Research Article

Water Quality Analysis of the Lake and Weather Studies at Keoladeo National Park, Bharatpur

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Abstract: Keoladeo National Park, situated between 27° 7.6' to 27° 12.2' N and 77° 29.5 to 77° 33.9' E, is two Southeast of the Bharatpur city, 38 Km Southwest of Mathura and 50 Km West of Agra. Delhi is 180 Km. North of Bharatpur. The total area of the park is about 29 Sq.Km. It is flat with a gentle slope towards the centre forming a depression, the total area of which is about 8.5 Sq.Km. This is a main submersible area of the park. The average elevation of the area is about 174 meters. The submersible area has been divided into various unequal compartments by means of dykes.

Keywords: Rainfall, pH, BOD, Temperature, Sunshine.

1. Introduction

Ghana Bird Sanctuary has created 250 years ago and is named a Keoladeo (Shiva) temple within its boundaries. Initially, it was a natural depression and was flooded after the 'Ajan Bund' was constructed by Maharaja Suraj Mal, during 1726 to 1763 AD, then the rules of the princely state of Bharatpur. The Bund was created at the confluence of two rivers, the Gambhir and Banganga. Prince Bhamji of Morvi state in Gujrat converted this area into a world-famous wildlife reserve. Duck shoots were organized in the area every year by the rulers of Bharatpur, in honor of the viceroy, Lord Curzon and his party on 1st December 1902. The exploits of all visiting dignitaries since 1902 have been engraved on stone plaques standing near the Keoladeo temple.

A masonry wall around the border separates the park from the surrounding agricultural fields. These are 18 villages around the park. Thick alluvium dominates the area. Patches of saline soils are common in the terrestrial area.

The Keoladeo Ghana, later to be the Keoladeo National Park, is a natural depression, which has been developed impounding and controlling water level into a waterfowl refuge by the Maharaja of Bharatpur, some 250 years ago. The main objective of the then rulers, to

whom the area belonged were game hunting, protecting the "scared" from hostile farmers as the cow often raided agricultural crops and for providing grazing land for buffaloes.

After independence, the refuge was threatened by the popular clamor to convert it into agricultural land (Ali, 1953). However, the "Bombay Natural History Society' (BNHS), through the efforts of Dr. Salim Ali, Managed to impress upon the then prime minister of India, Pd. Jawahar Lal Nehru, and the erstwhile Maharaja of Bharatpur the need for declaring the refuge as a bird sanctuary. This effort of Dr. Salim Ali and the determined timely action of the forest department of Rajasthan led to the declaration of the area as a bird sanctuary in 1956. Subsequently, in 1980 it was raised to the status of the National Park.

The Bombay National History Society has studied the birds of the area through banding since the early 1960 and the result obtained therefore provided a wealth of information on the purpose, provenance and route of migration of the multitude of waterfowl visiting the area. The annual fluctuation of the waterfowl population is the declining trend in the number of "Siberian Crane."

The climate of an area is sub-humid to semi-arid. According to "Thornthwaite (1948)" Climatic classification, the period 1982-1990 was more semi-

arid. During, 1982-1990 the precipitation effectiveness ratio ranged from 5.39 to 34.2, the lowest being in 1989 and the highest in 1985.

1.1 Location of the Park

Keoladeo National Park, situated between 27° 7.6' to 27° 12.2' N and 77° 29.5 to 77° 33.9' E, is two kilometer Southeast of Bharatpur city, 38 Km. Southwest of Mathura and 50 Km. West of Agra. Delhi is 180 Km. North of Bharatpur.

Coordinates: - 27° 10'00 77°31'0 E.
Area: - 2,873 hectares, 29 km^{2}.
Established: - March 10, 1982.

1.2 Topography of the Park

The total area of the park is about 29 Sq.Km. It is flat with a gentle slope towards the centre forming a depression, the total area of which is about 8.5 Sq.Km. This is the main submersible area of the park. The average elevation of the area is about 174 meters. The submersible area has been divided into various unequal compartments by means of dykes. The bottom of the compartments is generally flat except a narrow stretch alongside each dyke and a still narrower stretch around each mound where it is deeper owing to the removal of mud for constructing dykes and mounds. Occasionally some ditches of varying sizes occur in the rest of the area.

Much of the area is bushy, but it also contains semi-arid woodland and scrub. It lies 370 meters above sea level. It is separated from the surrounding villages and agricultural fields by a boundary wall. The soil is alluvial and at many places, the saline patches can be seen. In fact, Bharatpur was salt producing town and the salt production was banned in 1885 A.D. through a pact between Bharatpur state and the British Government.

Monitoring of surface water cannot be undertaken as the area is dry. For the purpose of groundwater monitoring the area is divided into three zones, these are:-

Zone 1: -   Inside the wetland
Zone 2: -   500m to 1500m away from the boundary of the wetland.
Zone 3: -   More than 1500m away from the boundary of the wetland.

Knowledge of changes in wetland is becoming a very important issue for sustainable management of natural resources. Water level in the park depends on the quantum of water released into it every year. The entire aquatic ecosystem depends on it. The extent of water spread area affects the breeding seasonality of even the land birds. Moreover, maintenance of a particular water level or supply of a definite quantum of water every year would help in stabilizing the system.

2. Results and Discussion

2.1 Physical studies of the lake water

During the physical study of the lake water, following parameters are studied:-

2.1.1   pH
2.1.2   Transparency
2.1.3   Biological Oxygen Demand (BOD)
2.1.4   Temperature

2.1.1 pH (Potentia *Hydrogenii*)

pH measures the hydrogen ion concentration in the water. It is measured on a log scale and equals to negative log 10 of Hydrogen ion concentration.

$$pH = Log\ 10(H^{+})$$
$$= Log\ 10(1/H^{+})$$

A neutral solution has a pH of 7 while a pH less than 7 acidic, and pH more than 7 is alkaline. pH was measured directly by the reading on water analysis Kit and pH meter. The river water was highly acidic in 2000 as the pH was below 7. After that, in 2004 there was a shift towards basic and the pH remained above 7 in all the years. Generally, the pH values were lower in monsoon and higher during spring-summer.

2.1.2 Transparency

It was measured by a standard Secchi disc of 20cms. Diameter painted black and white in four alternate quadrants tied with a nylon rope for measurement. The average depth of the visibility and disappearance of the disc was taken as Secchi transparency.

Transparency (cms.) = Depth of disappearance + Depth of Reappearance

2.1.3 Biological Oxygen Demand (BOD)

BOD is the measure of the degradable organic material present in a water sample and can be defined as the amount of oxygen required by the aquatic living organism in stabilizing the biologically degradable organic matter under aerobic condition. BOD is measured by incubating the sample at 27°C for three days.

BOD was determined by Winkler's method (APHA, 1989), two BOD bottles were filled with the water sample and can be defined as the amount of oxygen required by the living organism.

During, the process two BOD bottles were filled with the water sample avoiding air bubbles. One bottle was immediately fixed its initial dissolved oxygen content. The other bottle was incubated at 27°C for three days. After incubation, the dissolved oxygen content of the second bottle was analysed and was considered as final dissolved oxygen.

BOD was obtained by using the following formula:-

$$BOD\ (mg/L) = D_1 - D_3$$

Where, D_1 = initiates DO in the sample;
          D_3 = DO after three days.

During the study, it was observed that the maximum level of dissolved Oxygen was in February and the minimum in December. The values were comparatively lower in the winter and higher in spring. The low temperature and greater volumes of water enable retention and greater dissolution of oxygen during winter, whereas the condition in early summer or spring is the most ideal for peak photosynthetic activity resulting in increased production of oxygen.

The fluctuation in the level of oxygen probably is released to the excessive growth of macrophyte in the aquatic region are from 2004 to 2006. The thick mat of grass causes shading effect which prevents photosynthesis (Frodge). The uptake of oxygen for decomposition of the macrophyte litter (Johnstone), also might have added to this effect, from the second half of 2006, the aquatic grass was harvested and hence, the water bodies became more open allowing more light into the water which increased the photosynthetic activities.

2.1.4 Temperature

Temperature is the measure of the hotness of any material. The measurement of temperature in water is important basically for its effects on the chemical and biochemical reactions in the organisms. It is also important for determination of pH, conductivity and saturation levels of gases in water.

The surface water temperature was determined by the use of mercury filled centigrade thermometers up to the desired accuracy.

In Bharatpur, the monthly and annual variation in temperature is very high and due to these cause rivers water also shows high fluctuations. Generally, water temperature fluctuated according to the air temperature. It was lower than the air temperature in the most of the month. The temperature of water and air runs very closely during the winter.

2.2 Weather studies

2.2.1 Sunshine

Solar radiation is the radiant energy received from the sun. It is the intensity of sun rays falling per unit time per unit area and is usually expressed in watt/square meter (w/m^2).

The radiation incident on a surface varies from moment to moment depending on its geographic location (latitude and longitude of the place). Orientation season time of day and atmospheric conditions. Solar radiation is the most important weather variable that determines whether a place experiences high temperature or is predominantly cold. The instruments used for measuring of solar radiation are the "Pyranometer and the Pyrheliometer". The duration of sunshine is measured using a sunshine recorder. Sky condition generally refers to the extent of cloud cover in the sky, or the duration of sunshine. Under clear sky conditions, the intensity of solar radiation increases; whereas it reduces in monsoon due to cloud cover. The re-radiation loss from the external surface of buildings increases when facing clear skies than covered skies.

The weather is such a complex phenomenon that it can over very short periods of time. It can happen sometimes that is sunny in the morning, but suddenly the clouds appear from nowhere and it starts raining heavily. Or, a heavy rain may vanish in a matter of minutes and give way to bright sunshine. Since the weather is such a complex phenomenon, it is not easy to predict.

2.2.2 Total Rainfall

Bharatpur has been in steep decline in the last few years. Because of decreasing rainfall, lack of political will and rising population around the park, Bharatpur is denied its fair share of water. Bharatpur has always been a man-made oasis in a semi-arid landscape.

Insufficient & irregular rainfall in the last few years has brutally diminished the expanse of wetland to Bharatpur, placing immense stress on birds and on the life forms on which they depend. Occasional drought is part of the natural cycle in this region, yet the scale of the current dry spell is unprecedented. Undoubtedly, this has also created problems for local resident, and it is this conflict of interest in the struggle for water that has magnified the impact of drought at Bharatpur.

In, 2005-06 in response to the demands of local villages, water from sources usually drawn on to supply the park was diverted for land irrigation. Construction of a controversial pipeline to divert water to Bharatpur & the surrounding region from the "Chambal River" has already begun. The average rainfall is received throughout the year is very low. Many birds land Bharatpur at the onset of the monsoon, but owing to minimal rainfall in some years (2005 and 2006), the majority of waterfowl started moving away in search of other favorable habitats. Bharatpur district on average receives 673mm. of rainfall. In some lean years, it gets only a quarter of its normal share. In order to solve this recurring problem, it was proposed to release water through the "Pichuna canal" to the bird sanctuary. A former chief minister had also sought Rs. 109 Crores from the centre for bringing the Chambal waters to the National Park in Bharatpur. At present, the park is facing bleak prospects with the authorities shying away from taking a decision on the supply of the water through the "Pichuna canal" in the wake of stiff

resistance from the local farmers. Due to this impasse, a large part of the water body in the sanctuary remains dry out during the crucial breeding season. It is that this critical issue needs to be addressed in an ecological legerdemain, and with extreme caution and sensitivity.

"Abbasi (1997)" conducted studies in "Pookot Lake", a rare high altitude lake in Wayanad district, Kerala. He recorded the seasonal variation in pH and dissolved oxygen content of the lake. The pH varied between 0.8 and 8.6 while dissolved oxygen level ranged from 5 to 8.8mgl.

The Fragile ecosystem could maintain its water level throughout the year by the sluice and canal system. Hence, during March, April, May and June (2001) the water was above full of the reservoir level in all of the study habitats.

In the present study, it is clear that the physiochemical properties of water in the Fragile ecosystem habitat (F) is similar to the Natural Habitat (NH) indicating that both the habitats have conditions suitable to support a biotic community.

Table 1. Average sunshine (hrs) at Bharatpur during 2004-2011.

	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Mean	7.158333	7.083333	6.983333	7.066667	5.816667	6.691667	6.183333
S.D.	1.388919	1.080766	1.438074	1.559024	1.794358	1.243958	1.395728
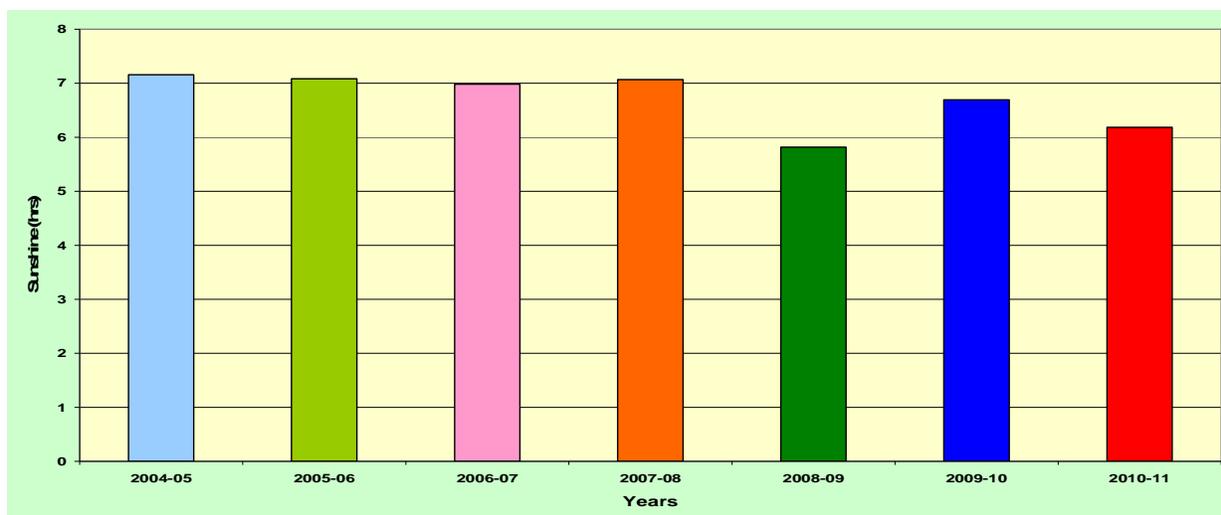
Table-2: Average rainfall (mm) at Bharatpur during 2004-2011.

	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Mean	18.13333	17.13333	18.49167	17.675	17.90833	18.38333	18.65
S.D.	7.862393	7.680639	7.568736	8.756153	7.298111	7.52649	8.630711
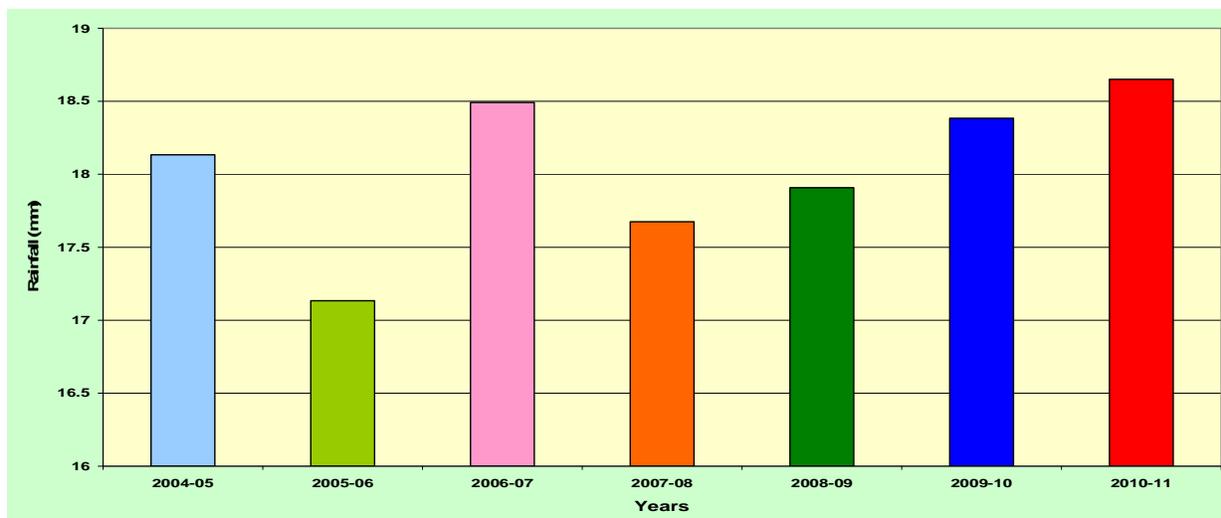
3. Statistical Analysis of the data

Statistical analysis of the data is proposed by "Fisher and Yates, 1963 model." There are three classes of models used in the analysis of variance. These are as follows:-

3.1 Fixed effects models (Model-1)

The fixed effects model of analysis of variance applies to situations in which apply one or more treatment to the subjects of the experiment. This allows estimating the range of response variable values that the treatment would generate in the population as whole.

3.2 Random effects models (Model-2)

The Random effects model is used when the treatments are not fixed. This occurs when the various factor levels sampled from a larger population. Because the levels themselves are random variables, some assumptions and the method of contrasting the treatments is differ model-1.

3.3 Mixed-effects models (Model-3)

A mixed-effects model contains experimental factors of both fixed and random effects type, with appropriately different interpretations and analysis of the two types.

The analysis of variance has been studied from several approaches, the most common of which use a linear model that relates the response to the treatments and blocks. Even when the statistical model is nonlinear, it can be approximated by a linear model for which an analysis of variance may be appropriate.

Monthly record data on Bharatpur i.e. Temperature (Maximum and Minimum), Relative humidity (Morning and afternoon hour), sunshine and rainfall, can be calculated by "Fisher and Yates, 1963", and on the basis of values, the histogram can be drawn and finally mean and standard deviation of the values are calculated.

The arithmetic mean or average is a measure of the central tendency of the data. A measure of the spread of data around the mean can be used either as a measure of variation within a data set or of the reliability of a measurement such as the mean.

The term standard deviation is used to summarize the spread of values around the mean and that 68% of the values fall within one standard deviation of the mean. It is a measure of how spreads out the data values are from the mean.

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