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Comparative Study of Water Quality Parameters of Surma and Kushiyara Rivers in Bangladesh

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Abstract: This study presents a comparative analysis of water quality parameters in urban sites, focusing on the Surma and Kushiyara rivers in Bangladesh. Water samples collected from 2010 to 2013 during rainy and winter seasons were analyzed for key parameters including temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids (TS), Total Dissolved Solids (TDS), and Suspended Solids (SS). Statistical tests, including Independent Sample t-test and Paired t-test, were employed to evaluate differences between the two rivers. By paired t test, it is found that statistically significant difference exists between temperature, DO, TS and TDS in rainy and winter seasons for the Surma river. For the Kushiyara river, temperature, pH, DO, TS, TDS and SS showed statistically significant difference among rainy and winter seasons. The independent t test among the Surma and the Kushiyara rivers water quality parameters, revealed that only temperature of winter seasons showed statistically significant difference, but all other water quality parameters showed statistically no significant difference between them.

Index Terms - Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Kushiyara, Independent t Test, Paired t Test, pH, Rainy Season, Surma, Suspended Solids (SS), Temperature, Total Solids (TS), Total Dissolved Solids (TDS), Water Quality Parameters and Winter Season.

I. INTRODUCTION

Utilizing water resources in a rational and sustainable manner is a critical challenge of the modern era [1]. River systems, particularly those flowing through densely populated areas, are integral to the balanced development of the environment [2]. Ensuring the ecological balance requires careful attention to the presence and quality of water [3], prompting an increase in research focused on monitoring water quality ([4] and [5]). The contamination of surface water with wastewater has become a pressing issue in water management ([6] and [7]). Poor water quality and environmental degradation not only hinder sustainable development but also pose potential threats to public health [8]. Ensuring the sustainability of ecological balance requires careful attention to the presence and quality of water [9]. Water is an essential component of life [10]. Its importance goes beyond simple existence; it supports essential operations in the fields of industry, agriculture, and household life [11]. However, the last few decades have witnessed an unprecedented strain on freshwater resources, fueled by rapid industrialization and population growth, thereby escalating the demand for clean water [12]. The integrity of water quality is thus determined by its physicochemical and biological parameters, which are subject to temporal and spatial variations due to a multitude of factors, including pollution sources and seasonal fluctuations [13].

Urbanization and industrial activities along river basins have notably contributed to the degradation of water quality, leading to environmental and health hazards ([29] and [26]). Rivers, integral to the ecological and hydrological balance, face the brunt of anthropogenic pressures, assimilating runoff from agricultural

fields, industrial effluents, and domestic sewage, thereby necessitating rigorous evaluation and management strategies to safeguard these water bodies ([28] and [16]). The Surma and Kushiyara rivers, cradling the northeastern part of Bangladesh, are no exception. Home to over 8 million people, these rivers are the lifeline for numerous households and industries, yet are increasingly marred by pollutants from various sources, underscoring the urgent need for comprehensive water quality monitoring ([18], [20] and [23]).

Against this backdrop, this study embarks on a comparative analysis of water quality parameters in urban sites along the Surma and Kushiyara rivers, employing statistical tools such as the Independent Sample t-test and Paired t-test to delineate the differences between these two rivers. By focusing on a select suite of physicochemical parameters—temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids (TS), Total Dissolved Solids (TDS), and Suspended Solids (SS). This comparative study focuses on the differences in water quality, but it also aims to provide insight on how to improve these important watercourses' ecological integrity in an age of growing environmental challenges.

II. STATISTICAL ANALYSIS

For the findings of this study, several statistical analyses were conducted using different statistical software tools. Descriptive analyses, including Independent t-test and paired t-test, were utilized to explore the interrelationship among the seasonal data of both the Surma and Kushiyara rivers ([17], [2] and [10]). The t-test, specifically the "two-sample t-test" or "independent samples t-test," is a widely employed statistical method for hypothesis testing when two distinct sets of independent and identically distributed samples are obtained from each of the two populations being compared [17].

The test statistic independent t test is formed as equation 3.1.

$$t = \frac{\overline{x_1} - \overline{x_2}}{s_p \cdot \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad (1)$$

Where,

$$s_p = \sqrt{\frac{(n_1 - 1)s_{x_1}^2 + (n_2 - 1)s_{x_2}^2}{n_1 + n_2 - 2}}$$

is an estimator of the pooled standard deviation (SP) of the two samples: it is defined in this way so that its square is an unbiased estimator of the common variance whether or not the population means are the same. In these formulae, ni − 1 is the number of degrees of freedom for each group, and the total sample size minus two (that is, n1 + n2 − 2) is the total number of degrees of freedom, which is used in significance testing.

A paired samples t-test involves a sample of matched pairs of similar units or one group of units tested twice, known as a "repeated measures" t-test. This test is appropriate when the samples are dependent, such as when there is only one sample tested twice (repeated measures) or when two samples are matched or "paired" (David et al., 1997).

The test statistic paired t test is formed as equation 3.2.

$$t = \frac{\bar{x}_D - \mu_0}{\frac{s_D}{\sqrt{n}}} \quad (2)$$

For equation 3.2, the differences between all pairs must be calculated. The pairs are either one person's pre-test and post-test scores or between pairs of persons matched into meaningful groups. The average (XD) and standard deviation (SD) of those differences are used in the equation. The constant μ0 is non-zero if you want to test whether the average of the difference is significantly different from μ0. The degree of freedom used is n − 1, where n represents the number of pairs.

III. RESULT AND DISCUSSION

A. Test of Normality of several WQP's of the Surma and Kushiyara river's

To perform some parametric tests i.e. Paired t-test and Independent sample t-test the normality assumption of the data is checked. Histogram with density curve helps to understand the distribution of the data. A bell shape density curve i.e. is a sign that data are approximately normally distributed. A slightly departure in highest is a sign that data follows a t-distribution i.e. comes from a t-distribution.

Histogram with density curves were drawn for each river's WQP's in both rainy and winter season. The figures are shown in Appendix D in figure D 1, D 2, D 3, D 4. From the figures, it can be seen that all the variables are approximately normally distributed, and their parent distribution is normal. As the

data fulfils the assumption of normality, Parametric tests can be performed.

B.Test significant difference (Paired) of several WQP's of the Surma and the Kushiyara river's

The paired samples t Test compares two means that are from the same individual, object or related units. In this paired sample test Winter and Rainy seasons data of eight water quality parameters like temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total solids (TS), total dissolved solids (TDS) and suspended solids (SS) of the Surma and the Kushiyara rivers are compared, and results are shown in tabular form in table 1.

Test significant difference of Temperature of the Surma and the Kushiyara Rivers in Winter and Rainy seasons

The Surma and the Kushiyara rivers mean temperatures are shown in figure 1. The Sig. (2-Tailed) or P-value in this test is 0.02 which is less than 0.05. Therefore it can be concluded that there is a statistically significant difference between the mean temperature of the Surma river in winter and rainy seasons. The paired samples statistics box revealed that the mean temperature of the Surma river in rainy season is greater than winter season, it is exposed that the Surma river in rainy season is significantly hotter compared to winter season. In rainy season the river is full of water and the ambient air temperature is naturally higher than winter season and the open air surfaces absorb more temperature from air and many other effluents from upstream is also responsible for this. From paired t-test analysis it is observed that the Sig. (2-Tailed) or P-value in this test is 0.0 which is less than 0.05. So it can be concluded that there is a statistically significant difference between the mean temperature of the Kushiyara river in winter season and rainy season. Since Paired Samples statistics box revealed that the Mean temperature of the Kushiyara river in rainy season is greater than winter season, hence it can be summarized that the Kushiyara river in rainy season is significantly hotter compared to winter season.

Table 1: Results of t test for several water quality parameters for the Surma and the Kushiyara rivers between winter and rainy seasons.

Paired Samples Test					
	Paired Differences		t	df	Sig. (2-tailed)
	Mean	Std. Error Mean			
Temperature of Kushiyara river in winter season - Temperature of Kushiyara river in rainy season	-1.64700***	0.14819	-11.114	9	0.000
P^H of Kushiyara river in winter season - P^H of Kushiyara river in rainy season	-.18000***	0.05035	-3.575	9	0.006
DO of Kushiyara river in winter season - DO of Kushiyara river in rainy season	-1.32100***	0.29361	-4.499	9	0.001
BOD of Kushiyara river in winter season - BOD of Kushiyara river in rainy season	-.44000	0.21412	-2.055	9	0.070
COD of Kushiyara river in winter season - COD of Kushiyara river in rainy season	-.23900	0.12673	-1.886	9	0.092
TS of Kushiyara river in winter season - TS of Kushiyara river in rainy season	-18.93600***	4.85102	-3.904	9	0.004
TDS of Kushiyara river in winter season - TDS of Kushiyara river in rainy season	-25.65100***	6.46934	-3.965	9	0.003
SS of Kushiyara river in winter season - SS of Kushiyara river in rainy season	7.51500**	2.58601	2.906	9	0.017
Temperature of Surma river in winter season - Temperature of Surma river in rainy season	-1.10800**	.39445	-2.809	9	0.020
P^H of Surma river in winter season - P^H of Surma river in rainy season	-.05900	.11869	-.497	9	0.631

DO of Surma river in winter season - DO of Surma river in rainy season	-1.17500***	.30915	-3.801	9	0.004
BOD of Surma river in winter season - BOD of Surma river in rainy season	-.17000	.20112	-.845	9	0.420
COD of Surma river in winter season - COD of Surma river in rainy season	-.32900	.21327	-1.543	9	0.157
TS of Surma river in winter season - TS of Surma river in rainy season	-24.12100***	3.19610	-7.547	9	0.000
TDS of Surma river in winter season - TDS of Surma river in rainy season	-26.58200***	5.91467	-4.494	9	0.002
SS of Surma river in winter season - SS of Surma river in rainy season	3.26000	5.50392	.592	9	0.568
Note: ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level					

Test significant difference of pH of the Surma and the Kushiyara rivers in Winter and Rainy seasons

Average pH of the Surma and the Kushiyara rivers are illustrated in figure 2. The Sig. (2-Tailed) or P-value in this test is 0.63 which is greater than 0.05. So there is no statistically significant difference between the mean pH of the Surma river in winter season and rainy season. Therefore it can be concluded that pH of the Surma river in winter season and rainy season are more likely to each other. The Sig. (2-Tailed) or P-value in this test is 0.006 which is less than 0.05. Hence it can be concluded that there is a statistically significant difference between the mean pH of the Kushiyara river in winter season and rainy season. Since paired samples statistics box revealed that the mean pH of the Kushiyara river in rainy season is greater than winter season, hence it can be concluded that the Kushiyara river in rainy season significantly having more pH compared to winter season.

Test significant difference of DO of the Surma and the Kushiyara Rivers in Winter and Rainy Seasons

Mean DO of the Surma and the Kushiyara rivers are cited in figure 3. The Sig. (2-Tailed) or P-value in this test is 0.004 which is less than 0.05. Hence it can be concluded that there is a statistically significant difference between the mean DO of the Surma river in winter season and rainy season. Since paired samples statistics box revealed that the mean temperature of the Surma river in rainy season is greater than winter season, so it can be concluded that the Surma river in rainy season significantly having more DO compared to winter season. The Sig. (2-Tailed) or P-value in this test is 0.57 which is greater than 0.05. Therefore it can be concluded that there is no statistically significant difference between the mean DO of the

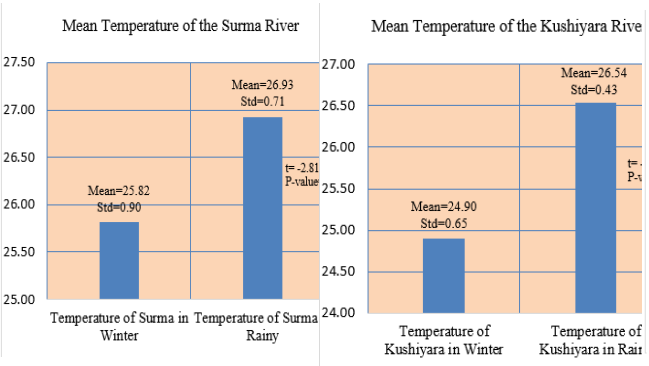


Figure 1: Mean Temperature of the Surma and the Kushiyara rivers.

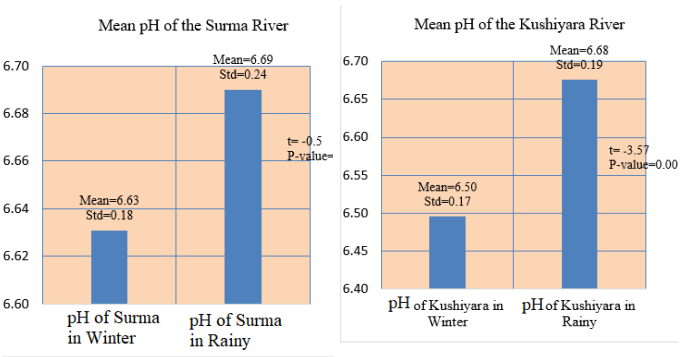
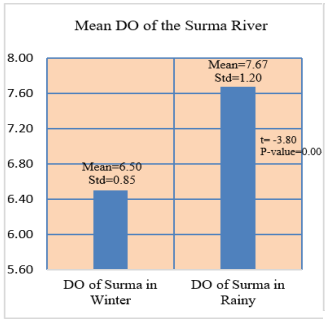


Figure 2: Mean pH of the Surma and the Kushiyara rivers.



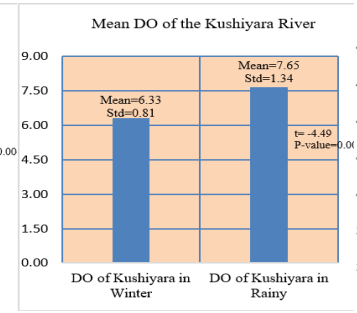
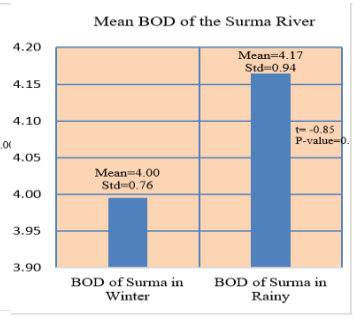


Figure 3: Mean DO of the Surma and the Kushiyara rivers.



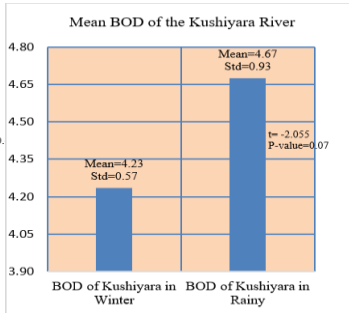
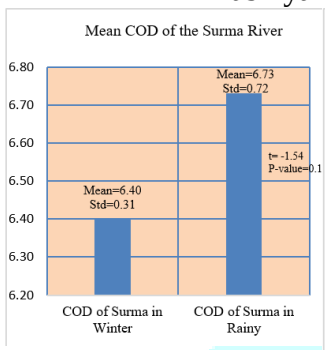


Figure 4: Mean BOD of the Surma and the Kushiyara rivers



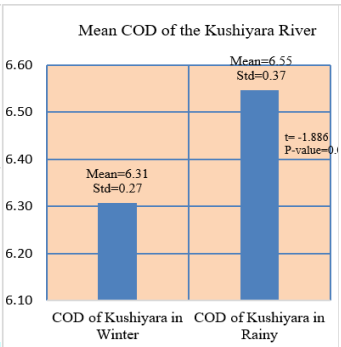
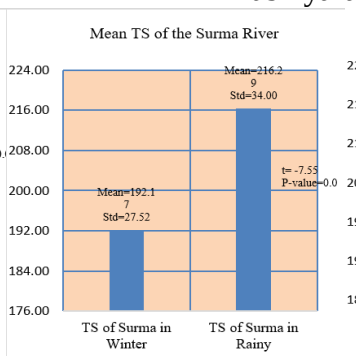


Figure 5: Mean COD of the Surma and the Kushiyara rivers



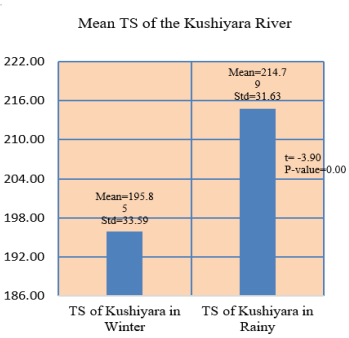
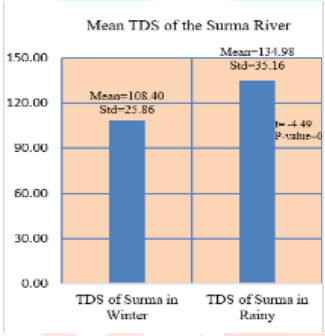


Figure 6: Mean TS of the Surma and the Kushiyara rivers



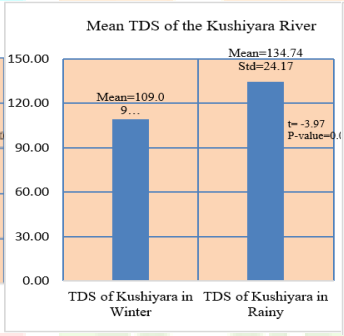
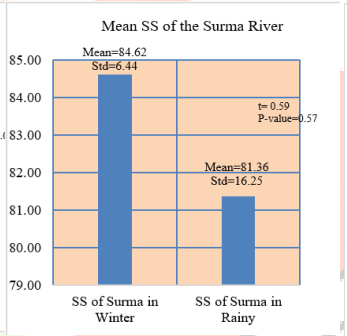


Figure 7: Mean TDS of the Surma and the Kushiyara rivers



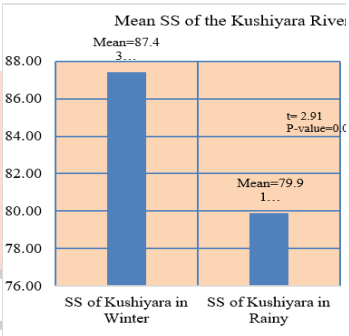


Figure 8: Mean SS of the Surma and the Kushiyara rivers

Kushiyara river in winter and rainy seasons. Hence it can be said that DO of the Kushiyara river in winter and rainy seasons are more likely to each other.

Test significant difference of BOD of the Surma and the Kushiyara rivers in Winter and Rainy seasons The Surma and the Kushiyara rivers average BOD values are illustrated in figure 4. The Sig. (2-Tailed) or P-value in this test is 0.42 which is greater than 0.05. For this reason it can be concluded that there is no statistically significant difference between the mean BOD of the Surma river in winter season and rainy season. So BOD of the Surma river in winter and rainy seasons are more likely to each other. For the Kushiyara river the Sig. (2-Tailed) or P-value in this test is 0.07 which is greater than 0.05. Hence it can be concluded that there is no statistically significant difference between the mean BOD of the Kushiyara river in winter season and rainy season. That is, BOD of the Kushiyara in winter and rainy seasons are more likely to each other.

Test significant difference of COD of the Surma and the Kushiyara rivers in Winter and Rainy seasons Average COD of the Surma and the Kushiyara rivers are shown in figure 5. The Sig. (2-Tailed) or P-value in this test is 0.16 which is greater than 0.05. Therefore it can be concluded that there is no statistically significant difference between the mean COD of the Surma river in winter and rainy seasons. That is, COD of the Surma river in winter and rainy seasons are more likely to each other. For the Kushiyara river the Sig. (2-Tailed) or P-value in this test is 0.092 which is greater than 0.05. Hence it can be concluded that there is no statistically significant difference between the mean COD of the Kushiyara river in winter and rainy seasons. That is, COD of the Kushiyara river in winter and rainy seasons are

more likely to each other.

Test significant difference of TS of the Surma and the Kushiyara rivers in Winter and Rainy seasons

The Surma and the Kushiyara rivers average TS values are displayed in figure 6. The Sig. (2-Tailed) or P-value in this test is 0.00 which is less than 0.05. For this reason it can be concluded that there is a statistically significant difference between the mean TS of the Surma river in winter and rainy seasons. Since paired samples statistics box revealed that the mean TS of the Surma river in rainy season is greater than winter season, it can be concluded that TS of the Surma river in rainy season significantly higher compared to winter season because in rainy season there comes a lot of external solid substances in different forms from upstream of the river sources and increase the volume of TS. The Sig. (2-Tailed) or P-value in this test is 0.004 which is less than 0.05. Hence it can be concluded that there is a statistically significant difference between the mean TS of the Kushiyara river in winter and rainy seasons. Since Paired Samples statistics box revealed that the mean TS of the Kushiyara river in rainy season is greater than winter season, it can be concluded that the Kushiyara river in rainy season, significantly having more TS compared to winter season.

Test significant difference of TDS of the Surma and the Kushiyara river in Winter and Rainy seasons

Mean TDS of the Surma river and the Kushiyara river is cited in Figure 7. The Sig. (2-Tailed) or P-value in this test is 0.002 which is less than 0.05. Hence it can be concluded that there is a statistically significant difference between the mean TDS of the Surma river in winter season and rainy season. Since paired samples statistics box revealed that the mean TDS of the Surma river in rainy season is greater than winter season, it can be concluded that the Surma river in rainy season, significantly having more TDS compared to winter season due to the upper stream contamination of TS. For the Kushiyara river the Sig. (2-Tailed) or P-value in this test is 0.003 which is less than 0.05. For this reason it can be concluded that there is a statistically significant difference between the mean TDS of the Kushiyara river in winter and rainy seasons. Since paired samples statistics box revealed that the mean TDS of the Kushiyara river in rainy season is greater than winter season, it can be concluded that the Kushiyara river in rainy season, significantly having more TDS compared to winter season.

Test significant difference of SS of the Surma and the Kushiyara rivers in Winter and Rainy seasons

Average SS values of the Surma river and the Kushiyara river are shown in figure 8. The Sig. (2-Tailed) or P-value in this test is 0.57 which is greater than 0.05. Hence it can be concluded that there is no statistically significant difference between the mean SS of the Surma river in winter and rainy seasons. That is, SS of the Surma river in winter and rainy seasons are more likely to each other. The Sig. (2-Tailed) or P-value in this test is 0.017 which is less than 0.05. Therefore it can be concluded that there is a statistically significant difference between the mean SS of the Kushiyara river in winter and rainy seasons. Since paired samples statistics box revealed that the mean SS of the Kushiyara river in rainy season is greater than winter season, it can be concluded that the Kushiyara river in rainy season, significantly having more SS compared to winter season. After paired t test analysis based on statistically significant and insignificant water quality parameters are divided into two group which are shown below in tabular form in table 2 and table 3.

Table 2: Statistical (Paired t-test) significant difference of seasonal variation of water quality parameters of the Surma and the Kushiyara rivers.

Name of parameter	Surma River		Kushiyara River	
	t-value	P-value	t-value	P-value
Temperature	-2.81	0.02	-11.11	0.00
DO	-3.80	0.004	-4.49	0.001
TS	-7.55	0.00	-3.90	0.004
TDS	-4.49	0.002	-3.97	0.003
pH	-	-	-3.57	0.006
SS	-	-	2.91	0.017

Table 3: Statistical (Paired t-test) insignificant difference of seasonal variation of water quality parameters between the Surma and the Kushiyara rivers

Name of parameter	Surma River		Kushiyara River	
	t-value	P-value	t-value	P-value
BOD	-0.85	0.42	-2.055	0.07
COD	-1.54	0.16	-1.886	0.092
pH	-0.5	0.63	-	-
SS	0.59	0.57	-	-

C. Test significant difference (Independent t-test) of each parameter between the Surma and the Kushiyara rivers

The independent samples t test compares two means of one object that are from different individual or related units. In this independent t-test Winter and Rainy seasons data of eight water quality parameters like temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total solids (TS), total dissolved solids (TDS) and suspended solids (SS) of the Surma and the Kushiyara rivers are compared, and results are shown in tabular form in table 4.

Table 4: Results of t test for several water quality parameters for the Surma and the Kushiyara rivers

Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.
Temperature of Surma in winter-Temperature of Kushiyara in winter	Equal variances assumed	0.93	0.35	2.50	18.00	0.02	0.93**	0.37
	Equal variances not assumed			2.50	16.39	0.02	0.93	0.37
Temperature of Surma in rainy-Temperature of Kushiyara in rainy	Equal variances assumed	1.43	0.25	1.39	18.00	0.18	0.39	0.28
	Equal variances not assumed			1.39	14.69	0.19	0.39	0.28
P^H of Surma in winter-P^H of Kushiyara in winter	Equal variances assumed	0.00	0.97	1.66	18.00	0.11	0.14	0.08
	Equal variances not assumed			1.66	17.91	0.11	0.14	0.08
P^H of Surma in rainy-P^H of Kushiyara in rainy	Equal variances assumed	0.27	0.61	0.14	18.00	0.89	0.01	0.10
	Equal variances not assumed			0.14	17.18	0.89	0.01	0.10
DO of Surma in winter-DO of	Equal variances assumed	0.03	0.88	0.43	18.00	0.67	0.17	0.39

Kushiyara in winter	Equal variances not assumed			0.43	17.96	0.67	0.17	0.39
DO of Surma in rainy-DO of Kushiyara in rainy	Equal variances assumed	0.00	0.99	0.04	18.00	0.97	0.02	0.60
	Equal variances not assumed			0.04	17.79	0.97	0.02	0.60
BOD of Surma in winter-BOD of Kushiyara in winter	Equal variances assumed	1.20	0.29	-0.76	18.00	0.46	-0.24	0.32
	Equal variances not assumed			-0.76	16.64	0.46	-0.24	0.32
BOD of Surma in rainy-BOD of Kushiyara in rainy	Equal variances assumed	0.00	0.95	-1.15	18.00	0.26	-0.51	0.44
	Equal variances not assumed			-1.15	18.00	0.26	-0.51	0.44
COD of Surma in winter-COD of Kushiyara in winter	Equal variances assumed	0.19	0.67	0.69	18.00	0.50	0.10	0.14
	Equal variances not assumed			0.69	17.55	0.50	0.10	0.14
COD of Surma in rainy-COD of Kushiyara in rainy	Equal variances assumed	5.54	0.03	0.69	18.00	0.50	0.19	0.27
	Equal variances not assumed			0.69	13.43	0.50	0.19	0.27
TS of Surma in winter-TS of Kushiyara in winter	Equal variances assumed	1.00	0.33	-0.26	18.00	0.80	-3.69	14.47
	Equal variances not assumed			-0.26	17.33	0.80	-3.69	14.47
TS of Surma in rainy-TS of Kushiyara in rainy	Equal variances assumed	0.44	0.52	0.10	18.00	0.92	1.50	15.48
	Equal variances not assumed			0.10	17.91	0.92	1.50	15.48
TDS of Surma in winter-TDS of Kushiyara in winter	Equal variances assumed	0.30	0.59	-0.05	18.00	0.96	-0.69	12.82
	Equal variances not assumed			-0.05	17.84	0.96	-0.69	12.82
TDS of Surma in rainy-TDS of Kushiyara in rainy	Equal variances assumed	5.89	0.03	0.02	18.00	0.99	0.24	14.22
	Equal variances not assumed			0.02	15.95	0.99	0.24	14.22
SS of Surma in winter-SS of Kushiyara in winter	Equal variances assumed	1.08	0.31	-0.85	18.00	0.41	-2.80	3.30
	Equal variances not assumed			-0.85	17.60	0.41	-2.80	3.30
SS of Surma in rainy-SS of Kushiyara in rainy	Equal variances assumed	0.03	0.87	0.21	18.00	0.84	1.45	7.05
	Equal variances not assumed			0.21	17.42	0.84	1.45	7.05
Note: ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level								

Test significant difference of Winter and Rainy seasons Temperature between the Surma and the Kushiyara rivers

Mean temperature of the Surma and the Kushiyara rivers during winter and rainy seasons are given in figure 9. From the table of independent t test it is found that F-statistic with Sig. value 0.35 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.022, which is less than .05 and for this reason it is clear that there is a statistically significant difference between the mean temperature of the Surma and the Kushiyara rivers in winter season. As the group statistics box reveals that the mean for the Surma river in winter is greater than the mean for the Kushiyara in winter, it can be concluded that temperature in the Surma river is significantly hotter than the Kushiyara river in winter season. The table of independent t test revealed that F-statistic with Sig. value 0.25 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.18. This value is greater than 0.05. For this reason it can be concluded that there is no statistically significant difference between the mean temperature of the Surma and the Kushiyara fivers in rainy season. Hence it can be concluded that temperature of the Surma and the Kushiyara rivers are relatively same to each other in rainy season.

Test significant difference of Winter and Rainy seasons pH between the Surma and the Kushiyara rivers

The Surma and the Kushiyara rivers mean pH values during winter and rainy season is shown in figure 10. From the table of independent t test it is found that F-statistic with Sig. value 0.97 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.11. This value is greater than 0.05, for this reason it can be concluded that there is no statistically significant difference between the mean pH of the Surma and the Kushiyara rivers in winter season. That is, pH of the Surma and the Kushiyara rivers are relatively same to each other in winter season.

From the table of independent t test it is found that F-statistic with Sig. value 0.61 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.89 which is greater than 0.05. Therefore it can be concluded that there is no statistically significant difference between the mean pH of the Surma and the Kushiyara rivers in rainy season. That is, pH of the Surma and the Kushiyara rivers are relatively same to each other in rainy season.

Test significant difference of Winter and Rainy seasons DO between the Surma and the Kushiyara rivers

Average DO of the Surma and the Kushiyara rivers during winter and rainy season is illustrated in figure 11. From the table of independent t test it is found that F-statistic with Sig. value 0.88 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.67. This value is greater than 0.05. For this reason it can be said that there is no statistically significant difference between the mean DO of the Surma and the Kushiyara rivers in winter season. Hence DO of the Surma and the Kushiyara rivers are relatively same to each other in winter season.

The table of independent t test showed that F-statistic with Sig. value 0.99 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.97. This value is greater than 0.05. Hence it can be concluded that there is no statistically significant difference between the mean DO of the Surma and the Kushiyara rivers in rainy season. That is, DO of the Surma and the Kushiyara rivers are relatively same to each other in rainy season.

Test significant difference of Winter and Rainy seasons BOD between the Surma and the Kushiyara rivers

The Surma and the Kushiyara rivers mean BOD during winter and rainy season is cited in figure 12. From the table of independent t test it is found that F-statistic with Sig. value 0.29 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.45. This value is greater than 0.05. Because of this, it can be concluded that there is no statistically significant difference between the mean BOD of the Surma and the Kushiyara rivers in winter season. That is, BOD of the Surma and the Kushiyara rivers are relatively same to each other in winter season. The table of independent t test revealed that F-statistic with Sig. value 0.95, which illustrates equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.264. This value is greater than 0.05. Because of this, it can be concluded that there is no statistically significant difference between the mean BOD of the Surma and the Kushiyara in rainy season. Therefore BOD of the Surma and the Kushiyara rivers are relatively same to each other in rainy season.

Test significant difference of Winter and Rainy seasons COD between the Surma and the Kushiyara rivers

Mean COD of the Surma and the Kushiyara rivers during winter and rainy seasons is shown in figure 13. From the table of independent t test it is found that F-statistic with Sig. value 0.67 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.49. This value is greater than 0.05. Hence it can be summarized that there is no statistically significant difference between the mean COD of the Surma and the Kushiyara rivers in winter season, which means COD of the Surma and the Kushiyara rivers are relatively same to each other in winter season. The table of

independent t test revealed that F-statistic with Sig. value 0.03 that is, equal variances are not assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.18. This value is greater than 0.05. For this reason, it can be concluded that there is no statistically significant difference between the mean COD of the Surma and the Kushiyara rivers in rainy season. That is, COD of the Surma and the Kushiyara rivers are relatively same to each other in rainy season.

Test significant difference of Winter and Rainy seasons TS between the Surma and the Kushiyara rivers

Mean TS of the Surma and the Kushiyara rivers during winter and rainy seasons is cited in figure 14. From the table of independent t test it is found that F-statistic with Sig. value 0.33 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.8. This value is greater than 0.05. Hence it can be concluded that there is no statistically significant difference between the mean TS of the Surma and the Kushiyara rivers in winter season. That is, TS of the Surma and the Kushiyara rivers are relatively same to each other in winter season. From the table of independent t test it is found that F-statistic with Sig. value 0.52 that is, equal variances are assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.92. This value is greater than 0.05. For this reason, it can be concluded that there is no statistically significant difference between the mean TS of the Surma and the Kushiyara rivers in rainy season. That is, TS of the Surma and the Kushiyara rivers are relatively same to each other in rainy season.

Test significant difference of Winter and Rainy seasons TDS between the Surma and the Kushiyara rivers

The Surma and the Kushiyara rivers average TDS values during winter and rainy seasons is given in figure 15. The table of independent t test revealed F-statistic with Sig. value 0.59 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.96. This value is greater than 0.05. Therefore it can be said that there is no statistically significant difference between the mean TDS of the Surma and the Kushiyara rivers in winter season. That is, TDS of the Surma and the Kushiyara rivers are relatively same to each other in winter season. From the table of independent t test it is found that F-statistic with Sig. value 0.03 that is, equal variances are not assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.99. This value is greater than 0.05, which means that there is no statistically significant difference between the mean TDS of the Surma and the Kushiyara rivers in rainy season. That is, TDS of the Surma and the Kushiyara rivers are relatively same to each other in rainy season.

Test significant difference of Winter and Rainy seasons SS between the Surma and the Kushiyara rivers

Mean SS of the Surma and the Kushiyara rivers during winter and rainy seasons is illustrated in figure 16. From the table of independent t test it is found that F-statistic with Sig. value 0.31 that is, equal variance assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.41. This value is greater than 0.05. Because of this, it can be concluded that there is no statistically significant difference between the mean SS of the Surma and the Kushiyara rivers in winter season. That is, SS of the Surma and the Kushiyara rivers are relatively same to each other in winter season. The table of independent t test it is illustrates that F-statistic with Sig. value 0.87. That is, equal variances are assumed between two groups and the Sig. (2-Tailed) value or p-value of t test is 0.84. This value is greater than 0.05, which showed that there is no statistically significant difference between the mean SS of the Surma and the Kushiyara rivers in rainy season. Therefore it can be concluded that SS of the Surma and the Kushiyara rivers are relatively same to each other in rainy season. From independent t test analysis based on statistically significant and insignificant water quality parameters are divided into two group which are shown below in tabular form in table 5 and table 6.

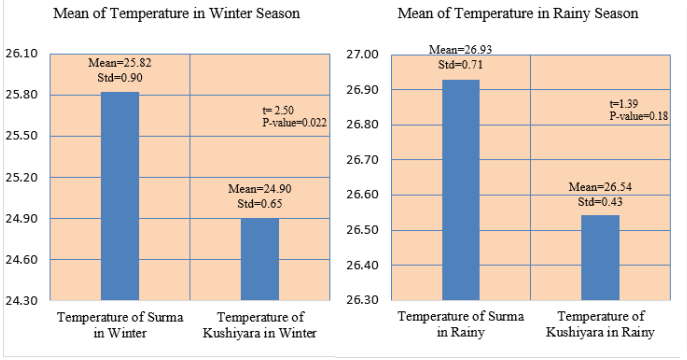


Figure 9: Mean Temperature of the Surma and the Kushiyara rivers in winter and rainy seasons

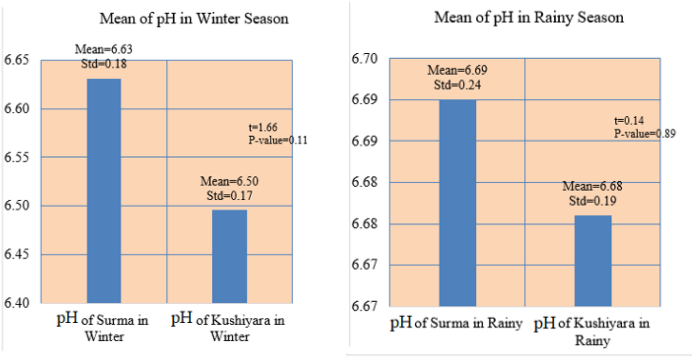


Figure 10: Mean pH of the Surma and the Kushiyara rivers in winter and rainy seasons

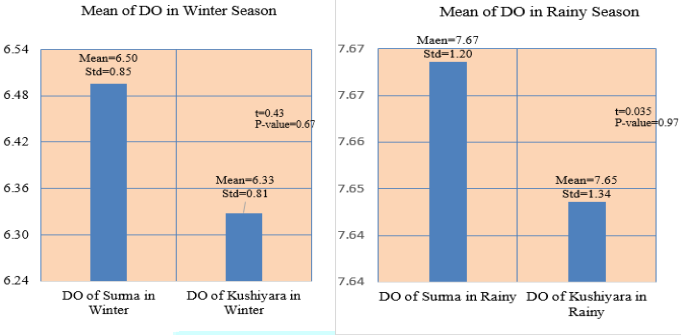


Figure 11: Mean DO of the Surma and the Kushiyara rivers in winter and rainy seasons

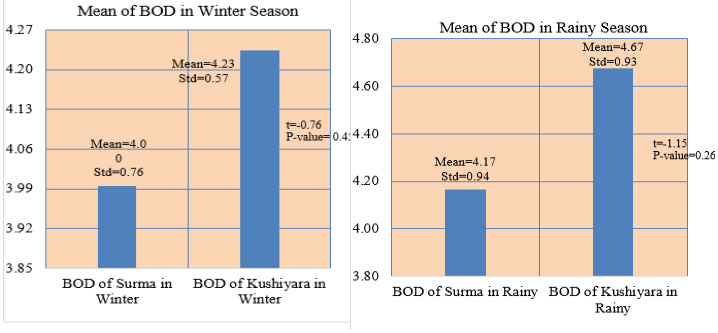


Figure 12: Mean BOD of the Surma and the Kushiyara rivers in winter and rainy seasons

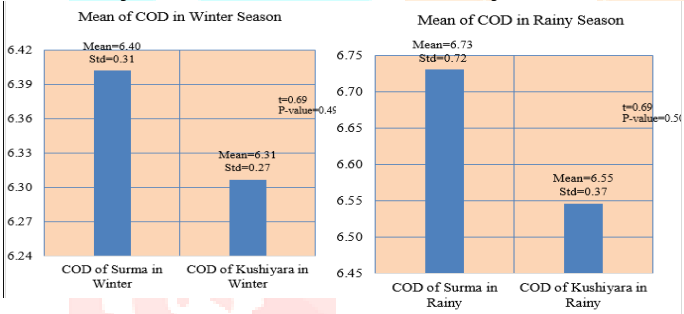


Figure 13: Mean COD of the Surma and the Kushiyara Rivers in winter and rainy seasons

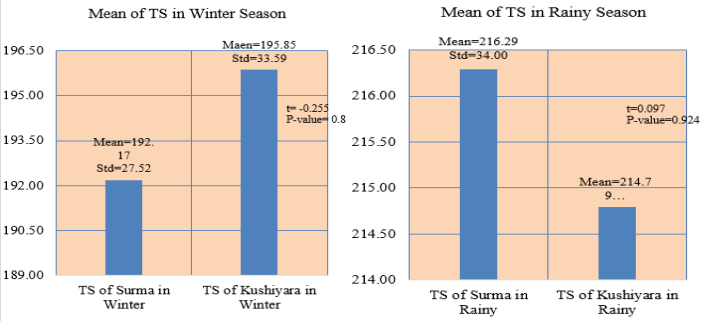


Figure 14: Mean TS of the Surma and the Kushiyara rivers in winter and rainy seasons

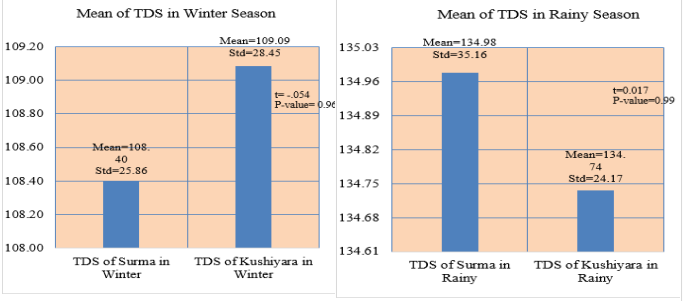


Figure 15: Mean TDS of the Surma and the Kushiyara rivers in winter and rainy seasons

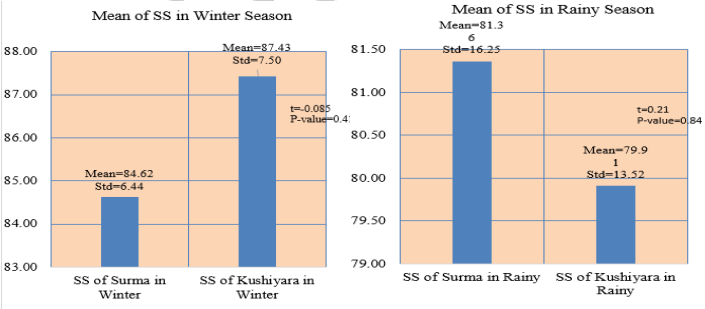


Figure 16: Mean SS of the Surma and the Kushiyara rivers in winter and rainy seasons

Table 5: Statistical (Independent t-test) significant difference of seasonal variation of water quality parameters between the Surma and the Kushiyara rivers.

Name of parameter	t- value	P- value
Temperature in Winter Season	2.50	0.022

Table 6: Statistical (Independent t-test) insignificant difference of seasonal variation of water quality parameters between the Surma and the Kushiyara rivers.

Name of parameter	Rainy Season		Winter Season	
	t-value	P-value	t-value	P-value
Temperature	1.39	0.18	-	-
pH	0.14	0.89	1.66	0.11
DO	0.035	0.97	0.43	0.67
BOD	-1.15	0.26	-0.76	0.45
COD	0.69	0.50	-0.69	0.49
TS	-0.097	0.924	-0.255	0.8
TDS	-0.017	0.99	-0.054	0.96
SS	0.21	0.84	-0.085	0.41

IV. CONCLUSION

After analysis of all water quality parameters mentioned in the study it is revealed that temperature, pH, TS and TDS of the Surma and the Kushiyara rivers in both season lie within the limit of Bangladesh water quality standard. However the average values of BOD, COD and SS cross the limit of Bangladesh water quality standard defined by the DoE, Bangladesh. DO of both rivers are strictly below the permissible limit. BOD of the Surma and the Kushiyara rivers in both season cross the Bangladesh water quality standard for drinking and recreational purpose while the values are ok for other categories. The paired sample's t test of the Surma river showed that temperature, DO, TS and TDS showed statistically significant difference in rainy and winter season, whereas pH, BOD, COD and SS showed no statistically significant difference for the Surma river in rainy and winter season. In rainy season all the water quality parameters showed higher mean values except SS for the Surma river. The paired sample's t test of the Kushiyara river demonstrate that temperature, pH, DO, TS, TDS and SS showed statistically significant difference in rainy and winter season's data. Whereas BOD and COD showed no statistically significant difference in rainy and winter season for the Kushiyara river. In rainy season, all the water quality parameters revealed higher mean values except SS for the Kushiyara river. Independent sample's t test of the Surma and the Kushiyara rivers rainy seasons data revealed that all the water quality parameters revealed statistically insignificant difference between each other. Independent t test of the Surma and the Kushiyara rivers winter seasons data revealed that only temperature showed statistically significant difference, however all other water quality parameters showed statistically insignificant difference between them.

REFERENCES

[1] Leščešen, I., Pantelić, M., Dolinaj, D., Stojanović, V., & Milošević, D. (2015). Statistical analysis of water quality parameters of the Drina River (West Serbia), 2004-11. Polish Journal of Environmental Studies, 24, 555–561. https://doi.org/10.15244/pjoes/29684

[2] KOWALOWSKI T., ZBYTNIEWSKI R., SZPEJNA J., BUSZEWSKI B. Application of chemometrics in river water classification. Water Research 40, (4), 744, 2006.

[3] KARADAVUT I. S., SAYDAM A. C., KALIPCI E., KARADAVUT S., ÖZDEMIR C. A research for water pollution of Melendiz stream in terms of sustainability of ecological balance. Carpathian Journal of Earth and Environmental Sciences, 6, (1), 65, 2011.

[4] FERENCZI L., BALOG A. A pesticide survey in soil, water and foodstuffs from central Romania. Carpathian Journal of Earth and Environmental Sciences, 5, (1), 111, 2010.

[5] PARVULESCU L., HAMCHEVICI C. The relation between water quality and the distribution of Gammarus balcanicus schäferna 1922 (amphipoda: gammaridae) in the anina mountains. Carpathian Journal of Earth and Environmental Sciences, 5, (2), 161, 2010.
[6] Alvarez-Vazquez, L. J., Martinez, A., Vazquez-Mendez, M. E., & Vilar, M. A. (2009). An application of optimal control theory to river pollution remediation. Applied Numerical Mathematics, 59, 845.
[7] PANTELIĆ M. Remediation and protection of Veliki Bački canal as a prerequisite for sustainable use of its development potential, PhD dissertation, University of Novi Sad, Department of geography, tourism and hotel management, 2012 [In Serbian].
[8] HUANG F., WANG X., LOU L., ZHOU Z., WU J. Spatial variation and source apportionment of water pollution in Qiantang River (China) using statistical techniques. Water Res., 44, (5), 1562, 2010.
[9] KARADVUT I.S., SAYDAM A. C., KALIPCI E., KARADVUT S., ÖZDEMIR C. A research for water pollution of Melendiz stream in terms of sustainability of ecological balance. Carpathian Journal of Earth and Environmental Sciences, 6, (1), 65, 2011.
[10] Sahoo, M.M. (2014). Analysis and Modelling of Surface Water Quality in Rivers Basins. (MSc. Thesis, National Institute of Technology Rourkela).
[11] Das, J., & Acharya, B. C. (2003). Hydrology and assessment of lotic water quality in Cuttack City, India. Water, Air, and Soil Pollution, 150(1-4), 163-175.
[12] Ramakrishnaiah, C. R., Sadashivaiah, C., & Ranganna, G. (2009). Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State, India. Journal of Chemistry, 6(2), 523-530.
[13] Loukas, A. (2010). Surface water quantity and quality assessment in Pinios River, Thessaly, Greece. Desalination, 250(1), 266-273.
[14] Anon. (2001). Water Effluent from Pig Farms in Sabah-A Preliminary investigation of the Key Environmental Issue. State Environmental Conservation Department, Sabah, Malaysia.
[15] Aziz, M. A. (1975). Water Supply Engineering. Hafiz Book Centre, Dhaka, Bangladesh.
[16] Chen, P., Yuan, H., & Shu, X. (2008, October). Forecasting crime using the arima model. In 2008 Fifth International Conference on Fuzzy Systems and Knowledge Discovery (Vol. 5, pp. 627-630). IEEE.
[17] Chen, Y., Fan, C., Teubner, K., & Dokulil, M. (2003). Changes of nutrients and phytoplankton chlorophyll-a in a large shallow lake, Taihu, China: an 8-year investigation. Hydrobiologia, 506(1-3), 273-279.
[18] Chowdhury, M. A. I., Naher, T., & Ahmed, P. (2011). Water Quality of the River Surma and Kushiyara. (B.Sc. Engineering Thesis, Civil and Environmental Engineering Department, Shah Jalal University of Science and Technology, Sylhet, Bangladesh).
[19] David, H. A., & Gunnink, J. L. (1997). The paired t test under artificial pairing. The American Statistician, 51(1), 9-12.
[20] DOE, (2001). Malaysia Environmental Quality Report, Department of Environment, Ministry of Science, Technology and Environment Maskha Sdn Bhd, Kuala Lumpur, Malaysia.
[21] DoE/BEMP. 2003. Fourth Dhaka Water Supply Project, Dhaka Water Resour. Manage. Programme.
[22] Feroze, M. A., & Rahman, M. M. (2000). Water supply & sanitation: Rural and low income urban communities. ITN-Bangladesh, Centre for Water Supply and Waste Management, BUET.
[23] Gasim, M. B., Jamil, M., Rahim, S. A., & Toriman, M. E. (2009). Water-Quality Assessment of the Langat River at Kilometre 7, Jalan Kajang-Bangi, Selangor, Malaysia. The Arab World Geographer, 12(3-4), 188-198.
[24] Gasim, M. B., Ismail, B. S., Wan, N. A., Muhammad, I. Y., & Marlia, M. H. (2005). Water quality assessment of the Semenyih River basin langor, Malaysia. Journal Biosains, 16(1), 95.
[25] Hamza, H. (2009). Water quality trend at the upper part of Johor River in relation to rainfall and runoff pattern (Doctoral dissertation, Universiti Teknologi Malaysia).
[26] Massoud, M. A., El-Fadel, M., Scrimshaw, M. D., & Lester, J. N. (2006). Factors influencing development of management strategies for the Abou Ali River in Lebanon: I: Spatial variation and land use. Science of the Total Environment, 362(1-3), 15-30.
[27] Seth, R., Singh, P., Mohan, M., Singh, R., & Aswal, R. S. (2013). Monitoring of phenolic compounds and surfactants in water of Ganga Canal, Haridwar (India). Applied Water Science, 3(4), 717-720.
[28] Sigua, G. C., & Tweedale, W. A. (2003). Watershed scale assessment of nitrogen and phosphorus loadings in the Indian River Lagoon basin, Florida. Journal of Environmental Management, 67(4), 363-372.

[29] Sumok, P. (2011). River water quality monitoring Sharing Sarawak experience. In proceedings of 6th SITE Research Seminar, 1-4.

[30] Tajmunnaher, T., & Chowdhury, M. A. I. (2017). Correlation Study for Assessment of Water Quality and its Parameters of Kushiyara River, Sylhet, Bangladesh. International Journal of New Technology and Research, 3(12)