CRITICAL ANALYSIS OF WATER QUALITY OF WETLAND AT KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

A DISSERTATION

Submitted in partial fulfillment of requirement for

OF

MASTER OF TECHNOLOGY

IN

HYDRAULICS AND WATER RESOURCES ENGINEERING

Submitted by

YASHODHARA

(2K19/HFE/19)

Under the supervision of

Dr. T. VIJAY KUMAR

DEPARTMENT OF CIVIL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi-110042

AUGUST 2021

CANDIDATE'S DECLARATION

I, **YASHODHARA**, Roll No. **2K19/HFE/19** of **M. Tech (HRE),** hereby declare that the project Dissertation titled "**Critical Analysis of Water Quality of Wetland at Keoladeo National Park, Bharatpur, Rajasthan**" which is submitted by me to the department Hydraulics and Water Resource Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technological, is original and not copied from any source without proper citation. This work has not previously formed the basis for any Degree, Diploma Associate ship, Fellowship or other similar title or recognition.

NAME: YASHODHARA

SIGNATURE:

CERTIFICATE

I hereby certify that the project Dissertation titled "**CRITICAL ANALYSIS OF WATER QUALITY OF WETLAND AT KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN.**" which is submitted by, **YASHODHARA**, Roll number **2K19/HFE/19** of M. Tech (HRE), Delhi Technological University, Delhi in partial requirement for the award of the degree of Master of Technology, is record of the project carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or fully for any Degree or Diploma To this University or elsewhere.

Place: Delhi (**Dr. T. Vijay Kumar**)

Date: (SUPERVISOR)

ABSTRACT

Wetlands are regions where the soil remains saturated with water throughout the year. Wetlands are most productive ecosystem on earth. The characteristics that differentiate wetlands from other landforms are vegetation adapted to unique hydric soil. They serve as home to wide range of plants and wild life. Wetlands are divided into Marine wetlands (coastal wetlands), Lacustrine (lakes), Palustrine (marshy-marshes, swamps and bogs), Riverine (along river and streams), and Estuarine (deltas, tidal marshes and swamps).Convention on wetland, Ramsar (Iran) furnishes framework for conservation and wise use of wetlands via local, national and international actions and co-operation so that we can achieve sustainable wetland management throughout the world. According to Ramsar wetlands are " Natural water bodies such as rivers , lakes , corals, lagoons ,etc. and artificial or man-made like sewage farms , irrigation fields , farm ponds etc. with water either static or flowing fresh, brackish or salt it include marine water also which depth of water doesn't exceed six meters at low tides. At present in India there are 42 Ramsar sites (42nd is Tso-kar wetland in Ladakh). Functions of Wetland are Multiple-use water services(Water for irrigation , Domestic needs, Fisheries, Recreational uses, Ground water recharge , Flood control, and silt capture), Carbon Sequestration , Pollution abatement , Flood Control, Biodiversity Hotspot ,Tourism and recreation , Shoreline stabilization, and storm protection , Water purification , Waste water treatment (Constructed wetlands) , and Reduce wave damage. Threats to wetlands are Urbanization and land use charges , Agricultural, municipal and Industrial Pollution, Climate change, Reduced Precipitation, Change in Precipitation, Runoff, temperature, and Evapotranspiration, Dehydration/Aridification, and Salinisation.

Such a wetland, which is international important too is Keoladeo National Park (KNP) in Bharatpur, Rajasthan in northwest India, which is chosen for the study. From KNP 12 water samples and 5 sediments sample were analyzed and physio-chemical properties such as temperature, pH, EC, TDS, TSS, etc. were determined. It is found that relatively high concentration of phosphorus indicates eutrophic status of lake, also water is found to be alkaline-cum-saline in nature further the water and sediment quality represent relatively degraded quality and immediate intervention in terms of improving water level, reviving the functional food chain etc. should be taken up.

ACKNOWLEDGEMENT

I take this opportunity to express my sincere regards and deep gratitude to **Dr. T. Vijay Kumar** (Associate Professor, Civil Engineering Department, DTU) for his consistent guidance, monitoring and constant encouragement throughout the course of this project work. Also, I express my gratitude to **Dr. Anil Kumar Haritash** (Associate Professor, Department of Environmental Engineering, DTU) for giving me such an opportunity to commence this project in the first instance and for his consistent guidance throughout the thesis.

Professors and staff of the civil engineering, DTU have been very supportive and cooperative. They were always present for their kind opinions and suggestions for the successful completion of work and therefore I am deeply grateful to them.

Last but not the least; I would like to thank my family and my friends from the civil department who encouraged me to bring work to a successful close.

Place: Delhi

Date: **(YASHODHARA)**

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LIST OF ABBREVIATIONS AND UNITS

1. KNP – KEOLADEO NATIONAL PARK
2. WWF – WORLD WIDE FUND
3. UNESCO – UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
4. IUCN – INTERNATIONAL UNION FOR CONSERVATION OF NATURE
5. TH – TOTAL HARDNESS
6. TA – TOTAL ALKALINITY
7. TP – TOTAL PHOSPHATE
8. TSS – TOTAL SUSPENDED SOLIDS
9. TDS – TOTAL DISSOLVED SOLIDS
10. TOC – TOTAL ORGANIC CARBON
11. EC – ELECTRICAL CONDUCTIVITY
12. µS/cm – MICRO SEIMENS PER CENTIMETER
13. DO – DISSOLVED OXYGEN
14. NH_3 – AMMONIA
15. PSU – PRACTICAL SALINITY UNIT
16. APHA – AMERICAN PUBLIC HEALTH ASSOCIATION
17. AET- ACTUAL EVAPOTRANSPIRATION
18. PET- POTENTIAL EVAPOTRANSPIRATION
19. AI- ARIDITY INDEX

CHAPTER-1 INTRODUCTION

Water is one of the essential natural resources present on earth for each and every living organism. Wetlands are the most diverse and productive aquatic ecosystems, they are called the natural sponges of ecosystems because they absorb excess water, store nutrients and pollutants from agricultural runoff and drainage systems. Wetlands act as a buffer zone between terrestrial and aquatic ecosystems, and also maintain a balance between sediment and nutrients. Water qualities in wetlands are affected by various factors like topography, types of soil, quality of water, seasons and vegetation in it. It's a measure of health status of wetland ecosystem.

1.1 DESCRIPTION OF THE STUDY AREA

Keoladeo National Park also known as Ghana Bird Sanctuary or Bharatpur Bird Sanctuary is situated 135 km from Jaipur and 58 km form Agra on NH-11 and 2 Km from South East of Bharatpur on NH-11. KNP area is 29km2 (11miles) in flood plain of Banganga and Gambhiri rivers. KNP mean sea level is about 173-176 m. It's a low lying area at confluence of Banganga and Gambhiri rivers in Bharatpur. Wetland area is about 9 Km^2 from total area.
It is named after Keoladeo (Shiva) temple located at centre of this park.

1.2 HISTORICAL BACKGROUND OF KEOLADEO NATIONAL PARK (Source-WWF, INDIA, BHARATPUR)

The park had been created almost 250 years ago. It was a natural depression terrain flooded by then ruler Maharaja Surajmal, ruler of princely states Bharatpur (1726-1763) who constructed Ajan Bandh.

Ajan Bandh is created at confluence of two rivers Gambhiri and Banganga. The park is a hunting place for Maharajas of Bharatpur with duck shoot which is organized yearly in honor of British Viceroys. In one shoot alone in 1938 Governor General of India killed over 4273 birds. After Independence, till 1972 rulers of princely state received shooting rights.

In 1982, government banned grazing in park.

AN OVERVIEW OF THE PARK

- 1726-1763: Ajan Bandh constructed.
- 1850-1899: Park was created as preserve by Maharaja of Bharatpur.
- 1901: Reserve flooded for the very first time.
- 1902: Reserve inaugurated with an organized duck shoot.
- 1956: Declared as Bird Sanctuary.
- 1967: Declared as Reserve forest under Rajasthan Forest Act 1953.
- 1976: Declared as protected wildlife sanctuary.
- 1981: Declared Ramsar wetland.
- 1982: Declared as National Park.
- 1985: UNESCO World's heritage site.
- 1990: It came under Montreaux record.
- 1919: Boundaries of duct shoot reserve notified.
- 1925: Bharatpur forest act passed.
- 1930-35: Rules for protection of wildlife and forest of Rajasthan framed.
- 1977-81: Wall around the sanctuary site was built.

1.3 BIODIVERSITY IN THE PARK (KNP) (Source WWF, INDIA)

KNP is a home for unique mosaic of habitats includes wetlands, shrubs, woodlands, and grasslands, support amazing diversity of both plants and animal species. Woodlands like Jamun (Syzygium euminii), Babul (Acacia nilotica), and Kadam (Mitragyna Parrifolia). Major grasses like Desmostachya bipinnata and vetiveria zizaniodies on which mammalian herbivores like Chital, Sambhar, Nilgai as well as domestic cattles food. Trees and Shrubs like Prosopis Cinemia, Acacia Nilotica, Salvadora pervica. KNP is home for about 375 avian species, 372 plants, 34 mammals, 57 fishes, 147 snakes, 7 hustles, 8 amphibians. There are more than 90 kinds of flowering plants in the wetlands of Keoladeo National Park. The main types are shown in the attached table. The wetland supports a list of aquatic plant species (Table 1), some of which are known to pose a threat to wetland management. The ecological importance of the park makes it uniquely recognized in the world's wetlands (Anoop K.R, 2009). This diversified vegetation mosaic has rich biodiversity and is home to various avian species (Table 2).

TABLE 1.1: REPRESENT LIST OF ECOLOGICALLY IMPORTANT AQUATIC SPECIES OF PLANTS IN KNP (ANOOP, 2009)

S. No.	**NAME OF AQUATIC PLANT**
1	*Paspalum distichum*
2	*Ipomoea aquatic*
3	*Cypersus rotundus*
4	*Nymphoides indica*
5	*Potamogetan pectinatus*
6	*Vallisneria natans*

TABLE 1.2: THE ACCOUNT OF BIODIVERSITY IN KEOLADEO NATIONAL PARK (ANOOP, 2009)

S. NO.	**CATEGORY**	**NUMBER OF SPECIES**
1.	AVES	375
2.	PLANTS	372
3.	FISH	57
4.	SNAKES	14
5.	.LIZARDS	5
6.	GECKOS	3

7.	TURTLES	7
8.	BUTTERFLIES	71
9.	DRAGONFLIES	16
10.	SPIDERS	8
11.	WATERFOWL	140
12.	MAMMALS	34
13.	AMPHIBIANS	8

1.4 INTERNATIONAL IMPORTANCE OF THE PARK (KNP)

KNP is a man made and man manages wetland. For a shift from wetland are wastelands Ramsar convention was signed in 1971, is an international treaty for conservation and sustainable use of wetlands. India signed it in on 01.02.1982. Presently 42 Ramsar sites are in India. KNP is a Ramsar site in 1981.

UNESCO included it in heritage site in 1985, based on criteria “Habitats of rare and endangered species. The park is an internationally important wetland for rare Siberian cranes and a habitat for a large number of resident nesting birds.”

According to the operating guidelines revised in 2005, the park belongs to category (X), which stipulates that the site must “contain the most important and important natural habitats that protect the biodiversity of the site, including those that contain threaten species of universal value" (UNESCO-IUCN2003 report).

1.5 SEMI ARID WETLANDS AND THREAT TO THEM

Semi-arid regions are sub type of dry land having aridity index (Ratio of AET/PET) between 0.2-0.5. They are also known as Palestine (swamps), it means they are dominated by trees, shrubs or other persistent emergent plants. There are confined to minor basis and small depressions, temporarily (but frequently) inundated and dominated by shrubs and trees.
Three main vegetation categories are - shrub, swamps, trees swamps, herb (green) swamps.

Semi-arid swamps provide ecological values such as providing services (livestock fodder, watering points), regulating services (sediment and nutrient retention), and supporting services (habitat for animal at particular stage of their life cycle ex-building).Threats to them are agriculture use, industrial influence, invasive species, and construction of dam.

CHAPTER-2 LITERATURE REVIEW

(Megan K. Greiner 1995) Using basin-level methods and using geographic information systems (GIS), explore the relationship between wetland total phosphorus retention, wetland location and watershed structure. The objectives of this study are: 1) To determine and characterize the total phosphorus retention of fourteen wetlands; 2) To describe the distribution of land use around wetland locations; Potential relationship between the functions of total phosphorus retention in the watershed . Wetland types cannot predict total phosphorus retention. It was found that the total phosphorus concentration was related to the clay ($p < 0.001$) and the location of the wetland defined by the order of the rivers ($p < 0.005$). It is found that the total phosphorus flux of the basin varies Much with the structure of the basin. The location of wetlands and development sites in the basin can significantly change the quality of the water in the basin. Therefore, the development of in the lower reaches of the basin may be the best option. The management of the wetland should not be based on wetland types, but should consider the structure of the watershed and the use of the surrounding land. The water quality of the basin is better to strategically locate wetlands downstream of any land use through , and there is a large amount of phosphorus runoff.

(S. Murlidharan 2000) Pesticides, especially organochlorines, will stay in the environment for a long time due to their slow decomposition speed and long half-life, and can have harmful effects on non-target organisms. The loss of water in the park is only due to evaporation and infiltration, and apart from years of flooding, the park has no outlet for water. As the size of the wetland ecosystem decreases or the volume and / or toxicity of the contaminant increases, the capacity of the wetland to contain and remove the contaminant is compromised. Once this point is reached, wetland may cause toxicity, not subsidence. Therefore, pesticides that enter Park remain inside unless silt containing pesticides is removed manually or mechanically. However, the effects on the system are mitigated to some extent by the natural decomposition of chemicals. As there is lack of water in this part of the country, water cannot be released from the park to reduce the build-up of pesticides in wetlands. Therefore, advice to farmers to turn to eco-friendly plant protection measures is the only alternative available to protect wetlands.

(Anju Baroth et. al. 2002) Keoladeo National Park holds completely essential vicinity in our country for being IUCN's (International Union for Conservation of Nature & Natural Resources) world heritage site and as a feeding floor for lots migratory birds. Three study sites had been recognized from the park for the collection of water and sediment samples. The park gets water from a brief water reservoir, Ajan Bandh a few kilometers away from it. This reservoir gets water infected with variety of insecticides from the catchment area of river Gambhiri as it is miles below widespread agricultural practice. Ajan Bandh additionally becomes a crop area in winters after the water is launched into the park thereby increasing the additional load of insecticides to the reservoir. Organochlorine insecticides (HCH & its isomers, DDT & its metabolites and Dieldrin) had been extracted from the samples with the help of liquid-liquid chromatography and analyzed by Gas chromatograph. All the samples had been located to be infected with the above mentioned insecticides and the concentration of overall Organochlorine insecticides in water ranged among 0.07-0.1 ppm even as that of sediment among 0.6-1.3 ppm.

(Malavika Chauhan 2006) Water conflicts with the Panchna dam in Keoladeo National Park. Farmers in the upper reaches of the dam's command area staged protests. The continuous increase in water consumption caused a rapid decrease in the water supply. There is a need to increase the amount of water available, although as part of a larger plan, the government plans to provide parks with chemically treated drinking water, which will leave millions of fish, invertebrates and young amphibians behind. A solution for this problem can be the revive of Banganga river along with increase in afforestation in catchment. Moreover intensive watershed management, flood plain revival programmes to be taken out especially in downstream side of Panchna Dam. Any of this type of project needs to work in communities and riverside lands (private and public), so it must involve the state government, forest departments and non-governmental organizations capable of mobilizing local people.

(R P Singh et al 2010) Keoladeo National Park is a "Ramsar site" flooded by Ajan Bandh and reserved for high levels of biodiversity. Due to its global ecological, fauna and flower importance, it was designated as a World Cultural Heritage Site in 1985. The total area (28.7 sq km) provides a variety of habitats, including wetlands / marshes, forests and grasslands. Wetlands support a variety of habitats. Inhabited by plants and fauna, it has the greatest

biodiversity due to its abundant nutrients. However, wetlands can show salt through upwelling of salt, which makes them a different place than every day. In analysis of soil and plants was performed to evaluate the salinity of the soil and its reflection on the plants. For analysis, the three dominant plants of the park namely. Acacia nilotica, Prosopis juliflora and Mitragynaparvifolia were selected. In addition to inorganic constituents, organic constituents of osmotic were determined in plants to evaluate their contribution under those. The three dominant species, namely Acacia nilotica, Prosopis juliflora, and Mitragyna parvifolia, may accumulate Na^+ and Cl^- ions. These ions may be isolated in vacuoles and exist in the form of free proline and free sugars. Osmotic regulation is established in the cytoplasm. The compartmentalization of by Na^+ ions can realize that salt-tolerant plants maintain a high cytoplasm K^+ / Na^+ ratio. It may be for these reasons that these plants can successfully grow in the park. In fact, it is generally found that inorganic matter (Na + and K +) and organic matter (sugar, free proline, etc. only in plants) infiltrate and accumulate in the soil, as well as the plants growing in the area of the park, indicating salt outcropping.

(Vikas Rai 2010) The model of the KNP wetland part is introduced and analyzed. Two-dimensional parameter analysis shows that this minimal model has dynamic complexity. The per capita water consumption of "bad" biomass (W1) is one of the most important parameters. The good health of the park can be ensured by limiting the per capita water consumption to a low value. The removal of "bad" biomass by issuing permits to villagers should be combined with water conservation and management activities. From an ecological and economic point of view, W_1 is the most critical parameter. It is about managing this limited resource, essential for all species it may be large plants or birds. It is concluded in this study that, by limiting the per capita water consumption of "bad" biomass to a low value, the good health of KNP can be guaranteed. This means that the removal of Paspalum by villagers must go hand in hand with the park's water conservation and management measures. Plants such as Babul and Cactus are recommended to be planted in the terrestrial area of the wetland. These plants consume less water and provide materials of economic value. For example, babul provides gum-like substances with considerable medicinal value. Similarly, cacti provide a high calorific fuel because in addition to the normal cellulose that makes up most of your body, there is also a large amount of hydrocarbons in their juice, which is why they have a high calorific value. Encourage the cultivation of slow-growing

floating plants and emerging plants with medicinal value and low water consumption in wetlands.

Alicia M. Frank (2011) In her study, she focused on the water losses that Keoladeo faced most of the time. The Chiksana Canal is proposed as a smaller supplementary water supply for KNP. This canal has been successfully built and implemented in the park delivers 50 mcft of runoff water to the wetlands during the monsoon (K.R., Anoop, 2010). The second option considered is the Chambal pipeline. This dedicated 79.6 km pipeline project intends to transport water from the Chambal River to KNP. The expected cost is more than 1 billion rupees (approximately US$22,200,000). Although will provide abundant water sources for the park, it is still unclear from which towns or communities will transfer this water. However, the high price of the project made it unsustainable, and the Chambal pipeline was eventually rejected and replaced by the shorter and cheaper Govardhan drainage pipeline. In fact, the 17-kilometer dedicated Govardhan drainage pipe which was finally deemed acceptable by Rajasthan and funded by the Planning Commission, is expected to bring 350 mcft of monsoon rain to the park every year (K.R.Anoop, 2010). In the end, the easiest and most obvious way to save KNP is to restore the water that flows downstream of River from the Panchna Dam to the Ajan Bandh.

(Nivedita et.al 2016) Keoladeo National Park (KNP) is a 29 Km^2 region arranged on the outrageous western edge of the Gangetic bowl that was once conjunction of Rivers Gambhiri and Banganga in Bharatpur area in the State of Rajasthan. KNP is important for the Indo Gangetic plain with rises going from 173-176 meters above ocean level. The significant sub region is around 8.5 square kilometer. The physicochemical boundaries of KNP's water tests were broke down for a time of long term from May 2006 to April 2009. The water tests gathered were examined, according to standard strategies. Boundaries like pH, inorganic phosphate, natural carbon, absolute nitrogen, sodium, potassium and calcium were estimated. Measurable examination was finished with the assistance of Graph cushion crystal Software. Every one of the outcomes were displayed as Mean ± SEM. Qualities were genuinely huge at $P< 0.05$ and $P<0.0001$.

(Surendra Singh et.al 2016) Keoladeo National Park is around 30 Km^2 region arranged on the outrageous western edge of the Gangetic bowl that was once confluence of waterways Gambhir also, Banganga in Bharatpur locale in the territory of Rajasthan. It has a special mosaic of territories that incorporate wetlands, forests, scour timberlands, fields that upholds an astounding variety of both plant and creature species. The site of Keoladeo National Park is a man-made muddy wetland and is an assigned Ramsar site at Bharatpur (Rajasthan). Wetlands are vital piece of stream bowls and are viewed as perhaps the most useful environments of the earth. They may incorporate a wide scope of territories comprising around six percent of earth's surface. As per Ramsar, wetlands are spaces of bog, fen, peat land or water bodies, regardless of whether regular or artificial, perpetual or impermanent, static or flowing, new, salty or salt counting spaces of marine water, the profundity of which at low tide doesn't surpass six meters. Soil bacterial communities play a key role in regulating the circulation of major nutrients and soil carbon in freshwater wetland, the retention and release of nutrients, and have a significant impact on water quality.

(Narendra Kumar 2016) Wetland ecosystems absorb essential nutrients, recycle them, treat sewage and purify waste. Trees and forest soils purify the water that flows through forest ecosystems. Approximately 130 billion metric tons of organic waste is processed each year by organisms decomposed on Earth. Many industrial wastes, including detergents, oils, acids and paper, are also detoxified and decomposed by biological activity. During this study period, the physicochemical study of Keoladeo Wetland revealed that the physicochemical properties of water are suitable for the growth of microorganisms. Wetland under investigation demonstrated a high organic content. Because organic carbon is the main energy source for bacteria, the number of bacteria in the wetlands has increased. High nitrogen levels indicate whether the soil contains a high percentage of sand. This prevents losses due to leaching of the growing monsoon soil. Statistically found that physicochemical properties were not correlated with water pH and interactions, including season. Therefore, the pH of water is expressed which may not necessarily depend on the season. Statistically, we could also see a significant difference at $P < 0.001$ between season and total nitrogen, potassium, water sodium, calcium. This shows that these parameters are seasonally dependent.

Atasi Patra (2016) A model is expanded again to maintain the good health of the park, controlling the unwanted growth of bad biomass. As the density of effort increases, good biomass increases, bad biomass decreases, and as a result, the density of the bird population increases. It has become clear that even if the wetlands are not healthy, the density of bad biomass can be reduced compared to good biomass and bird populations with proper efforts. This shows that wetlands can change from unhealthy to good health by applying appropriate conservation efforts. Therefore, the removal of Paspalum disistichum makes the wetlands healthy. The Paspalum distichum is a wild grass which exhausts the degree of oxygen in the vast water bodies influencing seriously the great biomass and thus the bird population in it.

(S.K. Tiwari et.al. 2017) The most common threats to wetlands and Keoladeo National Park are water scarcity, changes in biodiversity, increased pollution rates, uncontrolled growth of grass, urbanization, and human intervention. In this paper, an attempt was made to study the degradation and conservation of the biologic part of the park through reactive diffusion modeling. The biological fraction of wetlands can be divided into three categories of good biomass, bad biomass and bird populations. Excellent biomass is the species that feeds the avian population and includes floating plants, fish, waterfowl and useful species. Bad biomass contains Paspalum distichum and its family that affect the growth of good biomass. The interaction with good biomass and bird populations is considered a Crowley-Martin type functional response. In this article, we study the complex dynamics of the biological part of Keoladeo National Park and the effect of Paspalum distichum overgrowth over time and its effect over good biomass and bird populations. We also determined parameters that lead to poor wetland health through numerical simulations. The diffusion coefficient of bird populations and the per capita water availability for undesirable biomass are the key parameters of the dynamic behavior of wetlands. Through the study of theory, we found that under certain conditions of the theorem, level interference between bird populations plays an important level role in system dynamics.

Ritabrata Roy (2019) Water Quality Assessment is essential to Verifies that the water source is suitable for its designated purpose. Evaluate various water quality parameters and compare with their standard values to determine the acceptability of the water to be used. After a long period of research, procedures for evaluating water have been standardized. In this article, for the

convenience of researchers and analysts, these guidelines are briefly discussed in a place. Therefore, an overview of water quality assessment standards and procedures may be useful to them. Water sources must be regularly monitored to determine if is healthy or unhealthy. It is also a threat to the ecosystem. In industry, inadequate water quality can cause serious damage economic losses. Therefore, the quality of the water is very important in environmental and economic terms. Therefore, water quality analysis is essential for use for any purpose.

Nadka Ignatova (2020) As a UNESCO heritage site, the Pirin National Park Reserve is of great importance not only for its biodiversity, but also for its large water resources and high quality used to supply drinking water to all neighboring cities and towns for all human activities in this area. At the same time, the park is a very attractive tourist destination for people from all over the world in both winter and summer seasons. From this point of view, protecting the catchment surface waters of the park from pollution is a very important task. The primary purpose of this survey is to assess the water quality of the water bodies of major rivers and lakes in Pirin National Park. Data from local monitoring of water chemistry (electrical conductivity, temperature, pH, biochemical oxygen demand, chemical oxygen demand and concentrations of dissolved oxygen, suspended particulate matter, dissolved compounds, NNH_4^+, NNO_3,PPO_4, Fe and Mn from 2004 to 2013 Periods of years are treated statistically.
With increasing concentrations of nitrogen and phosphorus in surface waters, it is recommended to implement a local treatment unit at all point sources that discharge wastewater outside the area using a common canal system in the area of the park. It is recommended to halt the seasonal development of fishing in glacial lakes above 2000m within the park to avoid increased production of algal biomass causing eutrophication.

(Dr.V.B. Mathur, Ms. Ritu Singh et.al) Assessment of water quality in and around Keoladeo National Park was carried out as part of the project "Enhancing Our Heritage: Monitoring and Managing for Success at World Natural Heritage Sites" ". The project aims to demonstrate how the use of an assessment, monitoring and reporting framework can improve the effective management of protected areas. The integration of assessment and monitoring practices into the overall management process is one of the main objectives of the program. For this reason, a water quality assessment in and around Keoladeo National Park was performed. The concentration of chloride and other ions in all regions has increased over time. From January to

April, the concentration of chloride in some places almost doubled, and TDS (total dissolved solids) also increased correspondingly. An area west of the Wetland appears to have saline patches in the matrix, and has abnormally high salinity and chloride in the groundwater. Aquatic organisms are sensitive to changes in the physicochemical (physicochemical) properties of the water they inhabit. Most organisms experience a decline in reproduction and an increase in mortality when the water physicochemical state exceeds a maximum and a minimum. Each aquatic species works well within a specific range of that species. It is considered that, changes in physicochemical conditions are considered to have deteriorated water quality, and many types of living things are affected. As a result, diversity in both plants and animals generally decreases and only a few antifouling species predominate.

2.1 OBJECTIVE OF STUDY

Wetlands are far from useless and disease-ridden places, but they provide value that other ecosystems cannot. These include natural water quality improvement, flood control, shoreline erosion control, opportunities for recreation and aesthetic appreciation, and natural products for our free use also food and habitat for fish and wild animals, including threatened and endangered species; control of coastal erosion; economically beneficial natural products for human use; and opportunities for recreation, education and research. Wetlands improve water quality by capturing sediment, filtering pollutants, and absorbing nutrients. They also provide filters between surface water and shallow groundwater resources. Such an important wetland site is at Keoladeo National Park which is in Bharatpur, situated at confluence of Banganga and Gambhiri rivers. It is both Ramsar and UNESCO heritage site. It is an important wintering site for migratory birds, and is famous for large gatherings of breeding birds inhabited by non-migratory birds. The reserve was previously used primarily as a hunting ground for waterfowl, protecting Bharatpur from frequent flooding and providing the village's livestock grazing.

In this literature review it is find out that, one of the most important reasons for the declining numbers of migratory birds visiting Keoladeo National Park is the lack of water in the park. The park's main water source is a temporary reservoir, the Ajan dam, which gets its water from the Gambhiri River. Panchna dam construction across the Gambhiri River is becoming disastrous. The main cause of water shortages in the park is that the capacity of the Panchna dam has increased from 610 cubic feet to 210 million cubic feet and there is very little water flow

downstream. In addition to this, monsoon failures, canal and river system damage, leaks through damaged locks, leaks, transmission losses such as evaporation and infiltration, and illegal water withdrawals by farmers in waterways. The main effects of water scarcity can be manifested in various ways. Over the years, the quality of the habitat has declined significantly. The invasion of weed species has outstripped landfill efforts and has led to the invasion of Prosopis (type of grass/weed) in all ecosystems of the park, which in turn create people-park conflict. Also water quality of wetland is declining continuously because of the water that led by irrigation department may contain Organochlorine in it, which is a threat to the aquatic life or ecosystem. Since, while doing literature review it is found, that there is no such research is done on the sediment analysis of wetland at KNP. It is considered that water and sediment are related to each other and sediments are important because they enrich the soil with nutrients. Sediment-rich areas are often also biodiversity-rich. Hence, due to lack of studies on water and sediment quality both in that area, provides me the motivation to research in this particular area.

CHAPTER-3 DATA COLLECTION ABOUT PARK (KNP)

3.1 GEOMORPHOLOGY OF STUDY AREA

Geomorphologic ally, Bharatpur lies in the eastern part of Rajasthan plains, eastern Aravalli ranges. KNP lies in alluvial plains of Bharatpur. Several depressions are made due to confluence of Banganga and Gambhiri rivers, out of those, one such depression is KNP.

Banganga arrives from Aravalli hills and flow toward east to Bharatpur, because of no direct outlet to Yamuna, it finds it's ways to depressions, as a result of which KNP formed. While Gambhiri River (also called Utangan River) is a river that originates in the hills near Hindaun city in Karauli district (Rajasthan) and flows around Hindaun City. The river supplies water for Keoladeo Ghana Bird Century in Bharatpur (Rajasthan). Gambhiri is a seasonal river but becomes perennial after its confluence with the Parbati, outside Dhaulpur District. A dam named Panchana is situated over this river near Karauli district.

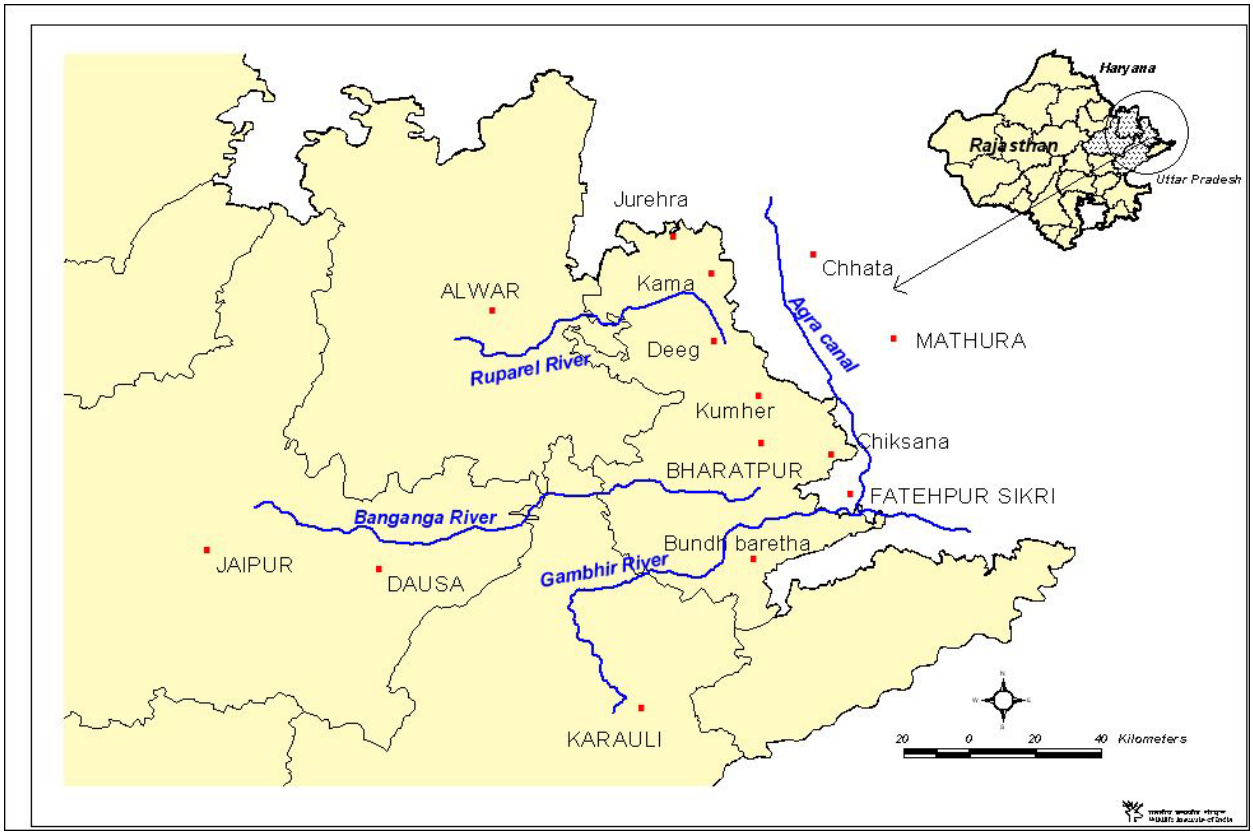

FIG 3.1: MAJOR RIVERS IN AREA OF KNP

3.2 GEOLOGY OF STUDY AREA

3.2.1 LOCATION OF PARK

KNP is situated between (27*7'6''N-27*12'2''N) latitude and (77*29'5''E-77*33'9''E) longitude at an average elevation of 174 mean sea level.

3. 2.2 TERRAIN

KNP is a flat, with gentle slope towards centre, forming a 8.5 Km2 depression, submersible area of park. It started as the Bharatpur floodplain, its origin was the rise of the seabed caused by the tectonic movement of the land and the geological erosion of the mountains of the peninsula, the Vindhiyan Mountains and Aravalis. The plain is obviously flat, sloping slightly to the east. Except when rainwater flows into the Banganga and Gambhiri rivers, the slope is hardly noticeable, although these rivers stop flowing and disappear in the floodplains of Bharatpur (Anoop K.R, 2009).

Keoladeo Marsh is a large, shallow dish-like dimple of over 30 square kilometers located on these plains. The edge of the plate extends about a meter and a half to the west and a meter to the east, and its depth has its lowest point, almost the center, about two meters this is near Sapanmori. Aghapur, Ramnagar Mallah, Main Gate, Forest Lodge, Forest Nursurey, Ghasola these are several cliffs near the python point. These are always dry as they are higher than the edge of the plate above. Topographical elevations vary from 173m to 176m, and the gentle slope towards the central depression is almost flat. Approximately 900 hectares of submersible area is divided into various sections by soil embankments where sluice gates are constructed strategically to control the water supply. The wetland block is surrounded by about 2000 ha of terrestrial habitat. Except for a small area in the northwest, it borders on farmland in nearby villages (Anoop, 2009).

The park digital elevation model created by Ms. Ritu Singh, shown in Figure 3.3, clearly shows the elevation profile of the study area.

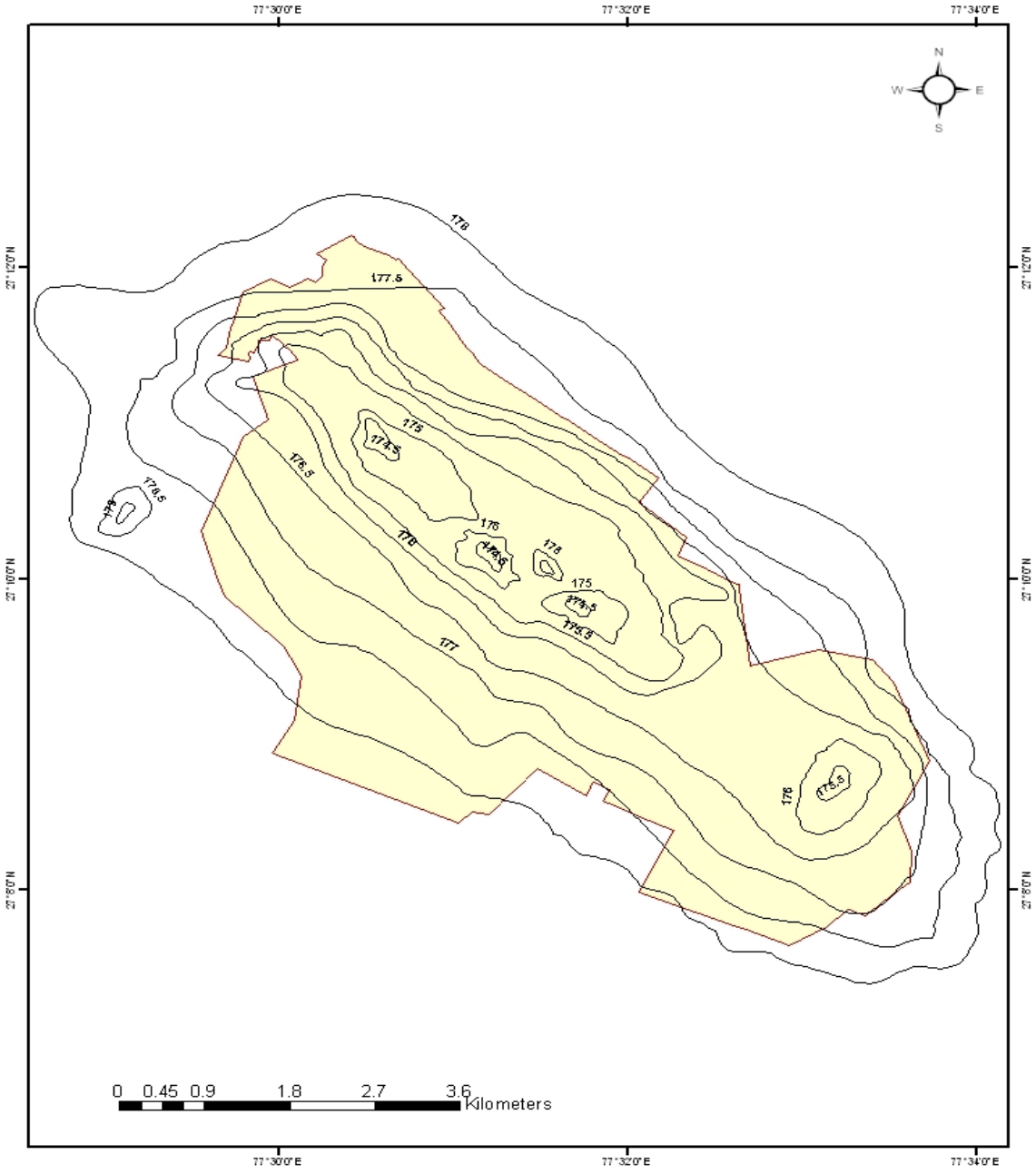

FIG 3.2: DIGITAL ELEVATION MAP OF PARK (Source: RITU SINGH 2011)

3.2.3 TEMPERATURE

Experiences extreme weather conditions. The daytime temperature varies from (0.5 ° C-2°C) in January to (48-50° C) in May. The monthly average minimum temperature ranges from 5.3°C to 32.2°C.

3.2.4 CLIMATE

Bharatpur experience extreme climate, hot dry summer (April-June) to cold winter (November-January) and short monsoon (July-September) also post monsoon (February-March).

3.2.5 RAINFALL

The mean annual precipitation is 662 mm, with rain falling on an average of 36 days per year Vijyan in his report (1990). It receives most of its precipitation from south west monsoon which sets in June-July and ends in September-October.

3.2.6 HUMIDITY

The average relative humidity is between 42.8% and 91.8%, the lowest in summer and the highest in winter.

3.2.7 PHYSICAL AND EDAPHIC FEATURES

Vijyan (1990) pointed out in his research that the KNP area is a mosaic of flat swamps created artificially in the Ganges plain and maintained by a system of gates, dams and canals. The river was submerged, water was injected into the swamp, and the river was seized by an artificial dam (Ajan Bandh). It was submerged 1 to 2 meters throughout the monsoon period (July-September), and began to dry from February to June; the water remained in only a few pockets.

3.2.8 SOIL AND TEXTURE

Soil at KNP is thick alluvium, some clay formation with overlaying Kankar path. Periodic inundation dominant the area. Patches of saline soil are common in terrestrial area. Overall texture, found in clayey loam to silt clay loam (Si-Cl). It is categorized as clayey to heavy clay in wetland, silty-clay loam in woodland, clay loam in grassland.

TABLE 3.1: SOIL OF KNP WITH DIFFERENT HYDRAULIC CONDUCTIVITIES

LAND USE IN THE KNP	SOIL TYPE	RANGE OF HYDRAULIC CONDUCTIVITIES (m/s)
Grassland	Clay loam	6.9×10^{-7} to 1.3×10^{-6}
Woodland	Silty clay loam	6.9×10^{-7} to 2.7×10^{-6}
Wetland	Clay to heavy clay	$<6.944\times10^{-7}$

3.2.9 VEGETATION

Due to the high density of vegetation found in KNP, the park is called "Ghana" or dense forest. KNP includes a variety of plant groups representing 64 families, 181 genera, and 227 subspecies. There are different types of vegetation. The main vegetation type is tropical dry deciduous forest, dominated by Acacia on the Nile, scattered with dry grasslands. In addition, the artificial swamps in most areas are covered by medium-sized trees and shrubs. Trees like Kadam, Babul, and Jamun dominate the area. The bushes are mainly Ber and Kair. Khus grass is the dominant grass family in the reserve. Among them, aquatic plants include water lilies, N. stulata, N. cristata, lotus, duckweed, and water fern.

3.2.10 HYDROLOGY OF KNP

Water is fed into the KNP by Ajan bund, as it is the main source of water in KNP. Ajan dam is situated about 500 m south west of the present park boundary. Ajan dam receives water from river Gambhiri and Banganga, at confluence of which park is located. Banganga is originated from low hills of Bairath in Jamuaramgarh in Jaipur flow towards east, and finally got meet Gambhir near Bayana tehsil of Bharatpur. Water from river Gambhir is brought into Ajan dam through Pichuna canal. It can be shown in the block diagram of KNP. Water is retained in Ajan dam for some days so that silt settled down before released into the park. Water from Ajan dam is taken to KNP through Ghana Canal and after which it released to various compartments of wetlands by means of sluice gate. Water in Dam is retained almost for 2 months (empted by

September). The water quantity that received, no doubt the most important factor is survival of wetland.

Once water is let through Dakan Mori into Ghana Canal which is within the park. It is taken to different compartments or blocks of wetlands through sluice gate or dykes at a desired level. The maximum water spread area is during September –October. Vijyan in his study said that water loss through infiltration is minimal; mostly it is lost by evapotranspiration, which is very high during dry summer season, which leaves only a few pools in central deeper portion of park.

Chapter-4 MATERIALS AND METHODS

4.1 SITE AREA STUDY

Keoladeo national park, Bharatpur is a Ramsar site (1981) as well as world heritage site (1985). Area of which is approximately 30 Km^2 out of which almost 9 Km^2 is wetland which is about 33% of the total area of the park. It is located at (27*7*6*-27*12.2*) and (77*29.5*-77*35.5*) and about 180 Km between Delhi and Jaipur.

The park is divided into 15 blocks, named in alphabetic orders from A to O. There are separated by earthen dykes or mud trails so that it can be helpful in management and tourism.

Out of 15 blocks, 5 blocks (due to availability of water) are selected for this study. These 5 blocks are named as K Block, L block, B block, D block, and E block.

LOCATION OF PARK IN MAP:

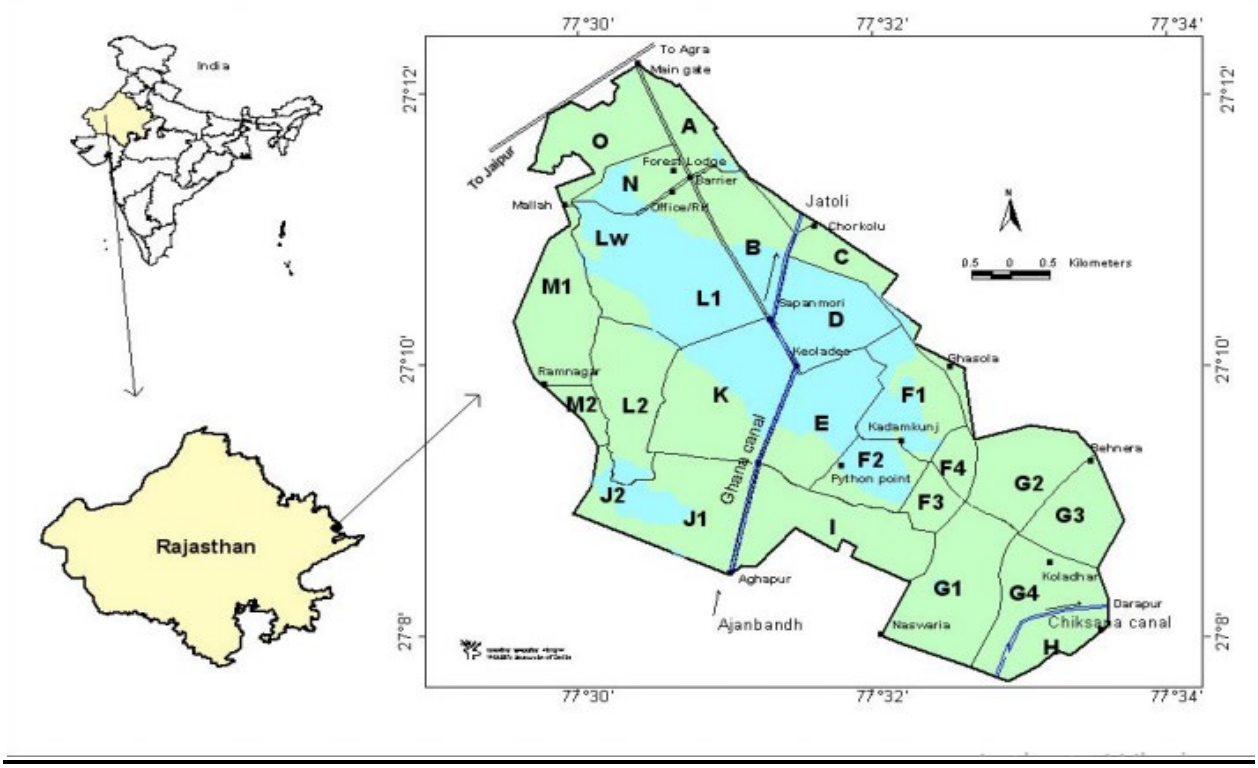

FIG4.1: LOCATION OF KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN, INDIA.

Water sample are collected from these 5 blocks (L block, K block, B block, D block, E block) out of 15 as well as sediment samples were also collected.

BLOCK DIAGRAM OF PARK

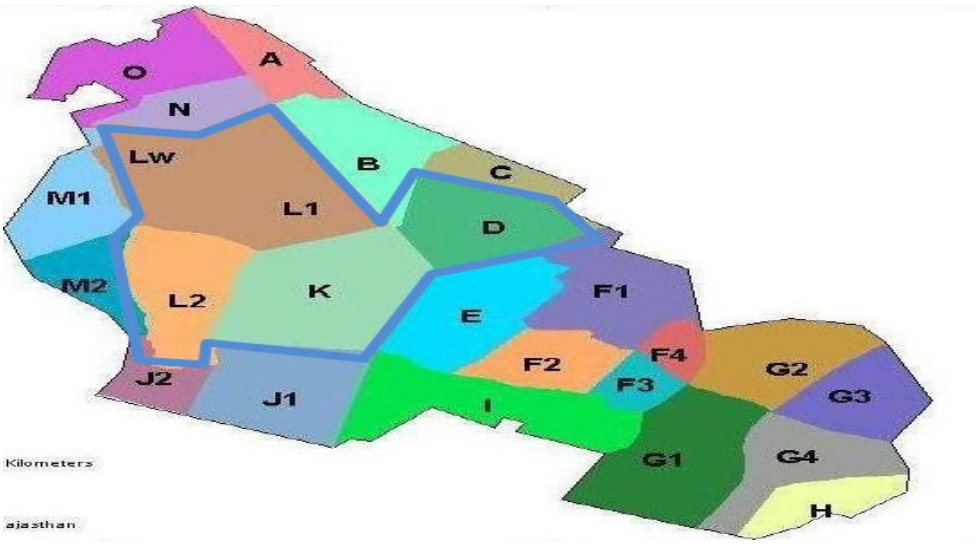

FIG 4.2: BLOCK DIAGRAM OF KEOLADEO NATIONAL PARK

4.2 SAMPLE COLLECTION OF WATER

The water samples are collected in pre-sterilized bottles. Each bottle has a capacity of one litre. Twelve water samples were collected at different locations.

TABLE 4.1: STUDY SITE NAMES AND LOCATION

Site Name	**Sapan Mori D1**	**L block**	**K1 block**	**B1 block**	**B2 block**	**D2 block**	**D3 block**	**E1 block**	**E2 block**	**K2 block**	**K3 block**	**E3 block**
Sample No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

4.3 SEDIMENT SAMPLES

Sediments samples were also collected from the park from 5 different sites. These are namely- Sapan Mori Canal Block, L block, K block, D Block, and E block.

TABLE 4.2: STUDY SITE NAMES FOR SEDIMENT SAMPLES

SITE NAME	SAMPLE NUMBER
SAPAN MORI CANAL	SITE 1
L BLOCK	SITE 2
K BLOCK	SITE 3
D BLOCK	SITE 4
E BLOCK	SITE 5

These samples were collected and various physiochemical parameters which are stated below were found out in Environmental lab.

4.4 PHYSIO-CHEMICAL STUDY OF WETLAND WATER

Out of 15 blocks 5 blocks are selected out of which 12 sample site are selected. Temperature, pH, Total dissolved solids (TDS), Dissolved oxygen (DO), Electrical conductivity salinity were measured on site using Onion make star A-329 model Multiparameter meter.

Other parameters were determined within 24 hours after transporting the preserved samples to laboratory using standard method of APHA (American Public Health Association). Total Phosphate (TP) was determined spectrophotometically. Other parameters like chloride, total alkalinity and Total hardness (TH) were determined by Volumetric analysis.

4.5 PHYSIO-CHEMICAL STUDY OF WETLAND SEDIMENTS

Sediment of KNP were collected from 5 blocks namely- B block, L block, K block, D block and E block. A 10 gm of sediment is mixed with 50 ml of distilled water, to determine physiochemical properties of sediments like pH, temperature, Electrical conductivity. Total dissolved solid and salinity using multiparameter.

4.6 ANALYSIS

In this section, we study about the instrument or methods that were used to determine the following physiochemical properties of water and sediments in KNP. All parameters determined using standard method of APHA.

TABLE 4.3: METHODS USED FOR PARAMETERS ANALYSIS

Parameters	**Methods**
pH, TDS, EC, Temperature, Salinity, DO	MULTIPARAMETER METER (ORION MAKE STAR A-329 MODEL)
TH , TOTAL ALKALINITY , CHLORIDES	VOLUMETRIC ANALYSIS
TOTAL PHOSPHATE (TP)	SPECTROPHOTOMETRICALLY
TOTAL ORAGANIC CARBON	THERMAL OXIDATION

CHAPTER-5 RESULTS AND DISCUSSION

Studies of Physio-chemical characteristics of water and sediments of "Keoladeo" suggest notable concentration of different cations and anions is present in surface water and sediments, and significant spatial variations have been observed in the present aquatic ecosystem. Different aspects of physiochemical characteristics of water have been studied. Following are the results related to samples. Surface water samples were analyzed for pH, temperature, electrical conductivity, total suspended solids (TSS), total dissolved solids (TDS), salinity and various cations and anions like phosphate, calcium, magnesium, lithium, potassium. The concentration of cations and anions was notable and was compared with standard concentration of drinking water.

5.1 PRELIMINARY CHARACTERISTICS OF SURFACE WATER

The values of pH, EC, Temperature, TDS, TSS were analyzed. The hydrogen ion concentration of water is a measure of its acidity.

pH value is an important factor in determining whether water is suitable for various purposes, including toxicity to animals and plants. In this study, it was found that the pH ranged from near neutral (7.5) to alkaline (9.1). A pH value of 8.5 or higher is a good indicator of the high content of soluble salts in the water. High pH water may require special cultivation and irrigation methods. The pH for surface water is generally considered suitable if it is slightly alkaline in range. The maximum and minimum values of pH are 9.1 and 7.5 respectively and mean value is 8.3 indicating that the water in Keoladeo National Park is suitable for the aquatic life.

Temperature is an important parameter in water-bodies because it regulates the dissolution of oxygen which in turn supports the aquatic life. Further, the biodegradation of organic impurities by microorganisms in water is a temperature-dependent process. Although aquatic organisms can tolerate a wide range of temperature, in contaminated water, temperature has a profound effect on DO and BOD. Such fluctuations in lake water temperature usually depend on the season, geographic location, sampling time, and the temperature of the effluent entering the lake. The biological reactions responsible for the elimination of biological oxygen demand (BOD), nitrification and denitrification depend on temperature. In addition, the temperature of the water is the main determinant of the process of water loss through evaporation. The average

temperature in the present study is found around 27.3°C. There was no significant variation in temperature of surface water during the sampling period.

TABLE 5.1: PRELIMINARY CHARACTERISTIC OF SURFACE WATER OF KNP

S. No.	pH	Temp. (°C)	EC (μS/cm)	SALINITY (psu)	TDS (mg/l)	DO (mg/l)	NH_3 (mg/l)
1.	7.71	27.2	1569	0.78	766	3.1	0.4
2.	8.43	27.2	4320	2.27	2170	1.2	3
3.	8.95	27.3	4550	2.45	2270	2.3	0.8
4.	7.58	27.2	4650	2.43	2340	0.6	1
5.	7.65	27.3	4640	2.54	2300	0.3	3
6.	8.39	27.2	2800	1.44	1422	0.3	0.3
7.	8.89	27.3	4810	2.64	2380	0.4	0.1
8.	8.84	27.3	1859	0.96	953	0.4	2
9.	9.19	27.3	1659	0.86	833	1.1	0.2
10.	8.22	27.2	1419	0.71	727	2.4	0.1
11.	8.69	27.2	6640	3.69	3320	0.7	0.06
12.	7.88	27.3	1423	0.72	719	0.2	1
Mean ± SD	**8.3 ± 0.6**	**27.3 ± 0.1**	**3361.6 ±1775.8**	**1.8 ± 1.0**	**1683.3 ±882.5**	**1.1 ±1.0**	**1 ±1**

Conductivity is a measure of the ability of an aqueous solution to carry current. It depends on the presence of ions (that is, total cations and anions), mobility, valence, and temperature. Conductivity also increases with increasing salinity. It is affected by temperature, the hotter the water, the higher the conductivity. The increase in conductivity and cation levels is a product of the decomposition and mineralization of organic materials. The conductivity of water is important because it indicates the presence of dissolved substances, chemicals or minerals in the water. More dissolved impurities lead to higher conductivity. Its unit is micro Siemens per cm

(μS/cm). The maximum and minimum value of EC is 6640 μS/cm and 1423 μS/cm with mean value of 3361.6 μS/cm.

Salinity is total concentration of all dissolved salt (Na-Cl) in water. It's a strong contributor to conductivity when it is derived from the conductivity measurements; it is called practical salinity as it is not measured directly. Salinity is an ambiguous term. Salinity is measured based on conductivity values, but are often followed by practical salinity unit (psu). The salinity is generally high in areas where rate of evaporation is high and the climate is dry. Major ions that contribute to salinity are chlorides of sodium and potassium. Fresh water usually has higher bicarbonate ratio while sea water has greater sodium and chloride concentration. As salinity increases it may lead to wetland degradation and decrease in biodiversity. If sulphate salts are present then formation of acid sulphate soil can occur. It affects dissolved oxygen solubility. The higher the salinity level, lower dissolved oxygen concentration. Oxygen is 20% less soluble in salty water as compared to fresh water at same temperature. The maximum and minimum values of salinity are 2.6 and 0.7, respectively, and mean is 1.8 indicating that there is significant presence of salts in soil, sediments, and surface water at Keoladeo National Park.

Total dissolved solids (TDS) contain inorganic salts, metals, cations, or anions which are dissolved in water. Salts like (Ca2+, Mg2+, K+, Na+, HCO3-, Cl-) and in small amount of organic matter that are dissolved in water. Higher level of TDS in drinking water affects the taste of water. However, the minimal content of water needs to stay constant for aquatic animals to survive, so the fluctuations may affect the quality of water and survival of aquatic species. The TDS is also related to hardness and it is a measure in mineral content of water. More TDS more hardness, also TDS dissolved with turbidity of water. Turbidity is a measure of "how clear the water is". Greater the TDS, lower the turbidity. TDS level affects more, aquatic animals than humans. Basically it changes the minimal quality of water, which is a need to survival of animals. It dehydrates the skin of aquatic animals and also increases temperature of water in which aquatic species can't survive. TDS level for drinking water is 500-2000 mg/l. When TDS ranged above 2200-3600 mg/l, Salmonids pike, perch (kinds of fish) etc. all show reduced hatching and egg survival rates. Generally, dissolved solids are important to keep cell density balanced for aquatic life. Whereas, if it is very high in concentration, cell will shrink which in turn affect ability of organism to move in water column. It either sinks or floats. Higher TDS

generally indicates presence of greater amount of dissolved solids which are due to high discharge of surface runoff containing sediments. The maximum and minimum value of TDS is 3320 mg/l and 719 mg/l and mean is 1683.3 mg/.

Ammonia is a form of nitrogen found in the aquatic environment. Unlike other forms of nitrogen, it can cause excessive enrichment of nutrients in high-concentration water bodies and have a direct impact on aquatic organisms. Natural sources of ammonia include decomposition or decomposition of organic waste, gas exchange with the atmosphere, animal and human waste, and nitrogen fixation processes. Ammonia can enter the aquatic environment directly through the excretion of nitrogenous wastes from animals, or it can enter the aquatic environment indirectly through nitrogen fixation, air deposition, and farmland runoff. When the ammonia content in the water is high, it is difficult for aquatic organisms to fully discharge toxic substances, causing toxins to accumulate in the body's tissues and blood, and may lead to death. Factors like pH and temperature will affect the ammonia in the water. Ammonia in water is not toxic to humans, but it is toxic to aquatic organisms.

5.2 CATIONS:

The samples were analyzed for the following cations – Sodium (Na^+), Magnesium (Mg^{2+}), Lithium (Li^+), Potassium (K^+) and Calcium (Ca^{2+}). The maximum and minimum value of Na+ is 890.53 mg/l and 186.75 mg/l and mean is 429.9 mg/l. The maximum and minimum value of Mg2+ is 127.73 mg/l and 29.25 mg/l and mean value is 69.5 mg/l. The maximum and minimum values of Li+ are 202 mg/l and 101 mg/l and mean is 109.4 mg/l. The maximum and minimum values of K+ are 70.18 mg/l and 28.2 mg/l and mean is 42.6 mg/l. The maximum and minimum values of calcium are 460.98 mg/l and 134.85 mg/l and mean is 228.4 mg/l. The values of cations are higher than the permissible limits for drinking water (BIS standards). The high values can be due to natural sources and because of anthropogenic activities in and around lake like discharge of sewage into the lake.

Total Hardness (TH) of water is important parameter to determine whether it can be used in domestic or industrial or agricultural purpose. It is caused due to polyvalent metallic ions in water. Primarily it is due to Ca^{2+} and Mg^{2+}. It is measured in terms of equivalent concentration of calcium carbonate CaCo3.

TABLE 5.2: CLASSIFICATION OF WATER HAVING HARDNESS IN IT (Wikipedia)

CONCENTRATION IN mg/l OF CaCO3	DESCRIPTION
0-75	SOFT
75-150	MODERATELY HARD
150-300	HARD
300 AND UP	VERY HARD

Naturally it is in limestone which gets dissolved by percolating rainwater made acid by dissolved CO2. Hardness of K block is found to be maximum (696 mg/l) and E block to be minimum (244 mg/l). It is the ions that affect the fish and other aquatic life, which create hardness rather than hardness.

TABLE 5.3: CONCENTRATION OF CATIONS IN SURFACE WATER OF KNP

S. No.	Na^+ (mg/l)	Mg^{2+} (mg/l)	Ca^{2+} (mg/l)	K^+ (mg/l)	Li^+ (mg/l)
1.	209	30.23	135	29	101
2.	534	82.88	269	43	101
3.	568	66.3	271	46	101
4.	526	107.3	247	52	101
5.	538	1101.2	254	54	101
6.	391	68.3	203	40	101
7.	562	108.23	262	49	101
8.	290	38.01	171	36	101
9.	259	29.25	166	33	101
10.	187	36.08	148	30	101
11.	890	127.73	461	70	202

12.	205	29.25	153	28	101
Mean ± SD	**429.9 ±412.5**	**69.5 ±67**	**228.4± 217.1**	**42.6 ±40.2**	**109.4 ±101**

5.3 ANIONS

The water samples were analyzed for the following anions – phosphate, carbonate, bicarbonate, and chloride.

Phosphate determination is important in assessing potential biological productivity of surface waters. Phosphate enters waterways from human and animal waste, phosphorus rich bedrock, fertilizer runoff. Increased level of phosphate in lakes and reservoir causes eutrophication. Eutrophication is the process of plant growth basically algal blooms due to increase of nutrients within the body of lake or reservoir. The plant dies more rapidly than they can be decomposed. These about plant build up and add up with sediments entering the water, fill the bed of lake making it shallow. Cultural Eutrophication is spreading up process, due to addition of phosphorous by humans. Too much phosphate results in algal and weeds growth which leads to consumption of oxygen rapidly due to which aquatic plants die. Consequently it results in death of many fish and aquatic organisms. Phosphate at 1.0 mg/l level stimulates growth of plantation and aquatic plants which provide food for fish. Consequently, increased fish population improves overall water quality. Total phosphate concentration was found maximum in B block (4.8 mg/l) and minimum in K block (0.2 mg/l). Phosphate if present at low levels does not affect human or animals. But if it is high in concentration causes eutrophication which is turn decay oxygen levels which result in death of aquatic life. The maximum and minimum values of phosphate are 4.8 mg/l and 0.2 mg/l respectively and mean value is 1.3 mg/l indicating that the water body Keoladeo National Park in eutrophic and may express the related after effects of this process.

Alkalinity is the ability of water to resist pH loads, which makes the water more acidic. In other words, it is the ability of water to neutralize acid. This capacity is called the buffer capacity. The buffer is a solution, if acid is added, the concentration of H + ions does not change significantly

(the pH value is not changed). Basically, it absorbs H + ions and protects water bodies from fluctuations in pH. The higher alkalinity of surface water buffers acid rain and other acidic wastes, and presents pH changes that are harmful to aquatic life. The higher alkalinity is due to higher evaporation and less fresh water flowing into the lake leading to higher carbonate concentrations. Excessive alkalinity will damage the outer surface of the fish, such as gills, eyes and skin, and will not be able to remove metabolic waste and even die. HCO_3^- is the main source of alkalinity in these waters. The maximum and minimum values of carbonate alkalinity are 216 mg/l and 12 mg/l and mean value is 85 mg/l. The maximum and minimum values of bicarbonate alkalinity are 1007 mg/l and 415 mg/l and mean value is 564.3 mg/l.

Chloride is found in water around the globe. It is ionized form of element chlorine. Chloride compounds are derived from mainly natural deposits, agricultural, or irrigation discharges. Chloride level in water bodies affected mainly by climate for ex- Chloride concentrations in water bodies in humid region tend to be low, whereas in arid and semi-arid regions may be hundred times higher because of evaporation rates bring so high.

A high amount of chloride water is detrimental to plant and wildlife, and may affect . On the other hand, if not that much salty aquatic quality may be affected. The chloride content was found to be maximum in K block and minimum in E block. Chloride varies from 324 mg/l to 2100 mg/l. High concentration of chloride leads to stream acidification; mobilize toxic metals by ion exchange from soils, affects mortality and aquatic plant and animal's reproduction. Basically chloride affects the osmoregulation (a biological process through which they maintain body salt and other solutes balanced). Difficulty in it, affects survival growth and reproduction. The maximum and minimum values of chloride are 2010 mg/l and 324 mg/l and mean value is 873 mg/l.

TABLE 5.4: CONCENTRATION OF ANIONS IN SURFACE WATER OF KNP

SAMPLES	TOTAL CHLORIDE (mg/l)	TOTAL HARDNESS (mg/l)	HCO_3^- (mg/l)	CO_3^{2-} (mg/l)	TOTAL PHOSPHATE (mg/l)
1.	366	264	494.1	36	0.8
2.	1076	484	475.8	60	0.6
3.	1096	392	463.6	60	0.3
4.	1096	620	1006.5	12	4.8
5.	1158	632	945.5	84	4.8
6.	710	476	671.0	84	1.8
7.	1238	584	530.7	216	0.6
8.	568	244	414.8	84	0.7
9.	468	192	292.8	144	0.5
10.	366	276	427.0	72	0.4
11.	2010	696	567.3	72	0.2
12.	324	240	481.9	96	0.6

MEAN ± SD	873 ±499.7	425 ±179.9	564.3 ±212.8	85 ±52.3	1.3 ±1.7

5.4 DISCUSSION

The values of pH, EC, Temperature, salinity, TDS, and TSS are quite high (as compared with BIS standard of drinking water) in sample no. 2, 3, 4, 5 and 7 and 11. These samples were collected from blocks L, K B1, B2, D3, and K3, respectively. Similar trend was observed in the concentration of cations and anions in blocks B, D, K, and L. High eutrophication (due to high value of phosphate) was observed at these blocks which correspond with the high values of different parameters. This significant difference in the concentration of different blocks can be due to anthropogenic activities that occur near those locations and it may also be due to nesting of birds. pH is found almost alkaline and same at all the locations. TDS and EC could be high because of the waste of animals which may be attributed to visit of or relatively more visits of wild animals at that particular location for grazing, nesting, drinking etc. Dissolved impurities are there due to which it is found that there is spatial variation in TDS, TSS and EC.

5.5 ANALYSIS OF WETLAND SEDIMENTS

The physiochemical properties of five sediments samples were determined using multiparameter. Those are pH, temperature, electrical conductivity, Total dissolved solids and salinity.

TABLE 5.5: PRELIMINARY CHARACTERISTICS OF SEDIMENTS SAMPLES

SAMPLES	pH	TEMPERATURE (°C)	EC (micro semen/cm)	SALINITY (psu)
1. SAPAN MORI CANAL	7.53	29.4	296	0.14

2. L BLOCK	7.86	29.4	500	0.25
3. K BLOCK	8.08	29.4	697	0.35
4. D BLOCK	7.81	29.4	475	0.23
5. E BLOCK	8.13	29.4	351	0.17
MEAN ± SD	7.86 ±0.25	29.4 ±0	463.8 ±155.5	0.23 ±0.08

pH is found to be maximum for K-BLOCK (8.1) and Sapan mori canal (D BLOCK) is minimum (7.5). Temperature is almost same for all the Keoladeo sampling blocks i.e. 29.4°C. EC is maximum for K block (697 micro Siemens per sec) and minimum for Sapan mori canal (296). Salinity is maximum for K block (0.35) and minimum for Sapan mori canal block (0.14).

TOC is the amount of carbon atoms tied up in organic compounds. It is organic carbon amount present in a source rock expressed by weight percentage. Basically, it measures the total organic matter present in sediment and also indicates source richness with respect to how much hydrocarbons the sediment can generate. TOC levels in water are known to increase upon exposure to air. TOC in sediment play important role in controlling mercury sequestration process by sediments. Mercury being toxic prefers to associate with finer particles of sediments (like silt and clay). Sediments are well known for their role of controlling mercury (Hg) pollution in aquatic systems which in turn beneficial for aquatic life.

TOC of five sediments samples are taken and tested in lab and the result are here in below table:

TABLE 5.6: TOC VALUES OF DIFFERENT SEDIMENT SAMPLES

S. No.	**INITIAL WEIGHT (g)**	**FINAL WEIGHT (g)**	**TOC** (In percent)
1.	3.7234	3.683	1.1
2.	4.5368	4.463	1.6
3.	4.7764	4.71195	1.4
4.	4.2445	4.17851	1.6
5.	4.06243	4.01369	1.2

From the above table we have concluded that TOC is maximum for block D (1.6 %) and minimum for Sapan mori canal block (1.1 %).

TOC presence or absence influences how chemical will react in soil or sediment.

CHAPTER6 CONCLUSION

Based on the observations of the present study following conclusions are made;

1. The surface water quality of Keoladeo National Park is compromised with respect to different parameters and it may have a bearing on the number and diversity of avian fauna visiting the park.
2. The presence of relatively higher concentration of phosphate in water indicates Eutrophic status of KNP wetland, which stresses upon immediate intervention to reduce the phosphate load and revive the water quality.
3. The alkaline-cum-saline nature of water in KNP is a cause of concern, since the salinity build-up way interfere with the natural processes occurring in the lab resulting in relatively reduced productivity.
4. Finally, it is very important to maintain a good volume/level of water in KNP. The low water level may result in concentration of pollutants/impurities upon evapotranspiration.
5. The water and sediment quality represent relatively degraded quality, and immediate intervention in terms of improving water level, reviving the functional food chain, and targeting nutrient export through fish catch etc. should be taken up.
6. Due to high level of phosphate, nitrate results in increased level of eutrophication which leads to increased level of algal bloom. There is urgent need to regularly monitor the wetland and to take necessary measures to reduce nutrient in it.

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