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"Anthropogenic Influences on Water Quality: A Study of Physico-Chemical Parameters in Kalukhedi Pond, Dewas, Madhya Pradesh"

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Abstract

This study evaluates the physicochemical characteristics of water in the Kalukhedi Pond, Dewas district, Madhya Pradesh, over a twelve-month period (July 2022–June 2023). The results indicate seasonal variations in water quality parameters, influenced by environmental factors and anthropogenic activities. Dissolved oxygen (DO) ranged from 3.3 mg/L to 6.6 mg/L, with the lowest levels in June, correlating with increased temperatures and organic pollution. Biological oxygen demand (BOD) varied from 2.7 mg/L to 5.3 mg/L, peaking in June due to organic waste accumulation. Chemical oxygen demand (COD) values fluctuated between 8.4 mg/L and 22.8 mg/L. Turbidity ranged from 3.0 NTU to 10.7 NTU, with peak levels in July due to agricultural runoff and sewage inflow. Total alkalinity ranged from 129 mg/L to 187 mg/L, while total dissolved solids (TDS) varied between 305 mg/L and 502 mg/L. The pH remained consistently alkaline, varying from 7.7 to 9.1. Salinity levels fluctuated between 119 mg/L and 270 mg/L, influenced by evaporation and runoff. Total hardness ranged from 135 mg/L to 188 mg/L, with higher values in winter. These findings highlight significant seasonal influences on water quality, emphasizing the need for sustainable water management to mitigate pollution and maintain ecological balance.

Keywords: Physicochemical characteristics, water quality, Seasonal Variations, Dissolved oxygen (DO), sustainable *water management.*

Introduction

Despite the fact that water consumes about 75% of the surface of the Earth, only around 3% of the water is freshwater that is suitable for human use. It is concerning that around one quarter of the world's population does not have access to sufficient amounts of clean and purified freshwater. Human life, aquatic organisms, and the ecosystem as a whole are all dependent on water bodies, including inland sources, which play an important role in maintaining environmental balance. For purposes such as drinking, the production of energy, the cooling of industrial processes, the preservation of biodiversity, the provision of ecosystem services, recreation, transportation, waste management, agriculture, fishing, and regional development, these water sources are indispensable(Adjovu et al., 2023).

All biological systems on Earth rely on water as their foundation, making it an important component. Because they contain water, ponds are vital to human survival. Over time, humans have made use of these bodies of water for a variety of purposes; they may have been natural features or man-made creations. According to many sources (Ress, 1997; Narayan et al., 2007; Bishnoi & Malik, 2008; Rajagopal et al., 2010), they can be used for a wide variety of functions, including transportation, defense, religious rites, industry, social status, aesthetic landscaping, recreation, fish farming, and defense.

One of the most practical ways to dispose of wastewater and one of the most easily available sources of water for both residential and commercial use are bodies of freshwater (Chatterjee et al., 2003; FEPA, 1991). The limnology of freshwater bodies in India has been the subject of several studies in recent years, with a number of them concentrating on this topic (e.g., Naganandini & Hosmani, 1998; Pandey et al., 2000; Patil & Tijare, 2001; Gupta & Shukla, 2006; Kavita Sahni & Sheela Yadav, 2012).

The contamination of water is a significant environmental problem that is getting worse as a result of the growing number of activities carried out by humans (Ma et al., 2020). One of the most important contributors to the deterioration of water quality is the presence of human-caused disturbances, which include the clearing of forests and the growth of agricultural and urban areas. Additionally, the pollutants that are produced as a result of these operations are frequently not effectively handled before being carried by runoff into rivers and lakes, which contributes to the contamination of water. An excessive amount of nutrients being introduced into bodies of water is the cause of a variety of environmental problems. Specifically, Niu et al. (2020) found that sewage and agricultural runoff, both of which contain high levels of nutrients, encourage an excessive proliferation of phytoplankton through their presence. A decrease in dissolved oxygen (DO) levels is brought about by this quick rise in algae, while an increase in biochemical oxygen demand over five days (BOD) and chemical oxygen demand (COD) is brought about. Not only do algal blooms create poisonous compounds, but they also deplete oxygen, which leads to the mass mortality of aquatic species. This, in turn, accelerates the process of eutrophication and further degrades the quality of the water. According to Li et al. (2024), the condition of water resources is deteriorating, which poses significant threats to the availability of drinking water, aquaculture, and recreational activities. Environmental scientists are looking into the chemical, physical, and biological properties of natural water sources because of the growing need for water from population growth, farming, and industrial growth (Mukhopadhyay et al., 2005; Jadhav et al., 2006). A great deal of the diversity and abundance of aquatic life is dependent on physicochemical factors. Discharges of chemically diverse urban, industrial, and agricultural waste into water bodies drastically change the physico-chemical characteristics of these bodies of water. Hutchinson (1957) and Prapurna and Shashikanth (2002) found that phosphate and nitrogen, which are present in fertilizers and household trash, hasten eutrophication and worsen water quality.

DO, BOD, COD, Turbidity, TDS, pH, total salinity, total alkalinity and total hardnessare significant parameters used to study the water quality (Hutchinson, 1957 and Athalye *et al*., 2003).

Kalukhedi Pond, located in the Malwa plateau area of Madhya Pradesh, is essential for sustaining water availability in the region. Domestic effluents and runoff are introduced, influencing its physicochemical properties and overall water quality. The pond supports the irrigation and water management systems in the area. With its gradual slopes and rich black soil that is perfect for farming, the surrounding geography reflects the usual undulating terrain of the Malwa plateau. By offering a dependable supply of water for irrigation, the pond is essential to the agricultural operations of the nearby villages. It additionally aids in groundwater recharging and preserves the area's biological equilibrium. The quality of water is affected by seasonal changes, human activities, and natural environmental elements. During the festival season, various idols are immersed in water of Kalukhedi pond. The immersion of these idols significantly impacts water quality by altering its physicochemical properties. The materials used in idol-making can contribute to increased turbidity, alkalinity, and heavy metal contamination, affecting aquatic ecosystems.

So, this pond water is ideal for the analysis of various parameters of water quality like DO, BOD, COD, turbidity, TDS, pH, total salinity, total alkalinity and total hardness etc.

Materials and Methods

The Kalukhedi Pond is located near Dewas city in the Dewas district of Madhya Pradesh, India, next to the village of Kalukhedi. The approximate coordinates of the pond are 76.0748° E longitude and 22.9656° N latitude as showed in Figure 1. The Malwa plateau region is characterized by a height of roughly 500 meters above sea level. It receives domestic effluents from residential buildings around the pond. The pond water is used for bathing, washing and other purposes also. Water samples were collected from four randomly selected points of pond. Water samples were collected in first week of each month for twelve months (July 2022 to June 2023) on fixed date.The pond water fulfils several functions, such as bathing and washing. Water samples were obtained from four randomly selected sites inside the pond. Sampling occurred monthly on a designated date during the initial week, covering a duration of 12 months from July 2022 to June 2023. The pH of the gathered water samples was measured utilizing a digital pH meter. Furthermore, physico-chemical parameters including dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), turbidity, total dissolved solids (TDS), total salinity, total alkalinity and total hardness concentration were assessed in accordance with the standard methodologies established by APHA-AWWA, WPCF (1989), and Saxena (1994).

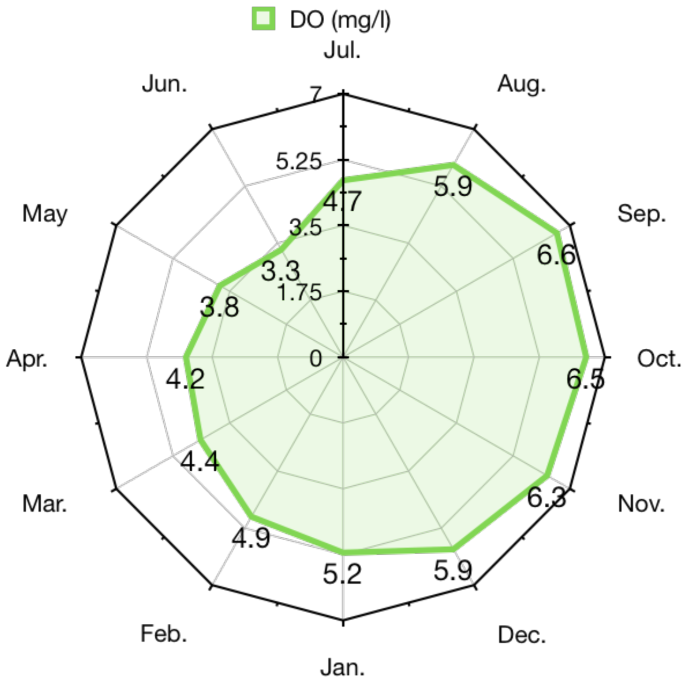
Figure 1. Kalukhedi Pond, Dewas, Madhya Pradesh- A Study Site for Physico-Chemical Analysis.

Results and Discussion

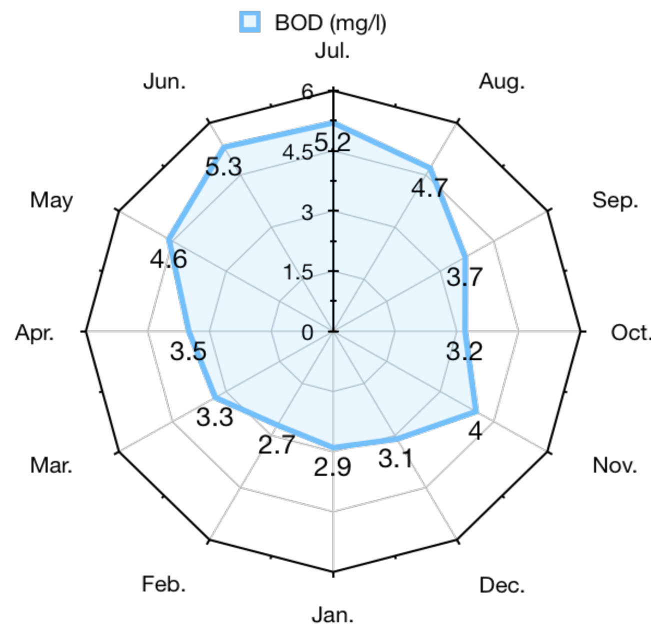
Table 1. Shows the monthly variations in various parameters of Kalukhedi pond, Dewas (76.0748º E Longitude and 22.9656º N latitude) for the year 2022-23

		Monthly variations in values of various parameters of Kalukhedi Pond, Dewas (76.0748° E longitude and 22.9656° N latitude) for the year 2022-23.											
S.No.	Parameters Analysed	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
1	DO (mg/l)	4.7± 0.764	5.9± 0.435	6.6± 0.397	6.5± 0.376	6.3± 0.311	5.9± 0.512	5.2± 0.509	4.9± 0.374	4.4± 0.365	4.2± 0.454	3.8± 0.219	3.3± 0.378
2	BOD (mg/l)	5.2± 0.472	4.7± 0.320	3.7± 0.178	3.2± 0.376	4.0± 0.393	3.1± 0.327	2.9± 0.298	2.7± 0.417	3.3± 0.3051	3.5± 0.402	4.6± 0.367	5.3± 0.356
3	COD (mg/l)	10.3± 0.416	9.5± 0.341	9.7± 0.493	10.8± 0.152	9.9± 0.436	8.7± 0.493	8.4± 0.305	9.3± 0.351	11.2± 0.351	16.6± 0.351	22.8± 0.351	19.6± 0.351
4	Turbidity (NTU)	10.7± 0.245	8.9± 0.307	9.8 ± 0.395	5.9± 0.198	5.0± 0.211	3.6± 0.217	3.0± 0.297	4.1± 0.411	5.9± 0.327	7.8± 0.225	8.7± 0.765	9.1± 0.438
5	TDS (mg/l)	305± 3.000	323± 3.511	350± 2.516	358± 3.511	418± 6.429	444± 2.516	456± 3.214	469± 3.257	485± 2.516	502± 3.511	445± 3.605	370± 2.000
6	pH	9.1± 0.307	8.6± 0.298	8.0± 0.386	7.7± 0.402	8.1± 0.301	8.8± 0.489	8.3± 0.391	8.6± 0.313	8.7± 0.374	8.9± 0.458	9.0± 0.344	9.1± 0.291
7	Total Salinity (mg/l)	127± 2.341	119± 2.234	134± 2.654	149± 1.381	200± 2.467	235± 2.456	239± 3.123	243± 3.364	261± 2.256	270± 3.278	212± 2.567	172± 2.387
8	Total Alkalinity (mg/l)	134± 1.671	129± 2.967	137± 3.201	149± 3.413	156± 3.545	170± 4.421	187± 4.678	182± 4.214	171± 3.316	162± 4.163	155± 3.055	140± 3.511
9	Total Hardness (mg/l)	142± 2.373	138± 2.906	144± 3.423	158± 3.789	179± 3.438	188± 3.502	182± 3.760	171± 2.983	163± 3.152	135± 2.974	139± 2.546	141± 1.980

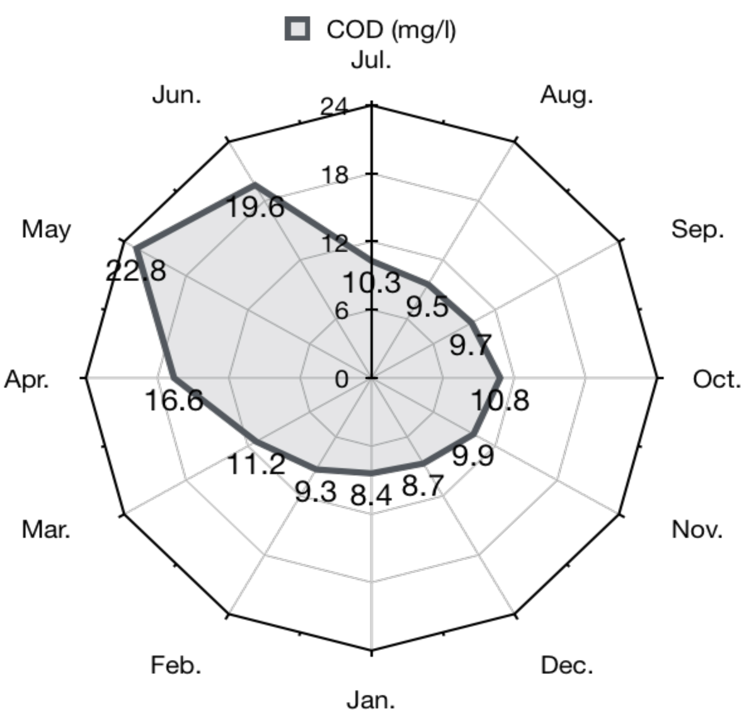
The data has showed in table-1 & Figure-2 the monthly fluctuations in Kalukhedi Pond water DO, BOD, COD, turbidity, TDS, pH, total salinity, total alkalinity, and total hardness (July 2022–June 2023). Water quality characteristics altered during summer and monsoon due to seasonal fluctuations and human activities.



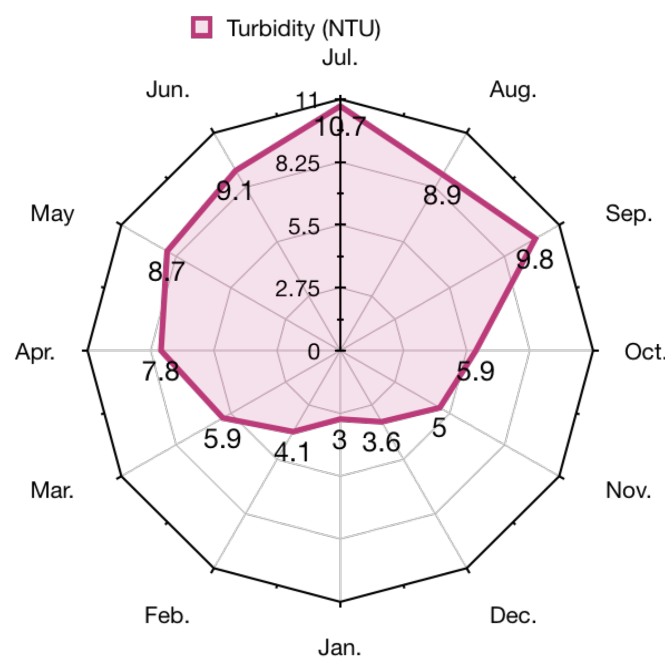
[A]



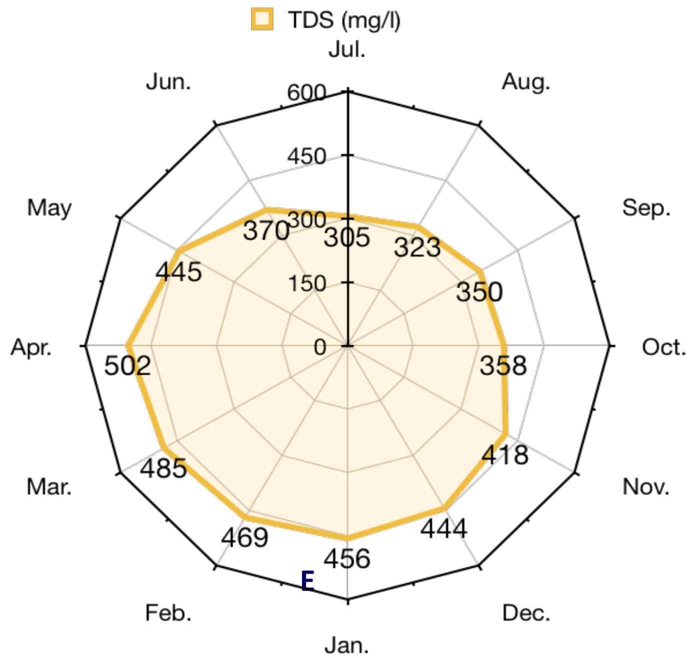
[B]



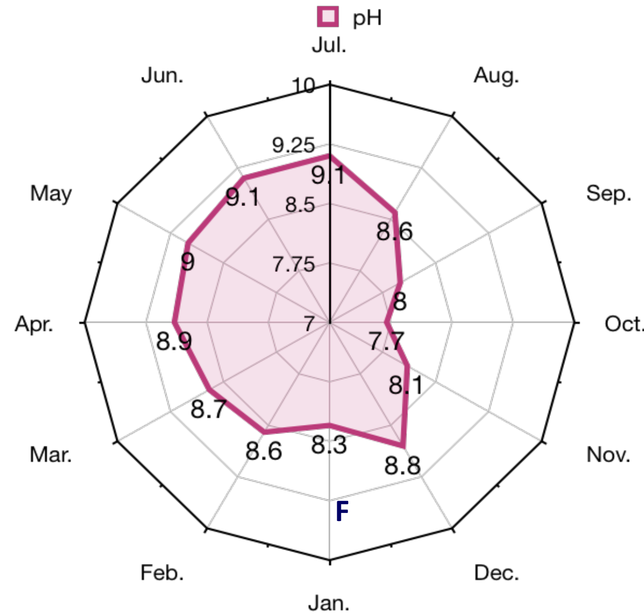
[C]



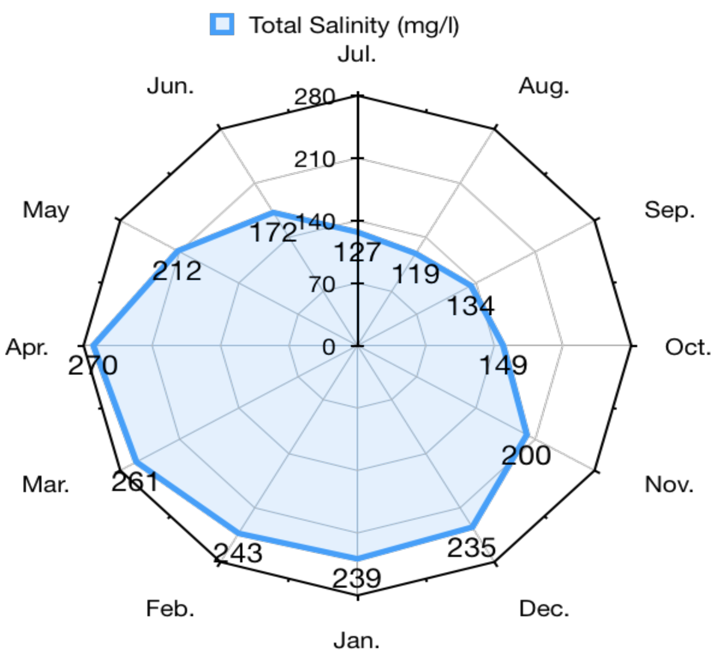
[D]


TDS (mg/l)
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
Jun.
600
450
300
150
0
305
323
350
358
418
444
456
469
485
502
445
370
E

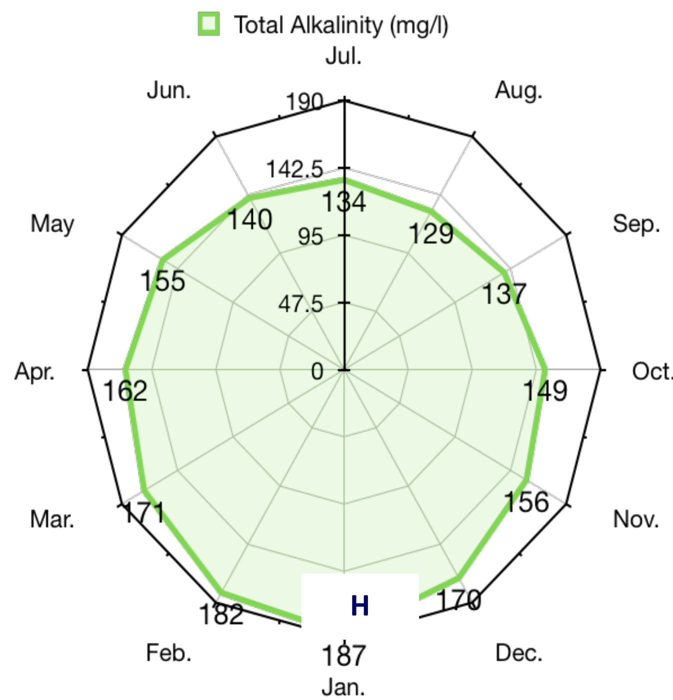
[E]


pH
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
Jun.
10
9.25
8.5
7.75
7
9.1
8.6
8
7.7
8.1
8.8
8.3
8.6
8.7
8.9
9
9.1
F

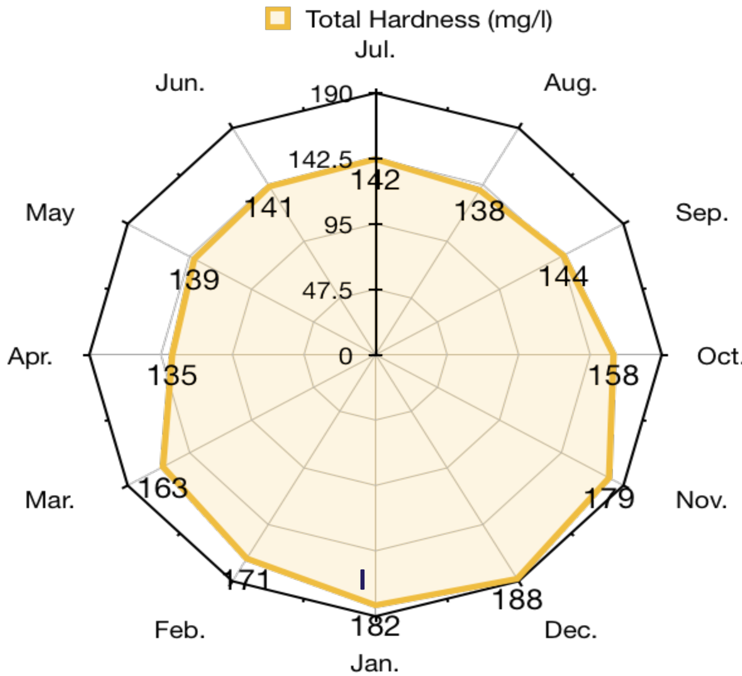
[F]


Total Salinity (mg/l)
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
Jun.
280
210
140
70
0
127
119
134
149
200
235
239
243
261
270
212
172

[G]


Total Alkalinity (mg/l)
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
Jun.
190
142.5
95
47.5
0
134
129
137
149
156
170
187
182
171
162
155
140
H

[H]



[I]

Figure 2: Monthly fluctuations in Kalukhedi Pond water DO, BOD, COD, turbidity, TDS, pH, total salinity, total alkalinity, and total hardness (July 2022–June 2023).

1. Dissolved Oxygen (DO)

This is because it is necessary for the development and continued existence of both plants and animals that are found in bodies of water. Water turbulence, surface diffusion, photosynthetic rate, biological oxygen demand (BOD), water temperature, and carbon dioxide concentration are some of the environmental elements that have an impact on dissolved oxygen (DO) levels. The levels of dissolved oxygen (DO) that were measured in this investigation ranged from 3.3 mg/L to 6.6 mg/L, with the lowest concentration being recorded in the month of June and the maximum during the month of September. The results were shown in panel [A] of Figure 2.According to the findings, greater temperatures produce a decrease in the amount of oxygen that is soluble in water. The presence of inorganic reductants such as ammonia, nitrates, and other oxidizable compounds can also be the cause of a low DO content, which occurs frequently as a result of organic contamination. Ara et al. (2003) have reported instances of patterns that are comparable to these.

2. Biological Oxygen Demand (BOD)

The biological oxygen demand (BOD) is a measurement of the amount of oxygen that microorganisms need in order to decompose organic materials in an aerobic environment. According to Athalye and Patil (2003), an increase in the amount of residential garbage that is brought in contributes to an increase in bulk oxygen demand. As a result of elevated BOD levels, there is a large depletion of oxygen, which is an indication of water pollution. According to the findings of this investigation, the BOD levels varied from 2.7 mg/L to 5.3 mg/L, with the lowest levels being recorded in February and the highest levels being recorded in June.The results were presented in panel [B] of Figure 2.It is believed that the peak levels of biological oxygen demand (BOD) in the month of May are the result of rising temperatures and the influx of animal fecal matter, which amplifies organic pollution. These observations are consistent with the findings that Kiran (2010) discovered.

3. Chemical oxygen demand (COD)

The chemical oxygen demand (COD) allows for the quantification of the total oxygen that is required to oxidize organic matter into carbon dioxide and water. The COD value that was reported as being the greatest during the summer was 22.8 mg/L, while the value that was recorded as being the lowest during the winter was 8.4 mg/L. The results were presented in panel [C], of Figure 2. Previous research conducted by Boyd (1981) has established a correlation between COD readings and BOD.

4. Turbidity

The term "turbidity" refers to the existence of particles that are finely scattered and suspended in water. These particles absorb and scatter light as it travels through the experiment sample. The clarity of the water has an inverse relationship with it. It is possible for turbidity to originate from either organic or inorganic sources. The rainy season was noted to have the highest levels of turbidity, which was mostly caused by the influx of rainwater from agricultural areas that were located in the surrounding area as well as the entry of sewage from the city. As a result of silt and other dissolved particles settling to the bottom of the pond throughout the winter, the turbidity levels were documented to be at their lowest recorded levels during this time of year. According to the Figure 2 panel [D], the results of this investigation showed that the turbidity levels varied from 3.0 NTU to 10.7 NTU, with the lowest levels being recorded in January and the highest levels being recorded in July. The results also showed in (Table 1).

5. Total Dissolved Solids (TDS)

In the pond, the total dissolved solids (TDS) levels varied from 305 mg/L to 502 mg/L. TDS is an essential criterion to consider when evaluating the quality of water. The results were shown in panel [E], of Figure 2. It is suggested that the maximum TDS content for drinking water be no more than 500 mg/L, as stated by the National Food and Drug Administration (2001).

6. pH

Over the course of the current investigation, the pH values that were recorded varied from 7.7 to 9.1 over the duration of the study. According to the Figure 2 panel [F], the results of this investigation showed that the pH level was measured at its lowest point of 7.7 in the month of October, while it reached its maximum point of 9.1 in the month of July. All of the observations came to the same conclusion: the pH remained continuously alkaline (Table 1). In the course of their research, Prapurna and Shashikanth (2002) saw a similar alkaline trend throughout their investigation. Furthermore, it was observed that the pH levels had a tendency to decline during the winter months and to increase during the summer months. Similar findings were also reported by Hutchinson in (1957).

7. Total Salinity

The salinity levels ranged between 119 mg/L and 270 mg/L during the course of the experiment. It was found that the salinity levels were at their peak during the summer for the reason of evaporation, and during the rainy season for the reason of the introduction of dissolved salts from runoff. The results were shown in panel [E], of Figure 2.

8. Total Alkalinity

According to the Figure 2 panel [H], the results of this study showed that 129 mg/L to 187 mg/L was the range of alkalinity that was found in the pond's water. Ion exchange is responsible for high alkalinity, as stated by Sharma and John (2009). This process involves the substitution of sodium ions for calcium ions, which in turn contributes to the total alkalinity levels. Moreover, the breakdown of organic matter results in the emission of carbon dioxide, which increases the alkalinity of the environment even further. A high pH is another factor that contributes to alkalinity. Wagh (1998), who measured values ranging between 105 mg/L and 240 mg/L in Harsul Dam, and Jadhav *et al.* (2006), who recorded values between 94 mg/L and 112 mg/L in Sonkhed Dam, came to similar conclusions on the variations in alkalinity. Both of these studies were conducted in the past.

9. Total Hardness

The quantities of calcium and magnesium ions in water are what determine the strength of the water. Hardness and alkalinity are tightly related to one another and frequently display similar patterns. This is because both components interact with carbonates and bicarbonates. In spite of the fact that water hardness is not a direct sign of pollution, it is a reflection of the overall quality of the water. During the course of this investigation, the total hardness values varied from 135 mg/L to 188 mg/L as showed in panel [I] of figure 2. It is likely that the lower water levels and the greater rate of decomposition that occur during the winter months are responsible for the greatest levels of hardness that were reported. Chatterjee and Rajiuddin (2007), Nirmal Kumar and Oome (2009), and Kiran (2010) have all reported findings that are comparable to one another at the same time.

Conclusion

We present a twelve months investigation of the physicochemical properties of water in Kalukhedi Pond, Dewas, Madhya Pradesh. The data show that seasonal fluctuations, human activities, and natural environmental factors affect water quality. Surface aeration raised dissolved oxygen (DO) levels in the monsoon months, while warmer months increased temperatures and organic pollution lowered them. Summertime BOD and COD readings were greater, indicating organic pollution from rural area effluents and agricultural runoff. Runoff sediment increased turbidity during the monsoon, but TDS remained within limits. The pH was alkaline throughout the trial, indicating low acidic contamination. Evaporation and runoff dissolved salts and enhanced salinity and alkalinity in summer and monsoon, respectively. Hardness followed a seasonal pattern affected by calcium and magnesium ions.

The present study shows that seasonal variations and human activity affect major physicochemical characteristics in Kalukhedi Pond water. Organic pollution is rising, especially during the summer, requiring adequate waste management and monitoring to prevent further degradation. Controlled agricultural runoff, effective sewage treatment, and community knowledge can help preserve water quality for irrigation, residential use, and aquatic biodiversity.

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