# Water Quality Index of the Ganga river water at Mirzapur, U.P, India

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**ABSTRACT**:

Various physico–chemical parameters were studied to assess the water quality of Ganga river water at Mirzapur in the year 2017. Subsequently, using this physico–chemical parameters, water quality index (WQI) was calculated through mathematical calculations. The experimental values of the various parameters were obtained by adopting standard procedures. These experimental values obtained were compared with the standard values suggested by International bodies such as WHO and ISI. The values were then substituted in the mathematical expression to calculate the WQI. Water Quality Indexing is a simple and convenient method to express the quality of water which leads to a single numeric value through which it could be easily suggested that whether the water is fit for human consumption. In the present investigation, we concluded that the water quality of analysis sites under study very poor water quality during all season.

KEY WORDS: Physico–chemical parameters, Standard methods, Potable water, Toxicity, Hazardous

INTRODUCTION:

India has a great cultural heritage. Its civilizations are recorded in the World's history. Ganga River is the oldest river on the Earth. This river has both religious and economic importance. Water is an essential constituent for the life of human beings as well as for our ecosystem. Without water, the existence of life on earth is not possible. Human and other living organism die, agricultural activities not initiated business also cannot operate [1]. It flows through the hills and undulating topography it has high energy which is converted into electricity and is used by many states. Its water is also used for agriculture, drinking and other industrial uses. Domestic and industrial wastewater constitute as a constant polluting source, whereas surface runoff is a seasonal phenomenon mainly controlled by climate [2] Small towns and big cities have developed on its banks. All these human activities have started polluting the water of river Ganga by releasing its waste containing lot of toxic and hazardous materials. Since big farmers these days have used extensive fertilizers and herbicides to get high yields. The intensive use of chemical fertilizers and poor waste management of industries and mass bathing activities during festivals etc. Have led to the environmental stress on the water ecosystem [3]. These chemicals are then discharged into the water and later it reaches the river water. Similarly, industrial effluents are discharged directly without being treated. Sewage disposal in the river also leads to the contamination of its water. Ganga is a major river and its water is useful for the mankind, hence it should be kept clean from the impurities and toxic materials. Many authors have studied various physical–chemical parameters in the water bodies [1– 8] to state the quality of water. The water Quality Index is an excellent approach in this direction, which was developed in the early 1970s. It gives an indication of the health of the water bodies at various points and can be used to keep a track of water quality over a period of time. To calculate the water quality index various physico–Chemical parameters should be studied in detail and then their experimental values are substituted in the mathematical expression as described in the study. Water Quality Index (WQI) is normally utilized for the discovery and assessment of water contamination and might be characterized as "a rating mirroring the composite impact of various quality boundaries on the general nature of water." The nature of water is getting limitlessly weakened because of informal garbage removal, inappropriate water the executives and heedlessness

towards condition, which has also led to scarcity of potable water affecting the human health [4]. The quality index comprised into two parts physico-chemical indices and biochemical indices. The physico-chemical indices are based on values of various physico-chemical parameters in a water sample. Water quality index is defined in terms of its physical, chemical and biological characteristics. Water quality index (WQI) has been developed with the aim of providing summary information on quality. Overall water quality was expressed by single number. WQI can be used to summarize the large amounts of water quality database into simple terms for reporting to public in a reliable manner. WQI can be used to summarize the large amounts of water quality database into simple terms for reporting to environmental planners and public in a reliable manner.

## MATERIALS & METHODS

The present study was carried out to calculate the water quality index of the river Ganga at Mirzapur. The physico-chemical characteristics of water like pH, Electrical conductivity, Total Dissolved solids (TDS), Total hardness, Alkalinity, Chloride, DO, Sulphate and Nitrate were determined in summer, monsoon and winter according to standard methods[5]. Here water quality index of the River Ganga has been calculated and subsequently modified by based on physico-chemical data. The water quality index has been calculated by using the standard of drinking water quality by the WHO, BIS, and ICMR. Therefore, the "Weight" for various water quality characteristics is assumed to be inversely proportional to the recommended standards for the corresponding parameters. According to this is

$$Wi= K/Si$$

Where Wi is the unit weight and Si is the recommended standard for the parameter. The constant of the proportionality K in equation can be determined from the condition.

$$\Sigma Wi = K\Sigma (1\backslash Si)$$

The quality rating qi for the parameter Pi is calculated from the following equation.

$$qi = 100 (Vi/Si)$$

Where Vi is the observed value. The sub index Si for the parameter Pi is given by

The Water quality index and Physico-chemical parameter value of the river Ganga is

$$(Si) = (qi\ wi)$$

The overall WQI can be calculated by aggregating the quality rating (qi) or sub-indices, linearly or taking their weighted mean,

$$WQI=[(\Sigma qi\ wi/\Sigma wi )]$$

Water quality index represents the integrated effects of the relevant water quality variables. Table- 2 show drinking water standard & unit weights for all the parameters used in calculating the WQI [6]. Gave the rating of water quality as shown in Table-1. These 11 physico-chemical parameter were taken for calculating the water quality parameter. Hardness, pH, DO, BOD, COD, Nitrate, Total Dissolved Solids, Sulphate, Electrical conductivity, Total Alkalinity and Chloride. Drinking water quality standards (Maximum permissible limit) Standards are taken according to WHO, BIS, ICMR etc.

For the calculation of Water Quality Index physico-chemical parameters were monitored for the monsoon, winter and summer seasons. Samples were collected from Mirzapur, Uttar Pradesh, as per the standard procedures. All the values are the mean value of the year 2017, used for calculating WQI. The sample S1 value are the mean value of the observed value of three site viz., Mirzapur upstream, midstream, and downstream in summer seasons. Like S1, S2 and S3 are calculated in monsoon and winter respectively.

The various Physico– chemical parameters like pH, Alkalinity, Total dissolved solids, Electrical Conductivity, Calcium and Magnesium ions, Total hardness were analysed and the results were compared with the WHO and ISI standards[9]. Chemicals used for analysis were of AR grade. Glass distilled water was used for the preparation of the reagents. pH and Electrical Conductivity were determined using Digital pH – meter and Conductometer respectively. Temperature of the samples was noted at their sampling points. Standards methods were employed for the determination of the various parameters [10]. The experimental results obtained were then compared with WHO and ISI standards are listed. (Table 1). Weighted arithmetic water quality index method Water Quality Index is a method to express the water quality according to the degree of purity. It is now widely used in scientific studies by using the physico – chemical parameters [11–16].

## RESULTS & DISCUSSION

### Temperature

Chemical and biochemical reactions are greatly affected by temperature. Increase in temperature of water increases the rate of chemical reactions in water on one hand and, decreases the solubility of gases in the water on the other. Hence, measurable variations in the temperature of water affect the aquatic life. The temperature of the water for samples S1, S2 and S3were found to be in safe limits. (Table 1)

### pH

pH is defined as “the negative logarithm of hydrogen ion concentration”. The pH of natural water is between 6 and 8. Variations in pH values are mainly due to hydrolysis of salts of strong bases and weak acids or vice versa and also due to the dissolved gases such as carbon dioxide, Hydrogen sulphide, ammonia etc. The pH of S1, S2 and S3were found to be well within the prescribed standard range. (Table 1, Fig 1)

### Alkalinity

Alkalinity of water is described as its quantitative capacity to neutralize acids. Compounds like bicarbonates, carbonates and hydroxides in water decreases the H+ ions and increases the pH of the water. Alkalinity in streams is due to breakdown and dissolution of rocks and soils, plant activities and industrial waste water discharges are also responsible for alkalinity. All the three samples S1, S2 and S3 showed very high alkalinity according to WHO standards but when compared to ISI standards it was found within the standard limits though on the higher side which could be alarming. (Table 1, Fig 1)

### Electrical Conductivity

Conductivity of water is defined as the capacity of water to conduct electrical current. Conductivity in water is affected by temperature, mobility of the ions and presence of electrolytes in the form of dissolved inorganic solids such as chloride, nitrate, sulphate, phosphate, sodium, magnesium, calcium, iron and aluminium ions. The Electrical Conductivity in the samples S1, S2 and S3were found to be within the tolerance limits of the standard values. (Table 1, Fig 1)

### Total, Temporary and Permanent hardness

Hardness in water is an important parameter as it affects the day to day human life and also the industries to a great extent. The presence of calcium and magnesium in the form of bicarbonates, chlorides and sulphates produces hardness in the water. Hardness is expressed in terms of CaCO3 equivalents. Hardness was reported to be very high in all the three samples S1, S2 and S3 according to the WHO standards but was within the tolerance limits of ISI standards. (Table 1, Fig 1)

**Calcium ions and Magnesium ions**

Calcium is the main constituent of the rocks. Hardness is caused due to the presence of calcium and magnesium ions. Excess of Calcium and Magnesium ions leads to the deposition of these in the soft tissues of the living beings causing various kinds of diseases such as stone formation, cancer etc. The presence of Calcium ions was found to be very high according to both the standards in all the samples. Magnesium ions on the other hand were found to be within the limits of WHO standards but high according to ISI standards. (Table 1, Fig 1)

**Total Dissolved Solids**

Total dissolved solids are the sum of all the chemical ions that are dissolved in the water. It is due to the dissolution of gypsum, rocks, soil etc. The amount of Total Dissolved Solids was well within the permissible range of the said standards in all the samples. (Table 1, Fig 1).

Coordinated impacts of the applicable water quality factors were spoken to by water quality record. Water quality file (WQI) is the best method to convey water quality. Water quality list (WQI) = 0 methods complete nonappearance of contaminations. When 0< 100, indicates the water is under consideration and fit for human use and WQI > 100 reflects its unsuitability for human use [10]. This clearly indicates that water samples of this region are highly polluted. They are not suitable for drinking purpose and other useful human activities [11].

TABLE1: WATER QUALITY AND THEIR WHO ANS ISI STANDARDS

| parameters | method | WHO Standards | ISI Standards | Samples of Narmada river water | | |
|---|---|---|---|---|---|---|
| | | | | S1 | S2 | S3 |
| pH | pH meter | 7.0 – 8.0 | 6.5-8.5 | 7.89 | 7.79 | 8.03 |
| Electrical Conductivity (µs / cm) | conductometry | 1400 | | 345.67 | 342.33 | 360.67 |
| Total Dissolved Solid (mg/L) | Filtration Method | 1000 | 500 | 319 | 364.33 | 312.66 |
| Total Hardness (mg/L) | EDTA titration | 100 | 300 | 198.33 | 182 | 192 |
| Dissolve oxygen mg/l | Azide modified wrinkler method | 6 | - | 5.23 | 5.2 | 5.2 |
| Biological oxygen demand (mg/l) | Azide modified wrinkler method | 5 | | 17.9 | 18.47 | 19.6 |
| Nitrate mg/l | | 10 | | .74 | .72 | .69 |
| Phosphate mg/l | | | | .79 | .84 | .75 |
| Alkalinity (mg/L) | Titration Method | 120 | 200 | 273 | 277 | 274.67 |
| chloride | | | | 24.07 | 27.27 | 22.03 |

Table 2: Calculation of WQI for S1 sample

| calculation of WQI for S1 sample | | | | | |
|---|---|---|---|---|---|
| Parameters | Observed values | Standard values | unit weight wi=1/si | quality rating qi | weighted values wiqi |
| pH | 7.89 | 8.5 | 0.117647 | 92.8235 | 10.9204063 |
| Electrical Conductivity (µs / cm) | 345.67 | 300 | 0.00333 | 115.2233 | 0.383693589 |
| Total Dissolved Solid (mg/L) | 319 | 500 | 0.002 | 63.8 | 0.1276 |
| Total Hardness (mg/L) | 198.33 | 300 | 0.00333 | 66.11 | 0.2201463 |
| Dissolve oxygen mg/l | 5.23 | 5 | 0.2 | 104.6 | 20.92 |
| Biological oxygen demand (mg/l) | 17.9 | 5 | 0.2 | 358 | 71.6 |
| Nitrate mg/l | 0.74 | 20 | 0.05 | 3.7 | 0.185 |
| sulphate mg/l | 0.79 | 200 | 0.005 | 0.395 | 0.001975 |
| chloride | 24.07 | 250 | 0.004 | 9.625 | 0.0385 |
| Alkalinity (mg/L) | 273 | 120 | 0.008 | 227.5 | 1.82 |
| | | | ∑wi = 0.393307 | | ∑wiqi = 34.617321 |

WQI for S1 sample= ∑wiqi/∑wi

= 34.617321/0.393307

= 88.0839

Table 3: Calculation of WQI for S2 sample

| | | calculation of WQI for S2 sample | | | |
|---|---|---|---|---|---|
| Parameters | Observed values | Standard values | unit weight wi=1/si | quality rating qi | weighted values wiqi |
| pH | 7.79 | 8.5 | 0.117647 | 91.647 | 10.78199461 |
| Electrical Conductivity (µs / cm) | 342.33 | 300 | 0.00333 | 114.11 | 0.3799863 |
| Total Dissolved Solid (mg/L) | 364.33 | 500 | 0.002 | 72.866 | 0.145732 |
| Total Hardness (mg/L) | 182 | 300 | 0.00333 | 60.667 | 0.20202111 |
| Dissolve oxygen mg/l | 5.2 | 5 | 0.2 | 104 | 20.8 |
| Nitrate mg/l | 0.72 | 20 | 0.05 | 3.6 | 0.18 |
| sulphate mg/l | 0.84 | 200 | 0.005 | 0.42 | 0.0021 |
| Cholride | 27.27 | 250 | 0.004 | 10.91 | 0.04364 |
| Alkalinity (mg/L) | 277 | 120 | 0.008 | 230.83 | 1.84664 |
| | | | ∑wi= 0.393307 | | ∑wiqi= 34.382114 |

WQI for S2 sample= ∑wiqi/∑wi

= 34.382114/0.393307

= 87.4180

Table 4: Calculation of WQI for S3 sample

| | | calculation of WQI for S3 sample | | | |
|---|---|---|---|---|---|
| Parameters | Observed values | Standard values | unit weight wi=1/si | quality rating qi | weighted values wiqi |
| pH | 8.03 | 8.5 | 0.117647 | 94.47 | 11.11411209 |
| Electrical Conductivity (µs / cm) | 360.67 | 300 | 0.00333 | 120.22 | 0.4003326 |
| Total Dissolved Solid (mg/L) | 312.66 | 500 | 0.002 | 62.53 | 0.12506 |
| Total Hardness (mg/L) | 192 | 300 | 0.00333 | 64 | 0.21312 |
| Dissolve oxygen mg/l | 5.2 | 5 | 0.2 | 104 | 20.8 |
| Nitrate mg/l | 0.69 | 20 | 0.05 | 3.45 | 0.1725 |
| sulphate mg/l | 0.75 | 200 | 0.005 | 0.375 | 0.001875 |
| cholride | 22.03 | 250 | 0.004 | 8.8 | 0.0352 |
| Alkalinity (mg/L) | 274.67 | 120 | 0.008 | 228.89 | 1.83112 |
| | | | ∑wi= 0.393307 | | ∑wiqi= 34.693319 |

WQI for S3 sample= ∑wiqi/∑wi

= 34.693319/0.393307

= 88.2093

Table 5: Water quality index (WQI) status of water quality

| Water quality index level | Water quality status |
|---|---|
| 0-25 | Excellent water quality |
| 26-50 | Good water quality |
| 51-75 | Poor water quality |
| 76-100 | Very poor water quality |
| >100 | Unsuitable for drinking |

## CONCLUSION

In the present investigation water of River Ganga was found not to be good for drinking purpose at any season. The Water Quality Index was calculated for all the samples (Tables 2 - 4) and was found to be 88.0839, 87.4180 and 88.2093 for the samples S1, S2 and S3 respectively. The present study conducted on the Ganga River water reveals that the quality of the water are very poor (Table 5) [18]. Ganga River water is a chief source for drinking and irrigation, hence it should be free from the impurities. People consuming it directly without treatment suffer great health hazards which are significantly visible in the rural and tribal areas. In the electricity production water should be free from impurities and hardness otherwise it adversely affects the turbines and boilers.

## REFERENCES

[1]. Burim Haxhibeqiri, Faton Maloku and Ferdi Brahushi (2014) Physico-chemical and Bacteriological Analysis of The River Drini l Bardhe. European Scientific Journal Special edition 3.

[2]. Singh, K. P., Malik, A., Mohan, D. and Sinha, S. Water Res., 2004, 38, 3980.

[3]. Manoj Kumar Solaki, O.P., Gupta, D.K, Singh and Shukdeo Prasad Ahirwar (2014) Comparative Physico – chemical Analysis of River Water and Underground Water in Winter Season of Rewa City, MP, India. International Research Journal of Environment Sciences3, 59-61.

[4]. Agarkar, S.V. (2003) Flouride content in drinking water of villages around Chikhli, Distric. Buldana, Maharastra. Asian Journal of Chemistry 15(3, 4), 1875-1876.

[5]. APHA (2005) Standard methods for the examination of water and waste waters, 21st Edn., Washington, DC. USA.

[6]. Maruthi, Y.A. and Rao, S.R. (2004) Asian Journal. of Chemisty, 16, 122 (2004).

[7]. Joshi, Dhirendra Mohan (2009) observed the water quality of River Ganga for Drinking purpose at Haridwar District vol.2. no.1 (2009),195-203, ISSN:0974-1496, CODEN:RJCA

[8]. Chaurasia, M. and Pandey, G.C. (2007) Study of physico-chemical characteristic of some water pond o fAyodhyaFaizabad. Indian J. of Environ. Protect, 27(11), 1019-1023.

[9]. Chaterjee, C. and Razuddin, M. (2002) Determination ofWater Quality Index (W.Q.I.) of a degrade driver in Asanil Industrial area, Ranigunj, Burdwan, West Bengal. Environ. Poll. Technol., 1(2): 181- 189.

[10]. Bahera, H., Pal, L. and Rout, S.P. (2004) Seasonal variations in the water quality index for Vani Vihar leke in Bhuvaneshwar. In: Water pollution (Ed: Aravind Kumar). A.P.H. Publ. Corp, New Delhi. Pp. 199-209

[11]. Jena, V., Dixit, S. and Gupta, S. (2013) Assessment of Water Quality Index of Industrial Area Surface Water Samples. International Journal of Chem. Tech. Research. 5(1): 278-283.

[12]. Dr. Leena Singh and S.K Choudhary (2013) Physico-Chemical Characteristics of River Water of Ganga in Middle Ganga Plains. International Journal of Innovative Research in Science, Engineering and Technology, 2.

[13]. Janeshwar Yadav, Sujit Pillai and Atul Upadhyay. (2012) Analysis of Physico – chemical Parameters of Kunda River (major Tributary of Narmada From Nimar Region)Int J. Chem .Sci10, 1654-1656.

[14]. Guideline for Drinking Water, World Health Organization (1993). Geneva, 1: 52-82.

[15]. Mehari Muuz Weldermariam (2013) Physico– Chemical Analysis of Gud Bahri River Water of wukro, Eastern Tigrai, Ethiopia. International Journal of Scientific and Research Publications, 3.

[16]. Yadav, R.C. and Srivastava, V.C. (2011) Physico – Chemical properties of the water of river Ganga at Ghazipur. Indian J.Sci.Res.2, 41- 44.

[17]. Jadhav, S.D., Jadhav and Jawale, R.W. (2013) Physico-Chemical and Bacterilogical Analysis of indrayani River Water Alandi, Pune District (Maharashtra) India. International Journal of Scientific & Engineering Research 4.

[18]. Vinod Jena, Sapna Gupta and Natalija Matic (2013) Assessment of Kharoon River Water Quality at Raipur by Physico – Chemical Parameters Analysis. Asian J. Exp. Biol. Sci 4, 79 – 83.

[19]. Dara, S. S. (2001) A Textbook on Experiments and Calculations in Engineering Chemistry. S Chand & Co. Lt.

[20.]. Dhirendra Mohan Joshi, Alok Kumar and Namita Agrawal (2009) Studies On Physicochemical Parameters to Assess The Water Quality Of River Ganga For Drinking Purpose In Haridwar District. Rasayan J. Chem2, 195-203.

[21]. K. Jomet Sebastian, Sadanand M and Yamakanamardi (2013) Assessment of Water Quality Index of Cauvery and Kapila River and Their Confluence, International Journal of Lakes and riversl, 59-67.

[22]. Pathak, S.K., Shambhu Prasad and Tanmay Pathak (2015) Determination of Water Quality Index River Bhagirathi in Uttarkashi, Uttarakhand, India. Social Issues and Environmental Problems 3.

[23]. Priyanka Chugh, Amarjit Kaur, Harpreet Kaur, Satish Kumar and Sahota, H.S. (2014) On Water Quality Standards and Water Quality Indices. International Journal of Science and Research 3.

[24]. Shweta Tyagi1, Bhavtosh Sharma, Prashant Singh and Rajendra Dobhal (2013) Water Quality Assessment in Terms of Water Quality Index. American Journal of Water Resources 1, 34-38.

[25]. Cude, C. (2001) Oregon water quality index: A tool for evaluating water quality management effectiveness. Journal of the American Water Resources Association 37, 125 – 137.

[26]. Chaterjee, C and Raziuddin. (2002) Determination of water quality index (WQI) of a degraded river in Asanol industrial area, Raniganj, Burdwan, West Bengal. Nature, Environment and Pollution Technology 1, 181 – 189