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Physico-Chemical Parameters of Conventional Freshwater Ponds of Ren, Mundwa, Tankla and Rol Village at Nagaur District, Rajasthan, India

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Abstract

The current study aimed to investigate the seasonal variation in physicochemical parameters of water of four different conventional and major source of fresh water bodies namely Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol located at Nagaur District Western Rajasthan India, over a period of one year from July 2024 to June 2025. The analyzed parameters included air temperature, water temperature, turbidity, pH, specific conductivity, dissolved oxygen, dissolved solids, carbonate, total alkalinity, biological oxygen demand, total hardness, calcium, magnesium, chloride, fluoride and nitrate. The results showed that highest value of most of these parameters (including Specific conductivity, dissolved solids, carbonate, total alkalinity, biological oxygen demand, total hardness, calcium, magnesium, chloride, fluoride and nitrate) was observed in pre-monsoon season while the values were lowest in monsoon season. This occurred because monsoon season leads to dilution of dissolved ions and increased turbidity owing to land and agricultural runoff, whereas the pre-monsoon season is marked by relatively higher evaporation rate leading to higher concentrations of dissolved substances with reduced water volume. On the other hand, winter conditions tend to favour higher dissolved oxygen levels and lower biological activity.

***Key words*:** Water quality, Physico-chemical parameters, Seasonal variation, BOD, Dissolved oxygen

The earth's surface is formed by more than 2/3rd of water, which includes several water bodies such as rivers, lakes, ponds, reservoirs, and wetlands. All these are dynamic ecological systems whose health and productivity is determined by several physico-chemical characteristics of water bodies. All these physico-chemical parameters determine the physical as well as chemical nature of water and directly influence biological communities, ecosystem stability. Physico-chemical parameters of water bodies include temperature, pH, electrical conductivity, turbidity, total dissolved solids (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, hardness, salinity, and nutrient concentrations such as nitrates, chloride, fluoride and phosphates [1-3]. These parameters not only reflect the overall water quality and ecological status of aquatic ecosystems, but also serve as important indicators for assessing pollution levels, seasonal variations, and the suitability of water bodies for domestic, agricultural, and aquatic life purposes.

These physico-chemical parameters are controlled by a number of natural and anthropogenic factors. These include the geological characteristics, including the composition of surrounding rocks and soil, which affect water hardness and alkalinity. The other factors include climatic conditions and hydrological factors that affect evaporation, solar radiation, rainfall and sediment suspension. Biological factors such as rate of photosynthesis, decomposition, respiration and microbial metabolism also affect the pH and dissolved oxygen content of water bodies. Anthropogenic factors such as agricultural runoff and industrial effluents and sewage discharge also affect physico-chemical parameters of water bodies [4-5].

Seasonal variations also have a marked effect on physico-chemical parameters of water bodies. For instance, high temperature during summer season causes decreased oxygen solubility and increased evaporation causes high salinity, TDS and increased water hardness. On the contrary, monsoon season is marked by increased agricultural runoff, leading to higher nutrient concentration and high turbidity. Dilution in monsoon may lead to decreased salinity and hardness. Winter season causes increased oxygen solubility and decreased biological activity, leading to lower biological oxygen demand (BOD) [6-7].

Imbalance in these physico-chemical parameters may have a huge bearing on ecological and public health. For instance, low dissolved oxygen may cause fish stress, suffocation, and mass mortality. High nutrients may cause eutrophication and algal blooms and high turbidity and increased bod may cause hypoxic conditions, leading to decreased biodiversity. Humans are also adversely affected by consumption of contaminated drinking water. High nitrate levels may cause methemoglobinemia (blue baby syndrome).

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Toxic algal blooms may be harmful for human nervous systems. Increased bod accompanied by growth of pathogenic organisms may cause water borne diseases in humans. Considering the crucial effect of slight variation of physico-chemical parameters of water bodies on aquatic and human health, it is important to continuously monitor water resources in order to maintain ecological sustainability and public safety.

MATERIALS AND METHODS

Nagaur district is lies between 26°25' & 27°40' N latitude and 73°10' & 75°15' E longitude. It sits in the middle of the state and comprises roughly 11,000-12,000 square kilometers. Bikaner and Churu are to the north, Didwana-Kuchaman are to the east, Beawer and Ajmer are to the south, and Jodhpur, Phalodi is to the west. The district is a part of Great Indian Thar Desert, has a dry climate, very hot and cold temperatures, and not many plants. The climate is quite dry, with big changes in temperature and very unpredictable rainfall patterns. The average amount of rain that falls each year is about 349.8 mm. Because of its topography and climate, the region has a big problem with not having enough water. During the study, water was collected from 4 different ponds- Lakha Sagar Ren, Lakholav pond, Mundwa, Kansolav Rol and Tankala pond every month during July 2024- June 2025. The sample occurred in the early morning. Several characteristics are assessed at the collection location, including water temperature measured using a digital thermometer, pH determined with pH paper, and water clarity evaluated with transparency tubes. Additional physicochemical variables were analyzed within 24 hours post-sampling to prevent any variations in their precise concentration in the sample. From all sample locations of aquatic bodies Water samples were collected with measures to reduce any disturbance. Composite samples were systematically collected from both shallow and deep-water zones on a designated day to analyze the physicochemical parameters of the water bodies. During the research period, all sample collection and field observations occurred in the early morning from 7 to 10 a.m. Water samples were collected in plastic or glass bottles of sufficient volume for comprehensive parameter analysis and convenient transport. Dissolved oxygen was measured using small-mouth stopper containers with a capacity of 275 ml. The analysis of water samples was conducted utilizing established limnological methodologies. Temperature, transparency, turbidity, and pH were determined on-site, excluding Biological Oxygen Demand, which necessitates a 5-day incubation period at 20°C for assessment of the other parameters. Dissolved oxygen was quantified within 24 hours. Chloroform was utilized for sampling in the case of a delay.

RESULTS AND DISCUSSION

Air and water temperature

The temperature of air and water around all the four study sites, namely, Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol was recorded in order to understand the prevailing environmental conditions at the time of sampling. Air temperature of Lakha Sagar Ren pond ranged from 14 to 34°C (average temperature of 23.3°C), tankala pond ranged from 13 to 33°C (average temperature of 23.61°C), lakholav Mundwa pond ranged from 13.5 to 33.5°C (average temperature of 23.61°C) and air temperature of Kansolav Rol pond ranged from 12.8 to 34.1°C (average temperature of 23.6°C, with lowest air temperature of 1°C in January 2025 and highest temperature of 34°C in July 2024. Therefore, it can be said that air temperature of all the ponds lied between 12.8°C to 34.1°C, with lowest temperature being observed in peak winter season i.e. January 2025 and highest temperature being observed in monsoon season, July 2024. Water temperature of Lakha Sagar Ren Pond ranged from 12 to 30°C (average temperature of 21.25°C), Tankala pond ranged from 14 to 32°C (average temperature of 23.02°C), Lakholav Mundwa pond ranged from 13.2 to 31.5°C (average temperature of 22.91°C) and water temperature of Kansolav Rol pond ranged from 13.3 to 37°C (average temperature of 23.25°C). Therefore, it can be said that water temperature of all the ponds lied between 12°C to 37°C, with lowest temperature being observed in peak winter season i.e. January 2025 and highest temperature being observed in monsoon season, July 2024.

Turbidity

Turbidity is a measure of cloudiness occurring in water bodies due to suspended particles. Turbidity of a water body indicates presence of silt, clay and microbes. Presence of high turbidity is associated with reduced disinfection efficiency as well as possible pathogen presence in the water. The results show that turbidity of all the ponds varied from each other. Lakha Sagar RenRpond exhibited turbidity of 10 to 23 NTU (average: 14.66 NTU), Tankala pond exhibited turbidity of 10 to 11 NTU (average: 14.25 NTU), Lakholav Mundawa showed turbidity from 9 to 20 NTU (average: 13.41 NTU) while Kansolav Rol pond showed turbidity of 8 to 22 NTU (average: 13.5 NTU). For all the ponds, the highest turbidity was observed in July 2024 (monsoon season) while lowest turbidity occurred in June 2025. As per BIS standards, permissible limit for turbidity is 1 to 5 NTU, according to which, water from all the four ponds was found to be unfit for human consumption.

pH

pH is a measure of acidity or alkalinity of water. Low pH of a water body indicates acidity, while scaling occurs at high pH along with alkalinity and unpleasant taste. Scale of pH ranges from 0–14. The results show that pH of all the ponds varied from each other. Lakha Sagar Ren Pond exhibited pH of 7.45 to 9.25 (average: 8.48), Tankala pond exhibited pH of 7 to 9.1 (average: 8.12), Lakholav Mundawa showed turbidity from 7.1 to 8.95 (average: 7.91) while Kansolav Rol pond showed turbidity of 7.25 to 8.9 (average: 7.97). For all the ponds, the highest pH was observed in December 2024 to Feb 2025 (winter season) while lowest pH occurred in May 2025 to June 2025. As per BIS standards, permissible limit for pH is 6.5 to 8.5, according to which, water from all the four ponds was found to be slightly alkaline during winter season.

Specific conductivity

Specific conductivity is indicative of water's ability to conduct electricity. It reflects the dissolved ionic content of a water body. Presence of high specific conductivity is indicative of contamination and may cause unpleasant taste in water. The results show that specific conductivity of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 117.5 to 277.4, 116.1 to 195.3, 113.59 to 287. 46 and 129.9 to 320.11 units respectively. For all the ponds, specific conductivity was lowest in September 2024 while highest in June 2025.

Dissolved oxygen

Dissolved oxygen is indicative of the amount of oxygen dissolved in water. It indicates freshness and organic load of a water body. The results show that dissolved oxygen content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 2.3 to 8.2, 2.5 to 7.9, 3.4 to 7.2

and 3.8 to 7.4 units respectively. For all the ponds, dissolved oxygen was lowest in May 2025 while highest in January 2025.

Dissolved solids

Dissolved solids are indicative of total concentration of dissolved inorganic and organic substances in a water body. The amount of dissolved solids in a water body affect the taste as well as palatability of water. The results show that dissolved solids content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 105 to 217, 125 to 440, 133 to 297 and 100 to 284 units respectively. For all the ponds, dissolved oxygen was lowest in July 2024 while highest in June 2025. As per BIS standards, permissible limit for dissolved solids is 500 to 2000 mg/L, according to which, water from all the four ponds was found to lie within the permissible range.

Carbonate (mg/L)

Carbonate ions contribute to the alkalinity of water and are typically present in alkaline environments. They play a role in buffering capacity and scaling tendencies of a water body. The results show that dissolved oxygen content of Lakha Sagar, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 20 to 70, 20 to 70, 25 to 60 and 27 to 60 units respectively. For all the ponds, carbonate content was lowest in July 2024 while highest in June 2025.

Total alkalinity (mg/L)

The results show that total alkalinity content of Lakha Sagar, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 50 to 98, 30 to 310, 60 to 105 and 55 to 110 units respectively. For all the ponds, total alkalinity content was lowest in July 2024 while highest in June 2025.

Biological oxygen demand (mg/L)

The results show that BOD content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 3 to 5.6, 3.1 to 5.5, 2.5 to 3.6 and 2.1 to 3.7 units respectively. For all the ponds, BOD content was lowest in December 2024-January 2025 (winter season) while highest in June 2025 (pre-monsoon). High BOD leads to reduction of dissolved oxygen, leading to hypoxia as well as fish mortality. Also, high BOD is linked to sewage contamination and presence of potential pathogens in water bodies.

Total hardness (mg/L)

Total hardness of water is indicative of amount of calcium and magnesium salts in water bodies. While moderate hardness is beneficial for water bodies, extreme hardness may affect osmoregulation in fish. Also, consumption of hard water may contribute to development of kidney stones in humans. The results show that total hardness content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 40 to 100, 40 to 100, 75 to 170 and 70 to 170 units respectively. For all the ponds, total hardness content was lowest in July 2024 while highest in June 2025 (pre-monsoon). As per BIS standards, permissible limit for total hardness is 200 to 600 mg/L, according to which, water from all the four ponds was found to be suitable for consumption.

Calcium (mg/L)

Calcium contributes to hardness of water bodies. Optimum amount of calcium is needed for shell and skeleton development in aquatic life, while excess calcium causes scaling. The results show that calcium content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 20 to 40, 20 to 40, 25 to 50 and 26 to 58 units respectively. For all the ponds, calcium content was lowest in July 2024 while highest in June 2025 (pre-monsoon). As per BIS standards, permissible limit for calcium is 75 to 200 mg/L, according to which, water from all the four ponds was found to be suitable for consumption.

Magnesium (mg/L)

Magnesium contributes to hardness of water. Trace amounts of magnesium is needed for metabolic processes while excess of it is bad. The results show that magnesium content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 20 to 40, 25 to 40, 32 to 85 and 28 to 80 units respectively. For all the ponds, magnesium content was lowest in July 2024 while highest in June 2025 (pre-monsoon). As per BIS standards, permissible limit for magnesium is 30 to 100 mg/L, according to which, water from all the four ponds was found to be suitable for consumption.

Chloride (mg/L)

Chloride is a common salt ion present naturally and from pollution. Elevated amount of chloride in water bodies contributes to disruption of osmotic balance and may be toxic to freshwater species. Increased amount of chloride causes salty taste and high levels may contribute to hypertension in vulnerable individuals. The results show that Chloride content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 30 to 60, 30 to 90, 40 to 70 and 42 to 70 units respectively. For all the ponds, Chloride content was lowest in July 2024 while highest in June 2025 (pre-monsoon). As per BIS standards, permissible limit for chloride is 200 to 1000 mg/L, according to which, water from all the four ponds was found to be suitable for consumption.

Fluoride (mg/L)

Fluoride is a naturally occurring trace element in water bodies. However, high concentration of fluoride concentrations impairs growth as well as reproduction in aquatic organisms. Excess intake leads to dental and skeletal fluorosis. The results show that Fluoride content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 0.12 to 0.295, 0.12 to 3.2, 0.17 to 0.36 and 0.19 to 0.39 units respectively. For all the ponds, Fluoride content was lowest in August 2024 while highest in June 2025 (pre-monsoon). As per BIS standards, permissible limit for fluoride is 1 to 1.5 mg/L, according to which, water from all the four ponds was found to be unsuitable for consumption.

Nitrate (mg/L)

Nitrate amount increases in water bodies from common nitrogen compound from agricultural and sewage sources. Excess amount of nitrate causes eutrophication, algal blooms, and subsequent oxygen depletion. Furthermore, high nitrate causes methemoglobinemia in infants and may pose long-term health risks. The results show that nitrate content of Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol pond ranged from 0.138 to 11, 2.3 to 9.9, 3.39 to 10.99 and 3.61 to 11.53 units respectively. For all the ponds, nitrate content was lowest in July 2024 while highest in June 2025 (pre-monsoon). As per BIS standards, permissible limit for total hardness is 45 mg/L, according to which, water from all the four ponds was found to be suitable for consumption.

The current study aimed to investigate the seasonal variation in physicochemical parameters of water of four different ponds, namely Lakha Sagar Ren, Tankala pond, Lakholav Mundwa and Kansolav Rol, over a period of one year

from July 2024 to June 2025. The analysed parameters included Air temperature, Water temperature, Turbidity (NTU), pH, Specific conductivity (mMhos/cm), DO (mg/L), DS, Carbonate (mg/L), Total alkalinity (mg/L), BOD (mg/L), TH (mg/L), Calcium (mg/L), Mg (mg/L), Chloride (mg/L), Fluoride (mg/L), and Nitrate (mg/L).

Table 1 Annual average value of the physico-chemical parameters at different ponds

Name of parameter	Lakholav Mundwa	Lakha Sagar Ren	Tankala Pond	Kansolav Rol
Air temperature	23.62	23.31	23.617	23.60
Water temperature	22.92	21.25	23.025	23.25
Turbidity (NTU)	13.42	14.67	22.583	13.50
pH	7.91	8.49	8.214	7.97
Specific conductivity (mMhos/cm)	169.05	166.13	142.567	185.07
DO (mg/L)	5.78	5.24	5.292	5.80
DS	234.42	172.00	188.333	172.58
Carbonate (mg/L)	36.25	43.33	37.500	39.00
Total alkalinity (mg/L)	83.00	77.00	81.46	86.42
BOD (mg/L)	3.04	3.87	3.964	2.97
TH (mg/L)	108.33	73.08	62.727	112.83
Calcium (mg/L)	35.88	28.55	27.227	41.10
Mg (mg/L)	53.33	29.33	30.182	45.58
Chloride (mg/L)	59.58	50.00	46.818	57.00
Fluoride (mg/L)	0.25	0.17	0.455	0.28
Nitrate (mg/L)	7.40	6.32	6.043	7.37

Physicochemical parameters of aquatic bodies exhibit high variability in response to seasonal climatic changes, hydrological processes, as well as biological activities. All these parameters together play a crucial role in determining water quality, ecological balance as well as suitability of water bodies for aquatic organisms and human use. Similar seasonal variations in physicochemical parameters of freshwater ecosystems have been widely reported in several limnological studies. The results of the current study showcase considerable variation in several parameters, highlighting the combined effects of rainfall, evaporation, biological productivity as well as anthropogenic inputs [8-11].

Air temperature and water temperature depicted clear seasonal variation during the study period. Air temperature and water temperature ranged from approximately 12.8°C to 34.1°C and 12°C to 37°C across all the study sites, with the lowest temperature values being recorded during January (winter season) while the highest values were observed during July (monsoon season). Temperature is considered one of the most important physical factors influencing aquatic ecosystems because it regulates chemical reactions, metabolic activities and biological productivity in water bodies (Wetzel, 2001). Higher temperatures during monsoon as well as pre-summer months are indicative of increased microbial metabolism as well as enhanced decomposition of organic matter and primary productivity during these months. Similar seasonal fluctuations in water temperature in freshwater ponds have also been reported [12-14]. On the contrary, lower winter temperatures are indicative of decreased biological activity. Water temperature plays a crucial role in determining metabolic rate, reproduction and survival of aquatic organisms, thereby making it a pivotal factor in controlling determining ecosystem productivity.

Turbidity values showed significant variation amongst all the four ponds and ranged approximately from 8 NTU to 23 NTU, with highest turbidity was observed during July 2024, which may be attributed to heavy rainfall, surface runoff as well as increased inflow of suspended particles such as silt, clay and organic debris into the ponds. Increase in turbidity during monsoon months due to runoff and sediment inflow has been reported in several freshwater bodies [15-16]. On the contrary, turbidity values were lowest in the pre-monsoon period (June 2025), owing to settlement of silt and reduced inflow of suspended materials. Nonetheless, turbidity levels exceeded BIS standards in all the ponds, indicating that the water requires treatment before human consumption. The pH of the pond water was found to be slightly alkaline throughout the study period (7.0 and 9.25), with highest pH values during winter months (December to February) and lowest values during late summer and pre-monsoon months. The high alkalinity during winters is a direct consequence of increased photosynthesis and higher production of carbon dioxide with reduced decomposition. On the contrary, acidity increases in summers due to higher microbial decomposition and respiration, which release carbon dioxide and organic acids into the water.

Specific conductivity, which denotes the ionic concentration of dissolved substances in water, showed significant variability among the ponds with values ranging from 113 to 320 units. Th Conductivity and dissolved solids values were lowest during September 2024 and highest during June 2025. The increase in conductivity during the pre-monsoon season may be attributed to higher evaporation leading to increased concentration of dissolved ions with reduced water volume while lower conductivity during monsoon is indicative of water dilution [17-18]. Dissolved oxygen (DO) levels were highest in January 2025 (winter season), while the lowest values occurred during May 2025, which may be attributed to lower water temperatures and reduced microbial respiration in winters, which increase oxygen solubility. On the contrary, summer and pre-monsoon periods reduce lead to reduce oxygen solubility as well as increased microbial decomposition, leading to lower dissolved oxygen levels. Decline in Dissolved oxygen (DO) levels during warmer months is associated with higher biological oxygen demand and increased organic matter decomposition [19-22].

Carbonate, total alkalinity, total hardness, calcium, magnesium, chloride and fluoride also displayed seasonal variation. For all these parameters, the content was found to be lowest during the monsoon season and highest during the pre-monsoon period (June 2025). This pattern maybe attributed to

dilution effects of ions during rainfall and concentration of ions during dry periods. Higher alkalinity during dry seasons is indicative of increased accumulation of bicarbonate and carbonate ions. Ions such as calcium and magnesium control water hardness.

Biological oxygen demand (BOD) of all the water bodies ranged between approximately between 2.1 mg/L and 5.6 mg/L, with highest BOD values in June 2025, while the lowest values in winter months. Increased BOD during the pre-monsoon period maybe attributed to higher organic matter input along with increased microbial activity and decomposition processes. High BOD is indicative of increased oxygen consumption by microorganisms and is often associated with organic pollution or sewage contamination. Higher BOD levels may lead to dissolution of oxygen concentration and creation of stress for aquatic organisms, potentially leading to hypoxic conditions [23-25].

In exactly the same pattern as dissolved nutrients, nitrate levels were found to be lowest during the monsoon season and highest during the pre-monsoon months. This may be attributed to increased agricultural runoff, decomposition of organic matter and accumulation of nitrogen compounds during dry periods. Increased amount of nitrate concentrations can lead to eutrophication and algal blooms, as a consequence of which, oxygen depletion and deterioration of water quality occur [26-27].

Overall, the findings of the current study depict the crucial role of seasonal variations in determining the physicochemical characteristics of pond ecosystems. Monsoon season lead to dilution of dissolved ions and increased turbidity owing to land and agricultural runoff, whereas the pre-monsoon season is marked by relatively higher evaporation rate leading to higher concentrations of dissolved substances with reduced water volume. On the other hand, winter conditions tend to favour higher dissolved oxygen levels and lower biological activity. Looking carefully at these seasonal patterns, one very clear lesson that is depicted for the administrative bodies as well as the common masses is that it is critically important to continuously monitor and manage freshwater ecosystems. Also, more number of studies should be conducted in order to develop a comprehensive understanding of the relationship between seasonal climatic factors and the physicochemical parameters of water to ensure ecological stability, safeguard aquatic biodiversity, and ensuring safe utilization of water resources for domestic and agricultural purposes.

CONCLUSION

The present investigation revealed significant seasonal variations in the physicochemical characteristics of the four studied ponds, namely Lakha Sagar Ren, Tankala Pond, Lakholav Mundwa, and Kansolav Rol, during the period from July 2024 to June 2025. Parameters such as temperature, turbidity, conductivity, dissolved oxygen, alkalinity, hardness, nutrients, and Biological oxygen demand (BOD) exhibited clear fluctuations in response to monsoon, winter, and pre-monsoon conditions. Monsoon season was characterized by increased turbidity and dilution of dissolved ions due to runoff and rainfall, whereas pre-monsoon months showed higher concentrations of dissolved substances, alkalinity, hardness, fluoride, and nitrate as a result of evaporation and reduced water volume. Winter season favoured higher dissolved oxygen levels and relatively stable water quality conditions. Although most parameters remained within permissible BIS limits, elevated turbidity and fluoride levels indicated potential risks for direct human consumption without proper treatment. The study highlights the strong influence of seasonal dynamics on freshwater pond ecosystems and emphasizes the need for regular monitoring and sustainable management practices to maintain ecological balance, protect aquatic biodiversity, and ensure safe utilization of water resources for domestic and agricultural purposes.

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