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Water Quality Assessment of Some Rivers Near Railway Bridge Construction Sites

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ABSTRACT

In this study, analysis of the water quality parameters of three rivers i.e. Tangari, Ghaggar and Markanda in the state of Haryana, India was done with the standard procedures. After analysis and testing, water quality parameters were represented numerically. All the permissible limits were noted as prescribed by the MoEF & CC, BIS, etc. and compared with the observed values. The water quality parameters like pH, TDS, TSS, TA, TH, Ca^{2+}, Mg^{2+}, Cl^{-}, F^{-}, PC, Pb and Cr, near the railway bridge construction sites, were observed below the permissible limits. However, the average values of turbidity in all the rivers near the construction site exceeded the permissible limits, indicating that it may adversely affect the biota of that region.

Key words: River water, water quality, pH, turbidity, chloride

INTRODUCTION

The sustainability of every development project needs consideration of environmental, economic and social factors from the conceptual stage of the project (Armenia *et al.*, 2019). For the reduction of adverse impacts and for the betterment of the environment, economic and social enhancement opportunities an environmental impact assessment study of railway bridge projects is necessary (Henke *et al.*, 2020). Railway bridge construction over natural streams may affect the environment in many ways (Angyal *et al.*, 2016). Trains travelling over the railway bridge create noise and vibration. Therefore, all bridge construction projects have to identify possible potential impacts on the environment of the local community (Ongkowijoyo *et al.*, 2020).

The construction of a railway bridge is very important for the growth of the economic status of the community and country as a whole and also enhances mobility (Pulido *et al.*, 2018). The impacts due to the construction of railway bridges over any river or natural stream include deterioration of natural landscape, ecosystem, air, water, soil quality, etc. (Singh and Singh, 2017). However, railway bridges that were planned, designed and constructed inappropriately have more negative consequences (Xue *et al.*, 2015). Therefore, Railway bridges should be of high quality so that they can minimize the adverse impacts. This can be achieved by implementing a suitable environmental plan at all stages of railway bridge construction.

The construction of railway bridges over any river or stream will affect river water quality and quantity either directly or indirectly (Iqbal *et al.*, 2018). Therefore, baseline data collection is very important to assess the negative consequences on river water quality and biota (Musonge *et al.*, 2019). The physico-chemical and biological qualities of water that are generally affected by any construction project (Naveen *et al.*, 2017) are pH, suspended solids, turbidity, total dissolved solids, chlorides, phytoplankton, fish life, etc. Realizing the above facts, a systematic study was planned and conducted to assess the river water quality near the railway bridge construction site. However, significant studies related to river water quality were done by many researchers (Arun *et al.*, 2015a, b; Chadetrik *et*

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al., 2015; Bora and Goswami, 2017; Rout, 2017; Dutta *et al.*, 2018; Jaiswal *et al.*, 2019; Lkr *et al.*, 2020; Ali *et al.*, 2021; Krishan *et al.*, 2022; Sharma and Gupta, 2022).

MATERIALS AND METHODS

In order to assess the river water quality near the railway bridge construction site (50 m downstream), a total of 36 river water samples were collected from the rivers Tangari, Ghaggar and Markanda (Fig. 1).

Water sampling was done for three sampling periods in Jan 2019, June 2019 and November 2019. All water samples were collected and analyzed according to the vision of APHA, 2005. The river Markanda is a perennial, whereas Tangari and Ghaggar are seasonal rivers. The detailed descriptions of proposed railway bridges are given in Table 1.

Tangari, Ghaggar and Markanda railway bridges are part of project design and construction of a civil, structure and track works for single line railway involving formation in embankment/cutting, ballast on formation, track works, bridge structures, buildings, yards and integration with Indian railway's existing railway system and testing and commissioning on design-build lump sum basis of Pilkhani-Sahnewal section (Approx. 175 km) of eastern dedicated freight corridor and are being constructed over the rivers Tangari, Ghaggar and Markanda.

RESULTS AND DISCUSSION

Various water quality parameters (Physico-chemical) like pH, turbidity, TDS, TSS, TA, TH, Ca^{2+}, Mg^{2+}, Cl^{-}, F^{-}, PC, Pb and Cr were analyzed and discussed. Due to the absence of PC, Pb and Cr these are not discussed.

The observed pH values were 7.98, 7.61 and 7.52 during the months of January, June and November 2019 of the river water at the Tangri bridge construction site (Table 2). The pH value reached maximum during the month of January 2019 and minimum during the month of November 2019. The average value was calculated as 7.70 with a standard deviation of 0.24. The pH value of river water fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of class A to E.

Fig. 1. Sampling locations near the rivers Tangari, Ghaggar and Markanda.

The observed pH values at the Ghaggar bridge construction site were 7.85, 7.67 and 7.71 during the months of January, June and November 2019, respectively. The pH value reached maximum during the month of January 2019 and minimum during the month of November 2019. The average value was calculated as 7.74 with a standard deviation of 0.09. The pH value of river water fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of class A to E.

Table 1. Description of proposed truss well type railway bridges

Bridge	No. of spans	Span length (m)	UTM coordinates		District
			X (Easting) (m)	Y (Northing) (m)	
Tangari	3	46.50	679030	3354424	Ambala
Ghaggar	6	30.00	666163	3364299	Ambala
Markanda	6	47.24	689426	3347552	Ambala

Table 2. Physico-chemical characteristics of river water at Tangari, Ghaggar and Markanda bridges

S. No.	Railway bridge	Parameter	January 2019	June 2019	November 2019	Average
1.	Tangri	pH	7.98	7.61	7.52	7.70±0.24
	Ghaggar		7.85	7.67	7.71	7.74±0.09
	Markanda		7.82	7.31	7.20	7.44±0.33
2.	Tangri	Turbidity	115.00	22.60	109.00	82.20±51.70
	Ghaggar		119.00	28.72	105.00	84.24±48.59
	Markanda		108.00	24.10	22.90	51.67±48.79
3.	Tangri	TDS	187.21	120.00	181.20	162.80±37.19
	Ghaggar		254.21	182.00	234.80	223.67±37.37
	Markanda		435.00	178.00	406.00	339.67±140.76
4.	Tangri	TSS	44.28	40.50	43.20	42.66±1.95
	Ghaggar		33.54	29.90	32.50	31.98±1.87
	Markanda		60.00	34.85	34.67	43.17±14.57
5.	Tangri	TA	105.6	109.2	98.55	104.45±5.41
	Ghaggar		137.2	128.90	132.58	132.89±4.16
	Markanda		209.20	140.70	132.58	160.83±42.09
6.	Tangri	TH	157.00	143.00	129.00	143±14.0
	Ghaggar		198.00	118.00	181.00	165.67±42.15
	Markanda		278.50	124.00	330.00	244.17±107.21
7.	Tangri	Ca^{2+}	31.25	29.85	29.21	30.10±1.04
	Ghaggar		28.13	23.54	24.80	25.49±2.37
	Markanda		80.10	28.65	76.15	61.63±28.63
8.	Tangri	Mg^{2+}	14.21	13.25	13.58	13.68±0.49
	Ghaggar		15.24	14.40	14.67	14.77±0.43
	Markanda		19.11	12.76	15.70	15.86±3.18
9.	Tangri	Cl-	41.25	38.50	40.25	40.00±1.39
	Ghaggar		34.21	27.63	33.85	31.90±3.70
	Markanda		80.10	23.80	67.23	57.04±29.51
10.	Tangri	F-	0.29	0.25	0.27	0.27±0.02
	Ghaggar		0.86	0.78	0.76	0.80±0.05
	Markanda		0.60	0.41	0.49	0.50±0.10

The observed pH values at the Markanda bridge construction site was 7.82, 7.31 and 7.20 during the months of January, June and November 2019, respectively. The pH value reached maximum during the month of January 2019 and minimum during the month of June 2019. The average value was calculated as 7.44 with a standard deviation of 0.33. The pH value of river water fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of class A to E.

The observed values of turbidity in river water at the Tangri bridge construction site are shown in Table 2. The values of turbidity were found to be 115.0, 22.60 and 109.0 NTU during the months of January, June and November 2019, respectively. The turbidity value was maximum in the month of January 2019 and minimum in the month of June 2019. The average value was calculated as 82.20±51.70 NTU. The turbidity value of river water exceeded the desirable limit as prescribed by BIS (IS- 10500-1991) for drinking water purposes.

The observed values of turbidity in river water at the Ghaggar bridge construction site were 119.0, 28.72 and 105.0 NTU during the months of January, June and November 2019, respectively. The turbidity value was maximum in the month of January 2019 and minimum in the month of June 2019. The average value was calculated as 84.24±37.37NTU. The turbidity value of river water exceeded the desirable limits as prescribed by BIS (IS-10500-1991) for drinking water purposes.

The observed values of turbidity in river water at the Markanda bridge construction site were 108.0, 24.10 and 22.90 NTU during the months of January, June and November 2019, respectively. The turbidity value was maximum in the month of January 2019 and minimum in the month of November 2019. The average value was calculated as 51.67±48.79 NTU. The turbidity value of river water exceeded the desirable limit as prescribed by BIS (IS-10500-1991) for drinking water purposes.

Table 2 shows the observed TDS values in the river water at the Tangri bridge construction site. The TDS values were 187.21, 120.00 and 181.2 mg/l observed during the months of January, June and November 2019, respectively. The TDS value was found to be maximum during January 2019 and

minimum during June 2019. The average value was calculated as 162.80±37.19 mg/l. The TDS value of river water fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of classes A, B and E.

The observed TDS values in the river water at the Ghaggar bridge construction site were 254.21, 182.0 and 234.8 mg/l during the months of January, June and November 2019, respectively. The TDS value was found maximum during January 2019 and minimum during June 2019. The average value was calculated as 223.67±37.37 mg/l. The TDS value of river water fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of classes A, B and E.

The observed TDS values in the river water at the Markanda bridge construction site were 435.0, 178.0 and 406.0 mg/l during the months of January, June and November 2019, respectively. The TDS value was found to be maximum during January 2019 and minimum during June 2019. The average value was calculated as 339.67±140.76 mg/l. The TDS value of river water fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of classes A, B and E.

The observed TSS values in the river water at the Tangri bridge construction site are presented in Table 2. The TSS values were 44.28, 40.50 and 43.20 mg/l observed during the months of January, June and November 2019, respectively. TSS value was maximum during the month of January 2019 and minimum during the month of June 2019. The average TSS value was found 42.66±1.95 mg/l.

The observed TSS values in the river water at the Ghaggar bridge construction site were 33.54, 29.90 and 32.5 mg/l observed during the months of January, June and November 2019, respectively. TSS value was maximum during the month of January 2019 and minimum during the month of June 2019. The average TSS value was 31.98±1.87 mg/l.

The observed TSS values in the river water at the Markanda bridge construction site were 60, 34.85 and 34.67 mg/l, during the months of January, June and November 2019, respectively. TSS value was maximum during the month of January 2019 and minimum during the month of November 2019. The average TSS value was found 43.17±14.57 mg/l. However, there are no specific tolerance limits mentioned for TSS in ISI-IS: 2296-1982.

The total alkalinity of the river water at the Tangri bridge construction site was 105.6, 109.2 and 98.55 mg/l during the months of January, June and November 2019, respectively (Table 2). The alkalinity value was maximum during the month of June 2019 and minimum during the month of November 2019. The average alkalinity value was 104.45±5.41 mg/l. The total alkalinity of the river water at the Ghaggar bridge construction site was 137.2, 128.90 and 132.58 mg/l during the months of January, June and November 2019, respectively. The alkalinity value was maximum during the month of January 2019 and minimum during the month of June 2019. The average alkalinity value was 132.89±4.16 mg/l. The total alkalinity of the river water at the Markanda bridge construction site was 209.20, 140.70 and 132.58 mg/l during the months of January, June and November 2019, respectively. The alkalinity value was maximum during the month of January 2019 and minimum during the month of November 2019. The average alkalinity value was 160.83±42.09 mg/l.

The total hardness of the river water quality at the Tangri bridge construction site was 157.0, 143.0 and 129.0 mg/l during the months of January, June and November 2019, respectively (Table 2). The total hardness was maximum during the month of January 2019 and minimum during the month of November 2019. The average value was calculated as 143.0±14.0 mg/l. The total hardness of the river water quality at the Ghaggar bridge construction site was 198.0, 118.0 and 181.0 mg/l during the months of January, June and November 2019, respectively. The total hardness was maximum during the month of January 2019 and minimum during the month of June 2019. The average value was calculated as 165.67±42.15 mg/l. The total hardness of the river water quality at the Markanda bridge construction site was 278.50, 124 and 330 mg/l during the months of January, June and November 2019, respectively. The total hardness was maximum during the month of November 2019 and minimum during the month of June 2019. The average value was calculated as 224.17±107.21 mg/l. The TH value of river water fulfilled the criteria of tolerance

limits as mentioned in ISI-IS: 2296-1982 and was found under the category of class A in all three bridge sites.

Table 2 shows the Ca^{2+} content in river water at the Tangri bridge construction site. The observed values were 31.25, 29.85 and 29.21 mg/l during the months of January, June and November 2019, respectively. The maximum Ca^{2+} content was observed during January 2019 and minimum during November 2019. The average Ca^{2+} content was calculated as 30.10±1.04 mg/l. The observed Ca^{2+}values at the Ghaggar bridge construction site were 28.13, 23.54 and 24.8 mg/l during the months of January, June and November 2019, respectively. The maximum Ca^{2+} content was observed during January 2019 and minimum during June 2019. The average Ca^{2+} content was calculated as 25.49±2.37 mg/l. The observed Ca^{2+}content in river water at the Markanda bridge construction site was 80.10, 28.65 and 76.15 mg/l during the months of January, June and November 2019, respectively. The maximum Ca^{2+} content was observed during January 2019 and minimum during June 2019. The average Ca^{2+} content was calculated as 61.63±28.63 mg/l. The Ca^{2+} values of river water under all three bridge sites were found below the desirable limit as prescribed by BIS (IS-10500-1991) for drinking water purposes.

The observed values of Mg^{2+} content in the river water at the Tangri bridge construction site are shown in Table 2. The Mg^{2+} content was 14.21, 13.25 and 13.58 mg/l observed during the months of January, June and November 2019, respectively. The maximum value was observed in January 2019 and minimum in June 2019. The Mg^{2+} content was 15.24, 14.4 and 14.67 mg/l observed during the months of January, June and November 2019, respectively. The maximum Mg^{2+} content was found during January 2019 and minimum during June 2019. The Mg^{2+} content was 19.11, 12.76 and 15.70 mg/l found during the months of January, June and November 2019, respectively. The maximum Mg^{2+} content was observed during January 2019 and minimum during June 2019. The average value was calculated as 15.86±3.18 mg/l. The Mg^{2+} value of river water under all three construction sites fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of class A.

The Cl^- content in the river water at the Tangri bridge construction site was 41.25, 38.50 and 40.25 mg/l during the months of January, June and November 2019, respectively. The maximum Cl^- content was noticed in the month of January 2019 and minimum in the month of June 2019. The average Cl^- content was calculated as 40.00±1.39 mg/l. Similarly, the Cl^- content in the river water at the Ghaggar bridge construction site was 34.21, 27.63 and 33.85 mg/l during the months of January, June and November 2019, respectively. The maximum Cl^- content was observed in the month of January 2019 and minimum in the month of June 2019. The average Cl^- content was calculated as 31.90±3.70 mg/l. The observed Cl^- content in the river water at the Markanda bridge construction site was 80.10, 23.80 and 67.23 mg/l during the months of January, June and November 2019, respectively. The maximum Cl^- content was found in the month of January 2019 and minimum in the month of June 2019. The average Cl^- content was calculated as 57.04±29.50 mg/l. The Cl^- value of river water under all three construction sites fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of classes A, C and E.

Table 2 shows the F^-content in river water at the Tangri bridge construction site. The F^- content was 0.29, 0.25 and 0.27 mg/l observed during the months of January, June, and November 2019, respectively. The maximum F^- content was found during January 2019 and minimum during June 2019. The average F^- content was calculated as 0.27±0.02 mg/l. The fluoride content in river water at the Ghaggar bridge construction site was 0.86, 0.78 and 0.76 mg/l during the months of January, June and November 2019, respectively. The maximum fluoride content was observed during January 2019 and minimum during November 2019. The average fluoride content was calculated as 0.80±0.05 mg/l. The F^- content in river water at the Markanda bridge construction site was 0.60, 0.41 and 0.49 mg/l during the months of January, June and November 2019, respectively. The maximum F^- content was observed during January 2019 and minimum during June 2019. The average F^- content was calculated as 0.50±0.10 mg/l. The F^- value of river water of all three bridge sites fulfilled the criteria of tolerance limits as mentioned in ISI-IS: 2296-1982 and was found under the category of classes A, B and C.

CONCLUSION

Water quality parameters of three rivers i.e. Tangari, Ghaggar and Markanda in the state of Haryana, India were studied. In all cases, the river water quality near the study areas was found to be alkaline in nature. The water turbidity of all the three rivers indicated "not suitable" for drinking purposes. However, could be used for irrigation, pisciculture, industrial cooling, bathing purposes after conventional treatment.

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