IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 12, 2022

A study on Assessment of Drinking Water Quality of Shitla Lake, Durg Chhattisgarh Using water quality index (WQI) tool.

[1*]**Sunita Sharma,** [2]**Bindushree Baghel**
[1]PhD Scholar, [2]Assistant Professor
[1,2]Department of School of Sciences, MATS University, Raipur,(C.G.), India
*Corresponding Email: ravisunita1971@gmail.com

Abstract
Contaminated water supplies upset the delicate balance of the aquatic ecology. Inland water features, especially lakes, dams, and ponds, where water is retained for longer periods of time and serves as the main supply of drinking water, become more problematic. Therefore, it is crucial to monitor and evaluate the water quality of these inland water sources before using them for drinking. The present study evaluates thirteen essential physiochemical parameters of Shitla Lake of Durg, Chhattisgarh to determine the water quality for drinking purpose. The physiochemical parameters were calculated for each month in two years (June-2022 to May 2023). The water quality index (WQI) was calculated by using the values of some important physiochemical parameters. The results showed a significant difference ($p \leq 0.05$) in the recorded physiochemical properties across different months and years. Seasonal differences in the recorded physiochemical parameters were also found to be significant ($p \leq 0.05$). Finally the water quality index for dinking purpose was evaluated and, it was found that the quality of water varies from good to poor as per universal water quality index (U-WQI). It was observed that the water quality of Shitla Lake for drinking was good in winter season. But, in summer and monsoon the water of Shitla Lake was of poor quality for drinking. The seasonal changes in the water quality of Shitla Lake determine its necessity for adopting protective measures from the pollution during which the quality of water is deteriorated. Also the Lake is the primary source of drinking in the fringe area thus prior conservation strategies should be framed out to maintain good quality of its water.
Keywords: Shitla Lake , Drinking water, Physiochemical parameters, WQI, Seasonal variation.

Introduction

In India, inland water features, particularly dams, lakes, and ponds, are regarded as important sources of water. The demand for water from these bodies of water is rising in tandem with the growth of the human population. The water poisoning is partly a result of the rising demand for freshwater from these bodies of water. These bodies of water are vulnerable to pollution as a result of industry, agriculture, and other human activities. Since 70% of India's population lives in rural regions, these inland water bodies provide water services for them. Once these water bodies are contaminated it might have immediate health consequences, bioaccumulation and [1]. Since these bodies of water are the main sources of drinking water, pollution of the water poses a threat to public health. Increases in the concentration of various water contaminants, such as metals, oxides, fluorides, organic pollutants, etc., can lead to a number of illnesses, including worm infections, campylobacteriosis, cholera, typhoid, diarrhoea, scabies, hepatitis, and

gastroenteritis.[2-4].Therefore ensuring the safe drinking water is a growing problem. In this context, regular water quality assessment is important aspect of environmental monitoring [1]. A water body's water quality assessment can aid in more effective management of these water resources. Water bodies' physiochemical characteristics determine the requirements for safe drinking water[5]. Physiochemical and biological parameters are used to characterise the quality of water. Safe limits for physiochemical pollutants in drinking water are established by a number of organisations, including the Centres for Disease Control (CDC), Food and Agricultural Organisation (FAO), and World Health Organisation (WHO). when all of the water's physiological, chemical, and biological characteristics meet the required levels [6-8], such water is suitable for drinking purpose and human health is at risk if values exceed the limits. One of the Sustainable Development Goals (SDGs) is availability and sustainable management of good quality of water. However, given the conditions of climate change, poverty, population growth, and unfavourable human activities, it has proven difficult for policy makers and Water, Sanitation, and Hygiene (WASH) practitioners. Therefore, it becomes crucial to keep an eye on the water bodies' water quality index (WQI) to make sure the water is safe to consume.Water Quality Index (WQI) is regarded as the most elite method for measuring the water quality.It converts a number of physiochemical parameters into a mathematical figure which grades the water quality, thus it determines the suitability of water for drinking [9-12]. Horton created this index for the first time in 1965, measuring water quality using ten different water parameters.Several experts have since changed the formula used to calculate this index. The water quality index (WQI) was determine by each expert using a distinct set of factor.[13-15]. The four main processes in the assessment of the water quality index (WQI) are: a) parameter selection; b) subindex of quality rating calculation; c) unit weight calculation; and d) computation of WQI values using mathematical equation. Ultimately, the index yields a single figure that sums up the overall quality of the water for drinking and other uses.The present study aims at determining the water quality of Shitla Lake of Durg Chhattisgarh, with specific objectives of; a) examining thirteen physiochemical properties(Temperature (0C), Transparency(cm), pH, Alkalinity (mg/l), Total Hardness, Salinity (g/l), Conductivity (µs/cm), Total dissolved solids (mg/l), Calcium Hardness (mg/l), Magnesium Hardness(mg/l), Dissolved Oxygen(mg/l), COD(mg/l), BOD(mg/l) of water in Shitla Lake for each month in two consecutive years (June-2022 to May-2023), b) Comparision of these parameters to World Health Organisation (WHO) for drinking water quality, and c) finally, calculation of water quality index (WQI) for three different season (winter, summer and monsoon) for drinking water purpose.

Material and Methodology

2.1. Study area

The present study was conducted in Durg Chhattisgarh. The Shitla Lake is situated in Durg City of Chhattisgarh. The Durg district is situated between latitudes 20°54' and 21°32' N and longitudes 81°10' to 81°36' E. The Durg district is situated between 412 and 280 metres above mean sea level (MSL). The district experiences scorching summers and monsoon-style rains, which are followed by a dry and chilly winter. In the area, there is around 1,270 mm of rainfall throughout year. The yearly temperature ranges from 11 ºC in the winter to 42.2 ºC in the summer.

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 12, 2022

During the wet season, the relative humidity ranges from 86% to 36% (winter). This district suffers water scarcity during summer season. But the presence of inland water bodies like lakes, ponds and dams play an important role in fulfilling the water demand during this period.The water of inland water bodies is also used for domestic purposes. Thus its essential to assess the physico-chemical properties of these water bodies. The present study is an attempt to determine the water quality index of Shitla Lake Durg Chhattisgarh.

2.2. Sample collection and sample analysis.

1 The water samples from the Shitla Lake were collected in each month from four sites (Site-I, Site-II, Site-III and Site-IV) for two consecutive years (June-2022 to May-2023) respectively. Samples were collected from the surface water of the dam. All the measurements were taken four times and the results were expressed as Mean±SE. The comparative assessment of the water quality of the Shitla Lake was carried out by instituting various physiochemical properties. The physiochemical parameters studied in the present study included temperature, transparency, pH, water conductivity, Total hardness, total alkalinity, total dissolved solids, dissolved oxygen, salinity, BOD and COD measurements of the water body. Each water samples was analyzed by standard methods of APHA [16]. Further the whole year was divided into three seasons viz Winter (Nov-Feb), Summer (Mar-June), and Monsoon (July-Oct). For each season the average data of four months was used to determine the seasonal variation of physiochemical properties of Shitla Lake .

2.3. Water Quality Index (WQI)

To calculate the water quality index (WQI) of Shitla Lake all the calculated 13 physiochemica parameters (mentioned in previous section) of each season were used and the conclusions were drawn. It was found that one of the essential steps in calculation of water quality index (WQI) is computing the relative importance of physiochemical parameters (qualitative) in comparison with each other. Then the water quality index was calculated by using the formulas and steps given by Imneisi and Aydin [17]. Finally the computed water quality index (WQI) values of Shitla Lake were graded into five groups (Table-1), in terms of drinking water standards for each season.

Table-1: Natural Water quality classification as per total score of Water Quality Index (WQI)

S.No	WQI-Value	Rating of water quality (For drinking)	Grading
01.	0-25	Excellent quality of water	**A**
02.	26-50	Good quality of water	**B**
03.	51-75	Poor quality of water	**C**
04.	76-100	Very poor quality of water	**D**
05	Above 100	Unsuitable water for drinking	**E**

2.4. Data analysis

The results of physiochemical analysis were expressed as mean± SE of four replicates for each month and season. The obtained data were subjected to analysis of variance (ANOVA) to evaluate the level of significance ($p \leq 0.05$) using SPSS software version 16.5.

Results

Table-2 shows statistics of 13 physiochemical parameters (Temperature (^{0}C), Transparency(cm), pH, Alkalinity (mg/l), Salinity (g/l), Conductivity (µs/cm), Total dissolved solids (mg/l), Calcium Hardness (mg/l), Magnesium Hardness(mg/l), Dissolved Oxygen(mg/l), COD(mg/l), BOD(mg/l) and Total Hardness) for each month during a period of two years (June-2022 to May-2023) respectively. Water temperature of examined samples varies from 16.9±1.71^{0}C to 32.2±1.25^{0}C. The water transparency values ranged from 25±1.67 to70±1.99. pH does not recorded so much variation and its values remained between 7.2±0.09 to8.3±0.06. Similarly the other physiochemical properties of surface water of Shitla Lake ranged between; alkalinity (45.22±1.43 mg/l to71.02±2.65 mg/l), salinity (3.50±0.05 mg/l to4.75±0.09 mg/l), conductivity (307.67±08.30 µs/cm to 421.11±15.12 µs/cm), total dissolved solids(212.63±05.50 mg/l to 336.17±05.85 mg/l), total hardness (230.54±05.43 mg/l to265.25±09.44 mg/l), calcium hardness (49.28±3.74 mg/l to75.00±3.53mg/l), magnesium hardness (40.05±3.26 mg/l to 58.94±2.94 mg/l), dissolved oxygen (3.00±0.09 mg/l to 4.25±0.25mg/l), COD(18.68±2.80 mg/l to 24.16±1.54 mg/l) and BOD(3.02±0.33 mg/l to4.57±0.05 mg/l) during the time elapse of two years (June-2022 to May-2023). It was observed that the difference between physiochemical properties across different months was significant ($p \leq 0.05$), except water pH and BOD which show an insignificant difference. The overall results record a similar trend in the variation in all physiochemical properties across different months of a year.

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 12, 2022

Table-2: Physio-Chemical properties of **SHITLA LAKE** during ***June-2022 to May- 2023*** in Durg, Chhattisgarh. Data shown in Table is Mean±SE

Month	*Temperature (℃)*	*Transparency*	*pH*	*Alkalinity (mg/l)*	*Total Hardness (mg/l)*	*Salinity (g/l)*	*Conductivity (µs/cm)*	*Total dissolved solids (mg/l)*	*Calcium Hardness (mg/l)*	*Magnesium Hardness (mg/l)*	*Dissolved Oxygen (mg/l)*	*COD (mg/l)*	*BOD (mg/l)*
June	32.2±1.25	47±2.87	8.1±0.05	65.16±2.17	110.41±4.48	4.05±0.03	394.05±09.87	222.50±06.97	60.25±3.50	50.16±2.28	3.64±0.50	18.66±1.66	4.57±0.05
July	29.0±1.05	25±1.90	8.3±0.06	55.28±3.05	124.83±5.56	3.75±0.09	360.22±06.64	258.21±04.28	65.89±5.25	58.94±2.94	4.25±0.25	23.29±2.27	4.08±0.04
August	27.5±1.11	25±1.67	7.7±0.02	50.16±2.37	107.42±6.66	3.50±0.05	348.25±05.25	250.96±05.19	55.26±3.18	52.16±3.86	3.28±0.25	24.16±1.54	4.19±0.07
September	24.7±1.27	32±1.44	7.4±0.04	45.22±1.43	095.81±2.28	4.00±0.06	380.05±05.25	245.18±04.64	50.15±2.94	45.66±1.94	3.80±0.50	20.96±1.25	4.09±0.05
October	22.0±1.06	37±2.88	7.5±0.05	48.23±4.96	103.22±3.94	3.90±0.05	340.56±06.19	237.20±08.28	58.22±2.69	45.00±2.97	3.50±0.50	20.60±1.39	3.93±0.02
November	19.5±1.33	44±2.17	7.5±0.07	49.95±2.30	115.64±4.08	4.00±0.07	330.14±12.16	230.54±05.43	55.69±2.40	40.05±3.26	3.39±0.25	18.89±1.94	3.27±0.02
December	16.9±1.71	49±0.98	7.5±0.03	53.67±2.41	126.69±3.32	4.37±0.05	319.19±17.36	241.71±12.15	49.28±3.74	45.11±2.05	3.30±0.50	20.14±1.45	3.02±0.33
January	20.0±1.28	51±1.34	7.7±0.05	59.11±3.56	135.17±3.17	4.50±0.10	307.67±08.30	256.00±05.28	54.24±2.25	40.67±3.77	3.21±0.46	19.35±2.29	3.54±0.45
February	23.2±0.94	58±1.56	7.6±0.05	65.64±1.47	142.60±3.49	4.75±0.09	376.25±15.25	265.25±09.44	63.07±5.46	42.00±4.10	3.65±0.57	21.00±0.87	4.00±0.19
March	25.3±0.89	65±1.28	7.8±0.02	69.81±3.22	151.25±4.85	4.75±0.05	393.51±07.11	255.00±05.00	69.15±4.09	48.19±3.76	3.76±0.76	20.44±2.46	4.25±0.30
April	29.1±1.37	70±1.99	7.2±0.09	71.02±2.65	150.21±2.00	3.68±0.11	410.75±09.37	260.25±08.25	75.00±3.53	52.31±4.94	3.00±0.09	18.68±2.80	4.77±0.67
May	32.8±1.02	38±1.25	7.8±0.07	64.39±1.69	140.75±5.25	3.87±0.07	421.11±15.12	240.13±04.61	69.79±2.47	57.73±2.87	3.15±0.17	19.46±3.77	4.09±0.76

Table 4.10. Seasonal Variation of different physico-chemical characteristics of **Shitla Lake** of Durg Chhattisgarh during 2022 23. Values in table are Mean±SD

S.NO	Parameters	Standard Values (FF&DP)	*SEASON*			ANOVA (One way)
			Monsoon	Winter	Summer	
1.	Temperature (^{0}C)	--	28.35	19.60	27.60	*
2.	Transparency	--	32.25	45.25	57.75	*
3.	pH	6.5-7.5	7.8	7.5	7.6	NS
4.	Alkalinity (mg/l)	02-200	53.96	52.74	67.72	*
5.	Total Hardness	10-500	109.62	120.18	146.20	*
6.	Salinity (g/l)	0-1500	3.83	4.19	4.26	NS
7.	Conductivity (µs/cm)	0-1500	370.64	324.39	400.41	**
8.	Total dissolved solids (mg/l)	10-500	244.21	241.36	255.16	*
9.	Calcium Hardness (mg/l)	10-500	57.89	54.36	69.25	**
10.	Magnesium Hardness(mg/l)	10-300	51.73	42.71	50.06	*
11.	Dissolved Oxygen(mg/l)	08.00	3.74	3.35	3.39	NS
12.	COD(mg/l)	25.00	21.77	19.75	19.90	NS
13.	BOD(mg/l)	04.00	4.23	3.44	4.28	NS

The data shown are mean ± SE of four replicates
*Statistically significant difference at $p \leq 0.05$
**Statistically significant difference at $p \leq 0.01$
NS: Not significant
F&DU: Fish Farming and Drinking Purpose

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11, Iss 12, 2022

The monthly physiochemical parameters of Shitla Lake were further analyzed and arranged into three seasons (winter, summer and monsoon). Table-4 shows the statistics of analyzed physiochemical parameters in different seasons during June-2022 to May- 2023. The obtained physiochemical values were compared to the standards of World Health Organization [2] drinking water quality standards. All the thirteen physiochemical parameters fall within the standards of WHO [2]. It was noted that except water pH, salinity,DO,COD and BOD, all the physiochemical parameters showed a significant difference ($p \leq 0.05$) across all the three seasons. Also the physiochemical parameters viz., total hardness, conductivity, total dissolved solids, and calcium hardness show a high significant difference ($p \leq 0.001$) across all the three seasons.

Table-5: Water Quality index (WQI) of ***Shitla Lake*** across different seasons for drinking purpose

S.NO	Season	*Water Quality index (WQI)*	Grade	Remarks
01	*Winter*	**45±2.13**	**B**	Water quality is good for Fish Farming and Drinking
02	*Summer*	**44±1.57**	**B**	Water quality is good for Fish Farming and Drinking
03	*Monsoon*	**47±1.68**	**B**	Water quality is good for Fish Farming and Drinking
04	**ANOVA**	*****		*****Statistically significant difference at $p \leq 0.05$

The status of Shitla Lakes drinking water was assessed using the Water Quality Index (WQI). The physiochemical property values that were computed were examined in order to report the Shitla Lake water quality index (WQI). The water quality index (WQI) summary for Shitla Lake for the winter, summer, and monsoon seasons, from June-2022 to May-2023, is shown in Table 5. In three distinct seasons the water quality index (WQI) of Shitla Lake showed significant differences ($p \leq 0.05$). Shitla Lake's water quality was good according to the water quality index (WQI) grading system. It was noted that the monsoon season had the greatest rate of decline in water quality. Likewise during summer season due to severe pressure of bathing, washing etc by the fringe settlements the quality of water for drinking further decreased.

Discussion

According to WHO and FAO guidelines, inland water bodies (lakes, ponds, and dams) must have ongoing water quality index (WQI) monitoring in order to be used for drinking [18-19]. Since the physiochemical and biological qualities of water are significantly influenced by climate and other natural elements [20], it is important to monitor and evaluate the water quality all year round. In addition to posing a threat to human health, improper monitoring of the water quality in bodies of water used as drinking sources can upset the delicate balance of the aquatic environment [21]. Chhattisgarh state of India has a good network of inland water bodies, but still many of the water bodies remain still untouched from the water quality monitoring perspectives. Shitla Lake of Durg Chhattisgarh is located in Durg City. The dam has a good catchment area, thus the water of this dam becomes a major source of drinking, bathing, irrigation, washing and

other domestic uses of local settlements during summer season. In this context, the monitoring and assessment of the water quality of Shitla Lake is of prime importance. The current study assesses thirteen crucial physiochemical characteristics of Shitla Lake in order to establish whether or not water is safe to drink. Our investigation revealed that, with the exception of water pH and BOD, there was a significant change ($p \leq 0.05$) in the physiochemical attributes across several months and seasons. Numerous natural phenomena and anthropogenic activities may be linked to the alteration in the physiochemical characteristics. Climate change, geological processes, and hydrological processes are examples of natural causes that modify the physiochemical characteristics of water [22]. Natural events like as soil degradation, atmospheric conditions, pollution, algal blooms, droughts, floods, siltation, runoff, and earthquakes can change the physiochemical characteristics of water [23]. Aside from natural elements, anthropogenic influences are the primary reason for the decline in water quality. Aspects of human activity that cause the quality of water to decline include construction, heavy metal deposition, eutrophication, pesticide toxicity, industrial and municipal wastes, and water pollution [24]. Since Shitla Lake is not located in an industrial or urban region, runoff water, washing, bathing, irrigation, and pesticide toxicity are the main factors degrading the water quality. Human intervention is a key factor in changing the physiochemical characteristics of water, according to Patila and Dongare's [25] research on the impact of human activities on these qualities. When preparing this dam's management plan, a thorough monitoring of these variables may be taken into account. Additionally, every physiochemical property exhibits a variety of correlations, meaning that modifications to one physiochemical parameter might also affect changes to other physiochemical parameters. As an illustration, a rise in TDS concentration in water would inevitably alter its turbidity, temperature, salinity, alkalinity, pH, and other characteristics, all of which are indicators of chemical contamination [26]. The current research's findings are in line with those published by Mishra and Singh [27] at the Khutaghat dam in Durg, Chhattisgarh, as well as in a different study conducted in India [28]. The findings of the present study are inconsistent with those of Rameshbabu and Selvanayagam [29] of Kolavoi dam India, Bougarne et.al.,[30] of Bab Louta Morocco, Al-Hasawi et.al., [31] of water wells at Rabigh Saudi Arabia, Aregbe et.al., [32] of three dams of Nigeria.

The Water Quality Index (WQI) is considered a crucial statistical instrument for characterising the quality of water. Currently, inland water bodies (dams, lakes, and ponds) are the main source of drinking water in India's rural communities. Therefore, it is deemed vital to keep an eye on and evaluate these water bodies' water quality indexes (WQI) for drinking purposes. The water quality index (WQI) values of Shitla Lake varied considerably ($p \leq 0.05$) between the three seasons examined in this investigation. This establishes Shitla Lake's dynamic condition of physiochemical characteristics. Both anthropogenic (washing, bathing, and irrigation) and natural (climate, geology, runoff, soil weathering) elements control this water quality dynamic. The water quality index (WQI) grading show that the water quality of Shitla Lake for drinking purpose varies from poor to good quality. In summer the drinking quality of water in Shitla Lake

decreases, the decline in water quality index is primarily caused by the favorable conditions for development of algal blooms through eutrophication [33]. This also results in lowering of water pH. Further, the warming of surface water decreases the DO concentration during summer [34-35], this may lead to higher rates of organic matter decomposition [36]. In this way the almost all physiochemical properties of water are altered and result in poor drinking water quality index of Shitla Lake in summer. In monsoon, the runoff water from the drainage system of adjacent areas of is collected in Shitla Lake . With this runoff water much inert material is also added to this water, which results in conspicuous dilution of water [37] and then it deteriorates the drinking water quality index of Shitla Lake during monsoon. The water quality index of Shitla Lake suggests that the water is good for drinking in winter, summer and monsoon respectively. Regular monitoring in the dam and its catchment is required to avoid dumping of wastes in the dam and understand its trend of deterioration. The overall results of the present study could be useful for the future management of Shitla Lake.

Conclusion

The monitoring and assessment of the water quality of these inland water sources for drinking purposes is of prime importance. The present study evaluates thirteen essential physiochemical parameters of Shitla Lake of Durg, Chhattisgarh to determine the water quality for drinking purpose. The physiochemical parameters were calculated for each month in two years (June-2022 to May- 2023). None of the physiochemical parameter breached the acceptable limits of WHO for drinking water. The study reported a significant variation in physiochemical properties of Shitla Lake across different months and seasons. The alteration of physiochemical properties in different months and seasons was regulated by natural (climate, geology, runoff, soil weathering) and anthropogenic (washing, bathing, cooking, irrigation) factors. Water quality index (WQI) was calculated to determine the water quality status for dinking purpose. The water quality index (WQI) values of Shitla Lake were significantly different ($p \leq 0.05$) across three different seasons. The water quality index of Shitla Lake suggests that the water is good for drinking in winter but it remains poor in monsoon respectively. The seasonal changes in the water quality of Shitla Lake determine its necessity for adopting protective measures from the pollution during which the quality of water is deteriorated. Policy makers could use the results of present study to adopt proper approaches in protecting the water quality of Shitla Lake .

Conflict of interest

The authors declare that they do not have any conflict of interest

References

[1]. Amiri, H., Hadizadeh,B., Mooselu,MG., Azadi, S., Sayyahzadeh,AH (2021) Evaluating the water quality index in dam lake for cold water fish farming. Environmental Challenges. 5, 100378. doi.org/10.1016/j.envc.2021.100378

[2]. WHO, 2017. Guidelines for drinking-water quality: first addendum to the fourth edition. https://apps.who.int/iris/handle/10665/254637.

[3]. Chao, S., Fan, J., Wang, L (2016) Association between the levels of calcium in drinking water and coronary heart disease mortality risk: Evidence from a meta-analysis. Int. J. Clin. Exp. Med. 9, 17912–17918.

[4]. Kisaka, M (2018) Spatial variation of ground water quality parameters and its suitability for drinking at Makutopora aquifer, Dodoma municipality. Tanzania. Int. J. Environ. Geoinformatics 5, 337–352.

[5]. Chaudhari, U., Kondulkar, S., Wanjari, A., Wanjari, N (2016) Analysis of water quality using physico-chemical parameters from various dams of Amaravati district, Maharashtra. India. Int. J. Sci. Eng. Appl. Sci. 2, 317–325.

[6]. WHO, (2011) Guidelines for Drinking Water Quality. 4th edn. World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland.

[7]. Bureau of Indian Standards (BIS) (2012) Specification for drinking water. New Delhi, India: Food and Agricultural Division Council.

[8]. Central Pollution Control Board (CPCB) (2013). Guide manual: water and waste water. New Delhi, India: Central Pollution Control Board; 2013. Available: http://www.cpcb.nic.in/ upload/Latest/Latest_67_guidemanualw&wwanalysis.pdf.

[9]. Azadi, S., Amiri, H., Mooselu, M.G., Liltved, H., Castro-Muñoz, R., Sun, X., Boczkaj, G (2021) Network design for surface water quality monitoring in a road con- struction project using gamma test theory. Water Resour. Ind. 26, 100162. doi: 10.1016/j.wri.2021.100162 .

[10]. Mooselu, M.G., Amiri, H., Azadi, S., Liltved, H (2021) Spatiotemporal assessment of surface water vulnerability to road construction. Environ. Dev. Sustain. 1–23. doi: 10.1007/s10668-021-01763-9 .

[11]. Mooselu, MG., Liltved, H., Nikoo, MR., Hindar, A., Meland, S (2020) Assessing optimal water quality monitoring network in road construction using integrated information-theoretic techniques. J. Hydrol. 589, 125366. doi: 10.1016/j.jhydrol.2020.125366 .

[12]. Tyagi, S., Sharma, B., Singh, P., Dobhal, R (2013) Water quality assessment in terms of Water Quality Index. Am J Water Resour.1(3),34–8.

[13]. Basturk, E (2019) Assessing water quality of Mamas ı n Dam Turkey using water quality index method ecological and health risk assessments. CLEAN 47, 1900251. doi: 10.1002/clen.201900251 .

[14]. Dinius, S (1987)Design of an index of water quality. J. Am. Water Resour. Assoc. 23, 833–843. doi: 10.1111/j.1752-1688.1987.tb02959.x .

[15]. Torres, P., Cruz, CH., Patino, P., Escobar, J.C., Perez, A (2010) Applying water quality indexes (WQI) to the use of water sources for human consumption. Ing. Investig. 30, 86–95. doi: 10.15446/ing.investig.v30n3.18180

[16]. APHA, (2012) Standard methods for the examination of water and wastewater. American Public Health Association, Washington, DC.

[17]. Imneisi, IB., Aydin, M (2016) Water Quality Index (WQI) for Main Source of Drinking Water (Karaçomak Dam) in Kastamonu City, Turkey. J Environ Anal Toxicol 6, 407. doi: 10.4172/2161-0525.1000407.

[18]. Gulumbe, BH., Aliyu, B., Manga, SS (2016) Bacteriological and physicochemical analyses of aliero dam water. Int. J. Innov. Stud. Sci. Eng. Technol. 2, 30–34.

[19]. Mora, A., Mahlknecht, J., Rosales-Lagarde, L., Hernandez-Antonio, A (2017) Assessment of major ions and trace elements in groundwater supplied to the Monterrey metropolitan area, Nuevo León. Mexico. Environ. Monit. Assess. 189, 394.

[20]. Khelifa, R., Mahdjoub, H., Baaloudj, A., Canning, R., Samways, MJ (2021) Efects of both climate change and human water demand on a highly threatened damselfly. Sci Rep 11, 7725 (2021). doi.org/10.1038/s41598-021-86383-z.

[21]. Kahal, AY., Alfaifi, HJ., Abdelrehman, K., Zaidi, FK (2021) Physio-chemical properties of groundwater and their environmental hazardous impact: Case study of Southwestern Saudi Arabia. Journal of King Saud University - Science. 33(2), 101292.doi.org/10.1016/ j.jksus.2020.101292

[22]. Albaggar, AKA (2020) Assessment of Water Quality in Some Wells of Albaha Region and its Surrounding Area, Saudi Arabia. Biosci. Biotechnol. Res. Commun. 13, 1536–1544. https://doi.org/10.21786/bbrc/13.3/81.

[23]. Khatri, N., Tyagi, S (2015) Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. Front. Life Sci. 8, 23–39. https://doi.org/10.1080/21553769.2014.933716.

[24]. Bojarczuk, A., Jelonkiewicz, L., Lenart-Boron, A (2018) The effect of anthropogenic and natural factors on the prevalence of physicochemical parameters of water and bacterial

water quality indicators along the river Białka, southern Poland. Environ. Sci. Pollut. Res. 25, 10102–10114. https://doi.org/10.1007/s11356-018- 1212-2.

[25]. Patil, D.,Dongare, M (2006) Studies on physico-chemical characteristics of the waterbodies of Aundh of southern Maharashtra with reference to the stress of human activities. Indian Journal of Environmental Protection. 8 :109-114.

[26]. Muigai, PG., Shiundu, PM., Mwaura, FB., Kamau, GN (2010) Correlation between dissolved oxygen and total dissolved solids and their role in the eutrophication of Nairobi dam, Kenya. Int J Bio Chem Phys 18, 38–46.

[27]. Mishra, R., Singh, RK (2020) Seasonal variation in physiochemical properties of Khutaghat dam, Durg, Chhattisgarh, Central India. Journal of Xi'an University of Architecture & Technology. XII (VII): 836-845.

[28]. Jayabhaye U.M., Pentewar MS., Hiware CJ (2008) A study on physicochemical parameters of a minor reservoir, Sawana, Hingoli district,Maharashtra. Journal of Aquatic Biology. 23(2), 56-60.

[29]. Rameshbabu K. and Selvanayagam M (2013) Seasonal variations in physicochemical parameters and heavy metals concentration in water and sediment of Kolavoi Lake, Chengalpet, India

[30]. Bougarne, L., Bouchamma, E.L., ABBOU, M., Bouka, H (2017) Assessment of the water quality of the reservoir Bab Louta (Taza, Morocco). J. Mater. Environ. Sci. 8, 2296-2301.

[31]. Al-Hasawi, Z., Al-Hasawi, R., saeed, AZ (2018) The Study of some Physicochemical and Microbiological Properties in Water Wells at Rabigh Governate, Saudi Arabia. J. Biosci. . Res. 4, 170.

[32]. Aregbe, EA., Olonitola, OS., Inabo, HI., Ella, EE., Ameso, VC (2018) Temporal and Spatial Physico-Chemical Parameters of Kubanni Dam, Galma Dam and Shika Dam, Zaria, Kaduna State, Nigeria. Int. J. Curr. Microbiol. App. Sci 7, 812–822.

[33]. Vliet, M van., Zwolsman,G (2008) Impact of summer droughts on the water quality of the Meuse River. Journal of Hydrology 353(1):1-17.

[34]. Caruso, BS (2002) Temporal and spatial patterns of extreme low flows and effects on stream ecosystems in Otago, New Zealand. Journal of Hydrology 257, 115–133.

[35]. Murdoch, PS., Baron, JS., Miller, TL (2000) Potential effects of climate change on surface-water quality in North America. Journal of the American Water Resources Association 36, 347– 366.

[36]. Mimikou, M.A., Baltas, E., Varanou, E., Pantazis, K., 2000. Regional impacts of climate change on water resources quantity and quality indicators. Journal of Hydrology 234, 95–109.

[37]. Pramanik, AK, Majumdar,D., Chatterjee, A (2020) Factors affecting lean, wet-season water quality of Tilaiya reservoir in Koderma District, India during 2013–2017, Water Science, 34(1), 85-97, DOI: 10.1080/11104929.2020.1765451.