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Physico - Chemical Analysis and Water Quality Index (WQI) Determination of Sapana Dam Water at District Betul (M. P.)

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Abstract: ***The WQI of any water body is a single number that indicates the water quality of whole water body in the form of single value and presents useful information of overall quality of water for public or for any other utilities as well as in the pollution abatement programme and in water quality management. The present investigation was carried out to evaluate the water quality index (WQI) of Sapana dam water located at District Betul (M. P.) along with the analysis of various physico - chemical parameters such as pH, Turbidity, Electrical Conductivity (EC), Total Hardness (TH), Total Alkalinity (TA), Total Dissolve Solids (TDS), Chloride, Nitrate, Oil & Grease, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The calculated values of WQI for all four sampling stations collected from Sapana dam in the first week of every month of Jul.2021 to Sep.2021 were recorded as 49.06, 49.65, 49.8 and 50.8 respectively. On the basis of calculated WQI values and analysis of studied physico - chemical parameters, the results reveals that the quality of Sapana dam water falls under "Good" category and can be used for domestic and irrigation purposes after some proper and necessary treatment.***

Keywords: Physico - chemical parameters, Water Quality Index (WQI), Water Quality Status (WQS), Sapana Dam

1. Introduction

The most vital resource for life on the earth is water. There cannot be life without fresh water which is only 2.7 percent of total water on earth. The issues of water are becoming increasingly important to environment particularly with respect to human health and their food. Several towns, cities and communities have disappeared due to the shortage of water and climatic changes. Millions of people all over the world, particularly in the developing countries are losing their lives every year from water borne diseases. water quality assessment has become an important exercise to evaluate the nature and extent of pollution in order to take appropriate control measures. The water of Sapana dam is used for domestic and irrigation purposes. Due to the urbanization, sewage discharge, agricultural runoff and construction of housing colonies, a major part of dam water is greatly affected. The present study was aimed to assess the quality of Sapana dam water for its domestic and irrigation purposes.

2. Study Area

Sapana reservoir like others in the state was constructed for irrigation purpose and it is an important source of water supply to the wide agriculture, industrial and domestic area of District - Betul (M. P.) and also being used for fish culture. The dam was constructed in the year 1956 and its longitude and latitude are $77^0$59'05" and $21^0$15'15"respectively. The total length of the dam is 1790 sqm. and the catchment area is 44.75sqm. The gross capacity of the dam is 1690 cu. m. The sallow part of the reservoir gets exposed during summer session and the exposed land is used for agriculture purpose where in the farmers also used huge amount of chemical fertilizers and pesticides. For the purpose of this study, four sampling stations were identified on Sapana dam. The first two sampling stations namely S1 and S2 were located near village Ankawari and the last two namely S3 and S4 were near village Partapur, where domestic activities are mainly occurs and chemical fertilizers were used in a considerable amount.

3. Material and Methods

Water samples were collected in fresh one litre plastic bottles, previously cleaned with 1: 3 HNO_3 from 04 pre - selected sampling stations during the period of three months from Jul.2021 to Sep.2021 on monthly basis. Samples were collected during the first week of every month in the early hours of the day in between 6.00 AM to 10.00 AM. Analysis of physico - chemical parameters, the methods given by APHA (1992) were followed.

Water Quality Index Determination

Water quality index (WQI) is defined as the reflection of composite influence of different quality parameters on the overall quality of water. The water quality parameters are selected based on its direct involvement in deteriorating effect in water quality for human consumption. For WQI calculation, above mentioned twelve physico - chemical quality parameters have been selected. The weighed arithmetic WQI method was used for the calculation of water quality index of the Sapana dam water. Let there be n water quality parameters and quality rating or sub index (Q_n) number that reflects the relative value of n^{th} water quality parameter in polluted water with respect to its standard permissible value. Quality rating was calculated as follows:

$Q_n = 100 * (V_n - V_{I0}) / (S_n - V_{I0})$, Where,

Q_n = Quality Rating for the nth water quality parameter

V_n = Estimated value of n^{th} water quality parameters of collected samples

S_n = Standard permissible value of nth water quality parameter

V_{I0} = Ideal value of nth water quality parameter in pure water (V_{I0} value is 0 for all other parameters except pH and dissolved oxygen which are 7 and 14 respectively).

Unit weight (W_n) for nth water quality parameter is a value inversely proportional to the recommended standard value S_n of the corresponding parameter.

$W_n = K/S_n$, Where,

W_n = Unit weight for n^{th} water quality parameter

S_n = Standard permissible value of nth water quality parameter

K = Constant of Proportionality

The standards recommended by the Indian Council of Medical research (ICMR) and Indian Standards Institution (ISI) are considered for quality rating (Q_n) and Unit Weight (W_n).

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly and can be given by the following expression.
$WQI = \Sigma Q_n . W_n/\Sigma W_n$, Where,

Q_n= Quality Rating for the nth water quality parameter
W_n = Unit weight for nth water quality parameter

The ranges of WQI, the corresponding status of water quality and their possible use are summarized in Table 1.

Table 1: Summary of Water Quality Index (WQI) and Corresponding Water Quality Status (WQS)

S. No.	WQI	WQS	Possible Uses
1	0 - 25	Excellent	Drinking, Irrigation and Industrial
2	26 - 50	Good	Domestic, Irrigation and Industrial
3	51 - 75	Fair	Irrigation and Industrial
4	76 - 100	Poor	Irrigation
5	101 - 150	Very Poor	Restricted use for Irrigation
6	> 150	Unfit for Consumption	Proper Treatment Essential before use

4. Results and Discussion

The observed values of studied twelve physico - chemical parameters in all the samples and their corresponding WQI values are presented in tabular form. Among all parameters, pH, DO and Nitrate were found to be the highest influencing parameters in WQI determination. The summary of observations of physico - chemical parameters and WQI values of the water samples from all four water sampling stations are presented in Table - 2.

Table 2: Monthly variation in studied physico - chemical parameters at all 04 sampling stations with their Range, Calculated WQI values and their Water Quality Status (WQS) during the study periods Jul.2021 to Sep.2021

S. No.	Sampling Stations	Parameters	Month			Ave.	Min.	Max.	Range	WQI	WQS
			July	Aug.	Sep.						
1	S1	pH	7.2	7.5	7.5	7.4	7.2	7.5	7.2 - 7.5	49.06	Good
2		Turbidity	7.1	7.1	7.4	7.2	7.1	7.4	7.1 - 7.4		
3		Elec. Cond.	214	227	231	224	214	231	214 - 231		
4		Total Hardness	116.3	123	125.9	121.6	116.3	125.9	116.3 - 125.9		
5		Total Alkalinity	110.6	108	118.8	112.6	108	118.8	108 - 118.8		
6		TDS	165.6	167	171.5	168.1	165.6	171.5	165.6 - 171.5		
7		Chlorides	44.1	46.8	47.4	46.1	44.1	47.4	44.1 - 47.4		
8		Nitrate	21.1	21.7	22.3	21.7	21.1	22.3	21.1 - 22.3		
9		Oil & Grease	0.39	0.41	0.45	0.4	0.39	0.45	0.39 - 0.45		
10		DO	7.3	7.1	7.3	7.2	7.1	7.3	7.1 - 7.3		
11		BOD	3.9	3.9	4.1	4	3.9	4.1	3.9 - 4.1		
12		COD	75	78.4	79.1	77.5	75	79.1	75 - 79.1		

S. No.	Sampling Stations	Parameters	Month			Ave.	Min.	Max.	Range	WQI	WQS
			July	Aug.	Sep.						
1	S2	pH	7.3	7.4	7.4	7.36	7.3	7.4	7.3 - 7.4	49.65	Good
2		Turbidity	7.2	7.3	7.4	7.3	7.2	7.4	7.2 - 7.4		
3		Elec. Cond.	226	232	234	230.5	226	234	226 - 234		
4		Total Hardness	118.1	122	129	123.0	118.1	129	118.1 - 129		
5		Total Alkalinity	108	116	120.3	114.9	108	120.3	108 - 120.3		
6		TDS	178.4	179	180.1	179.2	178.4	180.1	178.4 - 180.1		
7		Chlorides	39.4	42.3	45.5	42.4	39.4	45.5	39.4 - 45.5		
8		Nitrate	21.2	23.6	25.7	23.5	21.2	25.7	21.2 - 25.7		
9		Oil & Grease	0.36	0.39	0.44	0.39	0.36	0.44	0.36 - 0.44		
10		DO	7.5	7.4	7.3	7.4	7.3	7.5	7.3 - 7.5		
11		BOD	4.5	4.7	5.1	4.76	4.5	5.1	4.5 - 5.1		
12		COD	76.3	75.1	75.8	75.73	75.1	76.3	75.1 - 76.3		
1	S3	pH	7.3	7.4	7.4	7.36	7.3	7.4	7.3 - 7.4	49.8	Good
2		Turbidity	6.9	7.2	7.4	7.16	6.9	7.4	6.9 - 7.4		
3		Elec. Cond.	236	241	242.5	239.8	236	242.5	236 - 242.5		
4		Total Hardness	128.1	126	130.2	128.2	126.3	130.2	126.3 - 130.2		

5		Total Alkalinity	118.4	121	125.6	121.7	118.4	125.6	118.4 - 125.6		
6		TDS	181.3	179	184.3	181.3	178.5	184.3	178.5 - 184.3		
7		Chlorides	38.4	42.2	45.6	42.06	38.4	45.6	38.4 - 45.6		
8		Nitrate	20.1	22.4	23.7	22.06	20.1	23.7	20.1 - 23.7		
9		Oil & Grease	0.41	0.39	0.45	0.41	0.39	0.45	0.39 - 0.45		
10		DO	7	7.4	7.5	7.3	7	7.5	7 - 7.5		
11		BOD	4.7	4.8	4.9	4.8	4.7	4.9	4.7 - 4.9		
12		COD	79.7	78.8	79.5	79.33	78.8	79.7	78.8 - 79.7		
1	S4	pH	7.4	7.5	7.7	7.53	7.4	7.7	7.4 - 7.7	50.8	Fair
2		Turbidity	7.4	7.3	7.2	7.3	7.2	7.4	7.2 - 7.4		
3		Elec. Cond.	224.6	229	230.1	227.8	224.6	230.1	224.6 - 230.1		
4		Total Hardness	119.5	123	126.7	122.9	119.5	126.7	119.5 - 126.7		
5		Total Alkalinity	118.3	121	126.8	122.1	118.3	126.8	118.3 - 126.8		
6		TDS	169.1	176	178.5	174.6	169.1	178.5	169.1 - 178.5		
7		Chlorides	42.1	43.4	47.3	44.26	42.1	47.3	42.1 - 47.3		
8		Nitrate	25.7	28.8	29.7	28.06	25.7	29.7	25.7 - 29.7		
9		Oil & Grease	0.38	0.41	0.44	0.41	0.38	0.44	0.38 - 0.44		
10		DO	7.2	7.4	7.1	7.23	7.1	7.4	7.1 - 7.4		
11		BOD	4.2	4.7	5.1	4.66	4.2	5.1	4.2 - 5.1		
12		COD	76.5	78.1	79.2	77.93	76.5	79.2	76.5 - 79.2		

Abbreviations - (Ave. - Average, Min. - Minimum, Max. - Maximum)

Table 3: Units of Studied Various Physico - Chemical Parameters

pH	Turbidity	Elec. Cond.	Total Hardness	Total Alkalinity	TDS	Chloride	Nitrate	Oil & Grease	DO	BOD	COD
-	NTU	µmhos/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l

5. Conclusion

The present study showed that the Sapana dam water is not much polluted. All the parameters are within permissible limits However, it requires some proper treatment to minimize the contamination especially domestic wastes and agricultural runoff. Present investigation is helpful to create the awareness among people and Government authorities to maintain the Sapana dam water at its highest quality and purity levels. On the basis of calculated WQI values and analysis of studied physico - chemical parameters, the results reveals that during the study period, the quality of Sapana dam water falls under “Good” category and it is concluded that the Sapana dam water is fit for domestic, irrigation and fish production purposes and it can be used for domestic and irrigation purposes after some proper and necessary treatment.

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