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SEASONAL VARIATION OF PHYSICO-CHEMICAL PROPERTIES OF DHASAN RIVER WATER IN DISTRICT CHHATARPUR, M.P., INDIA

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ABSTRACT

Fresh water is not only a limited resource but also essential for agriculture, industry and even human survival. The present investigation on seasonal variation of Physico-chemical parameters of water of Dhasan River in Chhatarpur district was conducted at eight sampling sites (four limnetic and four littoral) from February, 2024 to January, 2025. The effect of seasonal variation on the Physico-chemical properties of water of Dhasan River was studied in this research. The Physico-chemical parameters of water samples collected from river Dhasan at various locations of Chhatarpur District were assessed. Physico-chemical parameters like, Temperature, Conductivity, pH, Turbidity, Total Dissolved Solids, Total Hardness, Total Alkalinity, Chloride, Sulphate, Phosphate, Nitrate, Dissolved O_2 , B.O.D., C.O.D. were determined. The results were compared with standards prescribed by W.H.O. (1984), B.I.S. & I.C.M.R. Temperature, Conductivity, pH value, Turbidity, T.D.S., Total Hardness, Total Alkalinity, Chloride, SO_4 , PO_4 , NO_3 , D.O., B.O.D., C.O.D. of all the samples were found below the permissible limit set by WHO. It is concluded that the water of river is not polluted but there is an indication of increasing pollutant due to Human activities and agricultural runoff. Proper monitoring is needed to avoid Human activities and agricultural contamination.

Key words: Physico-chemical Properties, Seasonal Variation, Dhasan River.

Introduction

Water is essence of the life as found on the earth and totally dominates the chemical composition of all organism. 70% of the Earth's surface is covered with water, so we find a vast amount of water in the hydrosphere, of which more than 99% is stored in the oceans. Relatively small amount of water bodies, River, Dam, Lakes, Reservoirs, Pond, Tank, Streams and other small water bodies. Water is a unique substance from the perspective of ecology. Water has a higher specific heat, latent heat of fusion and latent heat of evaporation than any other common substance. These facts play a very important role in the heat regulation of organism themselves and in the resistance of natural environment to temperature change. Another unusual quality of water is its power as a solvent no other common substance compares with water in this respect. The surface tension of water is the highest, except for mercury.

The science studying the water bodies located on the earth surface is called limnology. This emphasized mainly the study of relationship between organism and the fresh water environment. In other word limnology deals with the study of structural and functional attributes of the fresh water environment.

Limnology is a broad term that studies the functional relationships and productivity of freshwater biological communities as influenced by the dynamics of physical, chemical, and biological environmental parameters. The limnology of running water (Lotic) deals with rivers and is reviewed in detail (Hynes H.B.N. 1970 and, APHA, AWWA, WPCF 2005).

Chhatarpur was founded in 1785 and is named after the leader Maharaja Chhatrasal, who was the founder of independence in Bundelkhand, and it contains his burial site. Until 1785, the rule was held by his descendants. At that time the Ponwar clan of the Rajput took control of Chhatarpur.

Chhatarpur is one of the District of Madhya Pradesh state of India. The district administration headquarters is located in Chhatarpur city, which is in the western part of Bhopal, Madhya Pradesh. Chhatarpur is situated in the north eastern boundary of the state of Madhya Pradesh it came into existence in 1956.

Dhasan River originate in Jasrath Hill of Begamganj Tehsil of Raisen District in Madhya Pradesh state, and meet Betwa on the right bank in the Devri village district of Hamirpur in Uttar Pradesh. Total length of river is 365 KM. 240 KM (52.1951 Mile) in Madhya Pradesh, 54 KM common boundary of Madhya Pradesh and Uttar Pradesh and 71 KM in Uttar Pradesh. Dhasan River enters Chhatarpur district from village Bamhori Kalan (Ghuwara) after flowing 130 Kilometers in Chhatarpur district, it crosses the border of Chhatarpur district from village Sarsed (Harpalpur) and flows into Uttar Pradesh. It is an important tributary of River Betwa but a second order tributary of River Yamuna. Dhasan form a part of the Yamuna Sub basin contributing a total basin area of approximately 142250 KM² and out of the area of 8291 KM² in Madhya Pradesh.

The Dhasan is a lesser-known river in Central India, which forms an important part of the river system of Madhya Pradesh. The Dhasan River is the major river of the Bundelkhand region of central India and flow through two states, Madhya Pradesh and Uttar Pradesh. In ancient times, this river was known by the name Dasharna. In ancient text, like most other river in India, Dhasan too has a holy status and is worshipped by the nearby villagers.

Material and Methods

For analysis of Physico-chemical parameters, samples were collected from four Litoral and Four Limnetic selected sampling stations once in a first week of every month from February 2024 to January 2025, in early hours of the day. Samples were collected in mid of stream at a depth of 0.5 m. to 1 m. and in direction of flow. The months were divided into different seasons such as Summer (February, March April and May), Rainy (June, July, August and September) and Winter (October, November, December and January). The analysis of temperature, pH, TDS and Dissolved oxygen was done on the field, The samples of water were collected in properly washed bottles of one-liter capacity. Sampling was done with all the precautions to avoid any changes in Physico-chemical characteristics of water and transported to laboratory in the same day.

Result and Discussion

The mean variations of Physico-chemical

characteristics of water in four Limnetic and four Litoral sites of Dhasan River at different seasons Summer, Rainy, and Winter for a period of one years were Presented in Table 1, 2 and 3. The water samples were analyzed for certain parameters like Water Temperature (W.T.), Hydrogen Ion Concentration (pH), Conductivity, Turbidity, Total Dissolved Solids (T.D.S.), Total Hardness (T.H.), Total Alkalinity (T.A.), Chloride, Sulphate, Phosphate, Nitrate, Dissolved Oxygen (D.O.), Biochemical Oxygen Demand (B.O.D.) and Chemical Oxygen Demand (C.O.D). Samples for Physico-chemical parameters were analyzed according to as per methods of W.H.O. (1984), B.I.S (2003). I.C.M.R. (1982) & A.P.H.A. (2005), Trivedi and Goel (1986), and Adoni (1985). The standard prices for drinking water are presented in Table 4. The graphical representation of the data is shown in Diagram No. 1 to 14. The present research works identify Physico-chemical characteristics of water of River Dhasan in Chhatarpur District. The results of water quality of River Dhasan in Chhatarpur District are given below.

Water Temperature (W.T.)

It is considered important abiotic environmental factors, as a degree and annual variation in temperature has widespread impact on water bodies its productivity. The water temperature of Dhasan River during the study period (February 2024 to January 2025) was varied from 18.34°C to 27.99°C at eight sampling stations (sites). The lowest temperature of water was recorded in winter season (18.34°C) and highest water temperature was recorded in Rainy season (27.99°C). Average seasonal data of recorded W.T. has given in Table 1, 2 & 3. It was observed that water temperature is directly affected by atmospheric temperature. The gradual increase of temperature during the summer and subsequently decrease in the monsoon season might be due to the low water, low velocity, atmospheric condition and greater solar radiation in summer and lesser solar radiation, frequent clouds, high humidity, high current velocity, more rainfall and high-water level during the monsoon season (Shastri Yogesh *et al.*, 2001). Seasonal variation in Physico-chemical properties of water was studied in Shivnath river, Durg, (Chhattisgarh) where the average morning temperature in summer was recorded as 31 °C which is approximately the same (Arvind Kumar *et al.*,

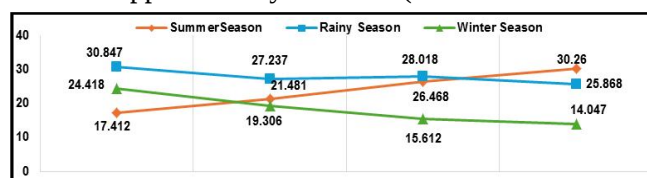


Fig. 1: The relationship between water temperature (°C) in summer, rainy and winter seasons is shown.

2025). The relation between Summer, Rainy and Winter season of Water Temperature is shown in Diagram No. 1.

Hydrogen Ion Concentration (pH)

pH plays an important role in checking water quality assessment because it has a great impact on biological and chemical processes in water bodies. The value of pH below 6.5 causes discontinuation in the making of vitamins in human body. When pH becomes more than 8.5, the taste of water becomes much salty and causes eye irritation and skin disorder (Gupta, A. *et al.*, 2017). The pH of Dhasan River water during the present study was varied from 7.55 to 7.88. The lowest pH value was recorded in Rainy Season while highest pH value was recorded in the Summer Season in all sampling sites. Average seasonal data of recorded pH has given in Table 1, 2 & 3. It was noticed in the present study that the Dhasan River water was alkaline in nature throughout the period of study. Similar trend was reported by (Deepa *et al.*, 2016), (Ajayan and Kumar 2016), (Luharia *et al.*, 2016). The relation between Summer, Rainy and Winter season of pH is shown in Diagram No. 2.

Conductivity

Conductivity itself is not a human or aquatic health concern, but because it is easily measured, it can serve as an indicator of other water quality problems. If the conductivity of a stream suddenly increases, it indicates that there is a source of dissolved ions in the vicinity.

Therefore, conductivity measurements can be used as a quick way to locate potential water quality problems. Higher the value of dissolved solids, greater the number of ions in water (Bhatt, L.R *et al.*, 1999). Increasing levels of conductivity and cations are the products of decomposition and mineralization of organic materials (Abida, B. & Harikrishna 2008). In the present study conductivity was found in range from 446.52 $\mu\text{S/cm}$. to 922.18 $\mu\text{S/cm}$. The recorded average data of Conductivity has given in Table 1, 2 & 3. Lowest conductivity was observed in the Winter Season while highest value of conductivity was noticed in Rainy Season in all sampling stations. Average data of conductivity has given in Table 1, 2 and 3. Seasonal variations showed higher value in pre-monsoon and lower value in monsoon due to dilution

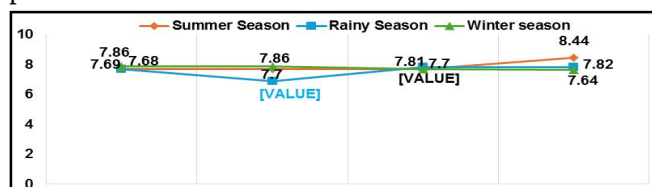


Fig. 2: The relationship between pH in summer, rainy and winter seasons is shown.

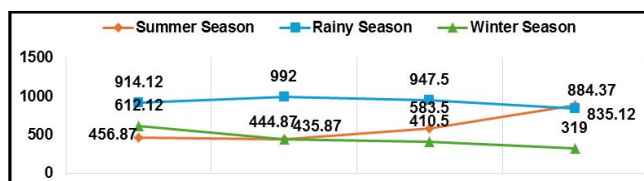


Fig. 3: The relationship between Conductivity ($\mu\text{S/cm}$) in summer, rainy and winter seasons is shown.

with rain water. Conductivity showed significant positive correlation with all the parameters except Dissolved Oxygen, Total Dissolved Solids. The lowering of EC values in Dudhganga River Water quality assessment using water quality index and anthropogenic activities (Vishwajeet Mahadev Lagade *et al.*, 2024). The relation between Summer, Rainy and Winter season of Conductivity is shown in Diagram No. 3.

Turbidity

Turbidity was recorded in range of 26.59 N.T.U. to 139.21 NT.U. among all selected sampling stations on Dhasan River. The recorded average data of Turbidity has given in Table 1, 2 and 3. The minimum transparency was recorded in the Summer Season while the maximum transparency was recorded in the Monsoon Season. These results are in accordance with the findings of Singh *et al.*, (2013), Singh *et al.*, (2020), Imran *et al.*, (2020), Sharma *et al.*, (2021), Abhilash (2022), and Gowrabathina & Sivakumar (2023), who also reported that the pre-monsoon season had the maximum turbidity, whereas the post-monsoon months had the lowest turbidity. This pattern may result from decreased rainfall and water flow in the pre monsoon season, allowing sediments to remain suspended. During the post-monsoon period, increased water volume might reduce turbidity levels by carrying sediments downstream or depositing them in quieter river sections. The relation between Summer, Rainy and Winter season of Turbidity shown in Diagram No. 4.

Total Dissolved Solids (T.D.S.)

Total dissolved solids denote the concentration of mineral constituents dissolved in water. TDS of natural

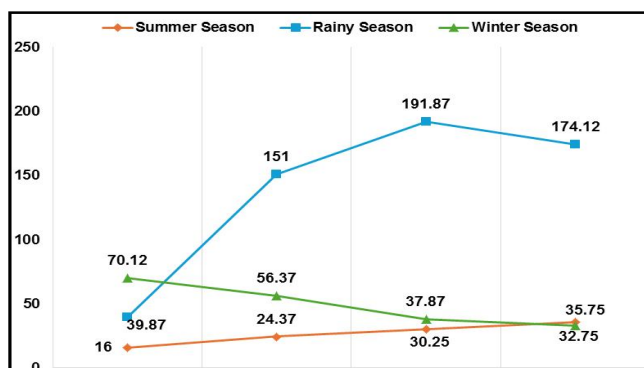


Fig. 4: The relationship between Turbidity (NTU) in summer, rainy and winter seasons is shown.

Table 1: Summer Season.

Parameters	Sampling Sites								Mean
	Lt.1	Lt.2	Lt.3	Lt.4	Lm.1	Lm.2	Lm.3	Lm.4	
W.T. °C	24.20	24.05	23.83	24.2	23.60	23.68	23.65	24.025	23.90
pH	7.97	7.97	7.83	7.94	7.83	7.84	7.82	7.85	7.88
Cond. (µS/cm)	590	594.75	590	590.75	585.28	593.55	585	592	590.15
Turb. (NTU)	28.25	28	27.25	28.25	26.25	26	23.75	25	26.59
T.D.S. (mg/L)	306.7	304.5	303.5	306	305	304	302.5	304.75	304.62
T.H. (mg/L)	117	115.37	112	114.62	113.25	112.12	111	112.87	113.53
T.A. (mg/L)	166	165.25	163.5	166.5	161.75	161.5	162.25	163.25	163.75
Cl (mg/L)	24.71	25.7	24.3	25.37	23.65	24.2	22.15	23.65	24.21
SO ₄ (mg/L)	24.1	24.5	22.75	23.37	22.62	23.45	21.25	22.37	23.05
PO ₄ (mg/L)	0.52	0.57	0.45	0.48	0.50	0.53	0.42	0.46	0.49
NO ₃ (mg/L)	0.67	0.68	0.65	0.67	0.64	0.63	0.62	0.63	0.65
D.O. (mg/L)	8.16	8.13	8.18	8.16	8.21	8.22	8.28	8.24	8.20
B.O.D. (mg/L)	1.68	2.18	1.51	1.55	1.53	1.75	1.39	1.41	1.62
C.O.D. (mg/L)	8.23	8.56	8.18	8.35	8.27	8.35	8.07	8.25	8.28

waters are mainly composed of carbonates, bicarbonates, chlorides, sulphate, phosphates, silicate, calcium and magnesium (EPA 1976). Recorded T.D.S. was varied from 285.05 mg/L to 650.75 mg/L in the present study at all sampling stations. The recorded average data of TDS has given in Table 1, 2 and 3. Minimum T.D.S. In the Winter Season, the maximum T.D.S. situation was observed in the Rainy Season. Recorded value of T.D.S. were satisfactory to good because in most time, it was more than prescribed limit of W.H.O. for drinking water (i.e., 300 to 600 mg/l). It is noticed that the organic matter, silting and agricultural run-off affects total dissolved solids. Dahegaonkar reported high TDS during summer due to receiving of large quantity of domestic and industrial effluents whereas lower TDS during winter might be due to no sedimentation in the rivers Wardha, Erai and Zarpal at Chandrapur (Dahegaonkar, N.R. 2008). The relation between Summer, Rainy and Winter season of TDS shown in Diagram No. 5.

Total Hardness (T.H.)

Hardness of water is due to the presence of certain salts of calcium, magnesium and other heavy metals. In

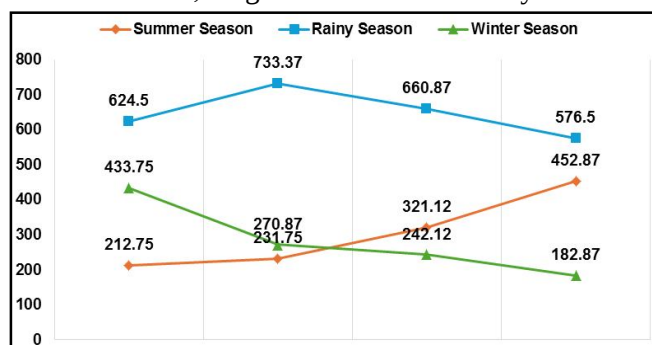


Fig. 5: The relationship between T.D.S. in summer, rainy and winter seasons is shown.

the present study range of Total Hardness as observed between 85.25 mg/L to 113.53 mg/L in all selected sampling station (sites). In the present study, the seasonal average of TH values maximum during in Summer and minimum during Winter Season. The recorded average data of total Hardness has given in Table 1, 2 and 3. Recorded Hardness value was under the prescribed limit of W.H.O. for drinking water (i.e., max. 500 mg/l). A similar finding was reported by Dubey and Ujjania (Dubey M and Ujjania NC. 2013). Higher values of hardness were observed during summer, which may be due to low water level and high rate of decomposition and evaporation, that concentrating the salts. During the present study the total hardness values within the permissible limit. It was found that total hardness is directly affected by alkalinity and pH of river water. The relation between Summer, Rainy and Winter season of TH shown in Diagram No. 6.

Total Alkalinity (T.A.)

Total alkalinity (TA) or acid combined capacity of natural freshwater is generally caused by carbonates and bicarbonates of calcium and magnesium. Alkalinity is often related to hardness because the main source of alkalinity is usually from carbonate rocks, which are mostly CaCO₃ (Manimegalai M. *et al.*, 2010). During the present

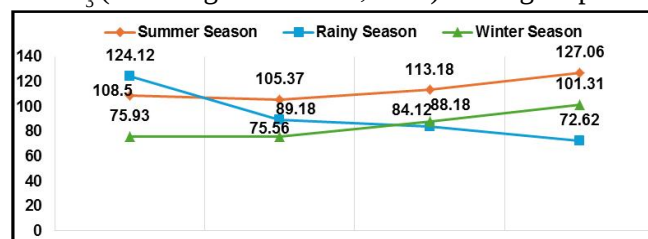


Fig. 6: The relationship between T.H. in summer, rainy and winter seasons is shown.

Table 2: Rainy Season.

Parameters	Sampling Sites								Mean
	Lt.1	Lt.2	Lt.3	Lt.4	Lm.1	Lm.2	Lm.3	Lm.4	
W.T. °C	28.47	27.30	28.42	28.49	27.67	27.80	27.83	27.93	27.99
pH	7.57	7.61	7.53	7.57	7.52	7.53	7.51	7.54	7.55
Cond. (µS/cm)	926	927	927.5	925.25	918.25	918.75	916.5	918.25	922.18
Turb. (NTU)	140.5	138.7	139.5	143.25	138.5	137.5	137	138.75	139.21
T.D.S. (mg/L)	651.7	649.7	650.7	650.75	650.75	650.75	650.7	650.75	650.75
T.H. (mg/L)	94.12	93.75	92.62	93	92.5	91.75	90.75	91.62	92.51
T.A. (mg/L)	142	145	146	144	145.5	146.75	144.7	146.75	145.09
Cl (mg/L)	21.37	23	18.17	19.375	20.275	20.25	17.75	20	20.025
SO ₄ (mg/L)	16	16.75	15.25	15.825	15.425	16.07	14.62	15.37	15.66
PO ₄ (mg/L)	0.85	0.84	0.81	0.84	0.84	0.83	0.80	0.82	0.83
NO ₃ (mg/L)	1.05	1.04	1.02	1.04	1.02	1.02	0.99	1.02	1.02
D.O. (mg/L)	6.78	6.75	6.77	6.79	6.82	6.78	6.86	6.83	6.80
B.O.D. (mg/L)	1.32	1.45	1.24	1.29	1.25	1.37	1.13	1.23	1.28
C.O.D. (mg/L)	6.88	7.07	6.75	6.86	6.76	6.99	6.52	6.70	6.82

study recorded total alkalinity was in the range between 145.05 mg/L to 170.25 mg/L. The recorded average data of total alkalinity has given in Table 1, 2 and 3. The maximum value of T.A. was recorded in the Winter Season while minimum value in the Rainy Season in all sampling stations. Manimegalai *et al.*, reported that apposite findings minimum T.A. value of summer season and Maximum T.A. value recorded of Rainy season in the study on Walayar reservoir, Palghat at Kerala (Manimegalai M. *et al.*, 2010). In the present study, during the study periods, Total alkalinity range is within the safe and acceptable limits for drinking water, particularly as per BSI (i.e., 200 to 600 mg/l). The relation between Summer, Rainy and Winter season of TA shown in Diagram No. 7.

Chloride (Cl)

Chloride is normally the most dominant anion in water, which can cause corrosion and pitting of iron plate or pipes. Chloride occurs in all-natural water in widely varying concentrations. Normal freshwater contains 8.3 mg of chloride per liter (Vijaya Bhaskar C. *et al.*, 2009). Chloride of Dhasan River was recorded in range between 12.875 mg/L to 24.21 mg/L among all sampling stations.

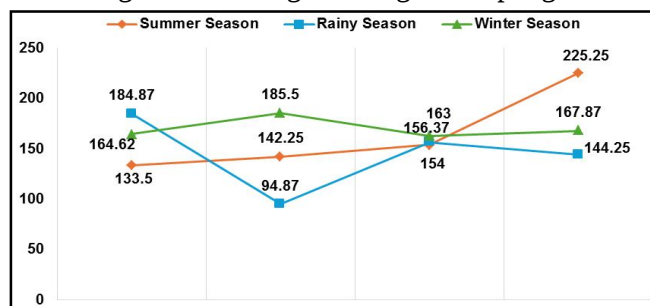


Fig. 7: The relationship between T.A. in summer, rainy and winter seasons is shown.

The recorded average data of Chloride has given in Table 1, 2 and 3. Minimum value of chloride was recorded in the Winter Season while maximum value was recorded in the Summer Season. Noticed chloride concentration was under the limit of W.H.O. for drinking water (i.e., 250 mg/l). Seasonal variation in Physico-chemical and microbiological parameters of Mahanadi River water in and around Hirakud, Orissa. Reported of higher value of chloride in Monsoon season and lowest value reported of Winter season (Kar P.K *et al.*, 2010). The relation between Summer, Rainy and Winter season of Chloride shown in Diagram No. 8.

Sulphate (SO₄)

During the present study sulphate content was observed in the range between 15.66 mg/L to 23.05 mg/L among all sampling stations (sites). Average data of recorded sulphate has given in Table 1, 2 and 3. Minimum concentration was noticed in the Rainy Season while maximum concentration was noticed in the Summer Season. Kulshreshtha, *et al.*, reported maximum sulphate in the monsoon season which believed to be due to rain water bringing in high input of sulphate from surrounding catchment area in Manasarovar reservoir, Bhopal, (MP)

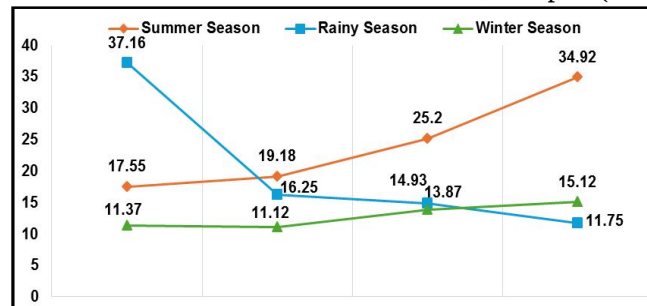


Fig. 8: The relationship between Chloride (mg/L) in summer, rainy and winter seasons is shown.

Table 3: Winter Season.

Parameters	Sampling Sites								Mean
	Lt.1	Lt.2	Lt.3	Lt.4	Lm.1	Lm.2	Lm.3	Lm.4	
W.T. °C	18.47	18.42	18.45	18.36	18.27	18.28	18.30	18.20	18.34
pH	7.80	7.76	7.72	7.80	7.74	7.77	7.76	7.75	7.76
Cond. (µS/cm)	447.5	447.75	446.75	450.5	448	444	443	445.5	446.62
Turb. (NTU)	51.00	49.25	49.00	51.5	49.25	47.75	47.25	49.25	49.28
T.D.S. (mg/L)	287.75	287.75	283.25	286.5	280	285.05	285.05	285.05	285.05
T.H. (mg/L)	87.25	86.87	85.75	86.25	84.37	84.12	83	84.375	85.25
T.A. (mg/L)	171.5	171.5	169.5	171.75	170.75	170.5	167.5	169	170.25
Cl (mg/L)	13.5	13.375	12.75	13.375	12.875	12.625	12	12.5	12.875
SO ₄ (mg/L)	18.62	19.07	17.8	18.28	18.22	18.77	17.52	18.35	18.33
PO ₄ (mg/L)	0.45	0.47	0.42	0.44	0.43	0.45	0.40	0.43	0.44
NO ₃ (mg/L)	0.53	0.51	0.49	0.52	0.50	0.49	0.46	0.49	0.50
D.O. (mg/L)	8.285	8.255	8.315	8.3025	8.325	8.3025	8.35	8.315	8.30
B.O.D. (mg/L)	1.02	1.07	0.95	0.98	0.96	1.01	0.88	0.96	0.98
C.O.D. (mg/L)	7.26	7.36	7.12	7.26	7.187	7.27	7.025	7.18	7.21

(Kulshreshtha, S.K *et al.*, 1992). A.W. Chavan, Reported the concentration of sulphate was minimum 5.34 mg/L at site A during winter whereas maximum 13.95 mg/L at site C during monsoon (A.W. Chavan *et al.*, 2006). The relation between Summer, Rainy and Winter season of Sulphate shown in Diagram No. 9.

Phosphate (PO₄)

Most of containing detergent and washing powder Phosphates, which are used to soften water other things that affect overall health Life in water (Ammons D. 1996). In the present study Phosphate value was recorded in between 0.44 mg/L to 0.83 mg/L. Average data of recorded Phosphate has given in Table 1, 2 and 3. Minimum phosphate value was recorded in the Winter Season while maximum phosphate value was recorded in the Rainy Season in all sampling sites. Higher concentration of phosphate in rainy season is due to storm and run-off from cultivated crop lands. Phosphate exhibited its inverse relation with the growth rate of planktonic organisms indicating its consumption to some extent and the results are in harmony with findings of Chowdhury and Mazumder (Chowdhury S.H., and Mazumder A. 2007). The relation between Summer,

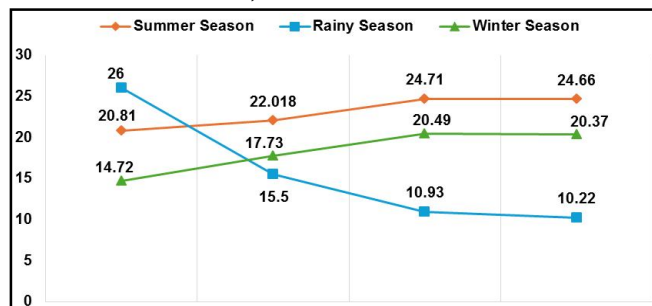


Fig. 9: The relationship between Sulphate (mg/L) in summer, rainy and winter seasons is shown.

Rainy and Winter season of Phosphate shown in Diagram No. 10.

Nitrate (NO₃)

Biological oxidation of organic nitrogenous substances presents in the domestic and industrial sewage and nitrifying bacteria add nitrates to water body. Nitrate is basically non-toxic but when ingested with food and water, it is reduced by bacterial action to nitrate and then to ammonia, which are toxic (Pejaver, and Gurav M. 2008). The nitrate of river Dhasan during the study period was varied from 0.50 mg/L to 1.02 mg/L in different sampling stations. Average Seasonal data of recorded Nitrate has given in Table 1, 2 and 3. Minimum nitrate value was recorded in the Winter Season while maximum nitrate value was recorded in the Rainy Season. Inverse reports were given by Arvind Kumar and Singh in the arid mangroves of Kachchh- Gujarat (Arvind Kumar and Singh, A.K. 2002). While nitrate itself is not typically harmful to humans at low levels, high concentrations of nitrate in drinking water can pose eutrophication, changes in aquatic plants and animals, and health risks, particularly to infants and pregnant women (Jorgensen S, and Sorenson B.H.

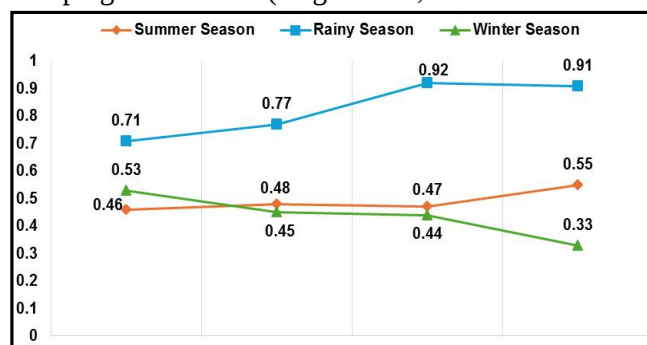


Fig. 10: The relationship between Phosphate (mg/L) in summer, rainy and winter seasons is shown.

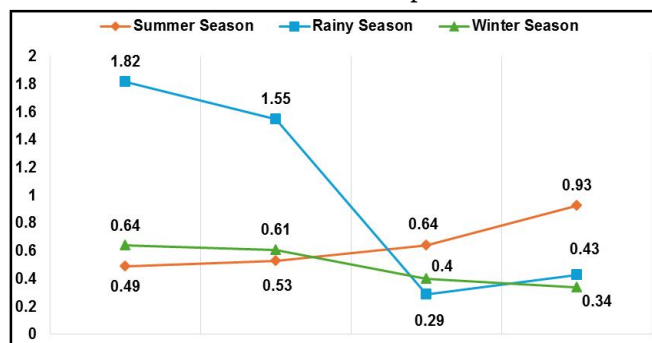
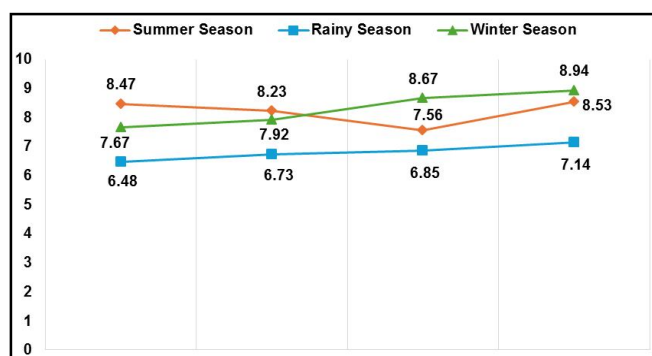
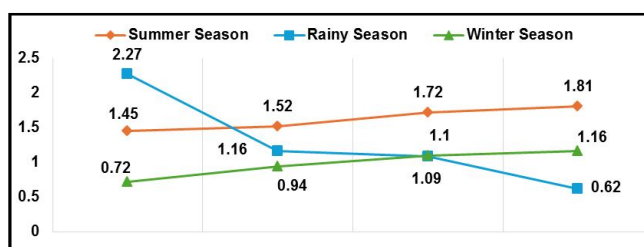
Table 4: Drinking water quality standards (Max. Permissible Limit).

S.	Parameters	W.H.O.	B.I.S.	I.C.M.R.
1.	Water Temp. (°C)	-	-	-
2.	pH	6.5-8.5	6.5-8.5	7.0-8.5
3.	Conductivity (µS/cm)	300	-	-
4.	Turbidity (NTU)	5.0	5.0-10	5
5.	T.D.S. (mg/L)	250-600	500-2000	500
6.	T.H. (mg/L)	500	300-600	300
7.	T.A. (mg/L)	200-600	200-600	-
8.	Chloride (mg/L)	250-1000	250-1000	200
9.	Sulphate (mg/L)	250	200-400	200
10.	Phosphate (mg/L)	0.5	-	-
11.	Nitrate (mg/L)	50	45	20
12.	D.O. (mg/L)	2-6	-	-
13.	B.O.D. (mg/L)	3	-	-
14.	C.O.D. (mg/L)	10	-	-

2014). The relation between Summer, Rainy and Winter season of Nitrate shown in Diagram No. 11.

Dissolved Oxygen (D.O.)

In the present study range of Dissolved Oxygen in the Dhasan River water was recorded in between 6.80 mg/L to 8.30 mg/L in all sites. Average Seasonal data of recorded DO has given in Table 1, 2 and 3. Higher DO values were observed in the winter season and lower in the Rainy season at all the sites. Winter maxima might be due to the clear zone, fall in temperature, increased in

**Fig. 11:** The relationship between Nitrate (mg/L) in summer, rainy and winter seasons is shown.**Fig. 12:** The relationship between Dissolved Oxygen (mg/L) in summer, rainy and winter seasons is shown.**Fig. 13:** The relationship between Biochemical Oxygen Demand (B.O.D.) (mg/L) in summer, rainy and winter seasons is shown.

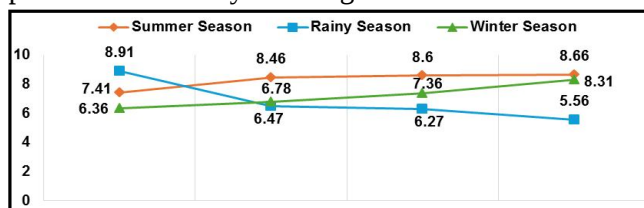
the solubility of oxygen, slightly more photosynthetic activities and high aeration rate whereas monsoon minima might be due to the increased organic matter from surface and agricultural runoff. Arvind Kumar And Singh recorded high DO values in the winter might be due to solubility of dissolved oxygen increased with reduction in the water temperature (Arvind Kumar and Singh, A.K. 2002). The relation between Summer, Rainy and Winter season of DO show in Diagram No. 12.

Biochemical Oxygen Demand (B.O.D.)

Biochemical oxygen demand is an important parameter that indicates water pollution by oxidisable organic matter. The main sources of organic pollution are untreated domestic sewage, agricultural runoff and certain industrial effluents. In the present investigation the value of observed Biochemical Oxygen Demand was varied from 0.98 mg/L to 1.62 mg/L in all sampling sites. Minimum B.O.D. was observed in the Winter Season and maximum B.O.D. of Dhasan river water was observed in the Summer Season. Recorded BOD range were satisfactory to good, it was less than the prescribed limit of W.H.O. for drinking water (i.e., 3 mg/L). Kataria *et al.*, and Shivanikar *et al.*, recorded maximum BOD in the monsoon and maximum in the summer in the Halali river, Bhopal and Godavari River, Nanded respectively (Kataria, H.C *et al.*, 1997 and Shivanikar, S.V. *et al.*, 1998). The relation between Summer, Rainy and Winter season of BOD show in Diagram No. 13.

Chemical Oxygen Demand (C.O.D.)

Chemical oxygen demand may be defined as: the amount of oxygen required to oxidize organic matter present in water by a strong chemical oxidant. In the

**Fig. 14:** The relationship between Chemical Oxygen Demand (C.O.D.) (mg/L) in summer, rainy and winter seasons is shown.

present analysis the noticed Chemical Oxygen Demand values were in range between 6.82 mg/L to 8.28 mg/L among all sampling stations. The minimum value of C.O.D. was observed in the Rainy Season while maximum value was observed in the Winter Season. The present results are in confirmation with the findings of Ololade & Ajayi, Garg *et al.*, Gupta *et al.*, Pal & Maiti, Singh *et al.*, Sharma *et al.*, Basu *et al.*, Abhilash, Nagpurkar *et al.*, and Monira *et al.*, who also reported maximum COD during the pre-monsoon season and minimum COD during the post-monsoon months. The significant seasonal increase in COD during the pre-monsoon period may be due to the higher organic matter concentration, reduced river flow, higher temperatures, and stagnation of water, which may contribute to elevated COD values. Conversely, the intense flow of water during the monsoon and post-monsoon periods might be able to remove accumulated pollutants, including both organic and inorganic substances, resulting in lower COD levels in the post-monsoon period (Ololade, I. A., & Ajayi, A. O. 2009, Garg, R. K. and Rao, R. *et al.*, 2010, Gupta, K., and Verma, S. C. *et al.*, 2014, Pal, D., & Maiti, S. K. 2018, Singh, G., Patel, N. *et al.*, 2020, Sharma, R. and Kumar, A. *et al.*, 2021, Basu, S. and Bhattacharyya, S. *et al.*, 2021, Abhilash, H.R. 2022, Nagpurkar, L.P. *et al.*, 2023, and Monira, U. *et al.*, 2024). The relation between Summer, Rainy and Winter season of COD show in Diagram No. 14.

Conclusion

In this study, analysed the Seasonal Variation of Physico-chemical properties of Dhasan River water of District Chhatarpur can be varied in the Summer, Rainy and Winter Season periods from the selected sampling locations. Samples were collected determined the following parameters Water Temperature, pH, Conductivity, Turbidity, TDS, Total Hardness, Total Alkalinity, Chloride, Sulphate, Phosphate, Nitrate, Dissolve Oxygen B.O.D. and C.O.D. The average values observed across all seasons on all 14 parameters are as follows, W.T. 18.34°C to 27.99°C, pH 7.55 to 7.88, Conductivity 446.52 µS/cm. to 922.18 µS/cm., Turbidity 26.59 N.T.U. to 139.21 NT.U., TDS 285.05 mg/l to 650.75 mg/l, T.H. 85.25 mg/l to 113.53 mg/l, T.A. 145.09 mg/l to 170.25 mg/l, Chloride 12.875 mg/l to 24.21 mg/l, Sulphate 15.66 mg/l to 23.05 mg/l, Phosphate 0.44 mg/l to 0.83 mg/l, Nitrate 0.50 mg/l to 1.02 mg/l, DO 6.80 mg/l to 8.30 mg/l, BOD 0.98 mg/l to 1.62 mg/l and COD 6.82 mg/l to 8.28 mg/l. changes in these parameters influence the decreasing quality of fresh water for the entire aquatic living biota as well as human usage. These changes occur due to high population, urban development and improper waste disposal of toxic

effluents. These activities should be controlled and monitored periodically otherwise it may contaminate the water, which may result in unsuitable for drinking, agricultural and industrial purpose. This study may help us to regulate and screen the fresh water quality according seasonally.

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