

**ASSESSMENT OF WATER QUALITY INDEX AND TROPHIC STATE INDEX OF RIVER MANDAKINI, INDIA.**

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**ABSTRACT:** The detailed survey of river revealed that small areas as well as large areas which fall in the way of river, dump domestic and toxic wastes in the river. Water contamination due to pathogenic agents, chemicals, heavy metals, pesticides water disinfectants and there by product as a consequence of industrial and agricultural activities leaching from soil, rocks, and atmospheric deposition and other human activities has become a hazard to human health in several regions of world. Physicochemical parameter of any water body plays a very important role in maintaining the fragile ecosystem that maintains various life forms. Water quality index is one of the most effective tools to communicate information on the quality of any water body. The value of W.Q.I. varied 31 to 42. So the water quality of all stations is bad for drinking and human consumption without purification. The results of the study showed that the river water at Ramghat & Karwi ghat is highly polluted with reference to WQI. Higher values of WQI clearly show that the status of river is not safe for human drinking & bathing purpose and Carlson's Trophic State Index categorized Mandakini River in between oligotrophic and mesotrophic state.

**Key words:** Physico-chemical, Trophic State, TSI, WQI

**INTRODUCTION**

The river Mandakini originates from the hills of Khillora near Pindra village, Majhagawan block (25° 09'24.8" N, 80° 52' 55.3"E), Satna district, M.P. at an elevation of 156 m above mean sea level in the state of Madhya Pradesh of northern India. Whole watershed area is 1956.3 sq. km. The river passes through two states especially between M.P. and U.P. states. Sati Anusuiya is a perennial reach of Mandakini River where a large number of small springs feed the river. Afterwards it passes through various religious and non-religious points. The number of drains carrying wastewater of town joining the river at various points increasing the pollution load of the river and altering its water quality. Water Quality Index (WQI) does not gives the overall picture on the water quality. There is a further need to translate it into a form that can be easily understood and can be effectively interpreted. According to the Indian standard by CPCB, for water quality index calculation, saturation percent of dissolved oxygen, biochemical oxygen demand, fecal coliform, pH, were measured. The water quality index ranges have been defined as excellent, good, medium, bad, and very bad [5]. Trophic state is defined as the total weight of the biomass in a water body at a specific location and time. Trophic state is the biological response for nutrient additions to the water bodies [9]. Carlson's trophic state index mainly uses algal biomass involving three variables namely chlorophyll-a (Chl-a), Secchi disc Transparency (SDT) and total phosphorus (TP). Based on the values of CTSI the river are classified as oligotrophic (low productive), mesotrophic (moderately productive) and eutrophic (highly productive).

Physico-chemical parameter of any water body plays a very important role in maintaining the fragile ecosystem that maintains various life forms. The various pollutants entering into eco-system through drains may be biodegradable and non-biodegradable; these pollutants have also higher BOD and COD level. Keeping the above points in mind, the study of river Mandakini at Chitrakoot has been selected for the study.

**OBJECTIVES OF STUDY**

- To monitor the water quality of river with the help of various physico-chemical parameters.
- To assess the water quality index & trophic state index.

## MATERIAL AND METHOD

On the stretch of river (29.5km) five sampling station were selected. Two sampling station Sati Anusuiya & Arogyadham was in MP part and three sampling stations namely Ramghat, Kawi ghat and Surajkund were in UP part. The water quality was studied for one year for various physicochemical parameters. All the analysis was done as per APHA AWWA WPCF 2005.

The Carlson trophic state index (TSI) of was calculated using the following formulae:

TSI for Chlorophyll-a (CA)  $TSI = 9.81 \ln \text{Chlorophyll-a } (\mu\text{g/l}) + 30.6$

TSI for Secchi depth (SD)  $TSI = 60 - 14.41 \ln \text{Secchi depth (Meters)}$

TSI for Total phosphorus (TP)  $TSI = 14.42 \ln \text{Total phosphorous } (\mu\text{g/l}) + 4.15$

Carlson's trophic state index (CTSI) =  $[TSI (TP) + TSI (CA) + TSI (SD)]/3$

## RESULT AND DISCUSSION

The results of the physico-chemical characteristics of river water are given table 1, water quality index are given table 2 & Fig. 1 and trophic state index are given table 4 & Fig.2.

### Temperature

Water temperature regulates the metabolism of the aquatic ecosystem. The temperature of water which is an ideal for the biological activities of microorganism is 20-25°C. During study, temperature of river range 24.64°C-25.83°C. A minimum temperature was record 24.64 at Satianusuiya. Maximum temperature was record 25.83 °C at Karwi ghat.

### Secchi Depth Transparency (SDT)

Transparency was recorded using a Secchi disk. The readings can be affected by algae and by suspended solids in the water. SDT of river Mandakini at various station values was found 21-48cm. The minimum SDT value was 21cm at Karwi ghat while maximum was 48 cm at Satianusuiya.

### Total Solids (TS)

Total solids of river water was found in the range of 472.46 to 592.63 mg/l. Minimum value of TS 472.46 mg/l was observed at Arogyadham while maximum value of TDS was 592.63 mg/l at Karwi ghat.

### pH

pH range of 6.0 to 9.0 appears to provide protection for the life of fresh water fish and bottom dwelling invertebrates. The pH value of river was recorded between 7.08-8.20. Minimum pH of river water was observed 7.08 of Arogyadham while maximum 8.20 at Karwi ghat.

### Electrical Conductivity (E.C.)

The EC value of river was found in the range of 364.19 to 457.83  $\mu\text{mho/cm}$ . Minimum value of EC was observed 364.19 $\mu\text{mho/cm}$  at Satianusuiya while maximum 457.83 at Karwi ghat. Conductivity is widely used to indicate the total ionized constituents of water. Similar value was found by Chaurasia and Raj Karan [4].

### Dissolved Oxygen (DO)

In river stretch dissolved oxygen (DO) was ranged from 5.87-7.78 mg/l. Minimum value of DO was found 5.87 mg/l at Ramghat and maximum value 7.78 mg/l at Satianusuiya. Low level of DO is again indicative of polluted nature of water body.

### Biochemical Oxygen Demand (BOD)

In river stretch BOD was ranged from 4.12-32.42 mg/l. Minimum value was 4.12 mg/l at Satianusuiya while maximum value was 32.42 mg/l at Ramghat. Increases in BOD can be due to domestic sewage, animal and crop wastes. High concentration of BOD due to heavy sediment, organic matter and domestic sewage are direct discharge in to river Mandakini.

### Chemical Oxygen Demand (COD)

The value of COD of River water was found in the ranged of 12.00-48.00 mg/l. Minimum value was 12.00 mg/l at Satianusuiya while maximum value was 48.00 mg/l at Ramghat. Chemical Oxygen Demand is a measure of the oxidation of reduced chemicals in water. It is commonly used to indirectly measure the amount of organic compounds in water [7].

### Nitrate (NO<sub>3</sub><sup>-</sup>)

The value of Nitrate was recorded in the range of 0.44-0.68mg/l. Minimum value was found 0.44 mg/l at Satianusuiya while maximum value 0.68 at Ramghat [3].

High level of nitrate in drinking water due to excessive use of agriculture fertilizers, decayed vegetable water, domestic effluent, sewage disposal industrial discharges, leachable from refuse dumps, atmospheric and atmospheric precipitation has become a serious problem [8].

#### Phosphate ( $\text{PO}_4$ )

Phosphates are not toxic to people or animals unless they are present in very high levels [6]. Digestive problem could occur from extremely high level of phosphate. The major sources of phosphate are domestic sewage, detergents, agricultural and runoff with fertilizers. The value of phosphate was found in range of 1.24-1.68 mg/l. minimum value was found 1.24 mg/l at Satianusuiya while maximum was found 1.68 mg/l at Surajkund.

#### Chlorophyll-a (Chl-a):

Chlorophyll-a is the pigment that makes plants and algae green. It is measured in river to determine algal concentration. High value of Chl-a indicates that there is a large amount of algae in the river. The Chl-a value was found in range of 1.34-5.16  $\mu\text{g/l}$ . The minimum value was found 1.34 $\mu\text{g/l}$  at Satianusuiya while maximum was 5.16 $\mu\text{g/l}$  at Karwi ghat.

#### Fecal Coliform (F.C.)

The presence of fecal coliform bacteria in aquatic environment indicates that the water has been contaminated with the fecal material of human or other animals. The fecal coliform was found in range of 840-2700 MPN/100 ml. The minimum value was found 840 MPN/ 100 ml. at Satianusuiya while maximum was found 2700 MPN/100 ml. at Ramghat. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water.

#### Water Quality Index (WQI):

The WQI very much depend upon the value of dissolved oxygen in water. Water Quality Index value was found in the range of 31-42. All stations of river Mandakini were in bad condition for purpose of drinking and bathing.

#### Carlson's Trophic State Index (TSI):

CTSI value was found 34.65-41.19. Minimum value was 34.65 at Satianusuiya while maximum value was 41.19 at Ramghat. The value <40 indicates that Satianusuiya and Arogyadham are oligotrophic and value  $\geq 40$  indicates that Ramghat Karwi ghat and Surajkund mesotrophic. The progression of river from oligotrophic to eutrophic state is a gradual process in nature. The conversion from one life stage to another is based on the changes in the degree of nutrient inflow and the productivity in the river [10].

**Table: 1–Average physico-chemical characteristics of river Mandakini at various stations (2013).**

Station	Parameters											
	Temp. °C	Secchi Depth (cm)	pH	TS (mg/l)	E.C. ( $\mu\text{mho/cm}$ )	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Nitrate (mg/l)	Chl-a ( $\text{mg/m}^3$ )	T.Phosphate (mg/l)	FC (MPN/100 ml)
Sati Anusuiya	24.64	48	7.08	472.46	364.19	7.78	4.12	12.00	0.44	1.34	1.24	840
Arogyadham	24.85	36	8.16	558.33	424.23	7.00	8.22	33.53	0.60	2.16	1.32	1180
Ramghat	25.16	23	8.18	582.46	456.34	5.87	32.42	48.00	0.68	5.05	1.54	2700
Karwi ghat	25.83	21	8.20	592.63	457.83	5.89	30.82	39.37	0.62	5.16	1.48	2430
Surajkund	24.82	42	7.60	523.39	398.42	7.53	9.42	23.00	0.55	3.82	1.68	900

**Table: 2. Overall water quality index of river Mandakini.**

Station	Water Quality Index
Sati Anusuiya	42
Arogyadham	36
Ramghat	31
Karwi ghat	31
Surajkund	37

Table: 3. Classification of water based on WQI .

Water Quality Index	Water Quality Status	Name of Station
90-100	Excellent	None
70-90	Good	None
50-70	Medium	None
25-50	Bad	All selected station of river Mandakini
00-25	Very Bad	None

Table: 4. Carlson's Trophic State Index value of River Mandakini 2013

Station	TSI of SDT	TSI of Chl-a	TSI of TP	CTSI
Sati Anusuiya	63.24	33.47	07.25	34.65
Arogyadham	64.50	41.88	08.15	38.18
Ramghat	66.48	46.70	10.38	41.19
Karwi ghat	66.88	46.83	09.80	41.10
Surajkund	63.83	47.75	11.63	41.07

Table: 5. Carlson's Trophic State Index value and trophic condition.

CTSI Value	Trophic Level	Attributes
>30	Oligotrophic	Clear water, oxygen throughout the year in the hypolimnion
30-40	Oligotrophic	A river will still exhibit oligotrophy, but some river will become anoxic during the summer
40-50	Mesotrophic	Water moderately clear, but increasing probability of anoxia during the summer
50-60	Eutrophic	Lower boundary of classical eutrophy: Decreased transparency, warm-water fisheries only
60-70	Eutrophic	Dominance of blue-green algae, algal scum probable, extensive macrophyte problems
70-80	Eutrophic	Heavy algal blooms possible throughout the summer, often hypereutrophic
<80	Eutrophic	Algal scum, summer fish kills, few macrophytes

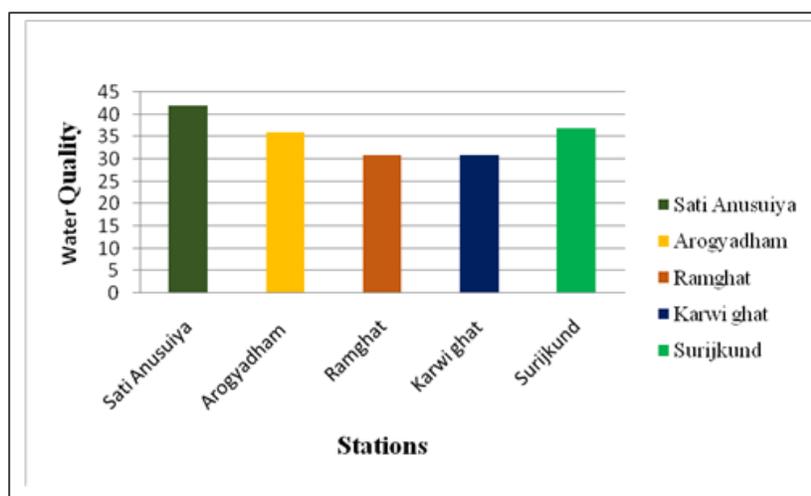
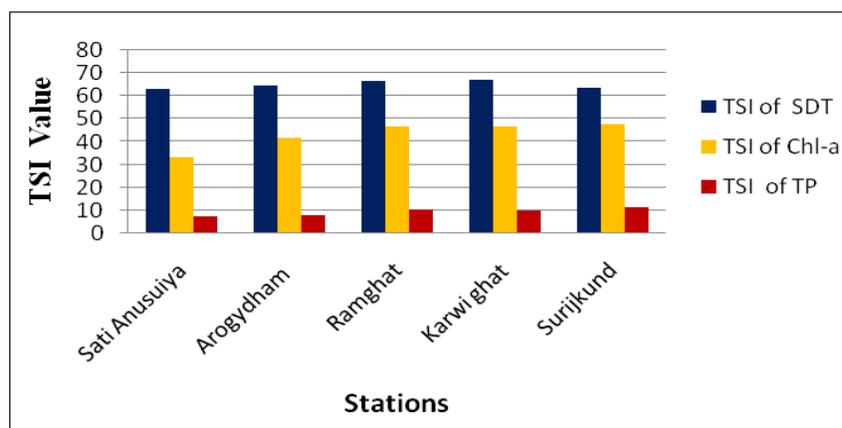


Figure-1: Water quality index at various station of River Mandakini



**Figure-2: Trophic state index at various station of River Mandakini**

## CONCLUSION

From the results it was concluded that the river water was not good. There is a need to develop awareness among people regarding the consequence of river pollution. The river water at Ramghat & Karwi ghat was highly polluted with reference to WQI. Higher values of WQI clearly show that the status of river was not safe for human drinking & bathing purpose. The Carlson's Trophic State Index categorized Mandakini River in between oligotrophic and mesotrophic state. The CTSI value were found <40 at Satianusuiya and Arogydham indicating oligotrophic condition and CTSI value  $\geq 40$  indicates at Ramghat, Karwi ghat and Surajkund indicating mesotrophic condition at respective reach of river. Phosphates and nitrate were founds high at the reach were domestic sewage joining the river. This may create serious problem to river and local people.

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