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Observation on the TDS and EC Values of Different Water Bodies at Cooch Behar, West Bengal, India

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ABSTRACT: A study was carried out on thirteen selected water bodies at Cooch Behar district of West Bengal to observe the values of Total Dissolved Solids (TDS) and Electrical Conductivity (EC) during the pre-monsoon period (April - June) of the year 2017. We restrict ourselves in the two important water quality parameters – Total Dissolved Solids and Electrical Conductivity as they might have some relationship. Although, the observed values of all the samples were within prescribed limits, but the estimated values, statistical analysis and Pearson product-moment correlation between Total Dissolved Solids and Electrical Conductivity clearly indicates that there is a positive correlation between these two parameters. The correlation coefficient also may be regarded as highly significant between these two parameters. Interestingly, Electrical conductivity can be used to give a rough estimate of the total amount of dissolved solids in water. Typically, the total dissolved solids value in ppm is about half of the electrical conductivity (µS/cm). From present study, it is predicted that, these two important water quality parameters (TDS and EC) are supposed to be highly co-related.

Key words: Water bodies, Total Dissolved Solids, Electrical conductivity, Correlation.

I. INTRODUCTION

All living organisms on the earth need water for their survival and growth. The term "Water quality" refers for the physical, chemical and biological parameters of water and all these characteristics directly or indirectly influences the survival and production of aquaculture species [1]. In the present study, we concentrate ourselves in the two important water quality parameters – Total Dissolved Solids (TDS) and Electrical Conductivity (EC).

Total Dissolved Solid (TDS) is a measurement of inorganic salts, organic matter and other dissolved materials in water [2]. It is aggregated amount of the entire floating suspended solids present in water sample. Total dissolved solids denote mainly the various kinds of minerals present in the water. "Dissolved Solids" refers to any mineral salts, metals, cations or anions dissolved in water. TDS is the portion of Solids that passes through a filter of 2.0 µm or smaller pore size.

The total concentration of dissolved solids or ions in a water body found useful parameter in describing the chemical density as a fitness factor [3]. A sudden or extreme change in TDS can kill aquatic life [4, 5]. Normally, TDS ranged from 5 to 1000 mg/L is considering as suitable range for fish growth [6]. The quantity of TDS was proportional to the degree of pollution [7]. In more polluted place the TDS value of the water and soil will be high and the water become notable for the aquatic purpose.

Electrical conductivity is the ability of an aqueous solution to carry electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement. The level of conductivity in water gives a good indication of the amount of joinable substances dissolved in it, such as phosphate, nitrate and nitrites. Generally conductivity of the natural water is directly proportional to the concentration of ions.

Fishes are very sensitive to conductivity, since conductivity is strictly related to the amount of osmotic pressure exerted on their cellular membranes. Conductivity of freshwater mostly lies between 50 to 1500µS/ml [8]. It is a useful tool to assess the purity of water. According to WHO [9] normal range of electrical conductivity for water is 400 - 600µS/cm.

The district Cooch Behar of West Bengal endeavors a large number of water bodies including natural as well as man-made water bodies. The ecosystem of these water bodies varies in nature, diversity and productivity as well. Keeping in view the importance of such water bodies, when we were investigating the physical characteristics of some water bodies at Cooch Behar and getting the readings, we restrict ourselves in the two important water quality parameters – Total Dissolved Solids (TDS) and Electrical Conductivity (EC), as they might have some relationship.

II. MATERIALS AND METHODS

A. Description of study area

The district of Cooch Behar is a part of the Himalayan Terai of West Bengal, located at the extreme of West Bengal and Assam border in the north-eastern part of India, occupies a pivotal position both historically and geographically. It lies between 25°57′57″ to 26°32′58″ North Latitude and between 88°45′28″ to 89°51′50″ East Longitude [10]. The total area of the district is 3,387.09 sq. km. The entire district is intersected by six river systems, like the Tista, Jaldhaka, Torsa, Kaljani, Raidak and Gadadhar, which are mainly originated in the Himalayas. Besides these rivers, the district includes a number of natural beels (lakes), ponds, canals and ephemeral water bodies. Thirteen different study sites was considered in terms of type of wetland (natural/manmade, ox-bow lake/ dead river/ river/tank) as well as location of wetland (urban/rural) to justify the relation between total dissolved solids and electrical conductivity.

B. Collection of water samples

The study was conducted during the pre-monsoon period (April- June) of the year 2017. The water sample was collected in the last week of each month of that period and finally an average of the readings was made for each site. Surface water samples for the two physical parameters (EC and TDS) were collected from the selected location by dipping well labeled sterilized plastic/glass containers of 250 ml to about 6-10 cm below the surface film.

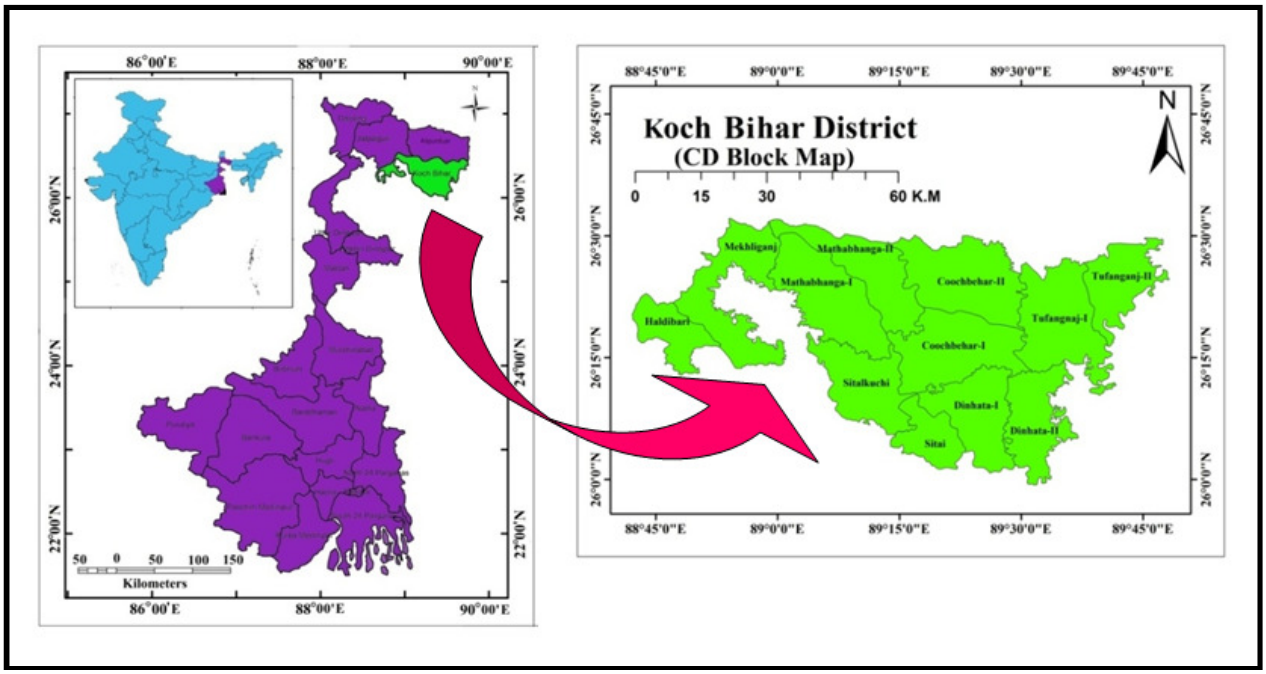


Fig. 1. Location Map of Cooch Bihar District.

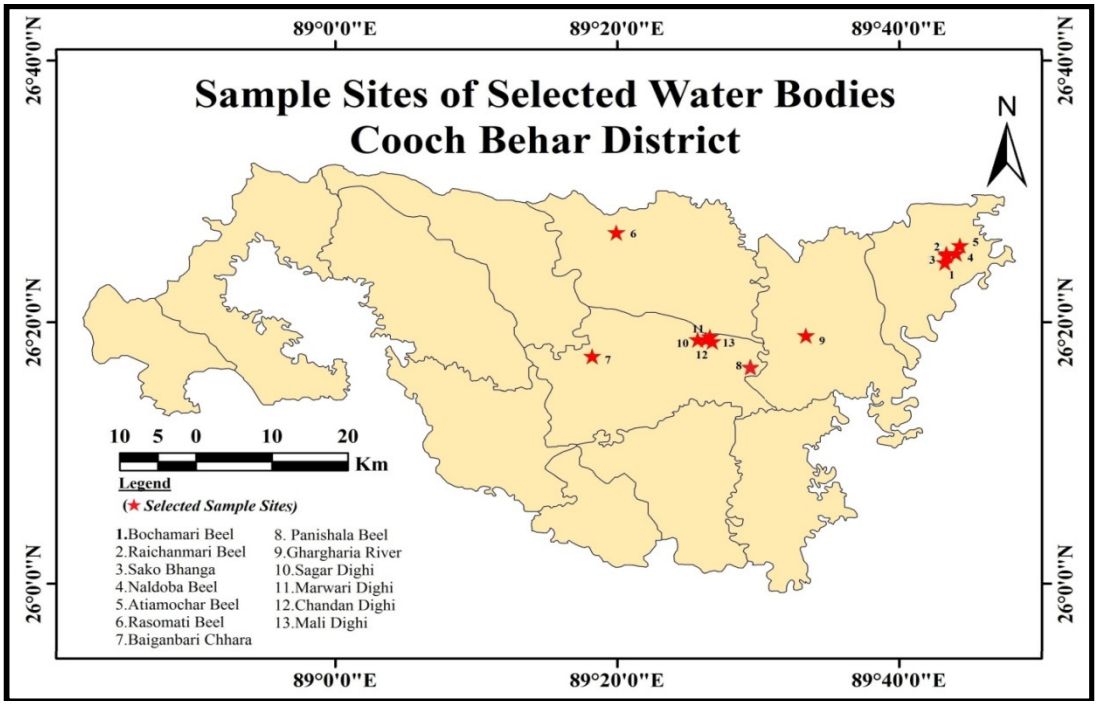


Fig. 2. Selected study sites of Cooch Behar district. Note: Sample Sites = Study sites.

Table 1: Description of Study sites.

Site No.	Site Name	GPS Readings	Location (Block/ Municipality)	Type of Water Body
1.	Bochamari Beel	26°24′30′′N, 89°43′15′′E	Tufanganj-II	Natural: Ox-bow lake
2.	Raichanmari Beel	26°25′03′′N, 89°43′21′′E	Tufanganj-II	Natural: Ox-bow lake
3.	Sako Bhanga	26°25′13′′N, 89°43′21′′E	Tufanganj-II	Natural: Dead river
4.	Naldoba Beel	26°25′14′′N, 89°44′02′′E	Tufanganj-II	Natural: Ox-bow lake
5.	Atiamochar Beel	26°25′51′′N, 89°44′19′′E	Tufanganj-II	Natural: Ox-bow lake
6.	Rasomati Beel	26°26′51′′N, 89°19′56′′E	Cooch Behar-II	Natural: Ox-bow lake
7.	Baiganbari Chhara	26°17′24′′N, 89°18′13′′E	Cooch Behar-I	Natural: Ox-bow lake
8.	Panishala Beel	26°16′14′′N, 89°31′46′′E	Cooch Behar-I	Natural: Ox-bow lake
9.	Ghargharia River	26°18′58″N, 89°33′23″E	Tufanganj-I	Natural : Stream
10.	Sagar Dighi	26°19′21′′N, 89°26′24′′E	Cooch Behar Municipality	Man-made: Pond (Dighi)
11.	Marwari Dighi	26°19′39′′N, 89°26′47′′E	Cooch Behar Municipality	Man-made: Pond (Dighi)
12.	Chandan Dighi	26°19′18′′N, 89°26′54′′E	Cooch Behar Municipality	Man-made: Pond (Dighi)
13.	Mali Dighi	26°18′48′′N, 89°26′59′′E	Cooch Behar Municipality	Man-made: Pond (Dighi)

1. Bochamari Beel

2. Raichanmari Beel

3. Sako Bhanga

4. Naldoba Beel

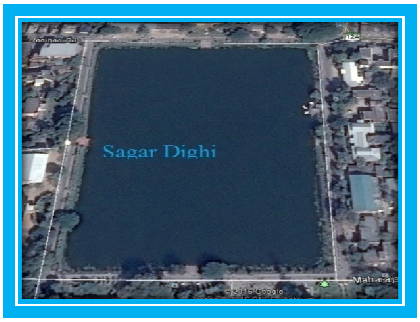
5. Atiamochar Beel

6. Rasomati Beel

7. Baiganbari Chhara

8. Panishala Beel

9. Ghargharia River



10. Sagar Dighi

11. Marwari Dighi

12. Chandan Dighi

13. Mali Dighi

Plate 1: Satellite images of the study sites.

C. Estimation of TDS and EC

Two physical parameters - Electrical conductivity (EC) and Total dissolved solid (TDS) was assessed following the standard protocols [11, 12] and by using standard instruments (Table 2).

D. Statistical Analysis

Statistical analysis like mean, standard deviation and correlation coefficient etc. [13] and some graphical representation are made using Microsoft excel (Version Windows 2007), a computer based programmer for windows. Standard error and the Student's t-test of the estimate are calculated by using the following formula:

The standard error of the estimate:

$$\sigma_{est} = \sqrt{\frac{\sum (Y - Y')^2}{N}}$$

Where, σ_{est} is the standard error of the estimate, Y is an actual score, Y' is a predicted score, and N is the number of pairs of scores.

Student's t-test:

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

Where, **t** is the Student's t-test, **r** is correlation coefficient, and **n** is the number of pairs of scores.

Table 2: Brief description of the instrument and units used for present observation.

Parameters	Method followed/instrument used	Units of observation	Reference zone (WHO)
Electrical Conductivity (EC)	HM Digitals Aqua Pro digital water tester (Model AP-1)	µS/cm	≤ 600 µS/cm
Total Dissolved Solid (TDS)	HM Digitals Aqua Pro digital water tester (Model AP-1)	ppm	≤ 1000 ppm

III. RESULTS AND DISCUSSION

Observation on the two physical parameters in thirteen different water bodies was carried out at Cooch Behar district of West Bengal. The results are delineated below.

A. Observation on the general estimation

When we were investigating the two physical characteristics (EC and TDS) of the thirteen water bodies at Cooch Behar and getting the readings, we tabulate our observed values as represented here in the following table. The observed values of all the samples were within prescribed limits. From the observation of the values this can be informed that highest TDS value was 149 ppm recorded at Chandan Dighi, and lowest one was 4 ppm at Atiamochar Beel. Similarly, highest EC (314 µS/cm) was recorded at Chandan Dighi and lowest one was (8 µS/cm) at Atiamochar Beel. From the recorded values we found that the EC values are surprisingly roughly doubles the TDS values. Recorded data is also graphically represented here for better illustration.

Table 3: Estimated TDS and EC values of selected water bodies in Cooch Behar.

Site No.	Name	EC (µS/cm)	TDS (ppm)
1	Bochamari Beel	67	32
2	Raichanmari Beel	55	26
3	Sako Bhanga	145	68
4	Naldoba Beel	21	09
5	Atiamochar Beel	08	04
6	Rasomati Beel	298	139
7	Baiganbari Chhara	68	33
8	Panishala Beel	224	102
9	Ghargharia River	231	109
10	Sagar Dighi	75	35
11	Marwari Dighi	305	144
12	Chandan Dighi	314	149
13	Mali Dighi	178	87

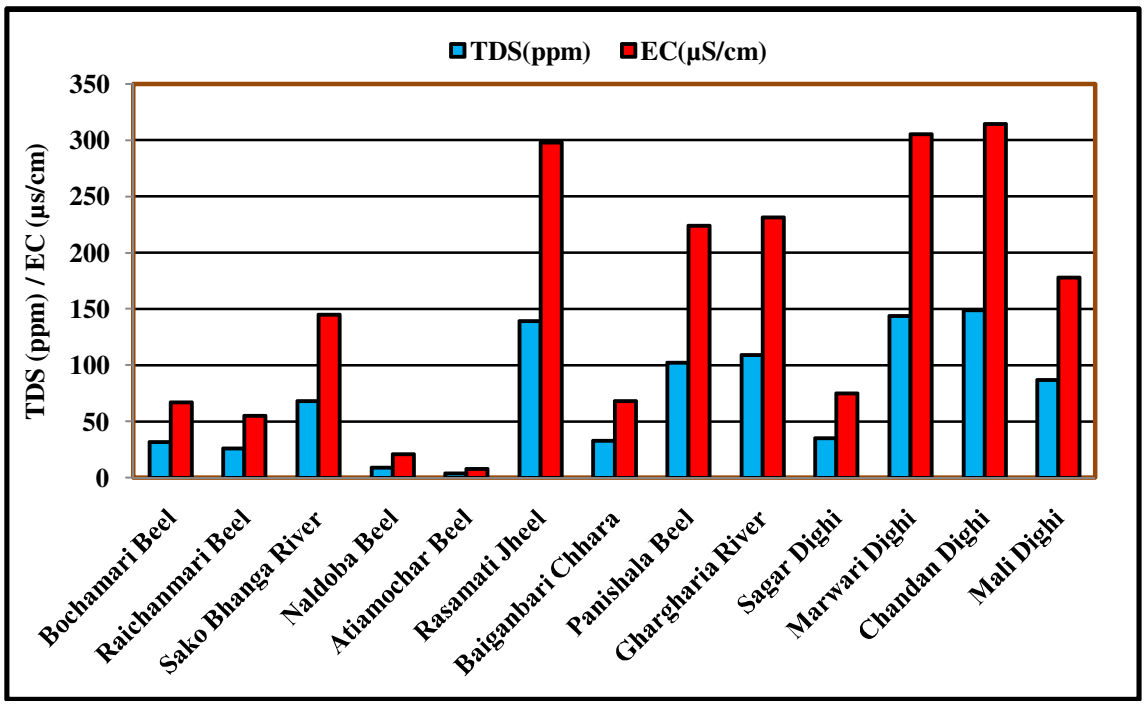


Fig. 3. Graphical presentation estimated values of TDS and EC in the thirteen study sites.

B. Observation on the statistical analysis

From statistical analysis we get the results as tabulated in the following table.

As the highest TDS (149 ppm) was recorded at Chandan Dighi, and lowest one was 4 ppm at Atiamochar Beel, the Mean and Standard Deviation of TDS are fall in 72.08 ppm and 52.69 ppm respectively. On the other hand, as the highest EC (314 µs/cm) was recorded at Chandan Dighi and lowest one was (8 µs/cm) at Atiamochar Beel, the Mean and Standard Deviation of EC are fall in 153 µs/cm and 112.03 µs/cm respectively (Table-4). The Standard Deviation of TDS and EC was found very high, which indicates that the TDS (ppm) and EC (µS/cm) vary significantly in the study sites as these thirteen water bodies were different in nature and location. But it was found that though they were different in nature and location, in almost all water bodies, the TDS value in ppm was about half of the EC (µS/cm).

Consequently, a Pearson product-moment correlation coefficient was computed to assess the relationship between Total Dissolved Solids and Electrical Conductivity from the collected data.

Table 4: Showing the Statistical Calculation results of the estimated values.

Statistiacal Parameters	TDS (ppm)	EC (µS/cm)
Minimum value	4	8
Maximum value	149	314
Mean	72.08	153.00
SD	52.69	112.03
r	0.99958621	
t	115.254	
df	11	
p	< 0.0001	
σ_{est}	3.366	

Note: ***SD*** = Standard Deviation, ***r*** = Correlation coefficient, ***t*** = Student's t-test, ***df*** = Degrees of Freedom, ***p*** = Significant level, $\boldsymbol{\sigma_{est}}$ = Standard error of the estimate.

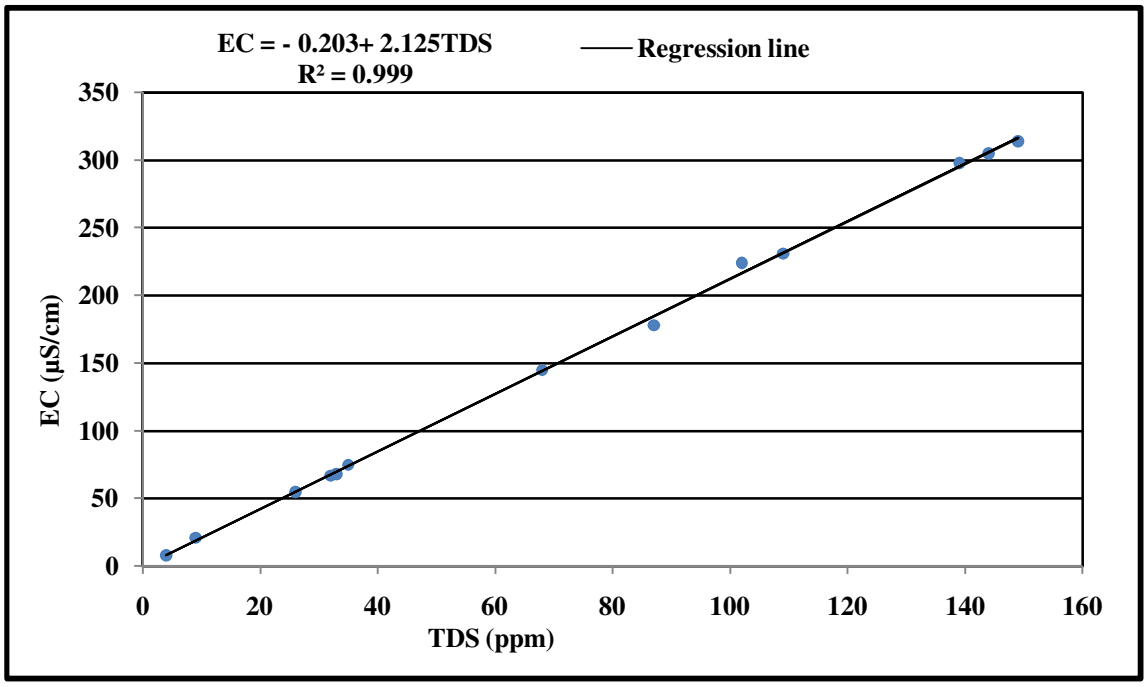


Fig. 4. Showing the Correlation Coefficient between TDS and EC.

Pearson product-moment correlation between Total Dissolved Solids and Electrical Conductivity from the collected data indicates that there was a positive correlation between the two variables, as r = 0.999, is very close to 1. So, we can conclude that there is a strong positive relationship between total dissolved solids and Electrical Conductivity. However, we cannot make any other conclusions about this relationship, based on this number.

Here, the result of standard error of the estimate is 3.366, which tells us that the average distance of the data points from the fitted line is about 3.4% body fat. Approximately 96% of the observations should fall within plus/minus (2 × Standard Error) of the regression from the regression line. At 13 - 2 = 11 degrees of freedom we find that t = 115.25, at P<0.001 which higher than tabulated value. So, the correlation coefficient may be regarded as highly significant.

Shahata and Mohamed [14] reported that the concentration of total dissolved solids (TDS) is related to electrical conductivity (EC; µS/cm) or specific conductance. A number of authors like Gayathri *et al*., Heydari *et al*. [15, 16] also mentioned in their literature that the two parameters - Total Dissolved Solids (TDS) and Electrical Conductivity (EC) are correlated. This relationship was agreed by different authors also like Sudani, Yilmaz and Koc etc. [17-21].

CONCLUSION

So, from all the present observations and statistical analysis we can conclude that there should be a definite relation between TDS and EC. From present study it can also be concluded that Electrical conductivity (EC) also can be used to give a rough estimate of the total amount of dissolved solids (TDS) in water. The Standard Deviation of TDS (ppm) and EC (µS/cm) was very high and that indicates the TDS (ppm) and EC (µS/cm) vary significantly in these thirteen water bodies because of their different nature, location, use and interference. But it was found that though they were different in nature and location, in almost all water bodies "the Total Dissolved Solids value in ppm was about half of the Electrical Conductivity (µS/cm) value". This finding inferred that, there might be a strong relation between the TDS and EC.

FUTURE SCOPE

On the basis of our present observation, there arises a provision to investigate the actual relation in between these two parameters (TDS and EC). This should have the need of some further analysis of water of these water bodies and a detailed study of these parameters.

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