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Assessment of seasonal variation in physico-chemical characteristics and quality of Torsha River water for irrigation used in Cooch Behar and Jalpaiguri districts of West Bengal, India

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ABSTRACT

In present investigation an attempt was made for assessment of Seasonal Variation in Physicochemical Characteristics and Quality of Torsha River Water for Irrigation during a year. The study reveals that most of the physicochemical parameters of river water at five selected sites show moderate variation in their concentration for all seasons. This is an evidence of discharge of waste water from the towns and various human activities in the catchments of the river.

Keywords - Assessment, Variation, Water quality index, Irrigation.

INTRODUCTION

Water plays an essential role in human life. Although statistics vary, the World Health. Organization (WHO) reports that approximately 36% of urban and 65% of rural Indian's were without access to safe drinking water (WHO, 2009) [1]. The consequence of urbanization and industrialization leads to spoil the water. For agricultural purposes ground water is explored in rural areas especially in those areas where other sources of water like dam and river or the canal is not available [2]. Indian agriculture receives most of its water from surface sources like river, reservoir, dam etc [3]. However, now a day the river water is largely influenced by discharge of industrial as well as domestic waste while flowing through big towns and increases the water pollution in rivers [4]. This changes the physical and chemical characteristics of river water and hence the quality for different use [5]. River water though has some self purification capacity,

but in most instances the level and quality of wastes and effluent discharged are far beyond the purifying capacity [6]. In spite of the fact that, the quality of river at any point reflects several major natural influences, like lithology of the basin, atmospheric inputs and climatic conditions but on the other hand municipal and industrial activity on the bank of river constantly discharge degraded water in all season and pollute the river water artificially. In many parts of the world the polluted water from river is used for irrigation purpose in agriculture without assessing its suitability [7, 8]. This affects the crop productivity as well as deteriorates the quality of soil. Hence, in present investigation an attempt has been made to assess the seasonal variation of physico-chemical characteristics and hence quality of Torsha river water for irrigation purpose of Cooch Behar and Jalpaiguri districts in West Bengal.

EXPERIMENTAL SECTION

Study Area

Torsha is an international river which is also known as **Machu** and **Amo Chhu**. It rises from the Chumbi Valley in Tibet, China, where it is known as Machu. Then it flows into Bhutan with name Amo Chu. It has total length of 358 km, out of which 113 km in China and 145 km in Bhutan before flowing into the northern part of West Bengal in India. Torsha enters in West Bengal through the important border towns, Phuntsholing (in Bhutan) and Jaigaon of district Jalpaiguri (on the Indian side of the border) [9]. After crossing a distance of 45.06 km. the river flows to Cooch Behar through Patlakhaowa and leaves the district from Gitaldah, Dinhata and enters into Bangla Desh [10]. The river supplies water for different purposes including agriculture, domestic, drinking and industrial purpose to number of villages and towns. The untreated domestic sewage of these villages and towns is being discharged directly in the river throughout the year and increases the pollution load on the river water. Water from this river in both the districts is being used mostly for agriculture purpose. Therefore suitability of water for irrigation is always in question throughout the year. For the purpose of our study we have considered Torsha River along Jalpaiguri and Cooch Behar districts, two sample sites from each district and one from the boarder line of two. Cooch Behar lies between $25^{o}57'47"$ to $26^{o}36'2"$ North latitude and between $89^{o}54'35"$ to $88^{o}47'44"$ East longitude. The area of the district is 3387 sq. kms, which contributes 3.82% of the land mass of the state of West Bengal [11]. Jalpaiguri is the largest district of North Bengal in West Bengal, covering an area 6245 sq. kms. It is situated between $26^{o}16'$ and $27^{o}0'$ North latitudes and $88^{o}4'$ and $89^{o}53'$ East longitudes [12].

Methodology

In all, five sampling sites were selected for all season (Pre-monsoon, and Post-Monsoon) on the river at Jalpaiguri and Cooch Behar, keeping in view the flow of water and discharge of domestic waste in river. These sites were recognized as Site 1, 2, 3, 4 and 5. The samples were collected from these sites on monthly basis for a period of one year. The pH, Electrical Conductivity (EC) and Total Dissolved Solids (TDS) were measured on site using digital pH, EC and TDS meters respectively. One liter sample from these sites were collected in plastic container and filtered in laboratory. The filtered samples were analyzed for the parameters such as Total Hardness (TH), Alkalinity (TA), Chloride (Cl), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD). The results obtained are averaged out for different seasons and are presented in table 1.

Table 1-Average values of physico chemical characteristics, of Torsha River water for different season in study area

Physico-Chemical Parameters													
Season	**Site**	**pH**	**Conduc-tivity**	**TDS**	**TSS**	**Total Hardness**	**Alkalinity**	**Chloride**	**D.O**	**BOD**	**COD**	**Total "N"**	**Total "P"**
	1	8.5	163.8	83.6	36.7	91.8	59.5	4.9	8.2	1	6.3	1.9	9.8
	2	8.4	185.8	96.8	48.5	82.9	92.1	4.8	7.9	1.3	4.2	1.8	56.6
Pre-	**3**	8.2	177.1	95.5	46.6	64.6	97.3	6.4	7	0.9	3.1	11.6	62.1
Monsoon	**4**	7.9	136.7	96.1	43	40	117.9	8.1	6.6	1.1	2.2	18.1	57.4
	5	8.2	122	187.9	118.1	44	89.6	7	6.5	0.6	2.2	19.4	33
	Avg.	8.24	157.08	111.98	58.58	64.66	91.28	6.24	7.24	0.98	3.6	10.56	43.78
	1	7.8	143.3	77.3	204.5	38.8	83.2	8	6.9	1.1	5.2	0.1	14.4
Post	**2**	7.8	139.3	76.7	350.7	59.7	104.5	8.9	7.3	2.5	5.8	0.6	85.9
Monsoon	**3**	8.3	247.6	227.3	52.3	118.4	109.5	7.2	8	1.3	4.6	18.7	86.2
	4	8.2	165	242.4	22.8	123.9	117.4	8	8.1	1.1	2	11	42.8
	5	8.2	143.7	95.4	28.1	59	101.4	8.5	8.3	1.1	2.6	17.3	5.9
	Avg.	8.06	167.78	143.82	131.68	79.96	103.2	8.12	7.72	1.42	4.04	9.54	47.04

RESULTS AND DISCUSSION

It is observed from table 1 that average values of 12 (twelve) physicochemical parameters of Torsha River water shows wide fluctuation in their concentration for different seasons. Some important parameters like TDS (83.6 to 187.9 mg/l), Total Hardness (40 to 91.8 mg/l), Chloride (4.8 to – to 8.1 mg/l), Alkalinity (59.5 to 117.9 mg/l), Phosphate (56.6 to 86.2 mg/l), and the indicator parameters like BOD (0.6 to 1.3 mg/l), COD (2.2-6.3 mg/l) showed minimum and maximum concentration as shown in parenthesis for Pre monsoon season. It is also clear that variation in parameter of water in pre-monsoon are not remain constant for minimum and maximum concentration during post monsoon.

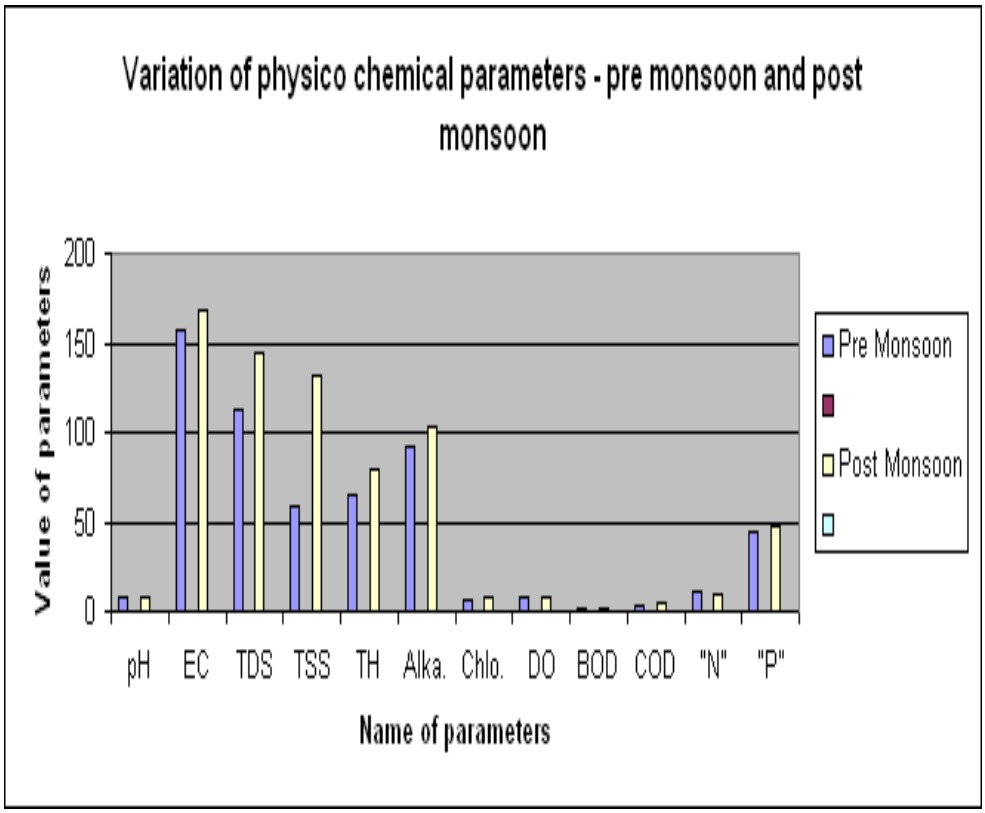
Post-monsoon characteristics of river water when compared with pre monsoon shows increased concentration of EC, TDS, TH, Cl, PO4, BOD and COD. This fluctuation may be attributed by the activities like discharge of sewage in the river and decreased and periodical flow of water in the river after monsoon season.

The average value of each parameter at 5 sample sites in different season are shown in table 2.

	Pre Monsoon		**Post Monsoon**	
pH	8.24		8.06	
EC	157.08		167.78	
TDS	111.98		143.82	
TSS	58.58		131.68	
TH	64.66		79.96	
Alka.	91.28		103.2	
Chlo.	6.24		8.12	
DO	7.24		7.72	
BOD	0.98		1.42	
COD	3.6		4.04	
"N"	10.56		9.54	
"P"	43.78		47.04	

All the values shown in table 1 and table 2 are in PPM Unit except EC (in Mho/cm) and pH.

Fig. 1 Variation of water quality parameters in different season



Calculation of Water Quality Index (WQI)

Water quality index is a 100 point scale that summarizes results from a total of nine different measurements. These are Temperature, pH, Dissolved Oxygen, Fecal Coliform, Total Phosphate, Nitrates, Turbidity, Total Suspended Solid and Biochemical Oxygen Demand [13, 14].

The nine different measurements or water quality factors and their corresponding weight are summarized in table 3.

Table 3 - Water Quality Factors and Weights

Factor	Weight
Dissolved oxygen	0.17
Fecal coliform	0.16
pH	0.11
Biochemical oxygen demand	0.11
Temperature change	0.10
Total phosphate	0.10
Nitrates	0.10
Turbidity	0.08
Total solids	0.07

Conversion of dissolved oxygen (ppm) to % of saturation for calculation of water quality index purpose:

DO of the study sample / Maximum DO at the temperature of the sample = % DO Saturation [15].

= 7.48 (ppm) / 8.5 (ppm) at 23.5^{o}C
= 88 % DO Saturation.

Calculated result of Overall Water Quality Index [13, 14].

Factor	Weight	Quality Index
Dissolved oxygen	0.17	93
Fecal Coliform	0.16	
pH	0.11	79
Biochemical oxygen demand	0.11	93
Temperature change	0.10	
Total phosphate	0.10	2
Nitrates	0.10	
Turbidity	0.08	
Total solids	0.07	84

Calculated by using - Source Code: Keith Alcock's Javascript WebMaster: webmaster@alcock.vip.best.co

Based on the 5 factors entered, the water quality index is 73. The 100 point index can be divided into several ranges corresponding to the general descriptive terms shown in the table below [13].

Water Quality Index Legend

Range	Quality
90-100	Excellent
70-90	**Good**
50-70	Medium
25-50	Bad
0-25	Very bad

Water Quality Index is 73, which is in the range of 70 to 90 i.e. the water quality of the study sites is good for irrigation.

CONCLUSION

From the above discussion and the result analysis in different aspects it may be concluded that Torsha river water quality is **good** as the water quality index for this river water is **73**, based on 5 quality parameters indicating suitability of water for irrigation purpose. The graph shows that the concentration of most of parameters increase in post monsoon season which means that the anthropogenic influences such as urbanisation and agricultural activities are the main cause for deterioration of water quality.

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