

Assessment and Correlation Analysis of Water Quality Parameters: A case Study of Surma River at Sylhet Division, Bangladesh.

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Abstract—Water is a valued natural resource for the existence of all living organisms. Management of the quality of this precious resource is, therefore, of special importance. The Surma River basin is located in the north eastern region of Bangladesh. The river receives wastewater from numerous numbers of sources along its way, which are discharged as industrial effluents, municipal sewage, household wastes and agricultural wastes. The purpose of this study is to assess water quality and correlation analysis on the basis of physico-chemical parameters such as Temperature, P^H , DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TS (Total Solids), TDS (Total Dissolved Solids) and SS (Suspended Solids) in both rainy season and winter season for the years 2010 to 2013. Pearson's correlation coefficient (r) value is determined using correlation matrix to identify the highly correlated and interrelated water quality parameters. To test the significance of the pair of parameters p -value is carried out. From the assessment study it is found that the temperature, P^H , BOD, COD, TS and TDS values are increasing with respect to time and SS is also increasing in winter season with respect to time. In case of correlation study we found that the relationship between temperature with P^H , P^H with COD, P^H with TS, BOD with COD, BOD with TS, BOD with TDS, COD with TS, COD with TDS and TS with TDS is established which showing a very good correlation for Surma River in rainy season and in winter season the relationship between DO with TS, DO with TDS and TS with TDS showing a very good correlation.

Keywords—Surma River, Water Quality Parameters, Correlation Coefficient, rainy season, winter season.

I. INTRODUCTION

Water is vital to the existence of all living creatures, but this valued resource is increasingly being threatened as human populations grow and demand more water of high quality for domestic purposes and economic activities. The quality of any body of surface or ground water is a function of either or

both natural influences and human activities ([19], and [43]). Rivers are the most important freshwater resource for man. Unfortunately, river waters are being polluted by indiscriminate disposal of sewerage, industrial waste and plethora of human activities, which affects their physico-chemical characteristics and microbiological quality [34]. Pollution of the aquatic environment is a serious and growing problem. Increasing numbers and amounts of industrial, agricultural and commercial chemicals discharged into the aquatic environment have led to various deleterious effects on aquatic organisms. Aquatic organisms, including fish, accumulate pollutants directly from contaminated water and indirectly via the food chain ([14] and [31]).

Rivers contribute significantly to the growth of a country's economy. The benefits of rivers are not limited to the supply of water; they also serve other purposes such as recreation and sport, fishing, navigation, irrigation, generation of hydropower, transportation, waste disposal, and even sand mining. A river is a system comprising both main course and tributaries, carrying the one-way flow of a significant load of matter in dissolved and particulate phases from both natural and anthropogenic sources. The quality of a river at any point reflects several major influences, including the lithology of the basin, atmospheric inputs, climatic conditions and anthropogenic inputs [44]. On the other hand, rivers play a major role in assimilation or transporting municipal and industrial wastewater and runoff from agricultural land. Municipal and industrial wastewater discharge constitutes a constant polluting source, whereas surface runoff is a seasonal phenomenon, largely affected by climate within the basin [23]. A lot of researchers ([9],[23],[25],[26],[30], [35], [37], [40], [50],[51],and [54]) studies on assessment of water quality of rivers of Bangladesh and all over the world ([21],[29],[42],[47],[48], and[58]). It is evident that pollution from various sources particularly from industries has negative impact on environment, irreversible in nature ([1],[2],[6],[14],[16],[18],[32],[33], and[57]). A number of studies ([5],[7],[16],[42],[54], and[57]) have shown that water pollution is taking a heavy

toll of human life, particularly, in the developing countries through ill health and premature mortality. As such, riverside development inevitably impacts river water quality. The water quality of water resources is a subject of ongoing concern and assessment of long-term water quality changes is a challenging problem [57]. Hence, to assist the local environmental policy makers in preparing well-informed action plans, it is important to provide the profile of rivers with detailed water quality parameter compositions. However, studies have been carried out so far on determining the level of contamination contributed by different water quality parameters. In recent years an easier and simpler approach based on statistical correlation, has been developed using mathematical relationship for comparison of physico-chemical parameters (Joshi, et. al., 2009 and Khatoon, et. al., 2013). Assessment of water quality parameters by correlation study is also found from (Agarwal, et. al., 2013, Khatoon, et. al., 2013, Kumar, 2010 and Patel, et. al., 2015) their research. Considering all these in mind, we attempt in this study to evaluate the water quality parameters along the Surma River within the years 2010 to 2013. The first objective of the paper is to assess the water quality parameters of Surma River in rainy season and winter season. The second objective is to investigate the relationship between water quality variables statistical procedures like correlation analysis is used. The results are expected to provide insight into the quality of the water and consequently enable managers to form appropriate action plans at the different locations along the river basin.

II. MATERIAL AND METHOD

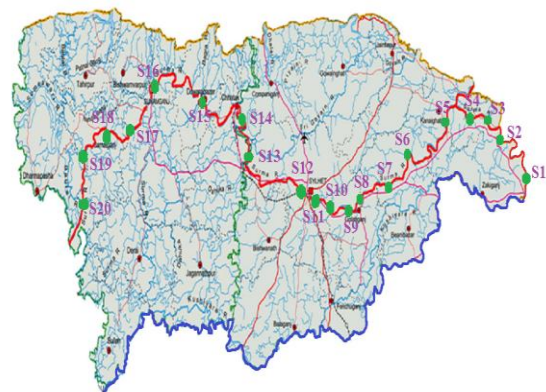
A. Description of Study Area

The Surma River is a major river in Bangladesh, part of the Surma-Meghna River System and total length of the river is 900 km. The average depth of the river is 282 feet (86 m) and maximum depth is 550 feet (170 m). The Surma is fed by tributaries from the Meghalaya Hills to the north[60]. The main source of Surma River is Barak River, India, on reaching the border with Bangladesh at Amalshid in Sylhet district, Barak bifurcates to form the steep and highly flashy rivers Surma and Kushiya [61]. The study area and sampling stations are shown in figure 1 and the sampling station names are given in table 1.

TABLE I

NAME OF SAMPLING STATIONS	
Station ID	Station Name
S1	Bholanater Bazar
S2	Kaliganj Bazar
S3	Atgram Bazar
S4	Andhurmukh Bazar
S5	Kanaighat Bazar
S6	Gach bari Bazar

S7	Rajaganj
S8	Golabganj Bazar
S9	Shahporan Bridge
S10	Shahjalal Bridge
S11	Kin Bridge
S12	Kazir Bazar
S13	Sheikh Ghat
S14	Tuker Bazar
S15	Chatak
S16	Dowara Bazar
S17	Sunamganj-1
S18	Sunamganj-2
S19	Joynagar Hut
S20	Laxmipur Bazar



Fig

B. Sampling and Environmental Analysis

Water samples were collected from the Surma River from upstream to downstream along the river during two seasons- namely rainy season and winter season and tested for some physical and chemical water quality parameters which are required for this study. Water samples were collected for the years 2010, 2011, 2012 and 2013 consequently. For first two years, 15 sampling points have been taken and for the years 2012 and 2013, 20 sampling stations have been taken along the river for both seasons. Water sample from various point in Surma River was collected and routine laboratory analysis made for physical and chemical qualities according to the standard method [18] in the water Supply and Sewerage Engineering Laboratory of Civil and Environmental Engineering Department, Shah Jalal University of Science and Technology, Sylhet, Bangladesh.

C. Statistical analysis

Statistical analysis was carried out using Statistical Packages for Social Science (SPSS Version 23). The physico-chemical parameters for all the study were analysed by calculating Pearson's correlation coefficient (r) value. Correlation is a bivariate analysis that measures the strengths of

association between two variables and the direction of the relationship ([28], and [46]). In terms of the strength of relationship, the value of the correlation coefficient varies between +1 and -1. When the value of the correlation coefficient lies around ± 1 , then it is said to be a perfect degree of association between the two variables. As the correlation coefficient value goes towards 0, the relationship between the two variables will be weaker. The direction of the relationship is simply the + (indicating a positive relationship between the variables) or - (indicating a negative relationship between the variables) sign of the correlation. The degree of association that exists between two variables is measured by the correlation coefficient (r) where one taken as dependent variable and is the mutual relationship between two variables. When increase or decrease in the value of one parameter is associated with a corresponding increase or decrease in the value of other parameter than direct correlation exists between this two variables [22]. Usually, in statistics, there are four types of correlations: Pearson correlation, Kendall rank correlation, Spearman correlation, and the Point-Biserial correlation. Among them Pearson r correlation is the most widely used correlation statistic to measure the degree of the relationship between linearly related variables. The following formula is used to calculate the Pearson r correlation:

$$r = \frac{N \sum xy - \sum x \sum y}{\sqrt{[N \sum x^2 - (\sum x)^2] [N \sum y^2 - (\sum y)^2]}}$$

Where,

r = Pearson r correlation coefficient

N = number of value in each data set

$\sum xy$ = sum of the products of paired scores

$\sum x$ = sum of x scores

$\sum y$ = sum of y scores

$\sum x^2$ = sum of squared x scores

$\sum y^2$ = sum of squared y scores

Assumptions for the Pearson r correlation, both variables should be normally distributed (normally distributed variables have a bell-shaped curve). Other assumptions include linearity and homoscedasticity. Linearity assumes a straight line relationship between each of the variables in the analysis and homoscedasticity assumes that data is normally distributed about the regression line. In order to calculate correlation coefficients, correlation matrix was constructed by calculating the coefficients of different pairs of parameters and correlation for significance was further tested by applying p value ([20], and [38]). The variations are significant if $p < 0.05$, $p < 0.01$, and non-significant if $p > 0.05$. The significance is considered at the level of 0.01 and 0.05 (2-tailed analysis).

D. General information of Water Quality Parameters

Temperature is a critical water quality and environmental parameter because it governs the kinds and types of aquatic life, regulates the maximum dissolved oxygen concentration of the water, and influences the rate of chemical and biological reactions [45]. P^H is a very important factor that must be considered to determine for water quality. The P^H of any water body surface is defined as a measure of Hydrogen ion concentration. In other words, P^H is a measure of the alkalinity or acidity of water soluble substances [8]. Dissolved Oxygen (DO) is defined as the amount of oxygen dissolved in a water body and measures the health of the water and its ability to support a balance aquatic ecosystem ([17], and [62]). The DO appears as microscopic bubbles of gaseous oxygen which are mixed in water and available to aquatic organisms for respiration ([17], and [59]). BOD (Biochemical Oxygen Demand) is defined as the amount of oxygen required by aerobic microorganisms to dissolve organic matter in a sample of water. It is one of the most essential and widely used parameters for the most essential and widely used parameters for measuring pollutants and biodegradable organic compounds in water ([15], [17], and [41]). Low the BOD, higher the desirability of using for human use, like drinking & domestic purposes. For drinking water, BOD should be nil. The COD is the amount of specified oxidant that reacts with a sample of water under controlled conditions and is expressed in terms of oxygen equivalence [17]. COD is viewed as a useful measure of water quality because its application determines the amount of organic pollutants present in surface water or wastewater [55]. Total solids includes both total suspended solids, the portion of total solids retained by a filter and total dissolved solids, the portion that passes through a filter [49]. The total amount of all dissolved solutes and silica present in a water body is recognized as the total dissolved solids (TDS). TDS are mainly the inorganic minerals and sometimes some organic matter. It can be determined gravimetrically by evaporating a known volume of water and measuring the mass of the residue left[53]. Suspended solid (SS) are the solid matter suspended in water, comprising of organic and inorganic materials, such as plankton, silt and industrial waste ([17] and [27]).

III. RESULT AND DISCUSSION

A. Water Quality parameter Assessment

The fluctuation of temperature at different times and locations of Surma River are presented in figure 2. The rainy season data for all the years is shown in left side and winter season data is shown in right side of the figure. The average rainy season water temperature for the years 2010, 2011, 2012 and 2013

are 27.03°C, 25.93°C, 27.69°C and 27.82°C respectively. The average winter season temperature for the years 2010 to 2013 are 24.56°C, 26.65°C, 24.99°C and 25.89°C respectively. The maximum rainy season temperature is 28.9°C at Laxmipur Bazar in the year 2013 and the maximum winter season temperature is 27.2°C at Shahporan Bridge in the year 2011. The minimum rainy season temperature is 25°C at Atgram Bazar in the year 2011 and the minimum winter season temperature is 23°C at Atgram Bazar in the year 2010.

The average rainy season P^H for the years 2010, 2011, 2012 and 2013 are 6.66, 6.57, 6.86 and 6.87 respectively. The average winter season P^H for the years 2010 to 2013 are 6.56, 6.60, 6.59 and 6.79 respectively. The maximum rainy season P^H is 7.12 at Atgram Bazar in the year 2013 and the minimum winter season P^H is 5.89 at Gach Bari Bazar in the year 2010. In winter season the maximum P^H value is 7.2 at Atgram Bazar in the year 2010 and minimum value is 5.98 at Kazir Bazar in the year 2010.

The average rainy season DO for the years 2010, 2011, 2012 and 2013 are 6.36, 10.64, 7.65 and 6.88 mg/l respectively. The average winter season DO for the years 2010 to 2013 are 5.85, 7.17, 6.10 and 5.85 mg/l respectively. The maximum rainy season DO is 14 mg/l at Chatak in the year 2011 and the maximum winter season DO is 8.7 mg/l at Tukur Bazar in the year 2011. The minimum rainy season DO is 4.7 mg/l at Sheikh Ghat in the year 2010 and the minimum winter season DO is 4 mg/l at Sheikh Ghat in the year 2013. However water of Surma River is deteriorating from the view point of DO; for instance in Chatak due to industrial activities, in Sheikh Ghat & Tukur Bazar due to urban activities like fish & markets, discharge from rice mills etc. to the river. The test results of BOD are presented in figure. The average rainy season BOD for the years 2010, 2011, 2012 and 2013 are 3.72, 4.76, 4.93 and 5.55 mg/l respectively. The average winter season BOD for the years 2010 to 2013 are 3.69, 3.67, 4.03 and 4.77 mg/l respectively. The maximum rainy season BOD is 7.30 mg/l at Golabganj Bazar in the year 2012 and Bholanater Bazar in the year 2013. The maximum winter season BOD is 6.2 mg/l at Kanaighat Bazar in the year 2013.

The minimum rainy season BOD is 2.6 mg/l at Kanaighat Bazar in the year 2010 and the minimum winter season BOD is 2.3 mg/l at Atgram Bazar in the year 2010. In Surma River, highest BOD is observed in Golabganj Bazar and Bholanater Bazar due to the direct defecation of human faces to the river. The average rainy season COD for the years 2010, 2011, 2012 and 2013 are 6.72, 7.05, 7.18 and 7.94 mg/l respectively. The average winter season COD for the years 2010 to 2013 are 5.83, 6.21, 6.13 and 6.84 mg/l respectively. The maximum and minimum rainy season COD are 10.20 mg/l at Atgram Bazar in the year 2010 and 5.4 mg/l at Dowara Bazar in the year 2010. The maximum and minimum winter season COD are 8.0 mg/l at Shahporan Bridge in the year 2013 and 5.0 mg/l at Golabganj Bazar in the year 2012 respectively. The average rainy season TS for the years 2010, 2011, 2012 and 2013 are 221.33, 238.80, 242.50 and 246.05 mg/l respectively. The average winter season TS for the years 2010 to 2013 are 189.13, 199.33, 208.95 and 215.65 mg/l respectively. The maximum rainy season TS is 310.00 mg/l at Dowara Bazar in the year 2013 and maximum winter season TS is 267.00 mg/l at Kazir Bazar in the year 2013. The minimum rainy season TS is 178.00 mg/l at Kin Bridge in the year 2010 and minimum winter season TS is 165.00 mg/l at two station Golabganj Bazar (2010) and Kanaighat Bazar (2012).

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The average rainy season TDS for the years 2010, 2011, 2012 and 2013 are 95.77, 168.53, 172.55 and 174.65 mg/l respectively. The average winter season TDS for the years 2010 to 2013 are 109.13, 115.60, 126.75 and 130.50 mg/l respectively. The maximum rainy season TDS is 241.00 mg/l at Kaliganj Bazar in the year 2013 and maximum winter season TDS is 195.00 mg/l at Shahporan Bridge in the year 2013. The minimum rainy season TDS is 78.00 mg/l at Kin Bridge in the year 2010 and minimum winter season TDS is 78.00 mg/l at Shahjalal Bridge (2010).

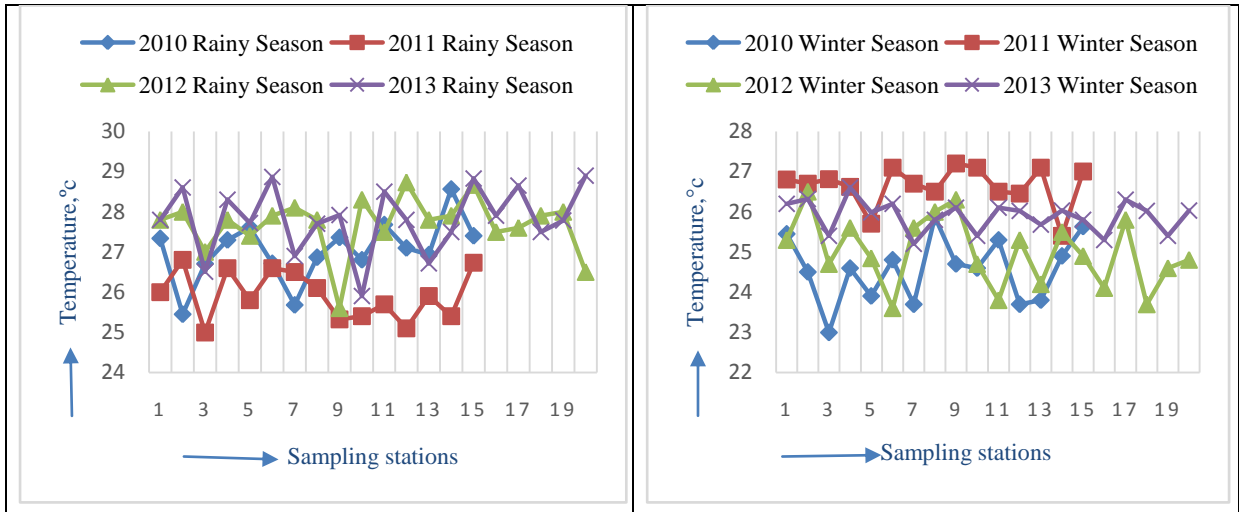


Fig. 2 Temperature of Surma River Rainy Season and winter season

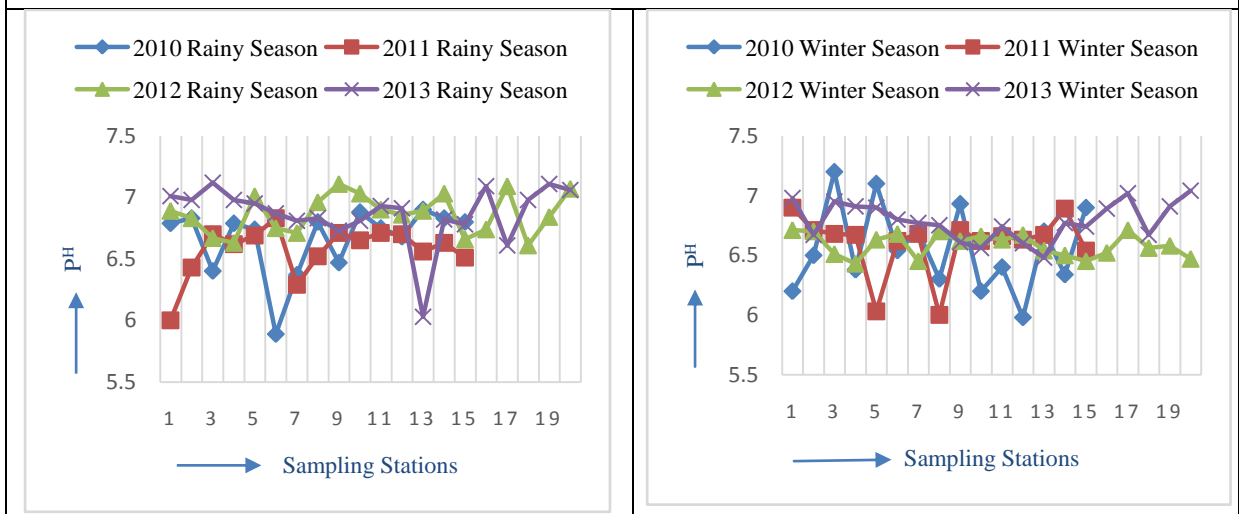


Fig. 3 P^H of Surma River Rainy Seasons and Winter Seasons

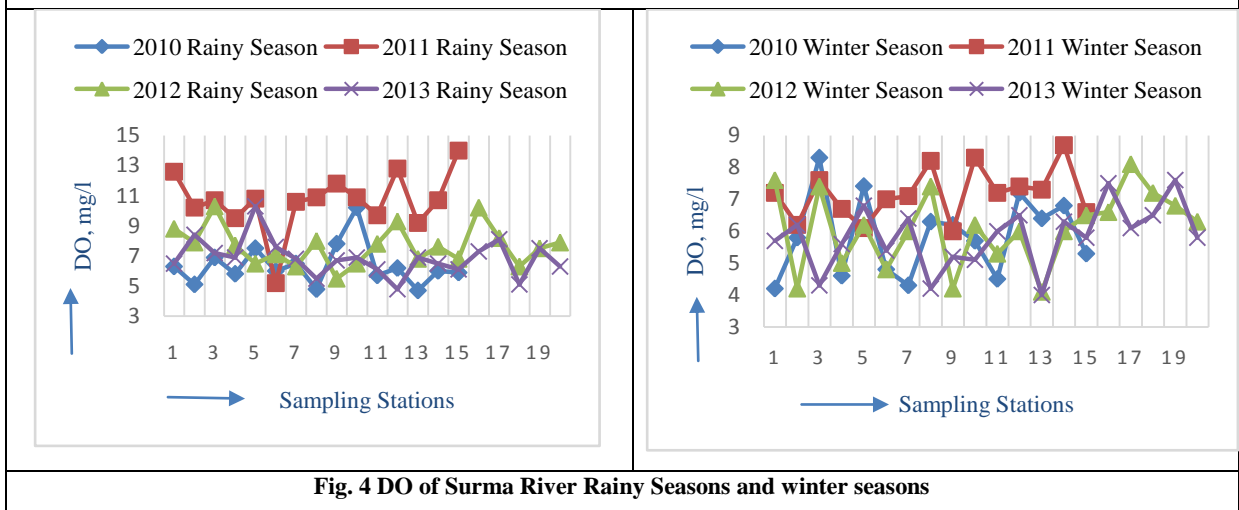


Fig. 4 DO of Surma River Rainy Seasons and winter seasons

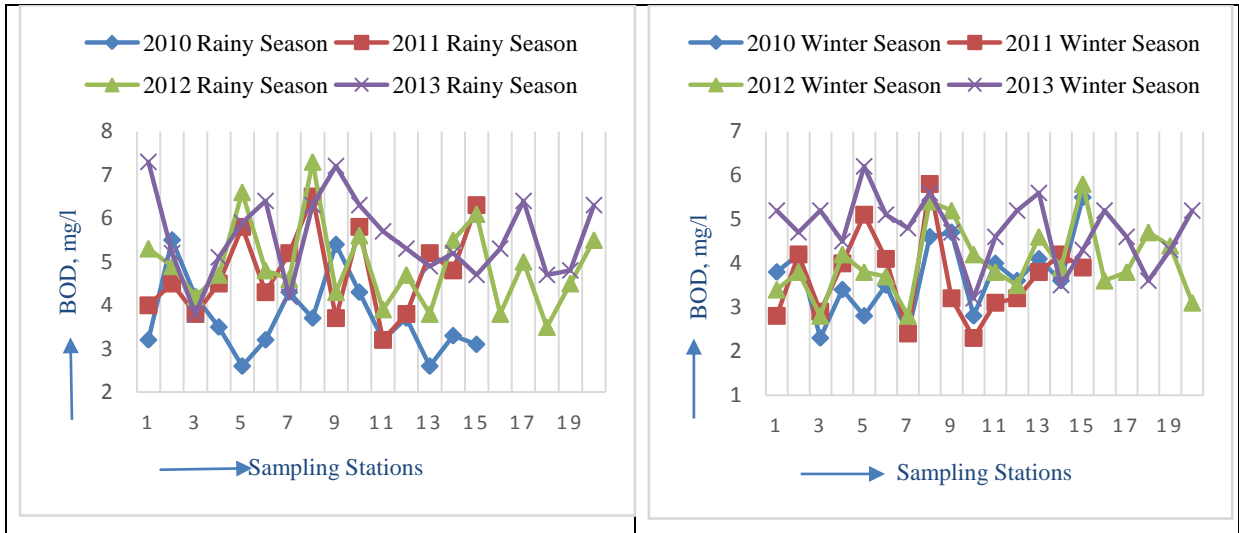


Fig. 5 BOD of Surma River Rainy Seasons and winter seasons

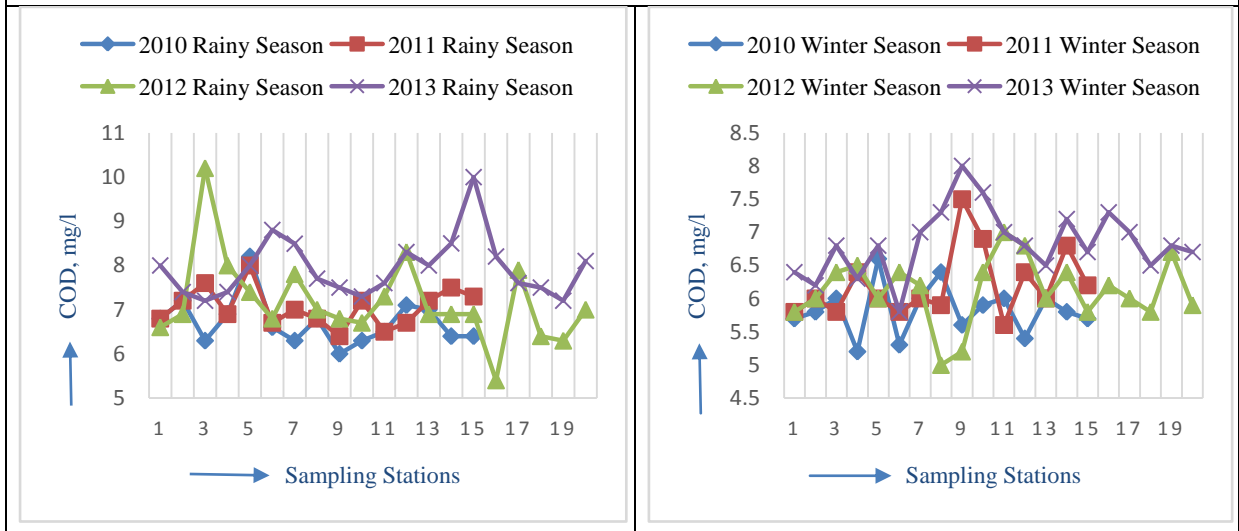


Fig. 6 COD of Surma River Rainy Seasons and winter seasons

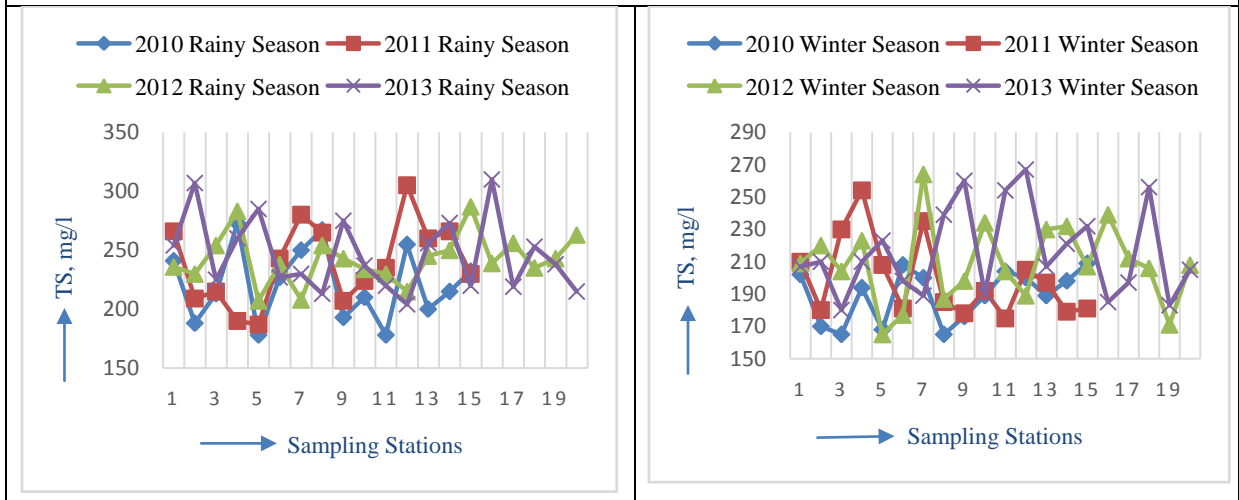


Fig. 7 TS of Surma River Rainy Seasons and winter seasons

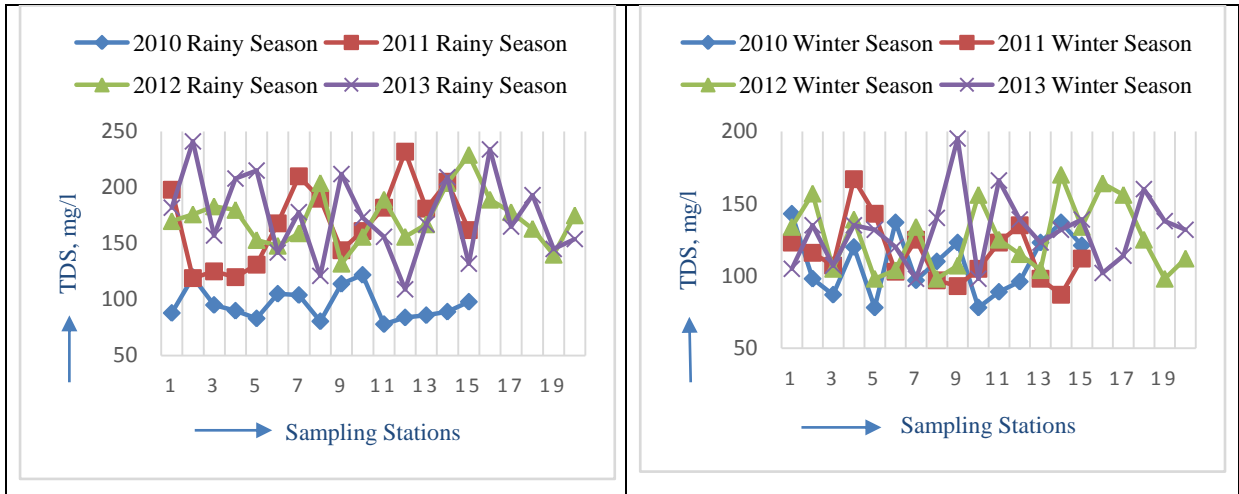


Fig. 8 TDS of Surma River Rainy Seasons and winter seasons

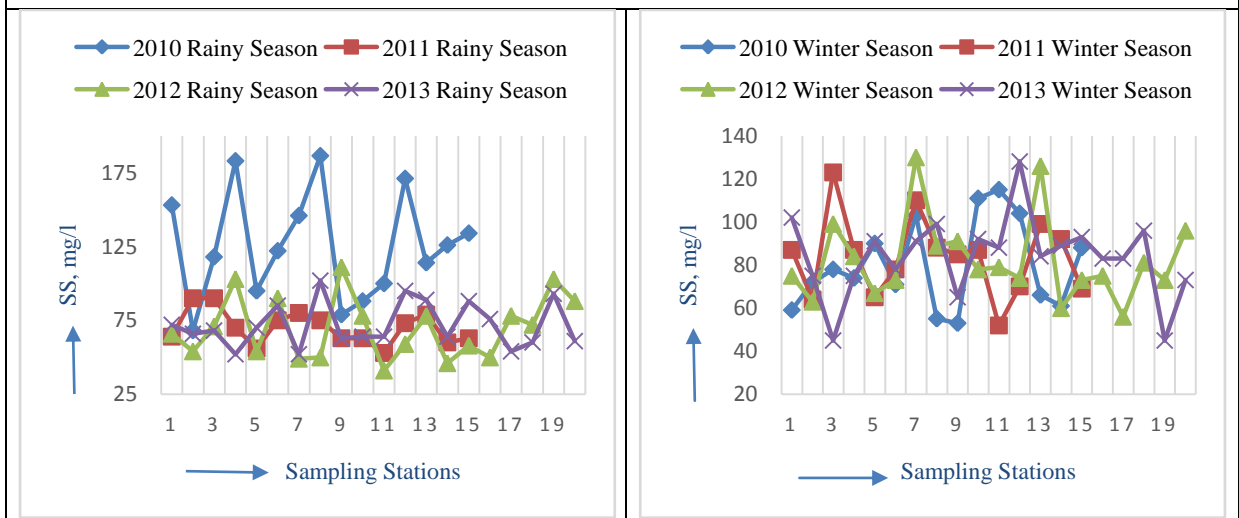


Fig. 9 SS data of Surma River rainy seasons and winter seasons

In Surma river large amount of TDS is due to indiscriminate stone extraction activities in Volagonj and Companigonj; also large amount of TDS are found in Chatak for industrial activities and in Sheikh Ghat indiscriminate urban activities in fish market, rice mills etc. The average rainy season SS for the years 2010, 2011, 2012 and 2013 are 125.57, 70.27, 69.95 and 71.90 mg/l respectively. The average winter season SS for the years 2010 to 2013 are 80.00, 83.73, 82.10 and 83.75 mg/l respectively. The maximum rainy season SS is 186.50 mg/l at Golabganj Bazar in the year 2010 and maximum winter season SS is 130.00 mg/l at Rajaganj in the year 2012. The minimum rainy season SS is 41.00 mg/l at Kin Bridge in the year 2012 and minimum winter season SS is 45.00 mg/l at Atgram Bazar in the year 2013.

The deterioration of water quality parameters of Surma River is also found by the researchers ([7], [18], [33] and [49]). Surma River is polluted day by day by human activities, poor structured sewerage and drainage system, discharging industrial and household wastes. The charas (natural channels) are

responsible for surface runoff conveyance from its urban catchments to the receiving Surma River [18]. The surface water quality of Surma River is polluted by agriculture, industrial, domestic and municipal sources. The concentration of silt in turbulent water in the rainy season is high and algal growth in stagnant water bodies in the winter season is also very high. People’s unhealthy sanitary practices have greatly contributed to the deterioration of the quality of surface water sources [33]. Several studies ([7] and [12]) showed that surface water quality of the rivers of the country especially Surma River is moderately polluted in different locations. Reference [7] discussed a study to determine the organic and inorganic pollutant loads of the selected industrial effluent of Chatak Pulp and Paper Mill on the water quality of Surma River. Reference [25] investigated the water quality of the Surma and Kushiya rivers. It was revealed that water from both of this rivers contains lower concentration of DO and higher concentration of suspended solids; the water was also found acidic in nature. The BOD and COD value was also high in some locations. They also

conclude that both of the rivers water were free from fecal coliform can be alternative source of drinking water supply for Sylhet city with some degree of treatment. And to keep these rivers biologically alive for long period proper treatment should be ensured while throwing waste effluent from efficient sources in these rivers. Reference [30] evaluated effects of wastes on the Physico-chemical characteristics of the Karnafully River due to presence of many chemical fertilizers, iron, leather and pharmaceutical industries. From the finding of the result they concluded that river Karnafully was losing its water quality day by day and the river was under severe pollution threat. From reference [11] it is found that found that the Barak River have been contaminated with waterborne pathogenic bacteria because of increased anthropogenic and socio-cultural activities at different sites of the Barak River and also by sewage, faecal contaminants and industrial wastes and the water of the Barak River is not suitable for drinking and other recreational purposes. As the Barak River is the source of Surma River from India and the water of this river is polluted day by day so the Surma River water quality is affected by this.

B. Findings from Correlation Analysis

The correlation analysis results of selected water quality parameters of Surma River rainy season and winter seasons are shown in table 2 and 3. The descriptive statistics results of Surma River rainy season and winter seasons water quality parameters are shown in table 4 and 5. From table 2 and 3 it is found that the water temperature showed positive correlation with P^H ($r = 0.827$, $p < 0.01$), COD ($r = 0.659$, $p < 0.05$) and TS ($r = 0.641$, $p < 0.05$) in rainy season and with COD ($r = 0.640$, $p < 0.05$) and SS ($r = 0.776$, $p < 0.01$) in winter season. Temperature showed negative correlation with DO ($r = -0.688$, $p < 0.05$) in rainy season and no remarkable negative correlation is noticed in winter season. The P^H showed positive correlation with temperature, BOD ($r = 0.637$, $p < 0.05$), COD ($r = 0.814$, $p < 0.01$), TS ($r = 0.859$, $p < 0.01$), and TDS ($r = 0.740$, $p < 0.05$) in rainy season. It showed no notable positive and negative correlation in winter season. P^H showed no negative mentionable correlation in rainy season at all. Fluctuations in P^H values during different season of the year were attributed to factors like removal of CO₂ by photosynthesis through bicarbonate degradation, dilution of waste with fresh water, reduction in salinity and temperature, and decomposition of organic matter [36]. The DO showed negative correlation with temperature, except this, it not showed significant correlation with other water quality parameter in rainy season. In winter season DO showed negative significant correlation with TS ($r = -0.869$, $p < 0.01$) and TDS ($r = -0.849$, $p < 0.01$) and no positive significant

correlation. The BOD showed positive correlation with P^H , COD ($r = 0.889$, $p < 0.01$), TS ($r = 0.829$, $p < 0.01$) and TDS ($r = 0.849$, $p < 0.01$) in rainy season and no notable negative correlation found in this season. In winter season BOD showed positive correlation with TS ($r = 0.699$, $p < 0.05$), TDS ($r = 0.637$, $p < 0.05$) and SS ($r = 0.678$, $p < 0.05$) and no mentionable negative correlation is found. The positive correlation between COD and BOD indicated that sources of organic material in river water are similar in nature.

The COD showed positive correlation with temperature, P^H , BOD, TS ($r = 0.953$, $p < 0.01$) and TDS ($r = 0.893$, $p < 0.01$) in rainy season and no notable negative correlation found in this season. In winter season COD showed positive correlation with temperature and SS ($r = 0.677$, $p < 0.05$) and no mentionable negative correlation is found. The TS showed positive correlation with temperature, PH, BOD, COD and TDS ($r = 0.890$, $p < 0.01$) in rainy season and no notable negative correlation found in this season. In winter season TS showed positive correlation with BOD, TDS ($r = 0.985$, $p < 0.01$) and SS ($r = 0.635$, $p < 0.05$) and negative correlation with DO ($r = -0.869$, $p < 0.01$). The TDS showed positive correlation with P^H , BOD, COD and TS in rainy season and no notable negative correlation found in this season. In winter season TDS showed positive correlation with BOD and TS. It showed negative correlation with DO. The SS showed no notable correlation with any other water quality parameter in rainy season. In winter season SS showed positive correlation with temperature, BOD, COD and TS and no notable negative correlation found in this season.

In case of correlation study we found that the relationship between temperature with P^H , P^H with COD, P^H with TS, BOD with COD, BOD with TS, BOD with TDS, COD with TS, COD with TDS and TS with TDS is established which give correlation coefficient ($r = 0.827$, $p < 0.01$), ($r = 0.814$, $p < 0.01$), ($r = 0.859$, $p < 0.01$), ($r = 0.889$, $p < 0.01$), ($r = 0.829$, $p < 0.01$), ($r = 0.849$, $p < 0.01$), ($r = 0.953$, $p < 0.01$), ($r = 0.893$, $p < 0.01$) and ($r = 0.890$, $p < 0.01$) respectively, showing a very good correlation for Surma River in rainy season. In case of winter season the relationship between DO with TS, DO with TDS and TS with TDS is established with ($r = -0.869$, $p < 0.01$), ($r = -0.849$, $p < 0.01$) and ($r = 0.985$, $p < 0.01$) respectively, showing a very good correlation.

From reference [3] it is found that the relationship between COD with BOD, DO with BOD, DO with COD and TS with alkalinity is established which give correlation coefficient ($r = 0.8657$, $p < 0.01$), ($r = -0.8795$, $p < 0.01$), ($r = -0.8897$, $p < 0.01$) and ($r =$

0.8328, $p < 0.01$) respectively, showing a very good correlation for the River Kosi, India.

Table. 2. Pearson Correlation coefficient of Surma River water quality parameter (rainy season)

Correlations								
	Temperature	P ^H	DO	BOD	COD	TS	TDS	SS
Temperature	1	.827**	-.688*	.621	.695*	.641*	.545	.164
P ^H		1	-.544	.637*	.814**	.859**	.740*	.197
DO			1	-.068	-.238	-.206	.062	-.567
BOD				1	.889**	.829**	.849**	-.098
COD					1	.953**	.893**	.067
TS						1	.890**	.170
TDS							1	-.299
SS								1
**. Correlation is significant at the 0.01 level (2-tailed).								
*. Correlation is significant at the 0.05 level (2-tailed).								

Table. 3. Pearson Correlation coefficient of Surma River water quality parameter (winter season)

Correlations								
	Temperature	P ^H	DO	BOD	COD	TS	TDS	SS
Temperature	1	.113	-.135	.481	.640*	.366	.231	.776**
P ^H		1	.390	-.336	-.020	-.462	-.516	-.207
DO			1	-.620	-.399	-.869**	-.849**	-.625
BOD				1	.626	.699*	.637*	.678*
COD					1	.502	.424	.677*
TS						1	.985**	.635*
TDS							1	.509
SS								1
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								

From reference [38] it is found that significant positive correlation holds between Temp with BOD GH1 ($r = 0.99$, $p < 0.01$), EC with chloride GH6 ($r = 0.877$, $p < 0.01$), EC with TDS GH6 ($r = 0.836$, $p < 0.01$); and TA with DO GH1 ($r = 0.842$, $p < 0.01$), PH with Mg GH6 ($r = -0.79$, $p < 0.01$), EC with Nitrate GH6 ($r = 0.846$, $p < 0.01$). A significant negative correlation was found for DO with BOD GH3 ($r = -0.943$, $p < 0.01$), DO with TDS GH6 ($r = -0.838$, $p < 0.01$), and TA with TDS GH6 ($r = -0.88$, $p < 0.01$) for Ganga River, Kanpur, Uttar Pradesh, India.

IV. CONCLUSIONS

Concerning all measured parameters it could be settled that in rainy season temperature, BOD, COD, TS, TDS and SS values are increasing more or less without some exceptions. The value of DO is decreasing in trend which indicates that the surface water of Surma River is polluted with respect to time. The winter seasons temperature, P^H, DO, BOD, COD, TS and SS values are less than that values of rainy seasons. Similar result was found by Pawari et al., 2015 for Indian water quality parameter study.

Finally it could be concluded that on the basis of monitoring of selected physico-chemical parameters in the last four years there is no doubt of the Surma River water quality is deteriorating day by day. The reason behind this is that along its course the Surma River receives many types of point and non-point sources pollutants from Cement factory, Pulp and Paper mill, agricultural fertilizers residue, municipal waste, rural markets discharges, detergents from washing cloth and bathing, human faces from slum areas of the cities, direct defecation of human excreta into the river in rural areas etc. Also pollutants come with the water from upstream source of India. Therefore, recovery process of the river water quality must start immediately otherwise it can cause serious problem in near future.

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