Index (WQI) was used in order to arrive at an assessment of the quality of the drinking water. For statistical analysis, Microsoft Excel was used as the main tool.

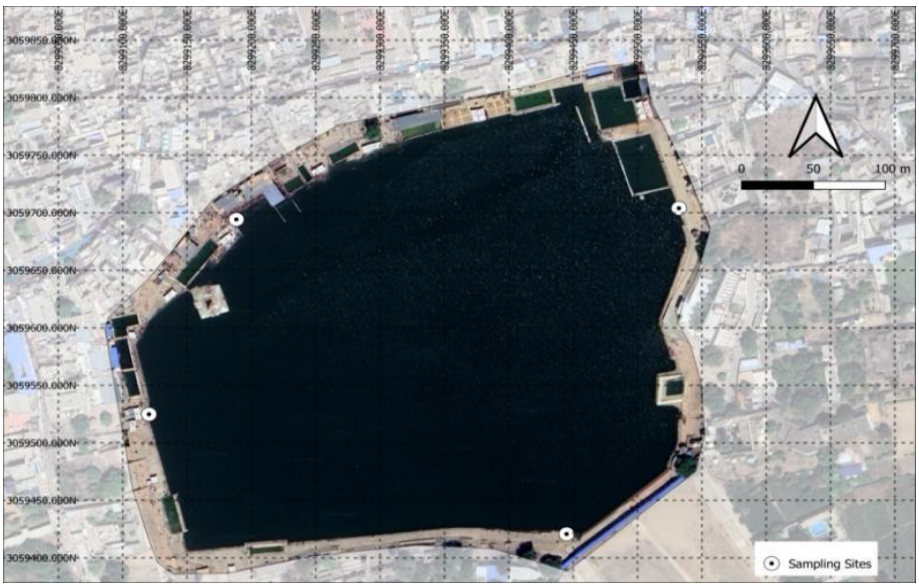

Figure-1: Pushkar Lake satellite picture

Figure-2: Pushkar Lake drone view

Figure-3: Pushkar Lake with Pilgrims

Table-1: Water quality assessment parameters and techniques

Parameters	Methods
Water Temperature	With the help of a digital thermometer (Testo-EN50081)
pH	This is a digital pH meter.
Electrical Conductivity	The digital conductivity meter is used.
Total Dissolved Solids (TDS)	This is a digital TDS meter. Method Based on Argentometry
Chloride	Via the Titrimetric technique
Alkalinity	The AQUASOL Test kit, with the following codes: AE-308; 302; 903
Nitrate, Silica, Dissolved Iron	The idiometric approach developed by Winkler
Dissolved Oxygen	Using the EDTA Titrimetric techniques
Hardness (Total, Calcium, Magnesium)	For the Iodometric Approach
Residual Chlorine	Via the Titrimetric technique

Free CO_2	using the flame photometric technique
Sodium & Potassium	Idiometric approach developed by Winkler, with a five-day interval
Biochemical Oxygen Demand	With the help of a digital thermometer (Testo-EN50081)

Results and Discussion

In Table 2, you can see the average findings for the general physical and chemical water quality indicators that were evaluated at each of the four different sites of Pushkar Lake. According to the findings of study that was carried out in past years, Table 4 illustrates the progression of the water quality in Pushkar Lake. A great number of indicators demonstrated significant shifts as a consequence of human activity and the circumstances of the climate. During the course of the investigation, the temperature ranged from 21 degrees Celsius to 25 degrees Celsius, with 21 degrees being the lowest reported.

The majority of cellular activities and metabolic functions are controlled by pH. Alterations in pH are mostly caused by the introduction of new components into bodies of water. At its point of peak concentration, the water of Pushkar Lake has a pH that ranges from 7.16 to 7.63. Ionic concentration, often known as the concentration of dissolved inorganic compounds, is the primary component that determines the degrees of electrical conductivity. The electrical conductivity of the material was examined in this experiment, and it was found to range from a low of 0.29 ms/cm to a high of 0.42 ms/cm. Total dissolved solids are just the sum of the concentrations of cations and anion, and the units of measurement for total dissolved solids are milligrams per liter and parts per million.

Because of the presence of dissolved particles in the water, the osmoregulation of freshwater species is affected, the solubility of gases (such as oxygen) is reduced, the water's suitability for drinking is impaired, and the aquatic ecosystem becomes more eutrophic. All of these effects are caused by the presence of carbon dioxide in the water. With the lowest result being the lowest, total dissolved solids (TDS) readings varied from 332 ppm to 462.37 ppm. There is a significant amount of chloride found in nature in the form of salts of calcium, potassium, and sodium. The presence of chloride in water is an indication of pollution, particularly when it originates from animals.

A chloride concentration of 32.48 mg/lt was found to be the lowest in the current experiment, while a chloride concentration of 39.58 mg/lt was found to be the highest. During the course of this experiment, the alkalinity concentration ranged from 78.37 mg/lt to 100.37 mg/lt, with the lowest concentration being 78.37 mg/lt on the lower end of the spectrum. It was found that the dissolved oxygen concentration ranged from a low of 5.96 mg/lt to a high of 9.68 mg/lt. During the course of the current investigation, it was discovered that the lowest concentration of nitrate was 1.31 parts per million (ppm), while the greatest concentration of silica was 18.75 ppm. Furthermore, the highest concentration of dissolved iron was 0.21 ppm. The amount of oxygen that was required for biological reactions ranged from 20.37 mg/lt to 26.23 mg/lt throughout the board.

It is possible that this is the consequence of an excessive amount of organic materials being consumed by humans as a result of activities such as mass bathing, feeding fish, birds, and other animals, and gifting flowers, garlands, and other sacred artefacts. The total hardness of Pushkar Lake was measured at a minimum of 185.75

mg/lt throughout the duration of the investigation. Surface runoff from watershed districts, which includes farms, is the primary contributor to the hardness of Pushkar Lake during the wet season. The lake receives calcium and magnesium from these runoff sources, which is the reason for this phenomenon. The consequence of this was the determination of the greatest overall hardness value, which was found to be 263.75 mg/lt. The magnesium hardness that was tested from lowest to greatest ranged from 38.71 mg/lt to 52.78 mg/lt. The lowest magnesium hardness recorded was 38.71 mg/lt. A calcium hardness value of 26.4 mg/lt was the lowest possible value, while a value of 46.5 mg/lt was the highest possible value. There was a minimum of 69 mg/lt for the carbonate hardness, and a maximum of 89.87 mg/lt for the carbonate hardness within the range of values.

During its lowest point, the non-carbonate hardness was measured at 116.75 mg/lt, and it reached its maximum point at 173.87 mg/lt. The residual chlorine amount was found to be anywhere between 1.96 mg/lt and 3.24 mg/lt, according to the findings revealed. Within the range of free CO2 concentrations, it was found that the highest concentration was 19.47 mg/lt, while the lowest concentration was 13.64 mg/Lt. In the samples that were taken, the amount of salt that was present varied from 33.43 mg/lt to 43.91 mg/lt.

The potassium concentrations varied from 32.15 mg/lt at the lowest concentration to 41.9 mg/lt at the highest concentration. The data may be seen in the table below. On the other hand, the water quality index of Pushkar Lake was found to be 107.21, which indicates that the water is very poor and should not be consumed. Given this information, it seems that the water in Pushkar Lake has not been subjected to an adequate level of filtration, which renders it unfit for human consumption. There is a possibility that this is due to the activities that pilgrims engage in during their pilgrimage in the region, which result in the release of pollutants into the lake. An important and positive correlation exists between dissolved oxygen and both residual chlorine and nitrate. This correlation is considerable. This connection is strong and favorable. Potassium, dissolved oxygen, carbonate hardness, and alkalinity all have a significant inverse connection with magnesium. In addition to non-carbonate, calcium, magnesium, and general hardness, there is a significant correlation between electrical conductivity and several other properties. Both magnesium and chloride hardness, as well as non-carbonate hardness, are significantly positively associated with residual calcium hardness. This correlation is substantial. There is a link that is somewhat negative with alkalinity, potassium, silica, and residual chlorine. There are connections with salt, nitrate, and alkalinity that are only marginally beneficial.

Table-2: Range observations for parameters

Parameter	Unit	Mini.	Maxi.	Avg
Water Temperature	0° C	21	25	24
pH		7.16	7.63	7.31
Conductivity	ms/cm	0.29	0.42	0.34
Total Dissolved Solids	Ppm	332	462.37	377.03

Chloride	mg/L	32.48	39.58	35.89
Alkalinity	mg/L	78.37	100.37	86.02
Nitrate	Ppm	1.31	4.31	2.2
Silica	Ppm	10	18.75	12.65
Dissolved Iron	Ppm	0.09	0.21	0.14
Dissolved Oxygen	mg/L	5.96	9.68	8.03
Total Hardness	mg/L	185.75	263.75	211.25
Calcium Hardness	mg/L	26.4	46.5	33.63
Parameter	**Unit**	**Mini.**	**Maxi.**	**Avg**
Magnesium Hardness	mg/L	38.71	52.78	43.16
Carbonate Hardness	mg/L	69	89.87	75.4
Non-Carbonate Hardness	mg/L	116.75	173.87	135.84
Residual Chlorine	mg/L	1.96	3.24	2.41
Free CO2	mg/L	13.64	19.47	15.75
Sodium (Na)	mg/L	33.43	43.91	37.73
Potassium (K)	mg/L	32.15	41.9	37.3
BOD	mg/L	20.37	26.23	23.67

Table-3: Water Quality Index Assessment

Parameter	Unit	Avg (Vi)	Standard value (Si)	*Wi*	*Qi*	*WiQi*
pH	-	7.31	7.5	0.226909	97.46667	22.11607
Conductivity	ms/cm	0.34	0.3	0.006427	113.3333	0.728435

T.D.S.	ppm	377.03	500	0.003856	75.406	0.290797
Chloride	mg/L	35.89	250	0.007713	14.356	0.110726
Alkalinity	mg/L	86.02	200	0.001145	43.01	0.049249
Nitrate	ppm	2.2	45	0.042849	4.888889	0.209485
Dissolved Iron	ppm	0.14	0.3	0.228954	46.66667	10.68451
Dissolved Oxygen	mg/L	8.03	5	0.385736	160.6	61.94917
Total Hardness	mg/L	211.25	200	0.006427	105.625	0.678891
Calcium Hardness	mg/L	33.63	75	0.025709	44.84	1.152813
Magnesium Hardness	mg/L	43.16	30	0.064274	143.8667	9.246843
				Σwi=1	ΣQi=850.0592	ΣWiQi=107.217

Here, V*i*= Monitored Value, S*i*= Recommended standard value,

wi= *Unit weightage*, $Wi = \frac{wi}{\Sigma wi}$, $= 100[{}^{Vi}/_{Si}]$, $WQI = \Sigma WiQi$

CONCLUSION

According to the findings of the investigation, the Water Quality Index (WQI) indicates that the water is not suitable for human consumption (WQI=107.21). This is due to the fact that the water of Pushkar Lake is revered and considered holy by tourists from all over the world. Among the several components that contribute to the quality of water, dissolved oxygen (DO) is the single most important factor that contributes to the degradation of water quality. A tremendous amount of waste that is composed of biological matter is poured into Pushkar Lake on a daily basis. Fish waste, fake fish food, and flower and ash remnants are some examples of the materials that fall into this category. Consequently, this quickens the process of breakdown, which in turn reduces the amount of dissolved oxygen and raises the biological oxygen demand (BOD). All of the following factors contribute to a decrease in the quality of the water in Pushkar Lake: sodium, potassium, hardness, total dissolved solids, and free carbon dioxide. A rise in the number of tourists visiting this lake has had a negative impact on the water quality because of the lake's small size and fragile environment.

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