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## Seasonal Variations in Physico-Chemical Parameters of Narmada River water at Omkareshwar Dam, Dist.-Khandwa(M.P.),India

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### Abstract :

In present study an attempt has been made to study the physico-chemical water quality parameters of Narmada River which is an ancient water body located in Omkareshwar, a religious place for worshipping lord Shiva. The comparative study was carried out for summer and monsoon season. Different physico-chemical parameters like Water temperature, Turbidity, Electrical conductivity, Total dissolved solids, Total alkalinity, pH, Free CO<sub>2</sub>, Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD) Phosphate, Sulphate and Nitrate were analysed. The results indicate that the Narmada River water in Omkareshwar Dam is not much polluted and is usable for human activities & aquatic organisms survival.

**Key words:** Narmada, Physico-chemical parameters, Water, Omkareshwar Dam, Human activities, Aquatic organism.

### Introduction :

Fresh water is necessary for the survival of all living organisms on Earth. Our bodies are made up of about 60% water and we cannot survive more than a few days without it.

Water is a precious substance that meets our physical needs while at the same time being of great spiritual importance to many people. Water is also an integral part of many ecosystems that support us and a myriad of other species. <https://www.mcgill.ca/waterislife/>

The River Narmada originates in the Amarkantak Plateau of the Maikala range in the district Shahdol of Madhya Pradesh at 1057 meters above mean sea level. The river Narmada transverses a distance of 1,312 km before it merges into the Gulf of Cambay in the Arabian Sea near Bharuch in Gujarat. The first 1,079 km of the Narmada run are in Madhya Pradesh. In the next 35 km, the Narmada forms the boundary between Madhya Pradesh and Maharashtra. Again, in the next length of 39 km, it forms the boundary between

Maharashtra and Gujarat. The last length of 159 km of river Narmada lies in Gujarat. The Narmada River basin encompasses an area of 98,796 sq. Km. The Narmada basin is bounded on all side by various hill ranges. The north by the Vindhyas, on the east by the Maikala range, on the south by the Satpuras and On the west side of Narmada lies the Arabian Sea. Most of the Narmada River basin is less than 500 meters above mean sea level. Only a tiny area around Panchmarhi is at an elevation of more than 1,000 meters above mean sea level. [https://upsccolorfullnotes.com/narmada-river-with-map/#Narmada\\_river](https://upsccolorfullnotes.com/narmada-river-with-map/#Narmada_river)



Source: <https://www.ias4sure.com/wikiias/prelims/narmada-river/>

Present study is aimed on comparative analysis of physicochemical parameters of water in Narmada River in summer & pre monsoon season at Omkareshwar Dam (Dist-Khandwa).

Omkareshwar Dam is situated in district Khandwa near religious worship place Omkareshwar. The main Dam and River bed Power House of 520 MW has been completed. <http://www.nvda.mp.gov.in/omkareshwar-project-0> Dam construction may be cause of water pollution. When a season changes mean summer season changes into pre monsoon, physicochemical parameters get changed in water and disturbs the quality of water. Some fluctuations are always found due to rain.

The main objective of the physico-chemical analysis of water is to determine the status of different chemical constituents, which are present in the natural and disturbed aquatic ecosystem. The quality of water may be affected in various ways due to pollution. The pollution manifests itself either by altering the existing elements in the water or by generating new substances. Hence, an attempt was made to analyse the physico-chemical parameters of Narmada River water at Omkareshwar dam at different seasons.

Present study compares the Physico-chemical parameters of water in summer & pre monsoon season and to check changes are found due to season variation. Many researchers have done work on these parameters in India and many studies have done on River Narmada.

### **Materials and methods:**

#### **Study area:**

The area selected for present investigation is Omkareshwar dam which is constructed near Omkareshwar temple. Six Sites around Omkareshwar dam have been selected for present investigation. Investigation were made in two seasons i.e., Summer & Pre monsoon.

#### **Samples collection & Analysis:**

Present comparative investigation was carried out to study the physico-chemical parameters of Narmada River water for two seasons summer (April-May) & Pre monsoon (June-July). The sampling stations were selected

on the basis of nature and degree of pollution load being added to the river. The analysis was carried out as per APHA 2017 method.

### **1.MPT Sailani Island Resort ( S1 ):**

It is located in Omkareshwar and is about 80km from Indore.The place is spread over 5-acres of land and is surrounded by the holy Narmada water on three sides.

### **2.Omkareshwar dam (Upstream) (S2):**

It is a gravity dam on the Narmada River just upstream of Mandhata in Dist: Khandwa(M.P.) India.

### **3.Omkareshwar dam (Downstream)(S3):**

It is a Sangam of Kaveri and Narmada River. An associated hydroelectric power station located at the base of the dam has an installed capacity of 520 MW.

### **4.Brahmapuri Ghat(S4):**

This ghat is used for pilgrimage transportation through boat. Several commercial activities are done around this place.

### **5.Mamleshwar ghat(S5):**

It is situated between Mamleshwar Jyotirlinga and Omkareshwar Jyotirlinga.

### **6.Nagar ghat(S6):**

It is the largest ghat on Narmada River at Omkareshwar.Several commercial and religious activities are done around this ghat too.

Standard methods as depicted in APHA (2017) were followed for collection of water samples and analysis of various physicochemical parameters.For investigation, some parameters were analysed on the field. Flow, Temperature, pH, Electric conductivity, TDS, Free CO<sub>2</sub> & Dissolve oxygen were analysed on every sampling site on the spot. Other water samples were brought to laboratory immediately. The sample had been stored in the thermocol box with cooling bags in order to minimize the changes in the characteristics of river water sample since it may vary from day to day.

Different methods & tools were used for analyzing physicochemical parameters on the field as well as in the laboratory.

Determination of the Physical and Chemical Characteristics in Surface Water. Water temperature was measured using mercury – in – glass thermometer calibrated from 0°C – 100°C (Krisson model-59) (Olomukoro and Dirisu, 2012). The modified floatation method earlier used by Olomukoro and Dirisu (2012). The pH, Electrical conductivity (EC) and Total dissolved solids (TDS) were measured in-situ using the potentiometric method with pH/Conductivity/TDS meter (Hach pH meter sense ion 2 Model). Total suspended solids -1 measured in mgl were determined using the photometric method with HACH UV/VIS Spectrophotometer (model DR/2000) (APHA, 2005). Turbidity was measured in the laboratory in NTU, using a HACH Turbidity meter Model 2100p (APHA, 2005). Dissolved oxygen and Biochemical Oxygen Demand (BOD) was estimated using the Winkler's method (APHA, 2005). Samples for Dissolved Oxygen (DO) were fixed in the field using 1.0 ml each of Winkler's solution A and

B and determined by titration in the laboratory using the Azide modification techniques of the Winkler's method (Ogbeibu and Victor, 1995; APHA, 1998). Chemical oxygen (COD) demand was measured in the laboratory (APHA, 1998). Nitrate was determined following with the Cadmium Reduction method and optical density read at 410nm in a Spectrophotometer (Hach UV/VIS Model DR 2000) (APHA, 2005). Phosphate was determined using the ascorbic acid method and optical density read at 890nm in a Spectrophotometer (Model DR 2000) (APHA, 2005) and Sulphate was determined following the turbidimetric method reading the optical density at 450nm in a Spectrophotometer (DR/2000) (APHA, 2005)

### Results and Discussion:

The analytical results for the river water samples in summer & pre monsoon seasons are shown in Table 1 (a) & Table (b).

### Field Analysis:

Results (Field Analysis) of water samples collected from different sampling stations is depicted in Table-1(a)

S. No.	Parameters	Seasons	S1	S2	S3	S4	S5	S6
1	<b>Flow</b>	Summer	T	T	T	T	T	T
		Pre-Monsoon	T	T	T	T	T	T
2	<b>Water Temp. °C</b>	Summer	30	30	31.4	33.1	32.1	33.7
		Pre-Monsoon	29	29.1	29.3	31	30	30.1
3	<b>TDS (ppm)</b>	Summer	106	106	106	116	93	231
		Pre-Monsoon	198	205	215	220	220	251
4	<b>Conductivity (µS/cm)</b>	Summer	213	213	213	232	186	115
		Pre-Monsoon	295	305	320	328	328	374
5	<b>pH</b>	Summer	7.9	7.91	7.89	8.45	8.29	8.07
		Pre-Monsoon	7.7	7.8	8.1	8.1	8.0	8.0
6	<b>Free CO<sub>2</sub> (mg/l)</b>	Summer	5	4	6	6	6	5
		Pre-Monsoon	7	7	8	7	9	9

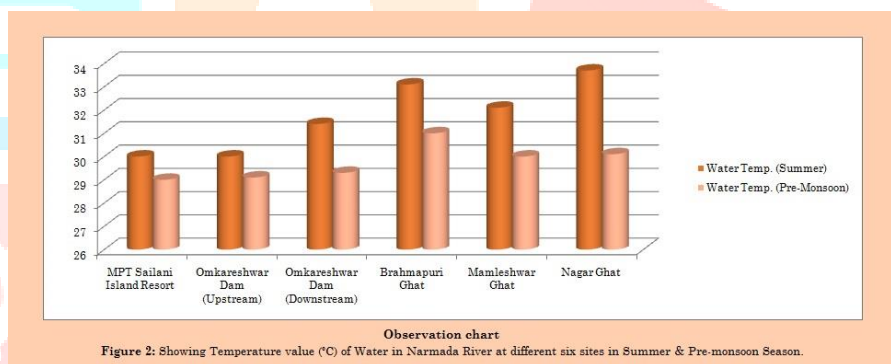
7	Dissolved Oxygen (mg/l)	Summer	8.2	8.1	8.1	8.2	8.2	8.3
		Pre-Monsoon	6.8	6.9	6.9	6.8	6.8	6.8

**Temperature (°C):**

Temperature is an important factor to consider when assessing water quality. In addition to its own effects, temperature influences several other parameters and can alter the physical and chemical properties of water.

(Source:<https://www.fondriest.com/environmental-measurements/parameters/water-quality/dissolved-oxygen/>)

Water temperature fluctuates in different season. The Minimum temperature 30°C was recorded at MPT Sailani Island Resort & maximum temperature 33.7 °C was recorded at Nagar Ghat in summer season. The temperature was found slight low in pre monsoon. The minimum temperature 29°C was recorded at MPT Sailani Island Resort & maximum temperature 31 °C was recorded at Brahmapuri Ghat. M.Gagan. et al ( 2018) also reported the same type of results in their studies on River Ganga.



**Total dissolved solids (mg/l) :**

According to the EPA secondary drinking water regulations, 500 ppm is the recommended maximum amount of TDS for your drinking water. Any measurement higher than 1000 ppm is an unsafe level of TDS. If the level exceeds 2000 ppm, then a filtration system may be unable to properly filter TDS. TDS value of Narmada River at Omkareshwar Dam was ranged from 93 to 216 ppm in summer season & 198 to 251 ppm in pre monsoon season. Minimum range 93 ppm was recorded at Mamleshwar ghat & maximum range 231 ppm was recorded at Nagar ghat in summer season whereas minimum range 198 ppm at & 251 ppm was recorded at Nagar Ghat. Kumari et al. (2013) found TDS value of 136–360 mg/l for Narmada River. Similarly results were reported by Jindal and Sharma (2010), in the TDS range 156–582 mg/l for Potrero de los Funes River. This may be due to sewage discharges and anthropogenic activities along the river banks at these sites (Jindal and Sharma, 2010).

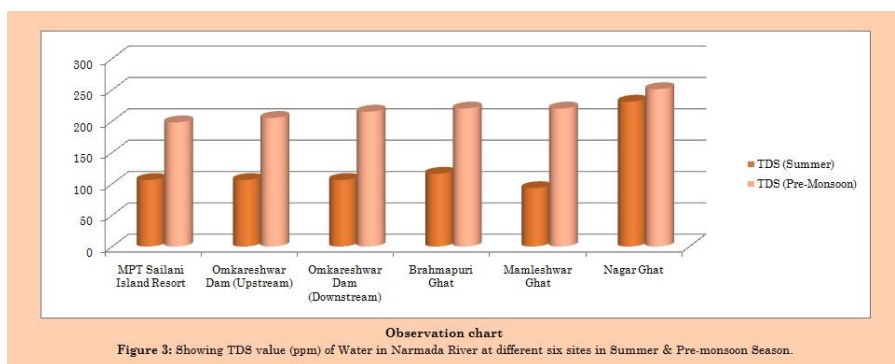


Figure 3: Showing TDS value (ppm) of Water in Narmada River at different six sites in Summer & Pre-monsoon Season.

**Electrical conductivity ( $\mu\text{S}/\text{cm}$ ):**

The electrical conductivity (EC) was maximum ( $374 \mu\text{S}/\text{cm}$ ) in pre monsoon season and minimum ( $115 \mu\text{S}/\text{cm}$ ) in summer season respectively. Both results were found in same sampling station known as Nagar Ghat (S6). The increased values of EC are due to high concentration of ionic constituents present in the water bodies and reflect the pollution by domestic wastes. EC is found to be good indicators of the overall water quality.

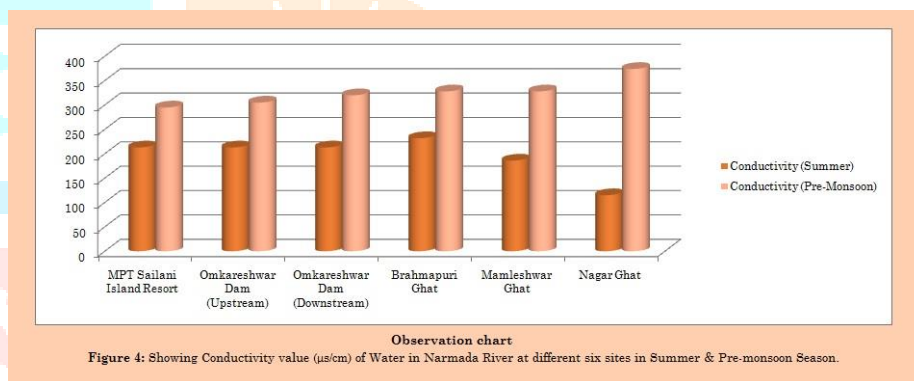


Figure 4: Showing Conductivity value ( $\mu\text{S}/\text{cm}$ ) of Water in Narmada River at different six sites in Summer & Pre-monsoon Season.

**pH:**

pH is a measurement of hydrogen ion concentration in water, which is either alkaline or acidic. (Harney et al 2013; Abir 2014). pH that responsible for the acidic or basic property, is a essential characteristic of any aquatic ecosystem since all the biochemical activities and retention of physico-chemical features of the water are greatly depend on pH of the surrounding water (Jalal and Sanal Kumar, 2013) . The rainwater which has no minerals useful for human body has a pH of 5.5–6 and not harmful on used as drinking purpose. pH in the range 3.5–4.5 affects the aquatic life.(Nidhi Gupta et al.2017).

The maximum pH value was recorded as 8.45 in summer season and minimum of 7.7 in pre monsoon season. The lower pH during pre monsoon is due to increased turbidity. Higher pH value was normally associated with the high photosynthetic activity in water.

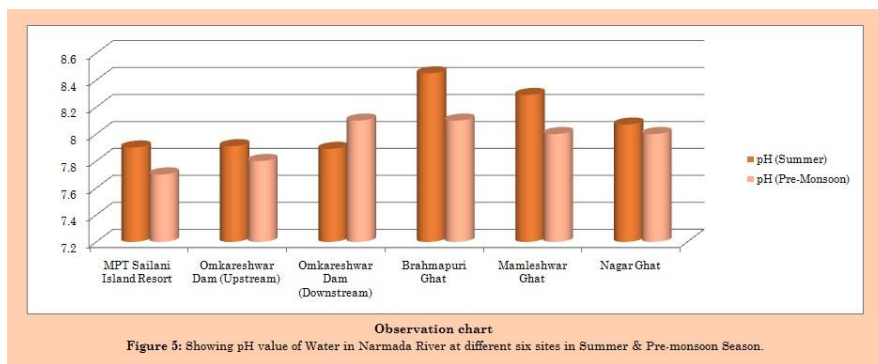


Figure 5: Showing pH value of Water in Narmada River at different six sites in Summer & Pre-monsoon Season.

**Free Carbon dioxide (mg/l):**

Free carbon dioxide is carbon dioxide that exists in the environment. It is present in water in the form of a dissolved gas. Surface water normally contains less than 10 ppm of free carbon dioxide, while some ground waters may exceed that concentration. Free carbon dioxide (CO<sub>2</sub>) in water exists naturally in varying amounts, but a large amount of carbon dioxide in water creates acidic water conditions. When carbon dioxide dissolves in water it yields carbonic acid (H<sub>2</sub>CO<sub>3</sub>).Source: <https://www.corrosionpedia.com/definition/548/free-carbon-dioxide>

The maximum (6 mg/l) free carbon dioxide (FCO<sub>2</sub>) was observed during summer season and minimum (7mg/l) value was observed during pre monsoon season. The increase amount of free carbon dioxide in pre monsoon season is due to the decomposition of organic matter and the respiration of aquatic flora and fauna. This investigation is also in close conformity with the report of Pawan kumar Singh et al.( 2016)

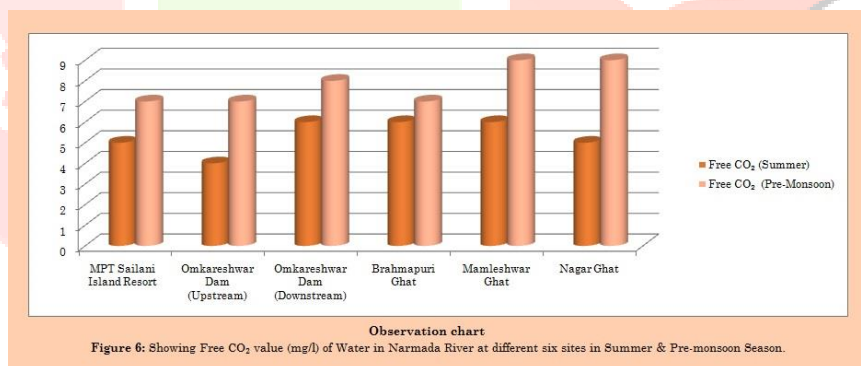


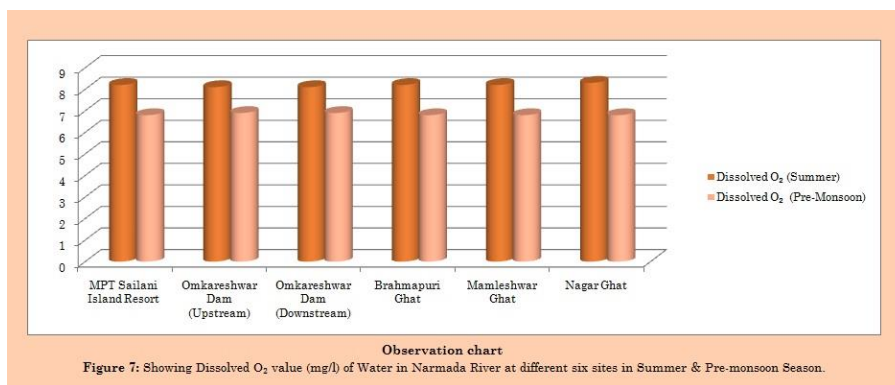
Figure 6: Showing Free CO<sub>2</sub> value (mg/l) of Water in Narmada River at different six sites in Summer & Pre-monsoon Season.

**Dissolved oxygen (mg/l):**

Oxygen levels depend on whether water is flowing or not, whether there are rocks or other obstacles for water to flow over, how many plants are growing in the water, and the temperature of the water. There is more oxygen in cold, flowing water with many obstacles and a moderate amount of plants. Plants take up carbon dioxide and release oxygen, but if there are too many plants all of the oxygen will be used up when bacteria decompose them after they die. [https://www.enr.gov.nt.ca/sites/enr/files/dissolved\\_oxygen.pdf](https://www.enr.gov.nt.ca/sites/enr/files/dissolved_oxygen.pdf)

It is one of the important parameters in water quality assessment. Dissolved oxygen was high (8.3 mg/l) at Nagar Ghat(S6) and low (8.1 mg/l)at Omkareshwar dam upstream (S2) & down stream(S3) in summer season during the study period where as During pre monsoon season it was reduced and was recorded(6.9mg/l)at

Omkareshwar dam upstream (S2)and downstream(S3)and 6.8mg/l at rest all four stations.i.e.S1,S4,S5 & S6. Reduction of DO may be due to increase values ofphytoplankton or decrease of photosynthetic activity as mentioned in above statement.



**Laboratory Analysis:**

Results of water samples collected from different sampling stations is depicted in Table-1(b)

S. No.	Parameters	Seasons	S1	S2	S3	S4	S5	S6
1	<b>Odor</b>	Summer	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
		Pre-Monsoon	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
2	<b>Color (Hz)</b>	Summer	1.5	2	1	1.5	0.5	2
		Pre-Monsoon	2.0	2.1	2.1	2.2	2.3	2.3
3	<b>Taste</b>	Summer	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
		Pre-Monsoon	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	<b>Turbidity (NTU)</b>	Summer	1.6	1.7	1.2	1.5	1.5	1
		Pre-Monsoon	1.2	1.3	1.2	1.2	1.2	1.2
5	<b>Alkalinity (mg/l)</b>	Summer	5	3	4	3	6	3
		Pre-Monsoon	10	11	11	11	11	11
6	<b>BOD (mg/l)</b>	Summer	18	16.2	15.6	17.4	17.4	17.4
		Pre-Monsoon	18	18	18	17.4	16.8	16.2



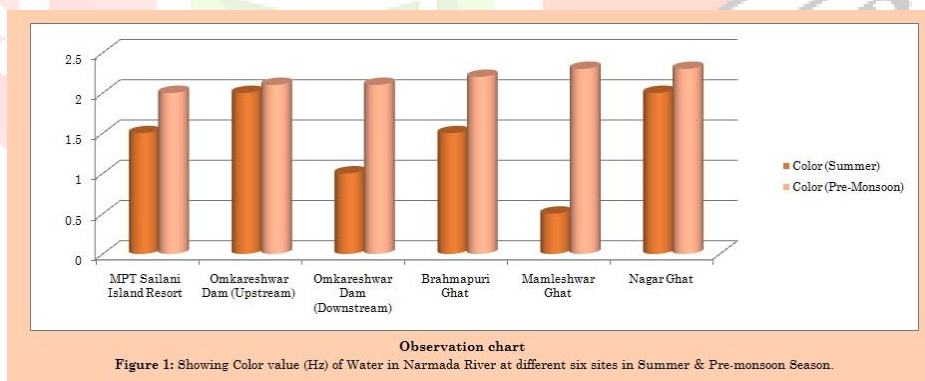
7	<b>COD (mg/l)</b>	Summer	131.5	136.8	135.6	141.8	138.9	142.6
		Pre-Monsoon	135.6	135.8	140.1	142.5	142.5	143.2
8	<b>PO<sub>4</sub><sup>3-</sup> (mg/l)</b>	Summer	6.4	6.5	6.8	6.7	6.7	6.7
		Pre-Monsoon	6.8	6.8	6.9	6.9	6.9	6.9
9	<b>SO<sub>4</sub><sup>2-</sup> (mg/l)</b>	Summer	117	42	41	123	24.69	12
		Pre-Monsoon	120	121	120	120	120	120
10	<b>NO<sub>3</sub><sup>-</sup> (mg/l)</b>	Summer	14	15	13	13	14	15
		Pre-Monsoon	15	16	16	15	15	16

**Odor:**

Odor of water at all the stations was agreeable in both the seasons i.e. Summer & pre monsoon.

**Color (Hz):**

Maximum color value 2Hz was recorded at S2 & S6 and minimum color value 0.5Hz was recorded at S5 in summer season where as maximum color value 2.3Hz was recorded at S5 & S6 and minimum color value 2 Hz was found at S1 in pre monsoon season.



**Taste:**

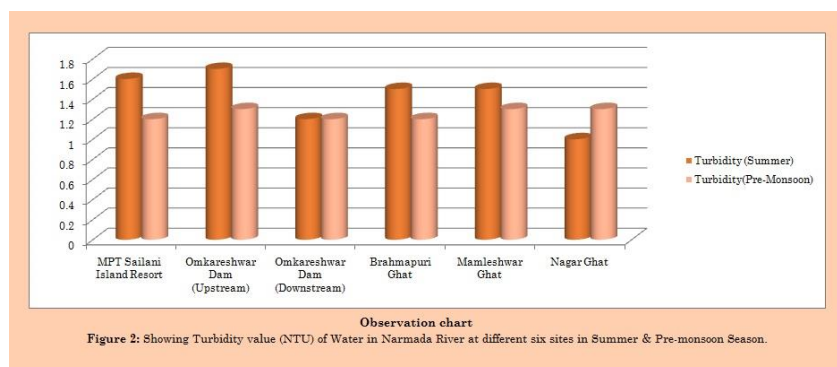
The taste of water was agreeable at all the stations in summer & pre monsoon season.

**Turbidity (NTU):**

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, it seems and the higher the turbidity. It is considered as a good measure of the quality of water. The WHO (World Health Organization) establishes that the turbidity of drinking water shouldn't be more than 5 NTU, and should ideally be below 1 NTU.

Source: <https://www.lenntech.com/turbidity.htm#What%20is%20turbidity?#ixzz7a91FXYyF>

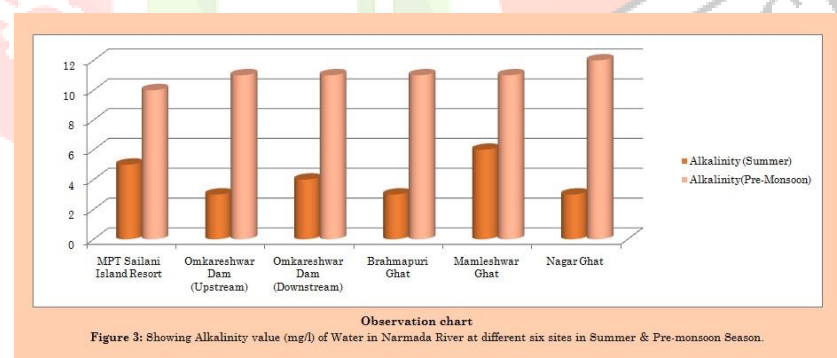
The maximum value 1.7NTU was recorded at S2 & minimum value 1 NTU was recorded during the summer season where as the maximum value 1.3 NTU was recorded at S2 & 1.2 NTU was recorded rest all stations.i.e.S1,S3,S4,S5&S6.Turbidity findings have been reported in the others river in monsoon season (Narayan and Chauhan, 2000; Almeida et al., 2012).



**Total Alkalinity (mg/l):**

Alkalinity is a measure of the acid-neutralising capacity of water & is usually determined by titration against sulphuric acid to the end point of the acid-base reaction.Source:Environmental Geochemistry,2008

Maximum alkalinity 6mg/l was recorded at Mamleshwar Ghat (S5)& minimum alkalinity 3mg/l was recorded at three stations.i.e.S2,S4 & S6 in summer season whereas Maximum alkalinity 11mg/l at five stations S2,S3,S4,S5,S6 &minimum alkalinity 10mg/l at S1 in pre monsoon season.Results are showing low alkalinity of water in both the season summer & pre monsoon which shows water is more likely to be corrosive.<https://www3.uwsp.edu/cnr-ap/weal/documents/hopininterp.pdf>



**Biological oxygen demand(BOD)(mg/l):**

The standard given by CPCB and BIS for BOD is 2–3 mg/ l for class A, B, C respectively. BOD is used for determination of requirement of oxygen for stabilizing household and industrial wastes (De, 2003). The effluents disposed by domestic and industries into the surface and ground water contaminate the quality of the water which can be assessed by BOD determination (Sawyer et al., 1994). During my study maximum value 18mg/l was recorded at S1 & minimum BOD 15.6mg/l was recorded at S3 in summer season whereas it was found same maximum readings 18mg/l at S1,S2,S3 & minimum BOD 16.2mg/l was recorded at S6 in pre

monsoon season. The readings were high than normal range in both the season. According to WHO drinking water standard, BOD should not exceed 6 mg/l (De, 2003). This level of BOD is also harmful to aquatic fauna too. Higher values of BOD indicate higher consumption of oxygen and a higher pollution load. (Singh P.K. et al., 2016).

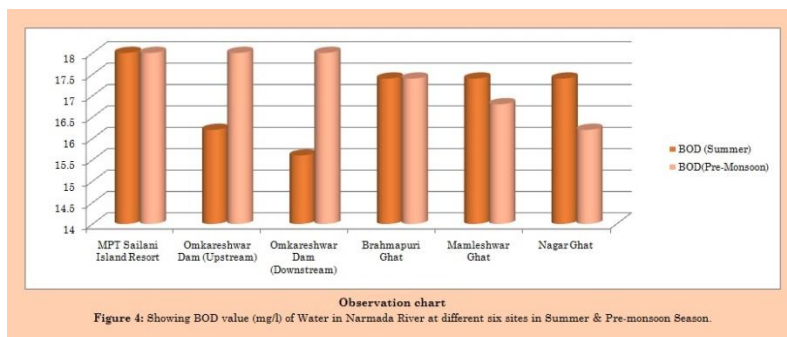


Figure 4: Showing BOD value (mg/l) of Water in Narmada River at different six sites in Summer & Pre-monsoon Season.

**Chemical oxygen demand(COD) (mg/l):**

Chemical oxygen demand (COD) is a measure of oxygen required for complete oxidation of organic matter by a strong oxidant. Conjunction with BOD, COD is useful in indicating toxic conditions and the presence of biologically resistant organic substances; the COD test is the only means available to determine oxidation requirements when biologically toxic substances are present, as in industrial wastewaters.

(Source: <https://onlinelibrary.wiley.com/doi/pdf/10.1002/9780470925386.app4>)

The maximum COD value 142.6 mg/l was recorded at S6 & the minimum COD value 135.6mg/l was recorded at S1 in summer season whereas the maximum COD value 143.2mg/l was recorded at S6 & minimum COD value 135.6mg/l was recorded at S1 in pre monsoon season.

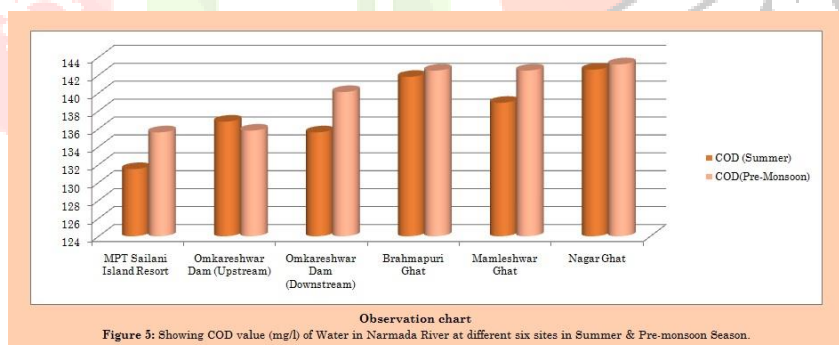
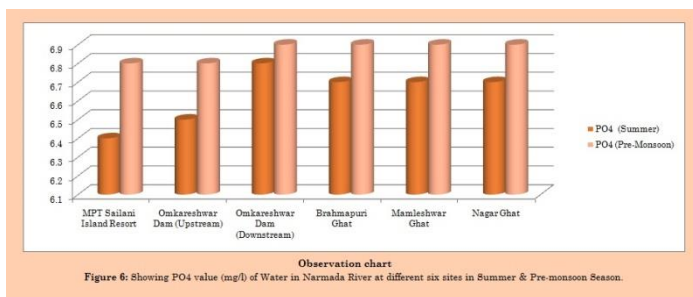


Figure 5: Showing COD value (mg/l) of Water in Narmada River at different six sites in Summer & Pre-monsoon Season.

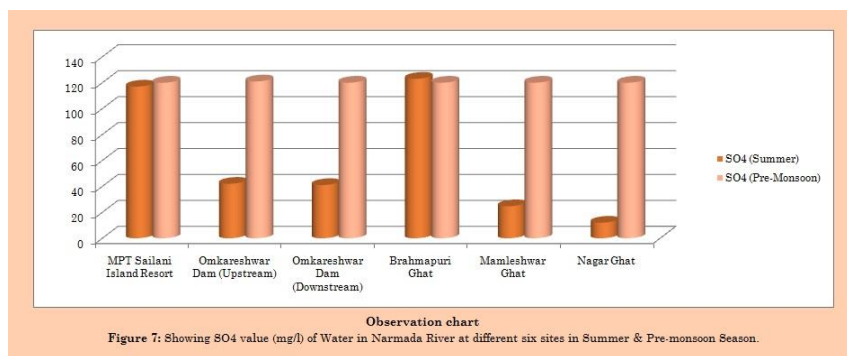
**Phosphate (PO4<sup>-3</sup>)(mg/l):**

Phosphorus in the form of phosphate (PO4<sup>-3</sup>) is an essential plant nutrient and is a major component of most fertilizers. The maximum phosphate content 6.8mg/l was recorded at S3 and minimum 6.5mg/l at S1 in summer season whereas the maximum phosphate content was recorded at S3, S4, S5 & S6 which was 6.9mg/l & the minimum phosphate content was found 6.8mg/l at S1 & S2 in pre monsoon season.



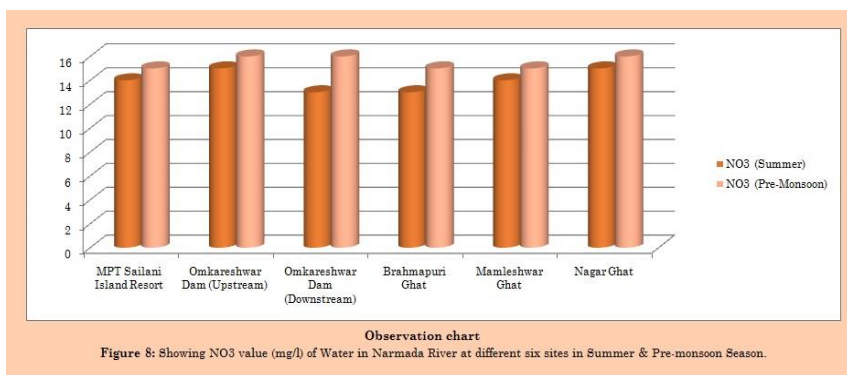
**Sulphate (SO<sub>4</sub><sup>2-</sup>)(mg/l):**

The natural concentrations of SO<sub>4</sub><sup>2-</sup> in aquatic systems show significant variability depending on the prevailing catchment geology and hydrology(Kleeberg, 2012).The maximum sulphate range 123mg/l was recorded at S4& minimum range 12mg/l was recorded at S6 in summer season. It was observed that much fluctuation was found in each & every station because of mixing of cewage flow in Narmada River.The maximum sulphate range 121mg/l was at S2 & 120mg/l was found at remaining stations



**Nitrate(NO<sub>3</sub><sup>-</sup>)(mg/l):**

Nitrate (NO<sub>3</sub><sup>-</sup>) is a compound of nitrogen and oxygen found in nature and in many food items in our diet. Generally, the concentration of nitrates in the ground water is low. Maximum nitrate range 15mg/l was found in S2 & S6 & minimum nitrate range 13mg/l was found in S3 & S4 in summer season where as maximum range 16mg/l was recorded at S2,S3 & S6 and minimum range 15mg/l was same at S1,S4 & S5.



**Observation:**

**Designated Best Use Criteria for Surface Waters (Source: CPCB)**

S.No.	Parameter	CPCB Standard	Observed value	Observed value	Mean	Mean
			Summer Season	Pre monsoon Season	Summer Season	Pre monsoon Season
1	pH	Class A 6.5-8.5 Class B 6.5-8.5 Class C 6.0-9.0 Class D 6.5-8.5 Class E 6.0-8.5	7.89-8.45	7.7-8.1	8.08	7.95
2	BOD	Class A 2mg/l or less Class B 3mg/l or less Class C 4 mg/l or less	15.6 -18	16.2-18	17	17.4
3	DO	Class A 6 mg/l or more Class B 5 mg/l or more Class C 4 mg/l or more Class D 4mg/l or more	8.1- 8.3	6.8-6.9	8.18	6.83

**Discussion:**

**pH:**

Class of Criteria	Range Value in Summer & pre monsoon season	Present Status in different stations in summer & pre monsoon season	Inference
A	6.5-8.5	All stations	Fairly good pH observed in water of all stations in both these seasons i.e. Summer & Pre monsoon

**Dissolved Oxygen:**

Class of Criteria	Range Value in Summer & pre monsoon season	Present Status in different stations in summer & pre monsoon season	Inference
A	6 mg/l or more	All stations	Fairly good DO observed in water of all stations in both the seasons i.e. Summer & Pre monsoon

**BOD:**

Class of Criteria	Range Value	Present Status in different stations in Summer Season	Present Status in different stations in Pre monsoon Season	Inference
No Criteria	Not in Range	18 mg/l 16.2 mg/l 15.6 mg/l 17.4 mg/l 17.4 mg/l 17.4 mg/l	18 mg/l 18mg/l 18mg/l 17.4mg/l 16.8mg/l 16.2mg/l	BOD is observed high than range value in water of all stations in both the seasons i.e. summer & Pre monsoon

**Conclusion:**

Based on the analysis of various indicative parameters (pH & Dissolved Oxygen) all sampling stations can be categorized under class A, i.e. Drinking water source without conventional treatment but after disinfection as per the Designated Best Use Criteria for Surface Waters (Source: CPCB) in summer & pre monsoon both the seasons while BOD is high than range value but was not harmful for survival of human being as well as aquatic life. So we can conclude that water of River Narmada at Omkareshwar dam is suitable for various activities like drinking, irrigation and all other useful purposes.

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