Original Research Article

Monitoring and Assessment of Subarnarekha River Water Quality Using Water Quality Index

ABSTRACT

Subarnarekha is the lifeline of tribal communities and fishing communities, residing on the riverbanks and their life and livelihood is affected by the river's pollution. The purpose of this study is to determine the water quality status of Subarnarekha River of Ranchi. River water samples were analyzed for physio-chemical parameters such as pH, Turbidity, DO, BOD□, Total hardness, Alkalinity, Chloride, Phosphorus and Chromium. After physio-chemical analysis, water quality index (WQI) was established for these 9 physio-chemical parameters by following weighted arithmetic method. For this study, samples from 8 sampling locations were collected in January 2024 to May 2024. WQI calculation of water quality of Subarnarekha River falls between the category of excellent to acceptable water quality, as they were recorded between 6.76 - 26.4, which can be considered as excellent quality levels and acceptable quality levels according to the water quality rating. The WQI value for Site 1 and Site 2 falls under the excellent category throughout the observation period, expect in the month of April; water is fit for drinking, bathing and aquatic life.

Keywords:Subarnarekha River, Water Quality Index, Physio-chemical Parameters, Pollution

1. INTRODUCTION

Water is the most essential natural resource for sustaining all forms of life, food production, economic development and general well-being. Water is also one of the most manageable natural resources as it can be diverted, transported, stored, and recycled **[10]**. River water, considered as the most important natural resource. It played vital role in connecting and channelizing the natural components of the basin such as land or soil, forest and vegetation productivity and animals. All human needs are dependent on the availability of water resources **[6]**.

As the global human population grows, so too do the demands for water. At the same time, human activity and climate change are disrupting natural water cycles, putting freshwater ecosystems under pressure. Poor water management, pollution, infrastructure development, and resource extraction further exacerbate the negative impacts on our freshwater systems **[1]**.Access to fresh water is often taken for granted, especially in developed countries that have built sophisticated water systems for collecting, purifying, and delivering water, and removing waste water. But growing economic, demographic, and climatic pressures are increasing concerns about water issues, leading to increasing competition for fixed water resources **[4]**. The day-by-day increased demand has developed new methods of water quality assessment and management **[24]**.

Subarnarekha is a rainfed river flowing in the eastern part of India and sustaining millions of people of Jha rkhand, West Bengal, and Orissa **[22**].The river water has been used by different agencies for different purposes. It is used by industry as a direct process input and as a disposal agent for the dilution of

effluents; by agriculturists for irrigation; and by household sector for drinking and other domestic use **[5]**. Subarnarekha is the lifeline of tribal communities and fishing communities, residing on the riverbanks and their life and livelihood is affected by the river's pollution. The basin therefore needs careful environmental management planning to protect its continued existence [**12**,**20**,**16**].

2. Materials and methods

The experiment was conducted during the month of January 2024 to May 2024, from 8 different sampling sites of Subarnarekha River i.e Nagri(S1), Dhurwa(S2), Hatia(S3), Chutia(S4), Namkum(S5), Tatisilwai(S6), Mesra(S7) and Rukka(S8) as mentioned in the table: 1.

2.1 Sampling Area

The Subarnarekha is one of the longest east flowing inter-state rivers. It originates near Nagri village (23° 18′ 02″N and 85° 11′ 04″E) in the Ranchi district of Jharkhand at an elevation of 600 m. Subarnarekha basin extends over states of Jharkhand, Odisha and comparatively smaller part in West Bengal having a total catchment area of 19,296 km^2.

2.2 Collection and Preservation of Samples

Water samples were collected during the month of January 2024 to May 2024 (5 months), from 8 different sampling locations along the route of the Subarnarekha River basin in Ranchi district. The samples were collected in clean air tight bottles without any contamination and were properly labelled and further preserved for physio-chemical analysis in laboratory.

2.3 Sampling frequency

Samples were collected and analyzed in every 15 days of interval during monitoring period.

2.4 Analysis of Collected Samples

After the collection of water samples, they were immediately brought and were analyzed in the laboratory of Biocrat Environmental Services, Ranchi. The parameters which were analyzed are pH, Turbidity, Dissolved oxygen, Biological oxygen demand, Total hardness, Alkalinity, Chloride, Phosphorus and Chromium. The pH and Dissolved oxygen were measured immediately after collection of samples in the laboratory.

2.5 Sampling Sites

Sampling sites were selected to cover various anthropogenic activities such as pollution through industrialization and disposal of untreated water into river, etc.

TABLE 1: Sampling sites of Subarnarekha river at Ranchi, Jharkhand

S.No.	Sampling Location	Site Notation	Distance from S1	Sampling Location Description
1.	Nagri	S1	0 km	Origination point of river
2.	Dhurwa	S2	14 km	Town Area
3.	Hatia	S3	18.7 km	Town Area
4.	Chutia	S4	30.7 km	City Area
5.	Namkum	S5	35.5 km	Industrial Area
6.	Tatisilwai	S6	44.1 km	Industrial Area
7.	Mesra	S7	59.1 km	Town Area
8.	Rukka	S8	67.5 km	Rural Area

2.6 Map of Study Area

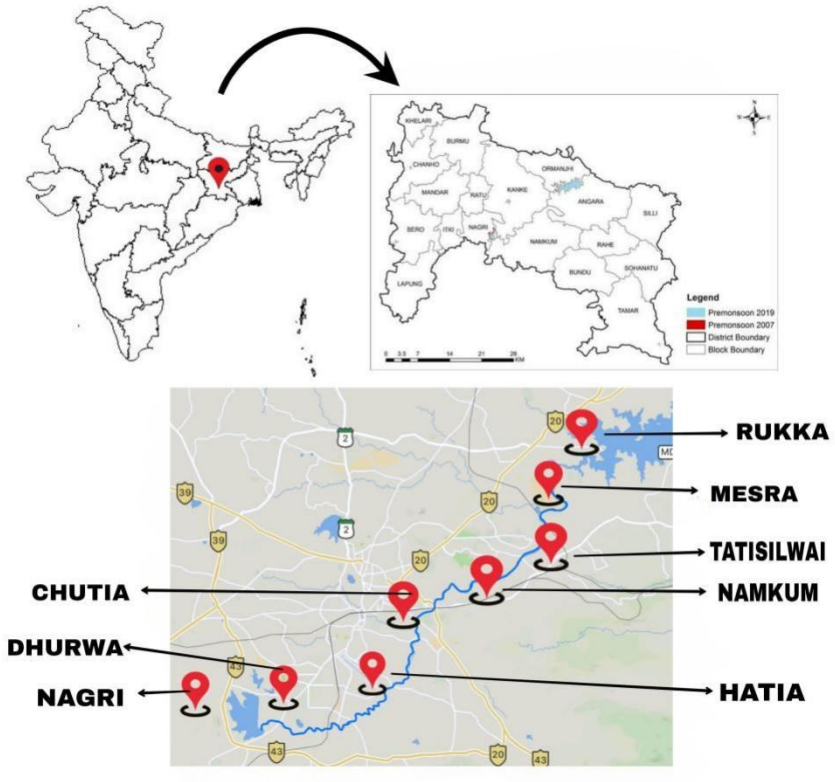

Fig 1: Map of Subarnarekha river showing the sampling site

2.7 Water Quality Index (WQI)

Water Quality Index (WQI) developed by Horton with approach of mathematical calculation with single value to represent the multiple water quality parameters **[7]**. Numerous techniques for assessing WQI have been developed in the last few decades by others authors also work on different water bodies using water quality index or pollution index (Smith, 1990; Dojlido*et a*l., 1994; Stambuk-Giljanvoic, 1999; Pesce and Wunderlin, 2000; Nagel *et al*., 2001; Kannel *et al*., 2007; Nasirian, 2007; Suyambu*et al*., 2010) **[26,3,27,18,13,8,14,28]**. The weighted arithmetic method has been used for calculating the WQI for several Indian rivers (Sargaonkar and Deshpande, 2003; Singh *et al*., 2008; Kankal *et al.,* 2012; Bidyabati and Nath S, 2023) **[19,23,7,2]**.

In the present study, pollution subindex graph and pollutant weight are used for the estimation of WQI **[23**]. All total nine parameters i.e. pH, Turbidity, DO, BOD_3, Total Hardness, Alkalinity, Chloride, Phosphorus and Chromium are included. The formula used to determine the water quality index can be noticed in the following arithmetic expression:

$$WQI = \sum [Pi.Wi]$$

Where,

Pi is the sub-index value;

Wi is the weight of each parameter.

TABLE 2: Water Quality Rating (Nath, S. 2007) [15]

Purpose	Classification				
	Excellent	Acceptable	Slightly polluted	Moderately polluted	Severely polluted
	Class I	Class II	Class III	Class IV	Class V
Drinking purpose	0-10	11-28	29-51	51-69	69 above
Bathing	0-10	11-30	31-61	62-85	85 above
Aquatic life	0-9	10-28	29-53	54-70	70 above

3. Results and Discussion

The river water quality at Subarnarekha River was determined in terms of weight arithmetic water quality index (WQI) using 9 selected parameters viz. pH, Turbidity, DO, BOD, Total Hardness, Alkalinity, Chloride, Phosphorus and Chromium. Water quality index in the historical and the present study is established from important various physiochemical parameters in different months. The water quality index was calculated with the help of subindex curves and weight of pollutant i.e given in the research paper **[23]**. The value of various parameters for calculation of WQI is given below.

3.1 Water quality assessment using WQI for month of January

The maximum value of WQI for January was 25.8 at Tatisilwai (S6) and the minimum value was 6.76 at Nagri (S1). The WQI value of the sampling site Nagri (S1) falls under the excellent category and sampling site from Dhurwa (S2) to Rukka (S8) falls under the acceptable category according to water quality rating. The possible reason for change in the class is due to the contamination of water during the observation period. (as shown in Table 3(a) and (b) and Figure 3(a) and (b).

Table 3(a) WQI for month of January at different sites of Subarnarekha river

Sites	S1	S2	S3	S4
WQI Value	6.76	11.7	14.6	22.2
WQI Status	Excellent	Acceptable	Acceptable	Acceptable

Table 3 (b) WQI for month of January at different sites of Subarnarekha river

Sites	S5	S6	S7	S8
WQI Value	23.4	25.8	18.9	14.3
WQI Status	Acceptable	Acceptable	Acceptable	Acceptable

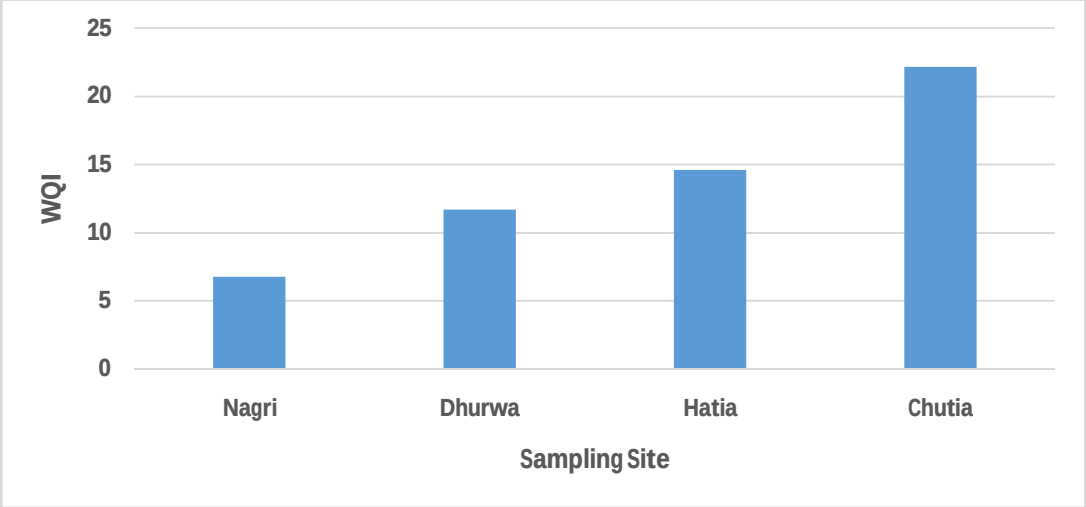

Fig. 3(a): WQI for the month of January at different sites Subarnarekha river

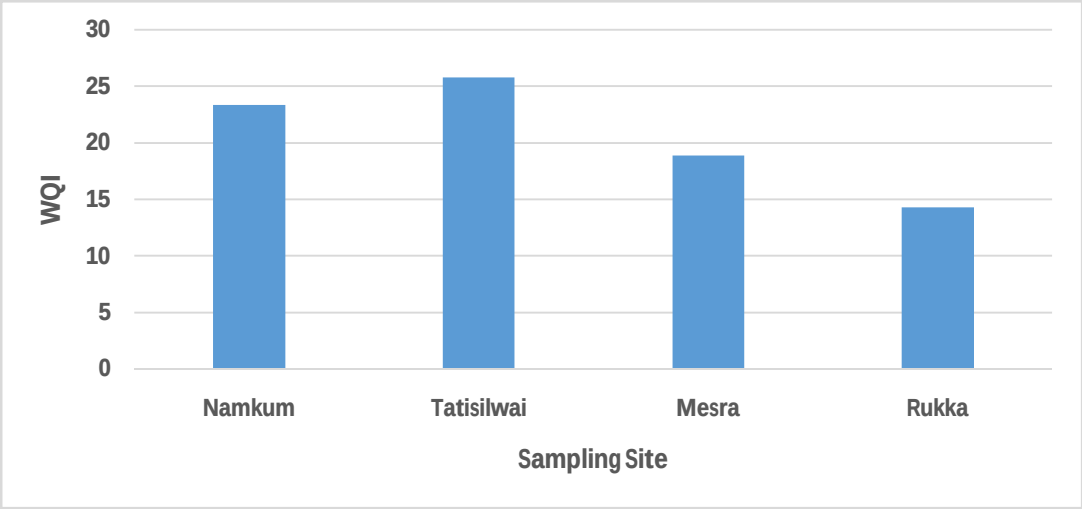

Fig. 3(b): WQI for the month of January at different sites Subarnarekha river

3.2 Water quality assessment using WQI for month of February

The maximum value of WQI for February was 25 at Tatisilwai (S6) and the minimum value was 8.43 at Dhurwa (S2). The WQI value of the sampling site Nagri (S1) and Dhurwa (S2) falls under the excellent category and sampling site from Hatia (S3) to Rukka (S8) falls under the acceptable category according to water quality rating. The possible reason for change in the class is due to the contamination of water during the observation period. (as shown in Table 4(a) and (b) and Figure 4(a) and (b).

Table 4(a) WQI for month of Feburary at different sites of Subarnarekha river

Sites	S1	S2	S3	S4
WQI Value	10.1	8.43	12.6	23.3
WQI Status	Excellent	Excellent	Acceptable	Acceptable

Table 4(b) WQI for month of Feburary at different sites of Subarnarekha river

Sites	S5	S6	S7	S8
WQI Value	23.6	25	17	12.8
WQI Status	Acceptable	Acceptable	Acceptable	Acceptable

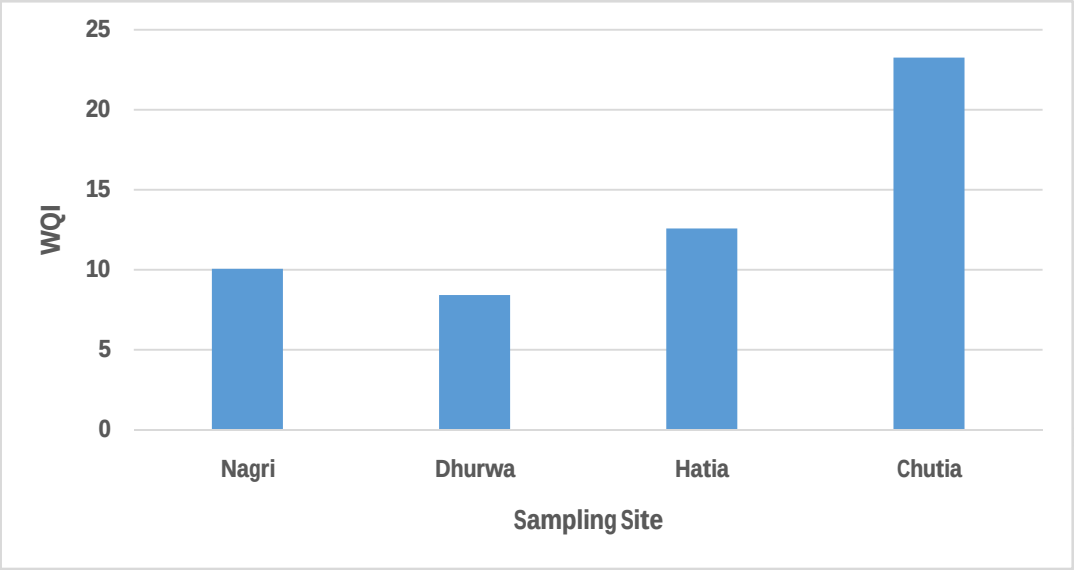

Fig 4(a): WQI for the month of February at different sites Subarnarekha river

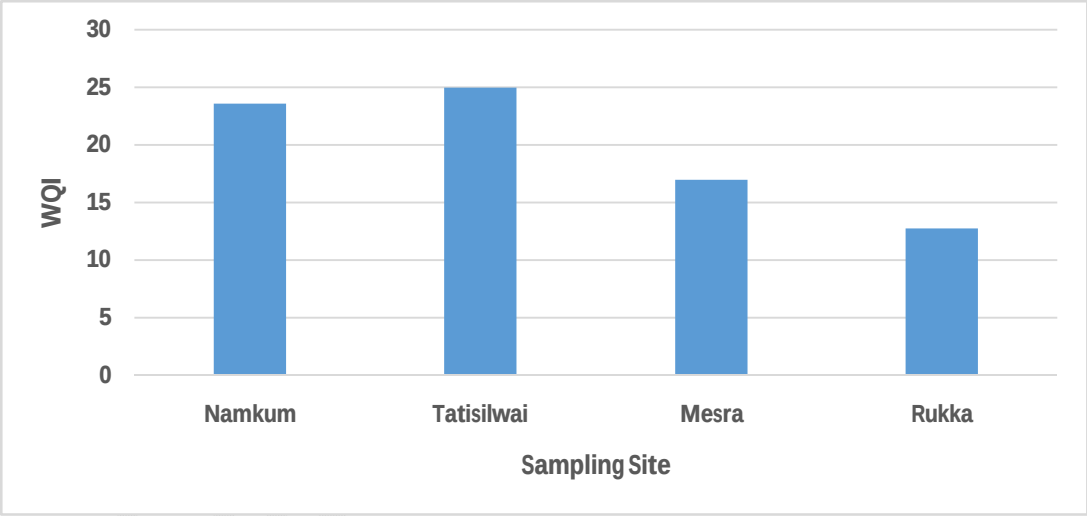

Fig 4(b): WQI for the month of February at different sites Subarnarekha river

3.3 Water quality assessment using WQI for month of March

The maximum value of WQI for March was 25.5 at Chutia (S4) and the minimum value was 9.85 at Dhurwa (S2). The WQI value of the sampling site Nagri (S1) and Dhurwa (S2) falls under the excellent category and sampling site from Hatia (S3) to Rukka (S8) falls under the acceptable category according to water quality rating. The possible reason for change in the class is due to the contamination of water during the observation period.(as shown in Table 5(a) and (b) and Figure 5(a) and (b).

Table 5(a) WQI for month of March at different sites of Subarnarekha river

Sites	S1	S2	S3	S4
WQI Value	10.3	9.85	12.4	25.5
WQI Status	Excellent	Excellent	Acceptable	Acceptable

Table 5(b) WQI for month of March at different sites of Subarnarekha river

Sites	S5	S6	S7	S8
WQI Value	24.1	24.2	18.4	14.3
WQI Status	Acceptable	Acceptable	Acceptable	Acceptable

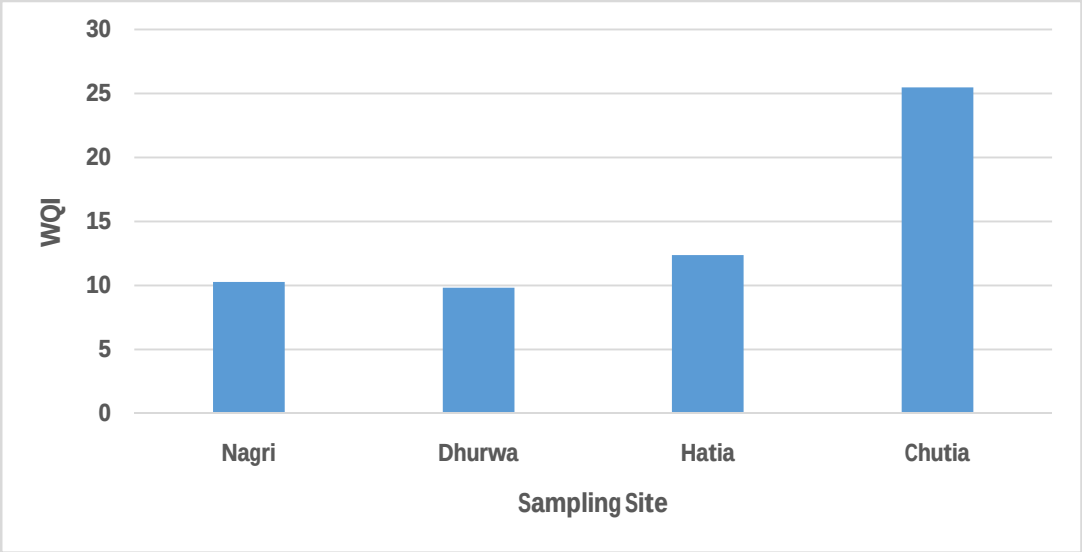

Fig 5(a): WQI for the month of March at different sites Subarnarekha river

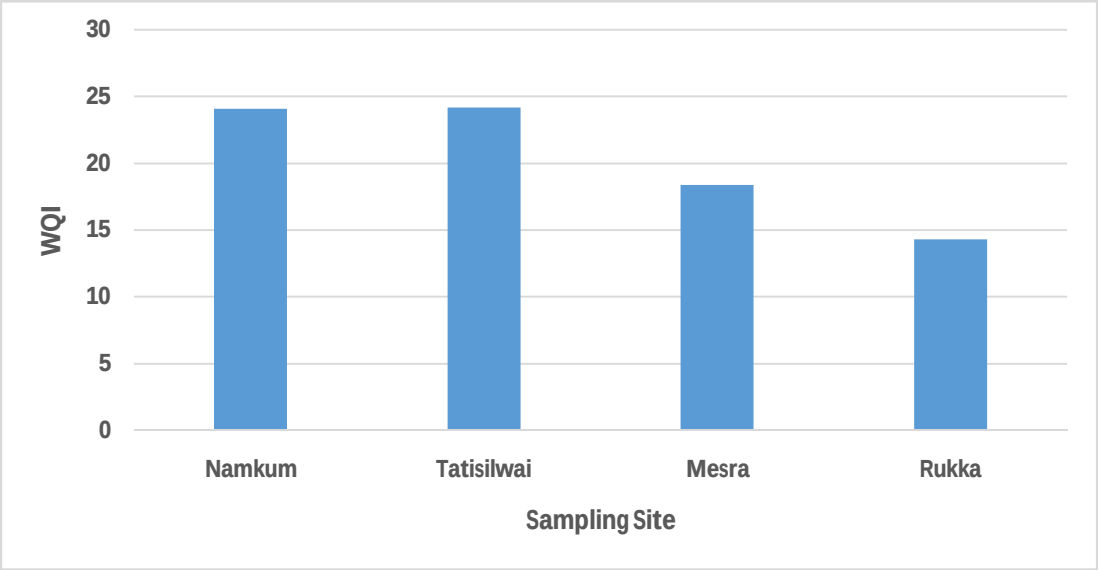

Fig 5(b): WQI for the month of March at different sites Subarnarekha river

3.4 Water quality assessment using WQI for month of April

The maximum value of WQI for April was 26.4 at Chutia (S4) and the minimum value was 11.1 at Nagri (S1). The WQI value of all the sampling site i.e Nagri (S1), Dhurwa (S2), Hatia (S3), Chutia (S4), Namkum (S5), Tatisilwai (S6), Mesra (S7) and Rukka (S8) falls under the acceptable category according to water quality rating. The possible reason for all the sites to fall under the category of acceptable is slightly high contamination of water during the observation period.(as shown in Table 6(a) and (b) and Figure 6(a) and (b).

Table 6(a) WQI for month of April at different sites of Subarnarekha River

Sites	S1	S2	S3	S4
WQI Value	11.1	11.2	13	26.4
WQI Status	Acceptable	Acceptable	Acceptable	Acceptable

Table 6(b) WQI for month of April at different sites of Subarnarekha river

Sites	S5	S6	S7	S8
WQI Value	24.1	24.5	22.7	14.3
WQI Status	Acceptable	Acceptable	Acceptable	Acceptable

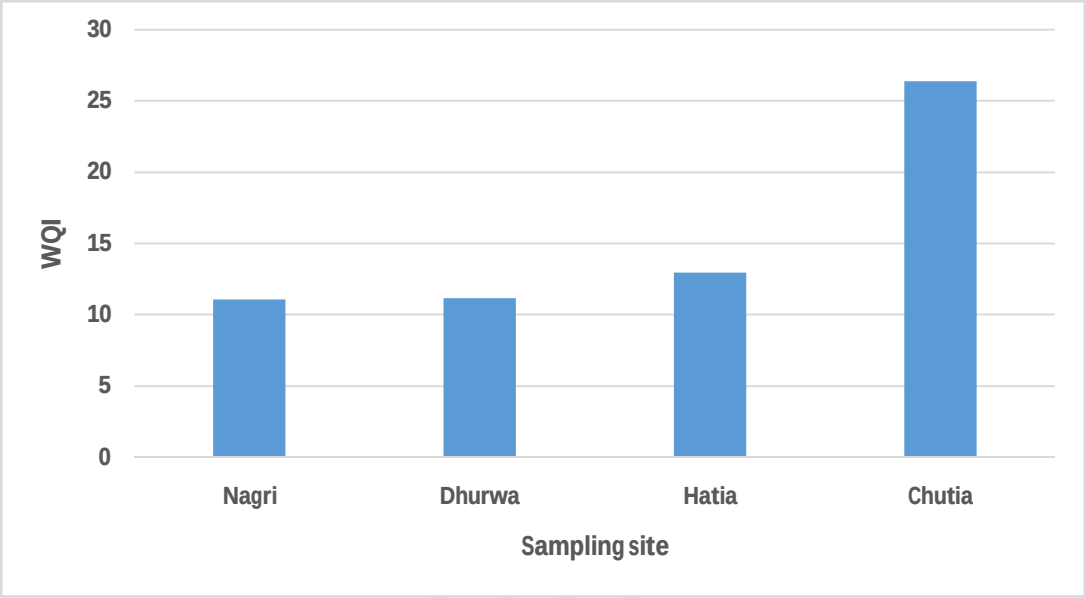

Fig 6(a): WQI for the month of April at different sites Subarnarekha river

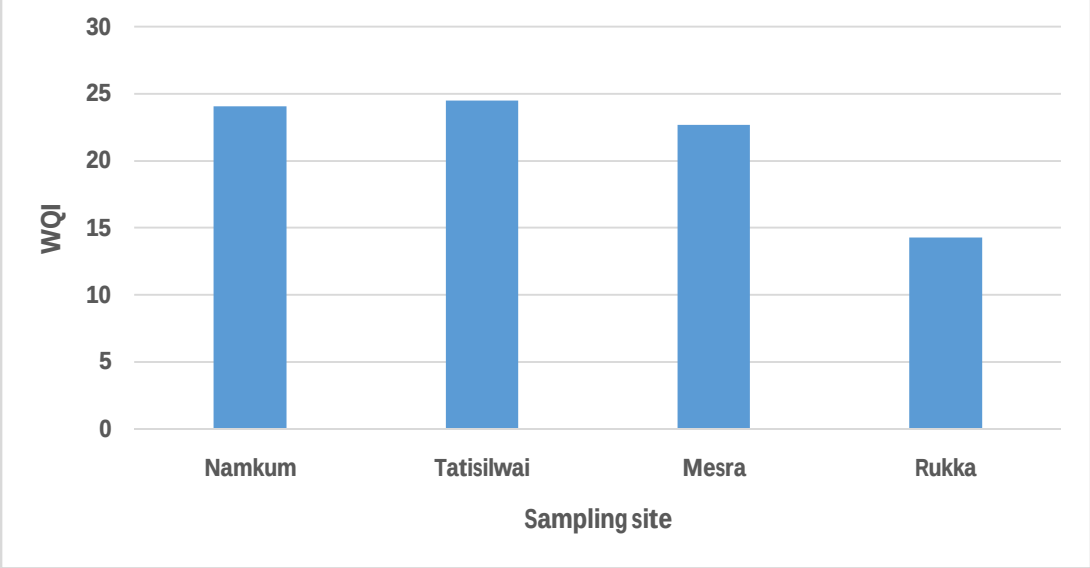

Fig 6(b): WQI for the month of April at different sites Subarnarekha river

3.5 Water quality assessment using WQI for month of May

The maximum value of WQI for May was 26.2 at Tatisilwai (S6) and the minimum value was 10.8 at Nagri (S1). The WQI value of the sampling site Nagri (S1) and Dhurwa (S2) falls under the excellent category and sampling site from Hatia (S3) to Rukka (S8) falls under the acceptable category according to water quality rating. The possible reason for change in the class is due to the contamination of water during the observation period.(as shown in Table 7(a) and (b) and Figure 7(a) and (b).

Table 7(a) WQI for month of May at different sites of Subarnarekha river

Sites	S1	S2	S3	S4
WQI Value	10.8	10.9	13.1	25.2
WQI Status	Excellent	Excellent	Acceptable	Acceptable

Table 7(b) WQI for month of May at different sites of Subarnarekha river

Sites	S5	S6	S7	S8
WQI Value	22.9	26.2	19.5	15.7
WQI Status	Acceptable	Acceptable	Acceptable	Acceptable

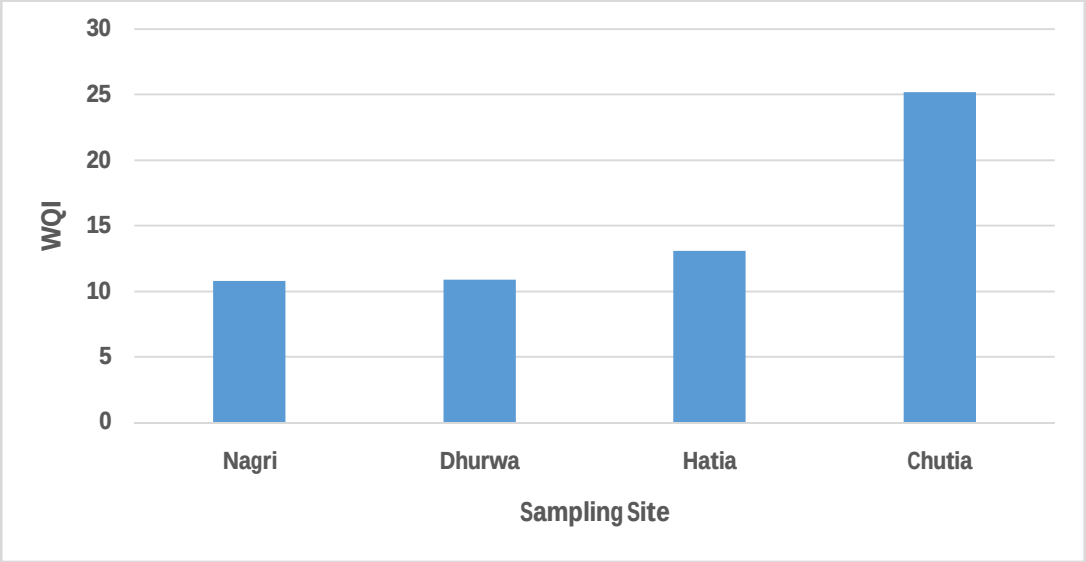

Fig 7(a): WQI for the month of May at different sites Subarnarekha river

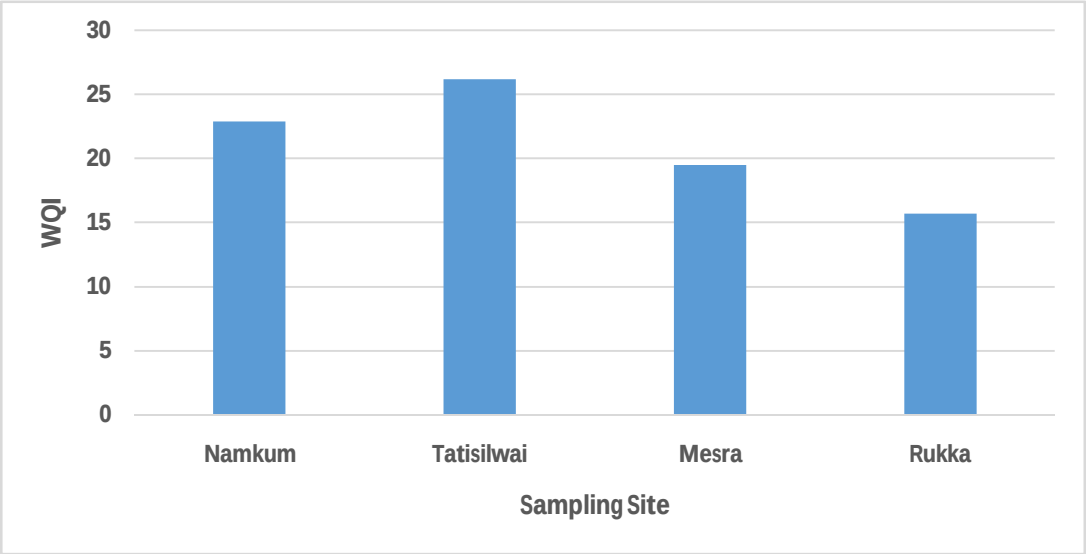

Fig 7(b): WQI for the month of May at different sites Subarnarekha river

4. Conclusion

Water quality index value for Subarnarekha river falls between the category of excellent to acceptable water quality, as they were recorded between 6.76 - 26.4, which can be considered as excellent to acceptable quality levels according to the water quality. The WQI value for Site 1 and Site 2 falls under the excellent category throughout the observation period, expect in the month of April the water of the river from originating point is found in excellent category afterwards slightly variation in water quality index in different sites due to the anthropogenic activities.

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