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Analysis of water quality parameter of a pond in Varanasi

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Abstract

Ponds are important freshwater resources that support aquatic organisms, local biodiversity, and human activities. However, increasing urbanization, domestic wastewater, agricultural runoff, solid waste and religious activities have created growing pressure on pond ecosystems, particularly in Varanasi, Uttar Pradesh. Previous studies have reported considerable variation in the physicochemical characteristics of ponds in and around Varanasi, indicating the need for regular assessment of their present water quality. The present study focuses on the analysis of selected water-quality parameters of a pond in Varanasi. Parameters such as temperature, pH, electrical conductivity, total dissolved solids, turbidity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, hardness, alkalinity, chloride, nitrate and phosphate are considered for evaluating the condition of the pond water. The study aims to identify variations in water quality and assess the possible influence of human activities on the pond ecosystem. The findings are expected to provide useful baseline information about the current condition of the selected pond and may support future monitoring, pollution-control measures and sustainable management of local freshwater resources.

Keywords: Pond Water Quality, Varanasi, Physicochemical Parameters, Water Pollution, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, pH, Total Dissolved Solids, Aquatic Ecosystem, Freshwater Resources, Environmental Monitoring.

Introduction

Water is one of the most important natural resources required for the survival of all living organisms. Freshwater bodies such as rivers, lakes and ponds play an important role in maintaining ecological balance and supporting aquatic life. Ponds are particularly valuable at the local level because they provide water for domestic activities, agriculture, livestock, groundwater recharge and various social and cultural practices. They also provide suitable habitats for aquatic plants, microorganisms, fish and other organisms.

In recent years, the quality of freshwater resources has been affected by increasing human activities. Rapid urbanization, population growth, disposal of domestic waste, wastewater discharge, agricultural runoff and religious activities can introduce organic matter, nutrients and other pollutants into pond water. Such inputs may alter important water-quality characteristics, including pH, turbidity, dissolved oxygen, electrical conductivity, total dissolved solids, hardness, alkalinity, nitrate and phosphate. Changes in these parameters can affect aquatic organisms and reduce the suitability of water for different uses. Varanasi, one of the oldest continuously inhabited cities in India, contains numerous ponds and traditional water bodies that have considerable ecological, social and cultural importance. However, many of these water bodies are exposed to human pressure arising from surrounding settlements, waste disposal, wastewater inflow and religious activities. Previous investigations in Varanasi have reported variations in the physicochemical characteristics of pond water and have indicated

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deterioration in water quality at several locations. These studies highlight the importance of regular monitoring of individual ponds to understand their changing environmental condition.

Water-quality assessment based on physicochemical parameters provides a practical way to evaluate the condition of a pond. Parameters such as temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), turbidity, electrical conductivity (EC), total dissolved solids (TDS), hardness, alkalinity, chloride, nitrate and phosphate provide information about the physical and chemical status of water. Studying these parameters together can help identify possible pollution sources and determine the overall condition of the aquatic environment.

Although several studies have examined ponds in Varanasi and other parts of Uttar Pradesh, detailed monitoring of individual ponds remains necessary because water quality can vary according to location, season, surrounding land use and human activities. Therefore, the present study was undertaken to analyse selected water-quality parameters of a pond in Varanasi, Uttar Pradesh. The study is intended to establish information on the present condition of the pond and provide a basis for understanding pollution pressures and supporting future conservation and management efforts.

Review of Literature

Ojha (2026) studied the water quality of lentic and lotic water bodies in Mathura, Uttar Pradesh, using physicochemical and microbiological parameters. The study reported nutrient enrichment and microbial contamination associated with anthropogenic activities.

Dwivedi (2024) investigated the physicochemical characteristics of five ponds in and around Varanasi. Significant variations in pH, EC, TDS, DO, BOD, COD, hardness and alkalinity were observed, indicating the influence of domestic, agricultural and religious activities.

Singh et al. (2023) analysed the physicochemical parameters of Mahil Pond, Orai, Uttar Pradesh, throughout the year. Seasonal variations in temperature, pH, DO, BOD, nitrate and phosphate were recorded, with anthropogenic activities contributing to water-quality deterioration.

Mishra (2018) examined the physicochemical characteristics of ponds and kunds in Varanasi. The study reported deterioration in several water-quality parameters due to urbanization, religious activities and wastewater inputs.

Gupta et al. (2017) assessed the Water Quality Index (WQI) of Keerat Sagar Pond, Mahoba, Uttar Pradesh. Parameters including pH, turbidity, alkalinity, chloride and DO were used to evaluate the overall quality of pond water.

Rehan et al. (2017) investigated physicochemical characteristics and heavy metals in pond water around Mau-Aima, Uttar Pradesh. The study highlighted the influence of agricultural and anthropogenic activities on pond-water quality.

Azam et al. (2015) analysed the water quality of fourteen ponds in Varanasi city. The study found that the ponds were generally alkaline, while variations in TDS, hardness, major ions and trace elements reflected both natural and anthropogenic influences.

Mishra et al. (2014) studied the physicochemical status of eight ponds in Varanasi under anthropogenic pressure. Elevated nutrient concentrations, BOD, TDS and other parameters indicated deterioration associated with domestic wastewater, municipal waste and religious activities.

Aim:

The main aim of the present study is to assess the water quality of a selected pond in Varanasi, Uttar Pradesh, by analysing important physicochemical parameters and to understand the possible influence of human activities on the condition of the pond.

Objectives

The specific objectives of the study are:

1. To analyse selected physicochemical parameters of the pond water, including temperature, pH, turbidity, electrical conductivity and total dissolved solids.
2. To determine the levels of dissolved oxygen (DO), biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in the pond water.
3. To estimate important chemical parameters such as hardness, alkalinity, chloride, nitrate and phosphate.
4. To observe variations in the measured water-quality parameters during the study period.

Material and method: pH

Material: pH test strip

Method: If you have a pond then you can test/measure the pH level in the pond in different ways. The simplest way is to use pH test strips. You hang it briefly in the water in the pond or in the sample taken from the pond. The pH test strip then discolours based on the pH value of the water. However, this remains an indication and will never give the exact pH value.

Material: Digital pH meter

If you want to measure more accurately and therefore more reliably use a digital pH meter. A digital pH meter measures, depending on the model, the pH value of the water.

Material: To test pond water, we recommend taking several samples and then testing them with a pH indicator or hand-held meter, as these are very accurate. Measuring pond water is done as follows:

Method:

- Take a water sample from the pond with a pipette.
- Fill a sample cup with the pond water from the pipette.
- Use the digital pH mete to take an accurate measurement of the water in the sample cup.

Dissolved Oxygen

Material: Pipette, Burette, flask stirring apparatus, water sample, manganese sulfate, alkali-iodide-azide solution, concentrated sulfuric acid, sodium thiosulfate solution, starch solution.

Method:

- Measure the volume of water with the help of reagent both.
- Added 2ml of Mnso4 to the bottom of the bottle
- Added 2ml of alkaline potassium iodide.
- Kept for 10 minutes. Colour precipitate appear due to Mn(OH)2.
- Added I ml of concentrated sulfuric acid and a clear yellow solution is obtained.
- Took 50 ml of yellow coloured sample water and added 2 drops of starch solution as indicator.
- Solution turned to deep blue.

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- Black blue colour disappear. Noted the point.

Free Carbon Dioxide

Materials: Burette, pipette, conical flask, beaker, Standard sodium carbonate solution (N/50), Phenolphthalein indicator.water sample, conical flask, measuring cylinder.

Method:

1. Take 100 ml. of the water sample in a conical flask.
2. Add 2-3 drops of phenolphthalein indicator,
3. If the solution is colorless, it indicates the presence of free CO.,
4. Titrate with standard N/50 sodium carbonate solution until a faint pink color appears.
5. Note the volume of sodium carbonate used

Temperature

Materials:

Pond water sample. Digital Water Analyzer Machine (with temperature sensor), Clean beaker or sample container Distilled water (for rinsing sensor), Tissue or cloth (for drying).

Method:

1. Collected pond water in a clean beaker.
2. Switched on the water analyzer machine.
3. Rinsed the temperature sensor with distilled water.
4. Inserted the sensor into the pond water sample.
5. Waited until the temperature reading stabilized.
6. Noted the temperature displayed on the analyzer.
7. Cleaned the sensor with distilled water after the test

Salinity

Material:

Pond water sample, Digital Water Analyzer Machine, beaker, glove. Distilled water.

Method

- 100ml of the pond water sample was poured into a clean beaker
- The salinity probe was immersed in the sample.
- The analyzer was allowed to stabilize before recording the reading. The probe was rinsed with distilled water between each use to prevent contamination.

Conductivity

Materials:

Pond water sample, Water Analyzer Machine (Conductivity Meter).Clean beaker. Distilled water for cleaning the probe), Tissue paper or soft cloth.

Method:

- Collect the pond water sample in a clean beaker.
- Switch on the water analyzer machine and calibrate it if necessary.
- Rinse the probe with distilled water and gently blot it dry.
- Immerse the conductivity probe into the water sample, ensuring it doesn't touch the container's sides or bottom.
- Wait until the reading stabilizes on the display screen.

- Record the conductivity value.
- Rinse the probe again with distilled water after testing.

Alkalinity

Material:

Pipette, Burette, Burette stand, dropper, Measuring cylinder, Beakers, conical flask, Chemicals - phenolphthalein indicator, "N/50 H2SO4 solution" means a sulfuric acid (H2SO4) solution that is 1/50th normal (0.02 N)

Method:

Rinsed the Burette and fixed it in Burette stand fill the Burette with standard solution of N/50 H2so4 up to the 0 mark and note the reading.

Take 50 ml sample in conical flask and added 2-3 drop of phenolphthalein indicator, pink colour appear.

Titrated the sample water with standard solution by adding drop by drop from Burette until pink colour just appear noted the reading**.**

Repeated the experiment till two reading are similar obtained.

Calculation:

- Phenolphthalein alkalinity in pond water sample 20xvolume of N/50
- H2so4 consumed 20×0.5-10ppm

Biochemical Oxygen Demand

Materials:

BOD bottles (300 ml capacity, but sample used: 200 ml) Incubator set at 20°C Manganese sulfate solution, Alkaline iodide azide reagent Concentrated sulfuric acid, Sodium thiosulphate solution, Starch indicator, Pipettes, burette, conical flask

Method:

- Fill two BOD bottles with 200 ml of pond water sample each.
- Measure the initial dissolved oxygen (DO) of the first bottle using Winkler's method:
- Add manganese sulfate and alkaline iodide azide reagent.
- Mix and allow precipitate to settle.
- Add concentrated H2SO4 to dissolve the precipitate.
- Titrate with sodium thiosulphate using starch as an indicator until blue color disappears.
- Keep the second bottle in the incubator at 20°C for 5 days in the dark to prevent photosynthesis.
- After 5 days, determine the final DO using the same method.

Calculation:

BOD Initial DO - Final DO

BOD 7.8 mg/L-4.2 mg/L 3.6 mg/L

Chemical Oxygen Demand

Material:

Reagent potassium dichromate (0.25N), sulfuric acid with silver sulfate as catalyst ferrous ammonium sulfate (0.1), ferroin indicator, Reflux condenser, Burette, Conical flask, Pipettes and measuring cylinders Hot plate or heating mantle, Stand and clamps,sample water.

Method:

- 200 ml of pond water sample was taken in a reflux flask.

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- Added 10 ml of 0.25 N potassium dichromate.
- Added 30 ml of H_2SO_4 containing silver sulfate slowly with stirring.
- Refluxed the mixture for 2 hours.
- After cooling, diluted with 100 ml distilled water.
- Titrated the excess dichromate with 0.1 N FAS using ferroin indicator until the color changed from blue-green to reddish-brown.
- A blank was prepared using distilled water instead of the sample.

Calculations:

COD (mg/L)(BS) × N×8000/ Volume of sample (ml)
Where:
B Volume of FAS for blank = 23.4 ml
S=Volume of FAS for sample 14.7 ml
N=Normality of FAS = 0.1 N
Volume of sample = 200 ml
COD (23.4-14.7)×0.1×8000/200
COD-8.7×0.1×8000/200-696/200-3.48mg/1

RESULT:

A total of nine (9) different physicochemical parameters were analyzed. The results obtained from the study are presented in Table.

Parameters	Sample
pH	7.2-7.5
Dissolved oxygen	16.32ppm
Free Carbon dioxide	65mg/l
Temperature	25°C to 29.3°C
Salinity	0.0ppt
Conductivity	2.92mS/cm
Alkalinity	15mg/l
BOD	3.6mg/1
COD	3.48mg/1

Discussion:

PH: This is a measure of hydrogen ion concentration. In this study, the pH values ranged from 7.2 to 7.5, which is a favourable condition for fish production. The optimal water pH range for fish farming is usually 6.5 to 9. Typically. pH ranges 4 to 6 or 9 to 10 reduce the growth rate of the fishes, although the majority of the fishes will still be alive. The pH of less than six results in a decrease in regeneration. The mortality of fish starts at pH less than 4 (acidic) or more than in the fish farm

Dissolved oxygen: DO is a measure of the amount of dissolved oxygen in the aquatic ecosystem. The sustenance. Development, mental soundness, behaviour and efficiency of living organisms are influenced by a change in dissolved oxygen, and it is used up usually during microbial decomposition of organic matter. In this study, the results of DO obtained 16.32 ppm. The higher values of DO obtained is an indication that the waste water samples used in this study were polluted.

Free Carbon Dioxide: The optimum range for free carbon dioxide in a fish pond is generally considered to be below 10mg/1. While tropical fish can tolerate fish can tolerate levels over 100mg/l, this level is not ideal for healthy fish pond. Concentration above 60 mg/l can be lethal to fish In this study the result of free carbon dioxide obtained 65mg/1. This value are not good for fish.

Temperature: Temperature is a key physiological controller and primarily influences the digestive system of aquatic organisms. A change in temperature affects the physiology and metabolism and productivity of fishes. An optimum temperature range of 31°C to 36°C is required for the growth and sustenance of fishes. In this study, the temperature range was between 25°C to 29.3°C which implies that the temperature of the water in the pond is less favourable for the fishes.

Salinity: In a fish pond, salinity is generally considered low, with value typically below 1ppt. Salinity is the measure amount of dissolved salt in water. While some fish species can tolerate higher salinities, maintaining a low salinity is generally recommended for optimal fish health and growth. In this study the use of a digital water analyzer machine provided a precise salinity reading 0.0 ppt.

Electrical Conductivity (EC): Electrical conductivity is a measure of the capacity of water to allow the passage of electricity through it. The results of the electrical conductivity obtained in this study ranged from 2.18 to 2.29umhos/cm. the electrical conductivity values recommended for fish farming range from 20 to 150 µS/cm. Electrical conductivity recognizes polluting sources and linearly increase with increasing concentration of salts within an aquatic setting.

Alkalinity: This shows the buffering capacity of water and it has a strong impact on aquatic life. Alkalinity equilibrates the changes in pH occurring naturally due to the photosynthetic activity exhibited by the phytoplankton. Fishes produce optimally at alkalinity between 50 and 200 mg/l. The alkalinity of unpolluted pond ranges from 171.2 to 235.5mg/l. Therefore, the result obtained in this study which had alkalinity range from 15 mg/l is suitable for fish farming in the pond. Total Hardness This is the sum of calcium and magnesium concentration in aquatic bodies usually present in the form of a combination of carbonates and bicarbonates which result in temporary hardness. Magnessium and calcium are essential nutrients needed for the formation of scale and bones in fishes.

Biochemical Oxygen Demand (BOD): BOD is the volume of oxygen microorganisms take up for decomposition of organics in water. Usually, the BOD value above 5mg/l is an indication of pollution of the water sample. In this study, the value of BOD ranged from 3 to 3.6 mg/l Previous studies reported that the levels of BOD range from 3.0 to 6.0 mg/l enhance fish activities. The values obtained from the study were within the range of WHO.

Chemical Oxygen Demand (COD): The optimum chemical oxygen demand value for fish culture is generally considered to be less than 15 mg/L. This means that the amount of oxygen required to oxidize all organic matter in the water should be below this level to ensure healthy fish growth and survival. In this study, the value of COD is 3.48 mg/l.

Conclusion: From the results, the waste water from pond was polluted and could harm water bodies if not properly treated before discharge. Therefore, the fish pond needs to be checked at regular intervals for quality assurance procedure to guarantee there are no harmful substances in the ponds prompting a conceivable bio-aggregation. This will guarantee the great wellbeing of the aquatic ecosystem, man, and the environment. It is recommended that farmers should be acquainted with the standard practices with respect to waste minimization, pond management feeding and the environmental protection. Water quality is an important part of environmental monitoring which is essential part of keeping the planet healthy and sustainable. When, water quality is poor, it not affect only aquatic life but the surrounding ecosystem as well which were carried out in the study.

Findings from the work reveled the regularly monitoring water such as temperature, pH, DO, BOD, COD etc. Provided insight to the health of the aquatic ecosystems. Based on the research conducted regarding water quality parameters for a small-scale fish pond. it can be concluded that water plays a pivotal role in ensuring the health, growth, and survival of aquatic species. The analysis focused on crucial factors such as pH level, dissolved oxygen (DO), temperature, ammonia content, turbidity, and nutrient levels (nitrate and nitrite), all of which significantly influence the pond ecosystem. From the observations aligned with standard aquaculture guidelines, it appears that the water quality in the small pond is within acceptable limits for freshwater fish culture, though close monitoring is essential.

The pH level remains within the optimal range of 7.2 to 7.5, supporting metabolic and enzymatic activities of fish. Dissolved oxygen levels, ideally above 16.3mg/L, are currently sufficient but may fluctuate due to seasonal or environmental factors highlighting the need for aeration or aquatic plants. The concentration of ammonia and nitrite is relatively low, which indicates a healthy nitrogen cycle in the pond. However, regular testing is advised, as even minor spikes in ammonia can be toxic to fish. Water temperature ranges between 25°C and 30°C, which is suitable for most commonly cultured of fish. Alkalinity and hardness levels also fall within the recommended range, ensuring buffering capacity and mineral availability. In conclusion, the small pond, as per current findings and previous queries, is suitable for sustainable fish farming. However, ongoing management-such as periodic water testing, controlled feeding, and partial water exchange will be necessary to maintain water quality and ensure long-term productivity

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