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PHYSICAL AND CHEMICAL ANALYSIS OF WATER AT KURNUR DAM IN SOLAPUR DISTRICT

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ABSTRACT:

This study evaluates the seasonal variations in the water quality of Kurnur Dam for the data collected in 2016, it was influenced by climatic and hydrological factors. The analysis of physical parameters reveals elevated turbidity, electrical conductivity (EC), and total dissolved solids (TDS) during monsoon months, indicating increased sediment load and dissolved minerals due to surface runoff. While pH and hardness remain within permissible limits, high EC values suggest potential salinity concerns. Chemical parameters show a decline in dissolved oxygen (DO) levels during summer, potentially impacting aquatic life, while biological oxygen demand (BOD) and chemical oxygen demand (COD) exceed safe limits, particularly during monsoon months, highlighting organic pollution. Nutrient concentrations remain within acceptable ranges, minimizing the risk of eutrophication.

A comparison with BIS and WHO drinking water standards indicates that most parameters are within safe limits, except for turbidity, EC, BOD, and COD, which exceed permissible levels in certain months. To mitigate these concerns, the study recommends implementing filtration and aeration systems to improve turbidity and DO levels, monitoring agricultural runoff to reduce nutrient influx, controlling industrial and sewage discharge to manage COD and BOD levels, and establishing a long-term water quality monitoring program. While Kurnur Dam water remains generally suitable for various uses, targeted interventions are essential to address specific water quality concerns and ensure its sustainability.

KEYWORDS : *electrical conductivity (EC), and total dissolved solids (TDS), chemical oxygen demand (COD).*

INTRODUCTION:

Earth is a distinctive planet that possesses water. Throughout history, the majority of human civilizations have thrived, been sustained, and ultimately declined in proximity to water. Water is the essence of life; it has been proposed that life on Earth began in aquatic environments (Oparin et al., 2003). On our planet, water naturally exists in three forms: ice in its solid state, liquid water, and vapor in its gaseous state. Water constitutes between 70% and 90% of the body mass of living organisms (H. H. Mitchell et al., 1945). It acts as a universal solvent, providing a medium for various metabolic processes, both catabolic and anabolic, within the bodies of organisms. In nature, the hydrological cycle facilitates the movement of water through the lithosphere, atmosphere, and biosphere.

The still water found in lakes is scientifically termed a lentic ecosystem, while moving water is referred to as a lotic ecosystem. When geographical features obstruct water flow, the accumulated water is known as a lake, whereas a human-made structure for water storage is called a reservoir (UNEP). Reservoirs, lakes, and wetlands are recognized as vital biogeographic areas (Nameer, 2005). In a continent-wise analysis of global water distribution, lakes and reservoirs occupy 31240 km3 in Africa, 29132 km3 in Asia, 26573 km3 in North America, 2449 km3 in Europe, 1199 km3 in South America, and 192 km3 in Australia (Korzun et al., 1978). According to estimates of global water resources by country, the total freshwater available worldwide is about 43,750 km3 per year, with America holding the largest share at 45%, followed by Asia with 28%, Europe with 15.5%, and Africa at just 9%. When considering freshwater resources per capita, America has 24,000 m3 per year, Europe has 9,300 m3 per year, Africa 5,000 m3 per year, and Asia 3,400 m3 per year (FAO UN., 2003).

Compared to rivers and lakes, reservoirs offer a substantial and consistent water supply. Lakes and reservoirs serve multiple purposes including domestic and industrial water supply, agricultural irrigation, transportation, and they also provide recreational opportunities as well as essential life-support systems for humans (Emily K. Read et al., 2015). Lakes or reservoirs operate as self-sustaining ecosystems that support aquatic life such as plankton, insects, crabs, fish, and more, making them significant sources of nutritious food like fish, crabs, and prawns (Hoverman, J. T. et al., 2012). Residents living near lakes utilize them in various ways, as these bodies of water deliver numerous social and economic advantages, including tourism and recreation. Lakes hold social, aesthetic, and cultural significance for people globally (J R Corrigan et al., 2009).

Lakes undergo a natural lifecycle influenced by nutrient levels, transitioning from a neotrophic state to an oligotrophic one, and ultimately reaching eutrophic conditions (Hoverman, J. T. et al., 201). Human interference can expedite this natural cycle by polluting the lakes (Thornton J.A., 2010). Anthropogenic activities, inappropriate water usage, and poor management of water resources have detrimental effects on water systems worldwide (Policansky, David., 1998). The primary contributors to water pollution include industrial wastewater, solid waste from urban areas, land use practices, and domestic waste pollutants that compromise water quality, negatively impacting the health of organisms reliant on these surface and subsurface water resources (Melissa Denchak., 2018)

Industrial pollution poses a significant challenge, as most surface and subsurface water bodies are contaminated by industrial discharges. Agricultural runoff and domestic sewage released into water bodies increase nutrient levels, leading to undesirable shifts in water quality and its intended uses (Chapman et al., 1999).

In light of the aforementioned points, it is essential to examine freshwater ecosystems for sustainable development, in order to conserve diminishing resources, ensure the functioning of aquatic ecosystems, and mitigate their adverse effects on human society. Such investigations can aid in comprehending the fundamental and primary regulatory mechanisms within aquatic ecosystems, which may assist in monitoring the direction and pace of changes occurring within these systems, allowing for focused attention on responses to such changes during ecosystem management and restoration planning (Thomas Elmqvist, 2003). To optimize benefits from the ecosystem without causing harm, integrated water resources management and development are necessary (Neil S. Grigg, 2008). Every ecosystem possesses a self-renewal process, and a research approach is required to enhance this natural characteristic.

In India, reservoirs serve as a critical source of water for agriculture, industry, and domestic uses. The usable potential of all surface water resources is 690 BMC; among the total number of reservoirs, Tamil Nadu, Karnataka, Andhra Pradesh, Kerala, Orissa, and Maharashtra account for approximately 56% (FAO., 2019). An analysis of sector-wise demand reveals that the agriculture sector consumes the largest portion, around 78%, followed by domestic use (6%) and the industrial sector (5%) (Press Information Bureau 2013). Approximately 70% of surface water is contaminated, leading to an increased reliance on groundwater, with 45% of total irrigation and 80% of domestic water sourced from groundwater reserves, causing water scarcity in several Indian states. There exists a significant disparity in domestic water consumption between rural and urban areas, with nearly 70% of urban domestic wastewater remaining untreated and directly discharged into the environment (ADRI., 2019). Industries utilize water for various functions such as washing, cleaning, cooling, and dyeing, contributing to the majority of untreated industrial effluent that contaminates natural water sources (ADRI., 2019). According to the Ministry of Statistics and Programme Implementation, the rapid economic growth is expected to drive an increase in the industrial sector, potentially raising water demand from 37 bcm in 2010 to 92 bcm by 2025 and reaching 161 bcm by 2050 (ADRI., 2019).

The water quality is influenced various factors and it is need to be studied for its management for sustainable use. The objective of the study is to study the significant influence of seasons on quality of water, to provide base data for further research. It explore its utility and assist management.

MATERIAL AND METHOD

The study was undertaken to find the influence of various physic chemical factors on the zooplankton community structure at Kurnur dam, which is located in Akklakot Taluka of Solapur District Maharashtra State in India. It is located in rain shadow region of western ghats. The catchment area of the reservoir lies in Akklakot Tehsil and Tuljapur Tehsil dominated by agricultureal land with few rural settlements. There are three distinct season summer from February to May, rainy season from June to October and winter season from November to January of succeeding year. Rainfall through south west monsoon in rainy season is the major source of water besides in summer the rainfall locally called as *Awakali* is the other source of water in the reservoir.

The local factors and anthropological activities have more stronger influence than regional factors (Xiong et al, 2016). Therefore various physical and chemical parameters are studied as earlier discussed in the result and discussion. They are volume of water in reservoir is controlled by precipitation, evaporation, percolation, inflow, outflow and storage capacity of the dam temperature, pH, salinity, DO, BOD,COD, hardness, TDS etc These factors were studied in three different season by collecting data on every fourth Sunday.

The season were classified into Summer season which included February, March, April, May months, Monsoonal Rainy season which included June, July, August, September, October months and Winter season which included November, December, January months. The period of study extended between January to December of 2016, where the water level in the reservoir was to low to be measured in TMC, but the water patches at the river bed below the dead storage which is technically termed as dry by the dam officials made it difficult to study the vertical distribution of zooplanktons.

RESULT AND DISCUSSION

The Table No. 2.2.2 includes study of various physical parameters at site P1 in 2016. All the parameters were measured on the spot at the site except Turbidity, TDS, TSS and TS. Temperature was measured in Degree Celsius (°C) with simple mercury glass thermometer at the same time throughout the study period. Temperature of water seems to follow the atmospheric temperature. Temperature was high in May measuring about 33 °C and minimum in December 19 °C. The portable pH meter was used to measure acidic or basic nature of water and from the Table.No.2.2.2 it seems that throughout the year water was slightly basic.

Table No. 2.2.2 Physical factors of water samples collected at P1 in 2016 at Kurnur Dam.

Dates	Temp	pH	EC	Turbidity	sechi	TDS	TSS	TS
17-01-2016	24	7.1	7.36	7.88	74.02	354.81	11.22	366.03
14-02-2016	24	6.9	6.70	7.29	77.8	309.03	11.75	320.78
13-03-2016	29	7.2	8.11	9.69	64.9	363.08	12.30	375.38
10-04-2016	31	6.8	7.85	9.73	64.7	346.74	11.75	358.49
08-05-2016	33	6.5	9.31	9.55	65.5	407.38	12.59	419.97
05-06-2016	27	6.6	9.10	10.7	60.9	426.58	13.49	440.07
03-07-2016	26	8.3	11.75	10.52	46.2	549.54	18.62	568.16
31-07-2016	24	8.7	10.87	10.06	63.36	524.81	15.14	539.95

28-08-2016	26	8.9	12.34	9.75	64.63	575.44	17.38	592.82
25-09-2016	25	8.1	14.04	9.53	43.57	676.08	24.55	700.63
23-10-2016	23	7.8	10.93	9.06	67.72	512.86	16.60	529.46
20-11-2016	21	7.6	7.45	8.14	91.86	363.08	13.49	376.57
18-12-2016	19	7.3	6.92	5.57	92.35	338.84	10.96	349.80

The Table 2.2.2 mentions the pH value was highest in August measuring about 8.9 and lowest but basic in May measuring 6.5. The conductivity meter was used to measure electric conductivity in terms of mS/m. The conductivity seems to be highest 14.04 in September and second highest 12.34 mS/m in August which was associated with rainfall and lowest 6.70 mS/m in February. Turbidity was measured with the help of nephalometer in terms of NTU. Turbidity was highest 10.70 NTU in June and lowest in 5.57 NTU in December 2016. Sechi disc was dipped in water to measure depth of disappearance and reappearance in the water in terms of centimeter. The sechi depth seems to be highest 92.35 cm deep in December and lowest 43.57 cm in September 2016. TDS was measured in lab with help of filter paper in terms of mg/l. It seems that TDS was highest 676.08 mg/l in September and lowest 309.3 mg/l in February 2016. TSS measures about suspended solids in terms of mg/l. TSS was highest 24.55 mg/l in September and mg/l lowest 10.96 mg/l in December 2016. The values of TS were derived from summation of values of TDS and TSS and expressed in terms of mg/l. From the Table 2.2.2. It seems that TS was highest 700.63 mg/l in September and lowest 320.78 mg/l in February.

Chemical factors in 2016 at P1 in Kurnur Dam.

Table No. 2.2.6 Chemical factors of water samples collected at Site P1 in Year 2016 at Kurnur Dam.

Date	DO	BOD	COD	Ca	Mg	TH	NO_3-	NO_2-	P	S	Cl
17-01-2016	5.83	3.92	38.02	20.34	11.37	31.71	1.75	0.20	0.24	16.95	32.29
14-02-2016	5.99	4.22	36.31	18.98	10.82	29.80	1.67	0.20	0.23	13.15	30.73
13-03-2016	5.41	3.53	28.18	20.58	11.46	32.04	1.48	0.18	0.26	12.47	38.37
10-04-2016	4.27	4.18	32.36	20.11	11.27	31.38	1.35	0.16	0.34	12.24	37.61
08-05-2016	3.59	4.68	39.81	21.8	11.94	33.74	1.16	0.15	0.4	10.78	45.06
05-06-2016	5.45	4.05	43.65	22.3	12.13	34.43	1.37	0.18	0.27	14.42	41.13
03-07-2016	7.04	4.68	38.90	25.32	13.27	38.59	1.95	0.36	0.14	15.76	53.16
31-07-2016	7.91	5.16	43.65	24.74	13.06	37.80	2.22	0.34	0.09	17.18	47.71
28-08-2016	6.89	4.83	36.31	25.91	13.49	39.40	2.23	0.39	0.12	17.38	56.04
25-09-2016	7.34	5.82	46.77	28.08	14.27	42.35	2.86	0.70	0.17	23.46	61.77
23-10-2016	7.37	5.46	46.77	24.46	12.95	37.41	2.56	0.42	0.16	18.36	49.33
20-11-2016	7.36	4.76	43.65	20.58	11.46	32.04	2.40	0.32	0.15	13.25	32.36
18-12-2016	7.67	4.53	38.02	19.88	11.18	31.06	2.23	0.25	0.13	12.81	29.96

Table No. 2.2.6 is for chemical factors analyzed in laboratory from the water sample collected at site P1 in 2016. The following chemical factors were analyzed- DO BOD, COD, Ca, Mg, TH, P, S and Cl. The parameters for Nitrate and Nitrite were measured on the spot with HANA made Nitrate analysis kit. Dissolved Oxygen (DO) was measured with help of Lurton make DO meter in terms of mg/l. The DO was found to be highest 7.91 mg/l in late July and lowest 3.59 mg/l in May 2016. BOD was highest 5.82 mg/l in September and lowest 3.53 mg/l in March 2016. COD was highest 46.77 mg/l in September and October and lowest in 28.18 mg/l in March. Among the important minerals ions studied in chemical parameter were Calcium (Ca), Magnesium (mg), Phosphate (P), Sulphate (S), and Chlorine (Cl), besides

Nitrate and Nitrite concentration were also studied. Ca concentration was highest 28.08 mg/l in September and lowest 18.98 mg/l in January 2016. Mg concentration was highest 14.27 mg/l in September and lowest 10.82 mg/l in January 2016. The total hardness was measured by adding the concentration of calcium and magnesium. The dam water was hardest with 42.35 mg/l in September and least hard with 29.80 mg/l in January. Nitrate concentration was highest 2.86 mg/l in December and lowest 1.16 mg/l May 2016, while nitrite concentration was highest 0.70 mg/l in March and lowest 0.15 mg/l in July 2016. The concentration of phosphate highest 0.40 mg/l measured in May and lowest 0.09 mg/l in late July 2016. The sulphate concentration was highest 23.46 mg/l in September and lowest 10.78 mg/l in May 2016. Chlorine concentration was highest 61.77 mg/l in September and lowest 29.96 mg/l December 2016.

The graphical representations (line charts and bar graphs) for key water quality parameters such as temperature, pH, DO, BOD, COD, EC, TDS, and turbidity are as shown below. The trends highlight seasonal variations in temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity (EC), total dissolved solids (TDS), and turbidity.

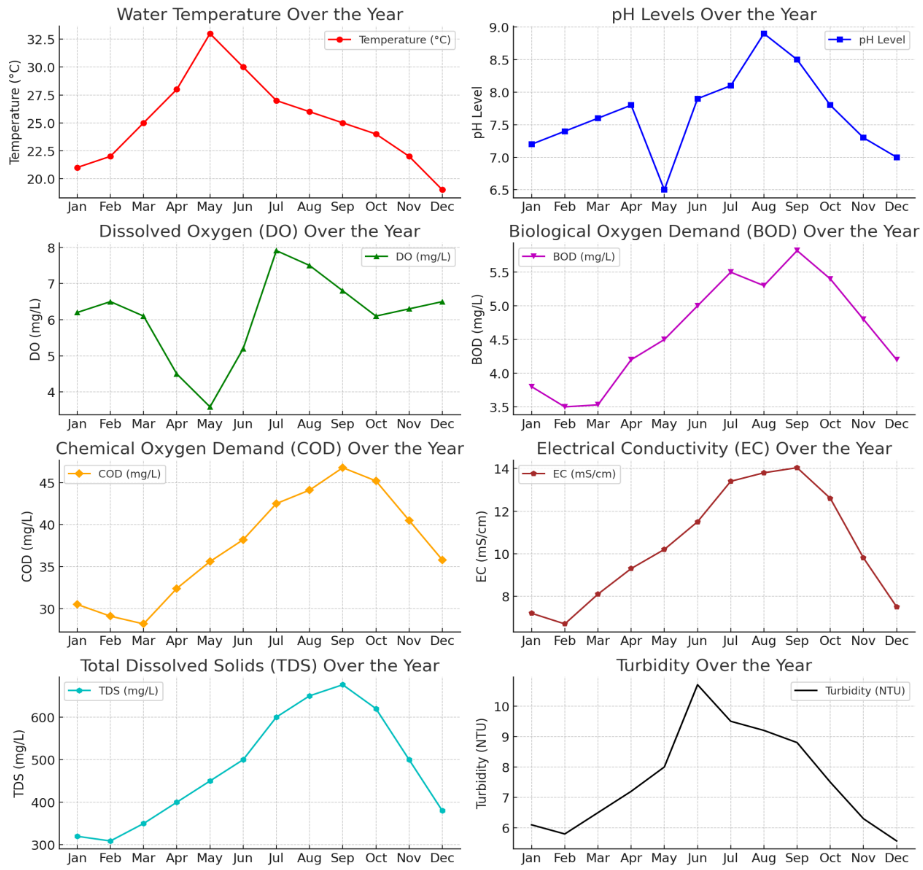
1. Physical Parameters

Temperature:

Water temperature varied from 19°C (December) to 33°C (May). Higher temperatures during summer months can accelerate biological activity, increasing respiration and decomposition rates, which may lower dissolved oxygen (DO) levels. The seasonal temperature variation is typical for freshwater bodies and follows climatic trends.

pH:

The pH values ranged from 6.5 (May) to 8.9 (August), indicating slightly acidic to moderately alkaline conditions. According to the BIS (Bureau of Indian Standards) 10500:2012, the acceptable pH range for drinking water is 6.5 to 8.5, which means that Kurnur Dam water remained within safe limits for most months, except for a slight exceedance in August (8.9). This alkalinity increase may be due to algal blooms, which consume CO_2 during photosynthesis, or the presence of carbonate and bicarbonate ions.



Electrical Conductivity (EC):

EC values increased significantly from 6.70 mS/cm (February) to 14.04 mS/cm (September), indicating higher dissolved ion concentrations. The acceptable EC limit for drinking water is up to 750 µS/cm (WHO standards), meaning the observed values are significantly above permissible levels, suggesting high dissolved salts and mineral content. Increased EC during the monsoon months (July-September) may be due to runoff carrying dissolved solids into the reservoir.

Turbidity:

Turbidity ranged from 5.57 NTU (December) to 10.7 NTU (June). The WHO standard for drinking water is ≤5 NTU, meaning turbidity exceeded permissible limits during most months. Higher turbidity levels in monsoon months (June-September) suggest suspended solids due to inflow from catchment areas. Increased turbidity reduces light penetration, potentially impacting aquatic plant growth and overall ecosystem health.

Secchi Depth (Water Clarity):

Secchi depth, an indicator of water transparency, varied from 43.57 cm (September) to 92.35 cm (December). The lowest transparency was observed in monsoon months, aligning with increased turbidity and total suspended solids (TSS).

Total Dissolved Solids (TDS):

TDS values ranged from 309.03 mg/L (February) to 676.08 mg/L (September). According to BIS standards, the acceptable TDS limit for drinking water is 500 mg/L, with a permissible limit of 2000 mg/L. While most values were within acceptable limits, monsoon months (July-September) showed elevated TDS levels, possibly due to sediment influx and dissolved salts from catchment runoff.

2. Chemical Parameters

Dissolved Oxygen (DO):

DO levels varied from 3.59 mg/L (May) to 7.91 mg/L (July). The BIS standard for drinking water DO is >5 mg/L, meaning values in May and April were below the desirable limit. Lower DO in summer could be due to increased microbial activity and decomposition, leading to oxygen depletion. The peak in July can be attributed to monsoon-induced aeration and lower temperatures, which enhance oxygen solubility.

Biological Oxygen Demand (BOD):

BOD levels ranged from 3.53 mg/L (March) to 5.82 mg/L (September). The CPCB (Central Pollution Control Board) standard for drinking water requires BOD to be <3 mg/L, indicating that water in Kurnur Dam exceeded safe limits for organic pollution in most months. Higher BOD in monsoon months suggests increased organic matter input from runoff.

Chemical Oxygen Demand (COD):

COD values ranged from 28.18 mg/L (March) to 46.77 mg/L (September and October). The standard for drinking water COD is ≤10 mg/L, meaning the dam water showed significantly higher values, indicating possible industrial, agricultural, or sewage contamination. High COD levels in monsoon months suggest organic and inorganic pollutants in runoff.

Total Hardness (TH):

TH values ranged from 29.80 mg/L (February) to 42.35 mg/L (September). According to BIS standards, the acceptable limit for hardness is 200 mg/L, meaning Kurnur Dam water is well within safe limits. However, a gradual increase in hardness from pre-monsoon to post-monsoon suggests mineral leaching from surrounding rocks and soil.

Calcium (Ca) and Magnesium (Mg):

Calcium ranged from 18.98 mg/L (February) to 28.08 mg/L (September), while Magnesium varied between 10.82 mg/L (February) and 14.27 mg/L (September). The WHO standard for drinking water is 75 mg/L for Ca and 30 mg/L for Mg, meaning levels in the dam are within acceptable limits. A post-monsoon increase indicates possible mineral leaching due to runoff.

Nutrients (NO_3^-, NO_2^-, P):

Nitrate (NO_3^-) levels varied from 1.16 mg/L (May) to 2.86 mg/L (September), well below the WHO limit of 50 mg/L. Nitrite (NO_2^-) ranged from 0.15 mg/L (May) to 0.70 mg/L (September), below the permissible limit of 3 mg/L.Phosphate (P) levels fluctuated between 0.09 mg/L (July) and 0.40 mg/L (May), suggesting minimal eutrophication risks.

Sulfate (S) and Chloride (Cl):

Sulfate ranged from 10.78 mg/L (May) to 23.46 mg/L (September), well below the WHO limit of 250 mg/L. Chloride levels ranged from 29.96 mg/L (December) to 61.77 mg/L (September), significantly lower than the BIS limit of 250 mg/L, indicating no chloride contamination.

CONCLUSION

The water quality of Kurnur Dam exhibits seasonal variations influenced by climatic and hydrological factors. Physical Parameters: Elevated turbidity, EC, and TDS during monsoon months suggest increased sediment load and dissolved solids due to runoff. While pH and hardness remain within permissible limits, higher EC values indicate potential salinity concerns. Chemical Parameters like DO levels drop in summer, affecting aquatic life, while BOD and COD exceed safe limits, particularly in monsoon months, indicating organic pollution. Nutrient levels remain within safe limits, suggesting minimal risk of eutrophication. Comparison with Standards: Most parameters align with BIS and WHO standards for drinking water, except for turbidity, EC, BOD, and COD, which exceed permissible limits in certain months.

The study provide the following recommendations:

Water Treatment: Filtration and aeration systems should be used to control turbidity and improve DO levels. Monitoring Agricultural Runoff: Measures to prevent excessive nutrient and organic matter runoff into the reservoir. Pollution Control: Reduce industrial and sewage discharge to control COD and BOD levels. Regular Monitoring: A long-term water quality assessment should be conducted to track seasonal trends and pollution sources. Overall, while Kurnur Dam water remains suitable for general use, specific concerns such as turbidity, EC, and organic pollution require attention to ensure sustained water quality.

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