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# Physio-Chemical Studies in Water: Based on Wainganga River, Before COVID and During COVID

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***Abstract:*** ***The main aim of this study is to check the suitability of the water for domestic and drinking purpose. A systematic study has been carried out to assess the water quality index of Wainganga river, at different locations. In present study, the physico-chemical parameters of the Wainganga river at Chhapara, in Seoni district of Madhya pradesh state studied for the five locations which use for the different purposes like bathing ,farming, pooja, washing, etc. In the present paper, water quality index (WQI) was estimated for the River Wainganga to study the affects of the human activities to the bank of the river and river water. The study was directed toward the use of WQI to describe the level of pollution in the river for the locations. The study also identifies the critical pollutants affecting the river water quality during its course through the village. The indices have been computed for five locations before the time of COVID-19 and the time of during COVID-19 in the river. The objective of WQI is to turn complex quality data into easily understandable and useable by the public. These samples are analyzed physico-chemical parameters like pH, Turbidity(NTU), Total Dissolved Solids (mg/L), Total Alkalinity (mg/L),Total Hardness (mg/L), Calcium Hardness (mg/L), Magnesium Hardness (mg/L), Iron (mg/L),Chloride (mg/L), Fluoride (mg/L), Sulphate (mg/L), were taken to assess the impact of pollutants due to anthropogenic activities .The results are compared with standards prescribed by WHO. Water quality of existing untreated and intermittent chemical & distribution of Chhapara village with special reference to suitability of water for drinking and domestic purposes. The practical approach shows its unsuitability for drinking without treatment.***

***Keywords: Wainganga river, Pollution, Water quality index, Quality of water.***

## I. INTRODUCTION

Freshwater is most important for the survival of life on earth. It is not only essential for human beings, but also for plants and animals ( Kumar, Sharma, Thukral and Bhardwaj, 2017). Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened as human population grows and demand more water of high quality for domestic purposes and economic activities (Rewatkar, Doifode, Kanojiya, 2016). Globally, there is an increasing awareness that water will be one of the most critical natural resources in future( Rewatkar, Doifode, Kanojiya, 2016). Thus preventing and controlling the overall degradation of the quantity and quality of these resources, proper management of available water resources is essential for the survival of mankind( Rewatkar, Doifode, Kanojiya, 2016). The chemical composition of water is a measure of its suitability for human and animal consumption, irrigation, and for industrial and other purposes (Srivastava, Mukherjee, Gupta, Singh, 2011). At the present time, to safeguard freshwater resources, it is important to develop a comprehensive river water quality monitoring program all over the world( Sharma , Kansal, 2011). Water chemistry describes the seasonal changes in the behavior of the major ions and catchment characteristics(Srivastava, Mukherjee, Gupta, Singh, 2011).

Rivers are the essential natural resources for the development of human civilization and are being polluted by industrial and domestic waste discharges, which affect the physio-chemical and microbiological properties of river water(Kumar, Sharma, Thukral and Bhardwaj, 2017). Rivers are lifeline of human establishments. They provide us with water and fertile lands. Civilizations have always settled on the banks of rivers. Wainganga also passes through many major cities and districts including, Seoni, Balaghat and Bhandara. Wainganga is not a transboundry river. It originates and ends within the Indian borders(Major rivers in India, Details of Wainganga river, Dashamlav.com). The River Wainganga is exist in Seoni and Balaghat district in Madhya Pradesh. The river originates from Talab of Village Mundwara District Seoni and passes through Chhapara, Keolari towns of Seoni District and then enter in Balaghat District. Balaghat city is located approx 3 km from bank of the River. After approx. 250 Km travel from origin in state of MP, it enters in to the state of Maharashtra(Regional office, M.P. pollution control board , Jabalpur). The River stretch may be observed in Figure.

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Waingangā river is a perennial river and water is used for drinking purpose by near by towns and cities and villages and for irrigation as well as for power generation(Regional office, M.P. pollution control board , Jabalpur). In Chhapara river water is directly used to farming purpose.

The Wainganga river basin consists of 9472 streams of different order. Analysis of the stream orientation reveals that 7% streams join the main stream from north, 24% from south, 13% from East, 5% from West, 6% from NE, 14% from SE, 19% from NW, 11% from SW. Most of the rivers that originate in the upland area of Deccan Plateau are sinuous in the source region. But the Wainganga channel is straight at source and meandering at confluence. In most of the places straight channel pattern is observed in segments (Nanabhau S. Kudnar,2015).

However, when a large number of samples and parameters are monitored, it becomes difficult to evaluate and present the water quality as a single unit (Chapman 1992; Pesce and Wunderlin 2000). Traditionally, river water quality has been assessed by comparing the values with the local norms.

However, this technique does not provide any information on the spatial and temporal trends of the overall quality (Debels et al. 2005). Thus, modern techniques such as water quality indices (WQI) and water quality modeling were developed( Sharma & Kansal 2011).

A water quality index (WQI) helps in understanding the general water quality status of a water source and hence it has been applied for both surface and ground water quality assessment all around the world since the last few decades (Samantray et al. 2009; Sharma and Kansal 2011; Alam

and Pathak 2010; Sebastian and Yamakanamardi 2013; Seth et al. 2014; Tyagi et al. 2013; Bhutiani et al. 2014; VishnuRadhan et al. 2015; Yadav et al. 2015; Dash et al. 2015; Krishnan et al. 2016; Kaviarasan et al. 2016, Bora & Goswami 2016). According to Stambuk-Giljanovic (1999), WQI is a mathematical tool which has the ability to provide a single number for the large quantities of water quality data in a comprehensive manner. Therefore, it is a simple tool for decision makers on thequality and possible uses of a given water body (Bordalo et al. 2001; Cude 2001; Kannel et al. 2007,Sharma & Kansal 2011).

### *A. Water Quality Index*

Categorization of water quality started in the mid-twentieth century by Horton (1965) and Landwehr (1974). Horton 1965 used the arithmetic aggregation function for the WQI.

He selected 10 most commonly measured water quality variables for his index including dissolved oxygen (DO), pH, coliforms, specific conductance, alkalinity, and chloride. The arithmetic weighing of the waterquality variables was multiplied with the temperature and ‘‘obvious pollution’’ to obtain the sum aggregation function from which the overall water quality index was found out.

The index weight ranged from 1 to 4. Brown et al. (1970) developed a general WQI. More than 20 water quality indices being used till late 1970s were reviewed by Ott (1978) and Steinhart et al. (1981). Steinhart et al. (1982) applied a novel environmental quality index to sum up technical information on the status and trends in Great Lakes ecosystem.

In India, the pioneer work on WQI was done by Bhargava (1983a, b, c), wherein the water quality is expressed as a number (ranging from 0 for highly/extremely polluted to 100 for absolutely unpolluted water) representing the integrated effect of the parameters amplifying the pollution load.

## II. DESCRIPTION OF STUDY AREA

This study is conducted in the Wainganga River which is an important river of the District Seoni, state Madhya Pradesh. It rises from village Mundara in Seoni district and passes through Chhapara, Keolari towns of Seoni District and then enter in Balaghat District. This river flows in West to East direction.

After approx. 250 Km travel from origin in state of MP, it enters in to the state of Maharashtra. During its total course of 569 km, Wainganga river passess through the states of Madhya Pradesh and Maharastra. Water quality monitoring of the River at Chhapara, Balaghat and near Budunda (State Boundary) is carried out every month and at Keolari once in 3 months. In the study area waterbody receives the domestic wastes and drainage water from the residential area throughout the season.

During dry seasons waste water do not reach to the river and these Nalas generally observed dried but during rains waste water mixing with storm water reaches to the river.

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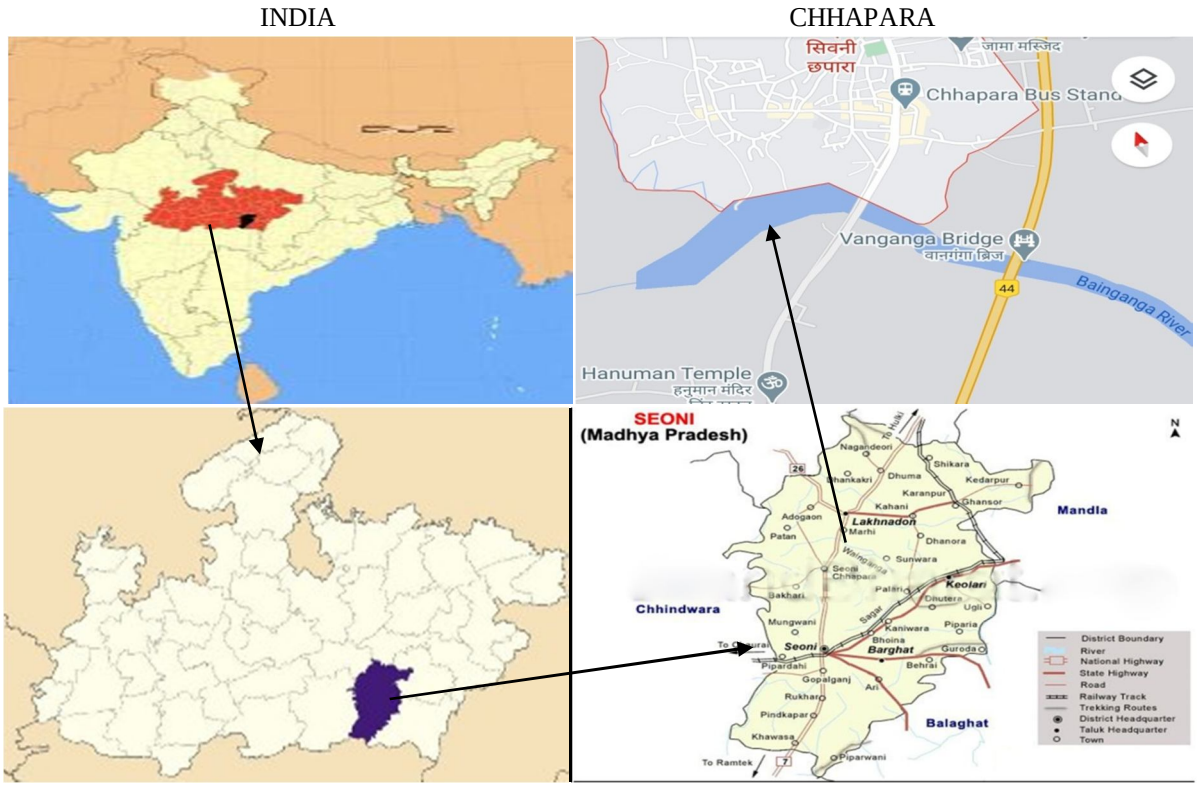



Figure. 1 Layout Of The Study Area

*A. Sampling and Collection of Water Samples*

With the objective in view the present work is planned to assess the quality of water from five different sites of Wainganga river in Seoni district, village Chhapara, for physico-chemical parameters and the results are compared with the standards given by WHO to determine the extent of pollution. Water samples were collected in the properly washed water bottle of 1 litre capacity in the month before covid-19 to month during covid0-19, from the five selected sites at 9.00am to 11.00am of River Wainganga for analyzing the water quality parameters within a period of 12 months from January 2020 to December2020. The main objective of study is To evaluate the physic- chemical properties of water.

Table : 1 Before COVID Sampling sites of Wainganga river at Chhapara, District-Seoni,(M.P.)

| Sampling Sites | Places | Longitude Latitude |
|---|---|---|
| W1 | Near sidhbaba Mandir | N22,23,24E79,32,19 |
| W2 | Near shiv Temple | N22,23,22E79,32,31 |
| W3 | Near kumhari ward Temple | N22,23,36E79,32,38 |
| W4 | Near main road Bridge | N22,23,21E79,32,32 |
| W5 | Near NH-7 bridge | N22,23,1E79,32,51 |

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Table : 2 During COVID Sampling sites of Wainganga river at Chhapara, District-Seoni,(M.P.)

| Sampling Sites | Places | Longitude Latitude |
|---|---|---|
| W1 | Near sidhbaba Mandir | N22,23,24E79,32,19 |
| W2 | Near shiv Temple | N22,23,22E79,32,31 |
| W3 | Near kumhari ward Temple | N22,23,36E79,32,38 |
| W4 | Near main road Bridge | N22,23,21E79,32,32 |
| W5 | Near NH-7 bridge | N22,23,1E79,32,51 |

## III. MATERIALS AND METHODS

The water samples from the water body were collected at an interval of before the COVID and during COVID and analysed for 11 physicochemical parameters by following the established procedures. The parameters like pH, Turbidity,Total Dissolved Solids, Total Alkalinity,Total Hardness,Calcium Hardness, Magnesium Hardness, Iron, Chloride, Fluoride, Sulphate, were analysed in the laboratory as per the standard procedures of APHA (1995). In this study, for the calculation of water quality index, eleven important parameters were chosen. The WQI has been calculated by using the standards of drinking water quality recommended by the World Health Organisation(WHO), Bureau of Indian Standards (BIS) and. The weighted arithmetic index method (Brown et. al.,) has been used for the calculation of WQI of the waterbody. Further, quality rating or sub index (*qn* ) was calculated using the following expression.

Calculation of WQI was carried out by following the 'weighted arithmetic index method' (Brown et al. 1970), using the equation:

$$WQI = \Sigma QnWn/\Sigma Wn$$

where Qn is the quality rating of nth water quality parameter,
Wn is the unit weight of nth water quality parameter.
The quality rating Qn is calculated using the equation

$$Qn = 100\ [(Vn - Vi)/(Vs - Vi)]$$

where Vn is the actual amount of nth parameter present,
Vi, is the ideal value of the parameter [Vi = 0, except for pH
(Vi = 7) and DO (Vi = 14.6 mg/l)],
Vs is the standard permissible value for the nth water quality parameter.
Unit weight (Wn) is calculated using the formula

$$Wn = k/Vs$$

where k is the constant of proportionality and it is
calculated using the equation

$$k = [1/\Sigma 1/Vs = 1,2,\ldots\ldots,n].$$

The water quality status (WQS) according to WQI is
shown in Table 1.

Table 1 WQI range, status and possible usage of the water sample (Brown et al. 1972)

| WQI | Water quality status (WQS) | Possible usage |
|---|---|---|
| 0–25 | Excellent | Drinking, irrigation and industrial |
| 26–50 | Good | Drinking, irrigation and industrial |
| 51–75 | Poor | Irrigation and industrial |
| 76–100 | Very poor | Irrigation |
| Above 100 | Unsuitable for drinking and fish culture | Proper treatment required before use |

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Table 2 Drinking Water standards As per Buereau of Indian Standards and Unit Weight

| S. NO. | PARAMETERS | AS PER IS:10500-2012 | UNIT WEIGHT,Wn |
|---|---|---|---|
| 1 | pH | 6.5 to 8.5 | 0.0249 |
| 2 | Turbidity | 1 | 0.0424 |
| 3 | Total Alkalinity | 200 | 0.0011 |
| 4 | Chloride | 250 | 0.0008 |
| 5 | Total Hardness | 200 | 0.0007 |
| 6 | Calcium | 75 | 0.0028 |
| 7 | Magnesium | 30 | 0.0071 |
| 8 | Total Dissolved Solids | 500 | 0.0004 |
| 9 | Iron | 1 | 0.7067 |
| 10 | Sulphate | 200 | 0.0011 |
| 11 | Fluoride | 1 | 0.212 |

Table 3 Calculation of WQI at Site 1

| | Before COVID | | | During COVID | | |
|---|---|---|---|---|---|---|
| Parameters | Vn | Qn | QnWn | Vn | Qn | QnWn |
| pH | 7.89 | 92.8235 | 2.315 | 7.93 | 93.2941 | 2.326865 |
| Turbidity | 5.4 | 108 | 4.579 | 8.5 | 170 | 7.208001 |
| Total Alkalinity | 191 | 95.5 | 0.101 | 142 | 71 | 0.07526 |
| Chloride | 27.6 | 11.04 | 0.009 | 14 | 5.6 | 0.004749 |
| Total Hardness | 218 | 72.6667 | 0.051 | 138 | 46 | 0.032507 |
| Calcium | 56 | 74.6667 | 0.211 | 36.8 | 49.0667 | 0.138695 |
| Magnesium | 19.2 | 64 | 0.452 | 11.5 | 38.3333 | 0.270889 |
| Total Dissolved Solids | 244 | 48.8 | 0.021 | 159 | 31.8 | 0.013483 |
| Iron | 0.08 | 26.6667 | 18.84 | 0.2 | 66.6667 | 47.11112 |
| Sulphate | 12 | 6 | 0.006 | 7.5 | 3.75 | 0.003975 |
| Fluoride | 0.16 | 16 | 3.392 | 0.17 | 17 | 3.604001 |
| ΣWnQn= 29.98 | | | | ΣWnQn= 60.79 | | WQI |
| =29.98 | | | | WQI =60.79 | | |

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Table 4 Calculation of WQI at Site 2

| | Before COVID | | | During COVID | | |
|---|---|---|---|---|---|---|
| Parameters | Vn | Qn | QnWn | Vn | Qn | QnWn |
| pH | 7.75 | 91.17647 | 2.274 | 7.87 | 92.588235 | 2.309 |
| Turbidity | 10.9 | 218 | 9.243 | 18.3 | 366 | 15.52 |
| Total Alkalinity | 187 | 93.5 | 0.099 | 138 | 69 | 0.073 |
| Chloride | 26.4 | 10.56 | 0.009 | 10.8 | 4.32 | 0.004 |
| Total Hardness | 221 | 73.66667 | 0.052 | 144 | 48 | 0.034 |
| Calcium | 57 | 76 | 0.215 | 37.6 | 50.133333 | 0.142 |
| Magnesium | 19.2 | 64 | 0.452 | 12.5 | 41.666667 | 0.294 |
| Total Dissolved Solids | 248 | 49.6 | 0.021 | 158 | 31.6 | 0.013 |
| Iron | 0.06 | 20 | 14.13 | 0.1 | 33.333333 | 23.56 |
| Sulphate | 16 | 8 | 0.008 | 6.6 | 3.3 | 0.003 |
| Fluoride | 0.14 | 14 | 2.968 | 0.17 | 17 | 3.604 |
| ΣWnQn= 29.48<br>WQI =29.48 | | | | ΣWnQn= 45.55<br>WQI =45.55 | | |

Table 5 Calculation of WQI at Site 3

| | Before COVID | | | During COVID | | |
|---|---|---|---|---|---|---|
| Parameters | Vn | Qn | QnWn | Vn | Qn | QnWn |
| pH | 7.83 | 92.11765 | 2.298 | 8.21 | 96.5882 | 2.409025 |
| Turbidity | 9.2 | 184 | 7.802 | 12.5 | 250 | 10.6 |
| Total Alkalinity | 185 | 92.5 | 0.098 | 136 | 68 | 0.07208 |
| Chloride | 25.2 | 10.08 | 0.009 | 11.7 | 4.68 | 0.003969 |
| Total Hardness | 224 | 74.66667 | 0.053 | 144 | 48 | 0.03392 |
| Calcium | 59.6 | 79.46667 | 0.225 | 39.2 | 52.2667 | 0.14774 |
| Magnesium | 10.7 | 35.66667 | 0.252 | 11.5 | 38.3333 | 0.270889 |
| Total Dissolved Solids | 251 | 50.2 | 0.021 | 158 | 31.6 | 0.013398 |
| Iron | 0.12 | 40 | 28.27 | 0.2 | 66.6667 | 47.11112 |
| Sulphate | 14 | 7 | 0.007 | 7.6 | 3.8 | 0.004028 |
| Fluoride | 0.18 | 18 | 3.816 | 0.17 | 17 | 3.604001 |
| ΣWnQn= 42.85<br>WQI =42.85 | | | | ΣWnQn= 64.27<br>WQI =64.27 | | |

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Table 6 Calculation of WQI at Site 4

| | Before COVID | | | During COVID | | |
|---|---|---|---|---|---|---|
| Parameters | Vn | Qn | QnWn | Vn | Qn | QnWn |
| pH | 7.9 | 92.94118 | 2.318 | 8.32 | 97.882353 | 2.4413 |
| Turbidity | 33.4 | 668 | 28.32 | 38.7 | 774 | 32.818 |
| Total Alkalinity | 182 | 91 | 0.096 | 128 | 64 | 0.0678 |
| Chloride | 29.8 | 11.92 | 0.01 | 10.8 | 4.32 | 0.0037 |
| Total Hardness | 217 | 72.33333 | 0.051 | 144 | 48 | 0.0339 |
| Calcium | 57 | 76 | 0.215 | 36 | 48 | 0.1357 |
| Magnesium | 18.5 | 61.66667 | 0.436 | 13.5 | 45 | 0.318 |
| Total Dissolved Solids | 266 | 53.2 | 0.023 | 152 | 30.4 | 0.0129 |
| Iron | 0.1 | 33.33333 | 23.56 | 0.2 | 66.666667 | 47.111 |
| Sulphate | 12 | 6 | 0.006 | 7.4 | 3.7 | 0.0039 |
| Fluoride | 0.14 | 14 | 2.968 | 0.17 | 17 | 3.604 |
| ΣWnQn= 58.00 | | | ΣWnQn= 86.55 | | | |
| WQI =58.00 | | | WQI =86.55 | | | |

Table 7 Calculation of WQI at Site 5

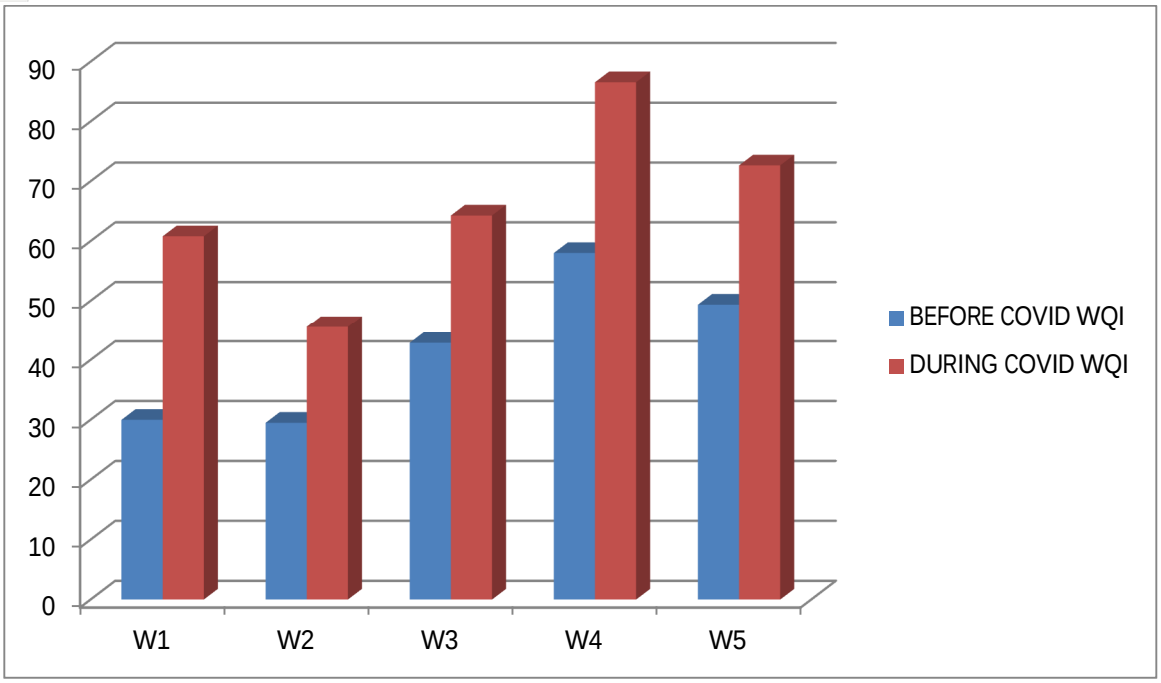
| | Before COVID | | | During COVID | | |
|---|---|---|---|---|---|---|
| Parameters | Vn | Qn | QnWn | Vn | Qn | QnWn |
| pH | 7.92 | 93.17647 | 2.324 | 8.32 | 97.8824 | 2.441301 |
| Turbidity | 18.1 | 362 | 15.35 | 22.4 | 448 | 18.9952 |
| Total Alkalinity | 188 | 94 | 0.1 | 128 | 64 | 0.06784 |
| Chloride | 24.8 | 9.92 | 0.008 | 11.7 | 4.68 | 0.003969 |
| Total Hardness | 219 | 73 | 0.052 | 134 | 44.6667 | 0.031564 |
| Calcium | 55.6 | 74.13333 | 0.21 | 36.8 | 49.0667 | 0.138695 |
| Magnesium | 20 | 66.66667 | 0.471 | 10.5 | 35 | 0.247333 |
| Total Dissolved Solids | 250 | 50 | 0.021 | 152 | 30.4 | 0.01289 |
| Iron | 0.12 | 40 | 28.27 | 0.2 | 66.6667 | 47.11112 |
| Sulphate | 14 | 7 | 0.007 | 7.9 | 3.95 | 0.004187 |
| Fluoride | 0.12 | 12 | 2.544 | 0.17 | 17 | 3.604001 |
| ΣWnQn= 49.35 | | | ΣWnQn= 72.65 | | | |
| WQI =49.35 | | | WQI =72.65 | | | |

Table 8 Water Quality Index values and WQI status for all five locations for Wainganga river Basin

| SAMPLE NO. | BEFORE COVID WQI SCALE | WQI STATUS | DURING COVID WQI SCALE | WQI STATUS |
|---|---|---|---|---|
| W1 | 29.98 | Good | 60.79 | Poor |
| W2 | 29.48 | Good | 45.55 | Good |
| W3 | 42.85 | Good | 64.27 | Poor |
| W4 | 58 | Poor | 86.55 | Very Poor |
| W5 | 49.35 | Good | 72.65 | Poor |

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Results Shows Wqi Value Variation

## IV. RESULTS AND DISSCUSSION

The test results gives information about water quality. Table 3 to 7 shows the test result of 11 parameters and Water Quality Index value of all five locations water sample of river basin before COVID and during COVID.

For the first location variation of WQI value is before COVID 29.98 to during COVID 60.79, the water quality status goes good quality to poor quality for the time of before COVID to during COVID respectively. Second location WQI value is 29.48 before COVID to 45.55 during COVID and the water quality status variation is not found, status was good to good quality. Third location WQI value as comparison to W1 and W2 high, which is 42.85 is before COVID and 64.27 during COVID, gives water quality status is good quality to poor quality. Fourth location WQI value is in increase order is 58 before COVID and 86.55 during COVID. And the fourth location water quality status is poor quality to very poor quality. Fifth location water sample test gives less value of WQI from the fourth location. WQI value is 49.35 before COVID and 72.65 during COVID, by the values water quality status record is good to very poor quality.

As per WQI , the value of WQI is higher in fourth location(W4) near main road bridge, before COVID time and also during COVID time. This area is highly used for the pooja, bath and because of the nearest cemetery, it is use for the different purposes, the water pollution is high in this location and WQI value is higher comparatively other four location.

According to this study period time we found the difference between the WQI value in second location W2 (29.48-45.55=16.07), then in increasing order fourth location W4 (58-86.55=28.55), fifth location W5 (49.35-72.65=23.30), third location W3 (42.85-64.27=21.42), and high difference in WQI value in first location W1 (29.98-60.79=30.81).

## V. CONCLUSION

From the results, it has been concluded that, the water of Wainganga river during the study period was showing the variations from good quality to very poor and poor quality except of site W2 shows good to good quality with variation of value and site W4 shows poor to very poor quality. The pollution increases as we go to end point of chhapara village near NH-7 bridge. Water quality of Wainganga river was comparatively good before COVID.

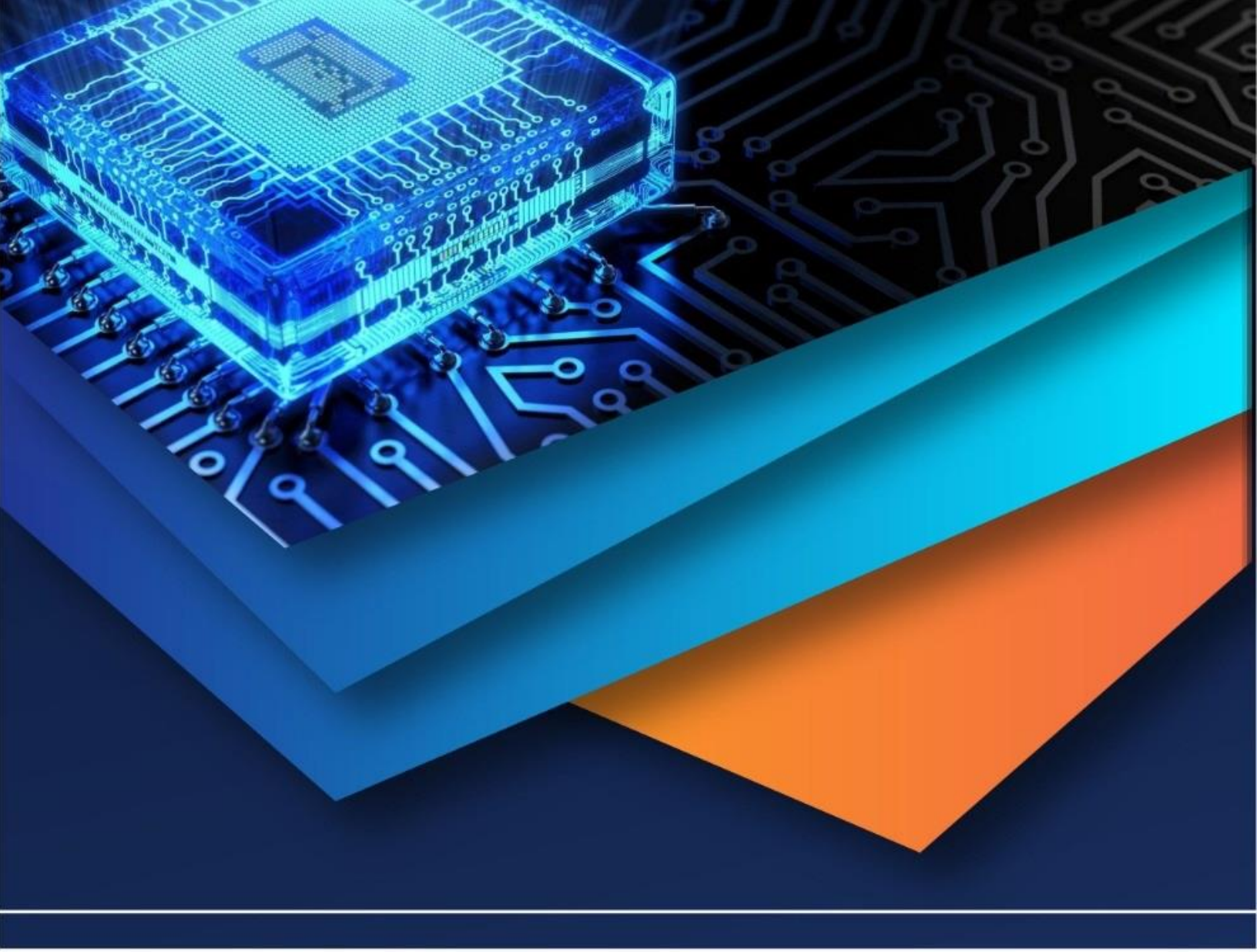
Based on WQI values, it could be inferred that the water quality was good, good, good,poor and good before COVID and poor, good, poor, very poor, and poor. This study will help to the water quality monitoring and improve water quality and management of water quality and for making water quality suitable for drinking, irrigation and other purposes.

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