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Assessment of Water Parameters of Upper Koder Dam in Mount Abu after Rainfall

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ABSTRACT

The current research aims to investigate the effects of physicochemical factors on water quality, particularly during the summer at Upper Koder Dam in Mount Abu (Raj), India. For the investigation of physicochemical factors such as water and air temperature, pH, transparency, total hardness, dissolved oxygen, total alkalinity, and chemical oxygen demand, water samples from the dam were taken. The acquired findings were compared to WHO BIS (World Health Organization and Bureau of Indian Standard) values permitted limits for drinking water. A few parameters at various stations were found to be close to the allowable limits. With reference to the analysed criteria, the current study identified how rainfall affects the water quality of Upper Koder Dam water. Samples of 10 water were taken from Upper Kodra Dam between May 2021 and November 2022. Total hardness, Alkalinity, chloride, pH, total dissolved solids, iron, dissolved oxygen, fluoride, nitrate, sulphate, chromium, iron, chromium, and MPN of coliforms are among the biological and physicochemical parameters that were examined. According to the report, the current water supply needs urgent remediation since the water quality is subpar.

Key words : Upper Kodra dam, Water quality, Total alkalinity, Total hardness, pH, Water and air temperature

Introduction

Water is the most valuable natural resource, a basic human need, and a priceless national asset. Considering that it is directly related to human wellbeing, water quality is a crucial problem for humanity. Water is used for home purposes, commercial uses, agriculture, and inland fisheries. Life begins in the water and develops there. Water is essential to all life forms, from tiny organisms to very sophisticated plant, animal, and human systems. In nature, water quality varies from location to location. Due to overuse and water contamination, freshwater has become a limited resource (Rawal *et al.*, 2018). Surface and subterranean water quality have deteriorated due to growing population and its needs. One of the best methods for informing concerned consumers

and decision-makers about water quality is the Water Quality Index (WQI). Each water quality parameter's values are compared to their goal values by the WQI. WQI is based on a few significant variables that may provide a quick indicator of water quality. It helps the general public comprehend any possible water problems in a certain location. To calculate WQI, nine parameters were collected. The range of the water quality index, which has no units and just one dimension, is 0 to 100.

Water quality index (WQI)

Lakes grow more contaminated due to surface runoff as well as chemical contaminants that originate from industry, domestic usage, and agricultural practises. Human activity is recognised as a significant contributor to environmental contamination.

Hortton (1965) produced the first Water Quality Index (WQI) and classification of WQI. He did this by taking into consideration various types of water bodies (Bhargava, 1989). Because it broadens the quality index, the choice of parameters is very important for the calculation of the WQI. Nine different physico-chemical variables were used in the calculation of WQI. These variables were pH, total alkalinity, dissolved oxygen, calcium, total hardness, chlorides, and magnesium.

Calculations for quality rating (q_n)

Assuming there are n different quality rating (q_n), water quality parameters, for the n^{th} parameter represents the parameter's relative value in the contaminated water in comparison to its standard allowed value (Thirupathaiah *et al.*, 2013). Using the following equation, the q_n is determined.

$$Q_n = 100(V_n - V_{10}) / (S_n - V_{10})$$

Where,

Q_n = Quality rating for the n^{th} water quality parameter.

V_n = Estimated value of n^{th} parameter at a given sampling station.

S_n = Standard permissible value of n^{th} parameter

V_{10} = Ideal value of n^{th} parameter in pure water.

Where, S_n is standard permissible value of n^{th} parameter.

Q_n is quality rating for the n^{th} water quality parameter.

V_{10} is ideal value of n^{th} parameter in pure water.

V_s is estimated value of n^{th} parameter at a given sampling station

For drinking water, all desirable values of the n^{th} variable (V_{10}) are set to zero, with the exception of pH = 7.0 as well as dissolved oxygen = 14.6 mg/l.

Calculating the pH quality rating

The optimum pH value is 7.0 (water that is neutral) and the permitted pH value is 8.20. The following expression is used to compute the pH quality rating.

$$q_{\text{pH}} = 100[(V_{\text{pH}} - 7.0), (8.20 - 7.0)]$$

Where, V_{pH} = observed value of pH

Where, V_{pH} is value of pH.

Calculating the dissolved oxygen quality rating

The ideal level of dissolved oxygen for drinking water is 14.6 mg/l, whereas the typical permissible limit is 5 mg/l. The following calculation is used to

calculate quality rating as a result.

$$q_{\text{DO}} = 100[(V_{\text{DO}} - 14.6), (5 - 14.6)]$$

Where, V_{DO} = Measured value of dissolved oxygen

Where, V_{DO} is dissolved oxygen

Unit weight calculations

The prescribed standards for each parameter are inversely correlated with the unit weights (W_n) for various water quality measurements.

$$W_n = K/S_n$$

Where, W_n = Unit weight for n^{th} parameters,

S_n = Standard value n^{th} parameters.

K = Constant for proportionality

Where, S_n is standard value n^{th} parameters.

W_n is unit weight for n^{th} parameters.

K is constant for proportionality.

WQI calculation

The following expression is used to determine Water quality index.

$$WQI = \sum q_n w_n / \sum w_n$$

Study Area

Mount Abu is a hill station in Rajasthan, India, located close to Sirohi. It is notable for the immense biodiversity it harbours as well as the old temples and peaks of the Aravalli range. It is important to note that Upper Kodra and Lower Kodra are now being considered as the primary sources of drinking water in Mount Abu's current water plans. Because of this, about 42.62 MCFT of water is accessible per year. In contrast, it is estimated that Mount Abu's current water consumption is 85.21 million cubic



Fig. 1. Upper Kodra Dam

feet (Patil, 2013; BIS 2012). Therefore, the demand for water significantly exceeds the amount of water that is already accessible. According to the Water Resources Department, the Salgaon dam will offer 140 million cubic feet of drinking water with a dependability of 75%. The water demand for this project for the design year 2071 is 147.63 million cubic feet (Rawat and Trivedi, 2018; Malik Suman *et al.*, 2014), and it is estimated that it will be completed in 2071. Therefore, the water that is available in the Salgaon dam will be sufficient to meet the requirements of the water demand.

Collection of Samples

The samples of surface water were collected in the months of May 2021 to November 2022 respectively. A total of ten samples of water were collected first thing in the morning, one for each parameter in its own sterile container that had been labelled in advance with the name of the station (Ara and Jamil, 2020). The BOD bottles used to collect the dissolved oxygen samples each had a capacity of 300 millilitres. On the spot, samples of the oxygen content were immediately taken and analysed.

Sample Analyzing

The investigation made use of a variety of physico-chemical variables, including air and water temperature, transparency, pH, total hardness, total alkalinity, Calcium hardness, Magnesium hardness, chloride, nitrate, fluoride and TDS. At the location, mercury thermometers were used to determine the temperature of the air and water, and secchi discs were used to determine the clarity of the water (Sharma and Jain, 2000). For the purpose of measuring pH, a digital pH meter manufactured by Systronics was used. Conventional titration methods were utilised for the purpose of determining total hardness, total alkalinity, dissolved oxygen, and COD levels. The parameters were measured on

a variety of occasions, which are detailed in Tables 1 and 2 that may be seen below.

Results and Discussion

pH

It is possible to determine how active the hydrogen ions in a solution are by measuring the solution's pH (potential hydrogen), which is defined as the reciprocal of the hydrogen ion activity at a certain temperature. The pH of the samples ranged from 6.6 to 9.2 as shown in Tables 1 and 2, which were presented before. At point S3, the pH level is the lowest, measuring 6.6, while at point S5, the pH level is the greatest, measuring 9.2. According to the Bureau of Indian Standards, the acceptable pH range for drinking water is between 6.5 and 8.5. This range includes all values in between (ICMR, 1975). The values of pH changed as a result of changes in the proportions of carbonate, CO₂, and bicarbonate found in the water. When the pH falls below 7.0, there is an increased risk of tuberculosis. At greater levels, there is an increased risk of impaction, deposition of silt and crust, as well as some complications with the use of chlorination to disinfect water. S1, S2, and S5 are the samples that do not fall within the permissible range that were collected during the present study. The pH of the water samples that were taken during this inquiry varied from 6.62 to 9.22.

Total Alkalinity

A low alkalinity increases the possibility that a large number of heavy metals will be discharged and promotes corrosion in pipe systems. According to the Indian Standards, the maximum amount of alkalinity that may be present in CaCO₃ is 200 mg/l (Chorus and Bartram, 1999). The water sample that was collected from the research area had an alkalinity

Table 1. Sample taken from Upper Kodra Dam

Name	date	pH	Tnr	T.A.	T.H.	Ca ⁺²	Mg ⁺²	Cl ⁻	NO ₃ ⁻	F ⁻	TDS
S1	22.5.21	8.9	10	40	60	-	-	30	2	0.2	137
S2	19.6.21	8.7	22	70	60	40	20	40	8	0.2	176
S3	26.6.21	6.6	22	20	30	20	10	20	8	0.2	66
S4	07.8.21	7	14	30	40	30	10	30	2	0.2	102
S5	07.9.21	9.2	12	20	30	20	10	10	2	0.2	74
S6	20.9.21	7.4	12	20	20	10	10	10	2	0.2	53
S7	12.10.21	7	10	20	30	20	10	10	-	-	50

Table 2

Sample No	Date	Ph	T.A.	T.H.	CaH	MgH	Cl ⁻	NO ₃ ⁻	F ⁻	TDS
S8	03.1.22	6.8	20	20	10	10	10	2	0.2	57
S9	18.10.22	7.8	50	40	30	10	30	2.5	0.2	129
S10	2.11.22	7.2	50	40	30	10	30	2	0.2	98

Table 3. Standards for Drinking Water

Parameters	WHO	BSI
TDS	50-150	50-150
Total Alkalinity	200	200
Nitrate	<=10	<=10
Total Hardness	200	200
Calcium	6-105	6-105
pH	6.5-8.5	6.5-8.5
Chloride	<=250	<=250
Magnesium	60-150	60-150
Fluoride	<=0.7	<=0.7

level that ranged from 20 to 50. Alkalinity and pH are the characteristics of waste water that are responsible for determining whether or not it can be treated biologically.

Total Hardness

The overall hardness of Kodra Dam varied anywhere from 20 to 60 on the scale, as measured by three separate locations. In May and June, the total hardness of Samples 1 and 2 reached its maximum of 60 mg/l, while in January and September; the total hardness of Samples 8 and 6 fell to its lowest point of 20 mg/l. It's possible that the rise in water hardness might be attributed to the rapid rate of evaporation that occurs when temperatures are greater, along with the low water level that occurs throughout the summer.

TDS

The TDS level is deemed to be appropriate when it falls between the ranges of 50 to 150. It fluctuates anywhere from 50 to 176 among the samples that were gathered for the investigation. TDS levels in the upper Kodra dam are at their highest in the month of June, and they are at their lowest in the month of October. In addition, it is clear that it exceeds the acceptable limit for the month of June.

Calcium

The amount of calcium that is present in drinking water should fall somewhere in the range of 6 to 105 mg/l. According to the samples that were gathered,

all of them fall somewhere between 10 and 40. Which is at its lowest in the month of September and its highest in the month of January, with a peak in the month of June.

Magnesium

The allowed maximum might be anything between 30 and 150. According to the samples that were taken from the upper Kodra dam, the value falls between 10 and 20. Which demonstrates very clearly that the magnesium level is much below the acceptable threshold (Gagan, 2018).

Nitrate

Nitrate levels in drinking water should be held to a standard that is lower than 10 mg/l for it to be deemed safe. According to the findings of the current research, it may vary anywhere from 2 to 8, which is suitable for drinking (CPCB, 2000).

Chloride

The maximum amount of chloride that may be present in drinking water is 250 mg/l. The answer lies somewhere between 10 and 40. The water from the higher Kodra dam may be used for drinking since it falls within the acceptable range of concentrations.

Fluoride

The ideal concentration of fluoride in water is 0.7 mg/l. In the present investigation, all of the samples had a fluoride content of 0.2.

Conclusion

During the summer season, there was a large amount of variance seen in the physicochemical parameters that were measured at the various stations of the Upper Kodra dam. "Upon comparing the data of several months' worth of fluctuations of physicochemical parameters samples from upper kodra dam (Table 1) with the National and International standards (WHO and BSI) given in Table 3", it was found that the total hardness was significantly

higher in the National standards than in the international standards. The measured levels of each sample fell within the allowable range of the requirements for safe drinking water. The ranges of pH and total alkalinity that were observed at sample sites that were on the edge of what is considered acceptable. The average value of dissolved oxygen was found to be over the limitations of WHO and BIS at station 8, and the pH was found to be beyond the limits of BIS at station 10. Additionally, greater concentrations of COD than the acceptable limits of 10 mg/l were identified at each of the stations. According to the samples, the water from Upper Kodra Dam is suitable for human consumption. Other parameters like chloride, fluoride, calcium, magnesium and nitrate were also under permissible limit which shows that the water quality of the upper kodra dam is good before or after the rainfall. And it could be considered as safe drinking water for the people of Mount Abu, Rajasthan.

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Conflict of Interest

The authors declare that they have no known competing financial interest or personal relationships that could have appeared to influence the work reported in this paper.

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