

Industrialisation scenario at Sreepur of Gazipur,
Bangladesh and physico-chemical properties of
wastewater discharged from industries

ABSTRACT

This study was conducted to explore the present trend and pattern of industrial growth with spatial distribution of industries and seasonal extent of physicochemical characteristics of wastewater at Sreepur of Gazipur, Bangladesh. The wastewater samples were collected from 5 locations in three seasons viz. pre-monsoon, monsoon and dry season. Total 120 medium to large industries were surveyed, among those 52 were in red category, 53 were in orange-B category, 13 were in orange-A and only 2 were in green category [1]. In 1995, there were only three industries, which gradually increased to a total of 29 in 2005, among them 11 were in red category and 18 were in orange-B category. But from 2006-2010, total 59 industries were developed and most of them were in red and orange-B categories. Similarly, during the period of 2011 to March 2013, total 16 industries were developed, among them 8 industries were in red and 3 were in orange-B category. Major types of wastewater discharging industries were textile, dyeing, washing and printing. Among the surveyed industries about 33% didn't have any effluent treatment plant (ETP). The mean value of pH, EC, DO, BOD, COD and TDS of wastewater were 7.28, 2.64, 1.62 mg L⁻¹, 82.0 mg L⁻¹, 217.31 mg L⁻¹ and 1380 mg L⁻¹, respectively during pre-monsoon; 6.7, 1.15, trace, 8.0 mg L⁻¹, 152.4 mg L⁻¹ and 539.58 mg L⁻¹, respectively during monsoon and 7.7, 1.82, 0.74 mg L⁻¹, 48.8 mg L⁻¹, 204.8 mg L⁻¹ and 993.6 mg L⁻¹, respectively during dry season. Average DO concentrations in all seasons and sites were significantly lower, while BOD and COD contents were higher in pre-monsoon and dry seasons than the DoE permissible limit. The study concluded that the area is now a hub of polluting industries which are mostly liable to pollute the surrounding environment.

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Keywords: Industrialisation, Spatial distribution, Wastewater, Sreepur, Gazipur, Bangladesh)

1. INTRODUCTION

During last two decades, Bangladesh has experienced a dramatic expansion in small and medium level industries, particularly in garments and textile sector, which have boosted the economy of the country. Undoubtedly, industrialization plays a significant role to accelerate economic growth and employment status, increase in incomes and standard of living of the people. On the contrary, with the rising of industries and expansion of urban areas the agricultural and residential places are under tremendous pressure in Bangladesh. Therefore, the peoples of such area are now suffering from various forms of environmental and social hazards. Ironically, environmental degradation in such area persistently continued despite multiple designated government agencies that are equipped with various conservation laws, codes and planning documents in hand during the past couple of years.

30 Once upon a time Sreepur of Gazipur district has a unique topographical position with rich
31 biodiversity and ecological habitats. But now-a-days farmlands are surrounded by boundary
32 walls and used for different industrial purposes. Beautiful water body's came to the carrier of
33 dark, filthy and foul smelled channel. Canals became narrowed down and the polluted water
34 spreading over the farmlands during heavy rain in the rainy season. Furthermore, irrigation
35 practices with these industrial wastewater adds significant quantities of different
36 contaminants including toxic metals which is ultimately damaging the soil quality [2-7].
37 Consumption of agricultural commodities produced in such contaminated soil can cause
38 serious health problems to the peoples [8-10].
39 However, there are scanty of inclusive research for the Sreepur area in context of industrial
40 pollution. Some of the researches are done sporadically along with areas of other upazila's
41 of same district, without providing an inclusive result especially for this area [11]. Therefore,
42 detailed systematic field researches on industrialisation scenario and their consequences on
43 water pollution were inadequate or missing. Considering the fact stated above this work was
44 conducted to assess industrialisation scenario, their categorization as environmental
45 pollution sources and physico-chemical properties of wastewater discharged from different
46 industries of Sreepur Upazila of Gazipur district.

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49 **2. MATERIAL AND METHODS**

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51 **2.1 Description of the Study Area**

52 According to physiographic features Sreepur is an area which evolved during Pleistocene
53 period having area of 465.25 km². The Upazila is located at the north-eastern part of Gazipur
54 district, which lies between 24°01' to 24°20' N latitude and 90°18' to 90°33' E longitude [12].
55 Geologically, the Gazipur cluster lies on the southern corner of Madhupur tract with its
56 average thickness of about 10 m consists of over consolidated clayey silt and is underlain by
57 the Pleistocene Dupi Tila formation. The rocks encountered here are much younger in
58 geologic age and ranges between Oligocene and Recent time. The basin has got the record
59 of rapid subsidence and sedimentation [13]. Jamindari system was there like other parts of
60 the then Bengal. "Bhawal Raja" estate was there for long time. By virtue of this Jamindari
61 system a number of people of this place historically owned handsome amount of land [14].

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63 **2.2 Data Collection about the Industries**

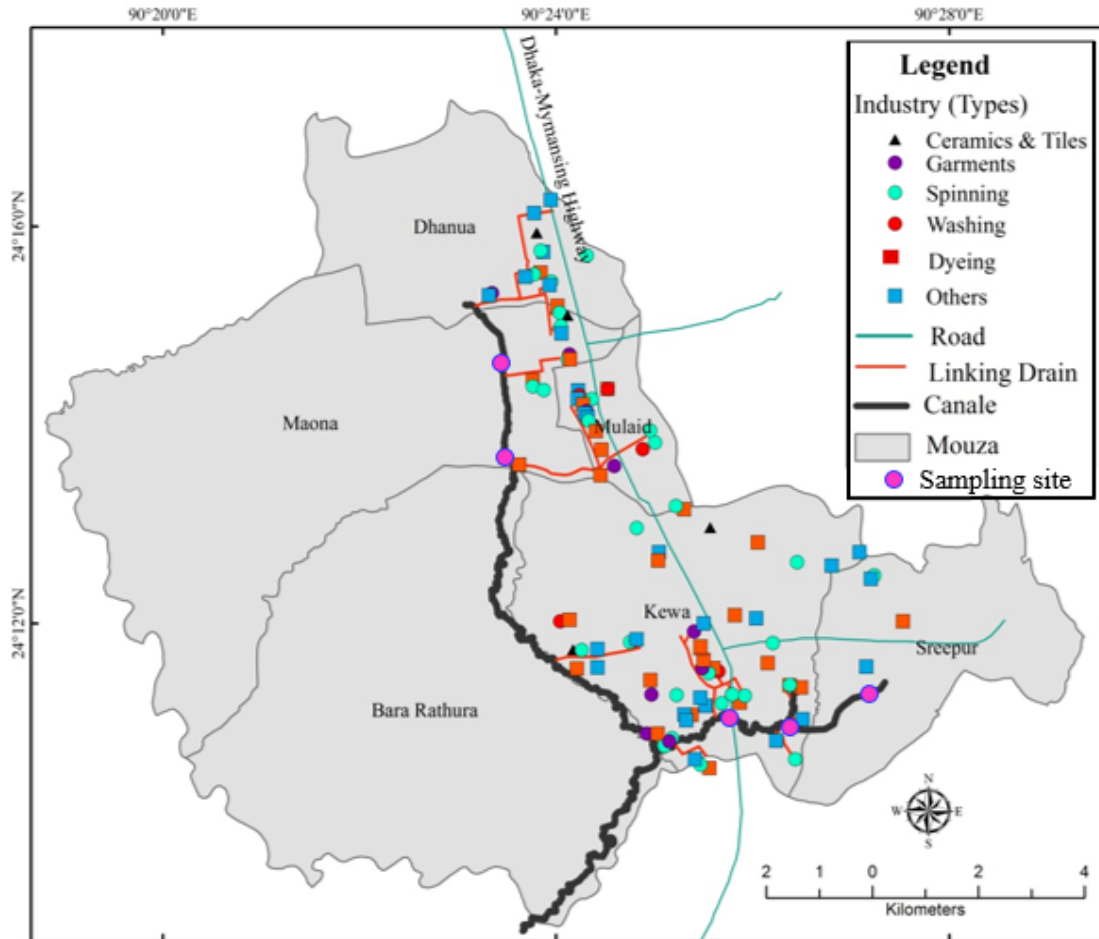
64 Data of the industries in the study area have been collected on the basis of the following pre-
65 structured format, viz. serial no., name of the industry, type of industry, category on the basis
66 of ECR, installation of ETP (yes/no), location, GPS point, establishment year and area
67 covered. In case of any query or clarification industry personnel were asked to reply and
68 sometimes it has been discussed also with people living nearby industry. Some of the
69 information collected on the basis of oral statement and some of the data collected black and
70 white provided by the industry personnel. Distribution of different types of industries in the
71 study area along with the sampling sites are shown in Fig. 1.

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73 **2.3 Water Sampling and Processing**

74 Total 5 wastewater samples were collected from the study area during three seasons viz.
75 pre-monsoon, monsoon and dry from different points of the canal following the sampling
76 techniques as outlined by APHA [15]. The collected water samples were stored in 500 mL
77 preconditioned clean, high density plastic bottles and use for the analysis of physicochemical
78 parameters. During collection of water samples, bottles were well rinsed using the same
79 water. All water samples were filtered through Whatman No.1 filter paper to remove
80 unwanted solid and suspended material. After filtration, 3-4 drops of nitric acid were added
81 to the samples to avoid any fungal and other pathogenic growth. In the laboratory, the

82 samples were kept in a clean, cool and dry place. The locations of the sampling sites have
83 been presented in Fig. 1.
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86 Figure 1: Distribution of different types of industries and sampling sites in study area
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89 2.4 Analytical Methods

90 Collected wastewater samples were analysed for various physicochemical parameters. The
91 pH, electrical conductivity (EC) and total dissolved solids (TDS) were measured within a few
92 hours by using a pH meter (Jenway 3505, UK) and a conductivity meter (SensION™+EC5,
93 HACH, USA), respectively. Dissolve oxygen (DO) was determined by Azide modification
94 method, where 2 ml of $MnSO_4$, 2 ml alkali iodide azide and 2 ml of conc. H_2SO_4 were added
95 as outlined by APHA [15]. Biochemical oxygen demand (BOD) was also determined by
96 Azide modification method, where the samples were kept in a BOD incubator at $20^\circ C$ for 5
97 days. The differences between 5 days DO and initial DO was treated as BOD of the water
98 sample. Chemical oxygen demand (COD) was measured by close reflux method using COD
99 vials and measured the concentration by means of a photometer as outlined by APHA [15].

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102 3. RESULTS AND DISCUSSION

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104 3.1 Spatial Distribution of Industries

105 Over the recent years, Sreepur is experiencing immense pressure of new industrial and
106 commercial establishments. But most of the development activities have done
107 indiscriminately violating the environmental laws and ignoring overall public convenience. In
108 absence of any land zoning system or strict monitoring of land use policy both land
109 developers and entrepreneurs are exploiting the farming land and using those lands for
110 industrial or commercial purposes.

111
112 In the study area industrial concentrations are high in three unions of Sreepur upazila.
113 Among these three unions, industries are mainly located in five mouzas namely- Sreepur,
114 Kewa, Maona, Mulaid and Danua. Most of the industries were developed along the Dhaka-
115 Mymensingh high way and *Gorgoria Masterbari*-Sreepur road. Major types of industries are
116 textile, dyeing, washing and printing. There have also other types of readymade garments
117 (RMG) industries such as, garments, spinning, sweaters, etc., but they don't release any
118 liquid waste to the surrounding environment or in the canal.

119
120 During Feb-March, 2013, a detailed survey of industries was carried out in the study area.
121 Total 120 medium to large industries was surveyed in the study area which are shown in
122 Table 1. Among the industries 52 were in red category and 53 were in orange-B category
123 and 13 were in orange-A and only 2 were in green category industries (categorized on the
124 basis of ECR [1]). Actual position and type of the major industries are depicted in Fig. 1.

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126 **3.2 Development Scenario and Density of Industries at the Study Area**

127 Among the 120 industries at least 20 textile dyeing and washing industries were close to the
128 water sampling points. These industries and others also discharge their wastewater to the
129 nearby canal through the pipeline or drain close to each of the sampling points. This pipeline
130 or drain either constructed by the individual industry up to the canal or joined the individual
131 pipeline/drain to a common pipeline/drain by which water ultimately goes to the canal.
132 Different clusters of industries close to the sampling points are shown in Fig. 2. The pipeline
133 or drain networking system so far identified in the field are also shown in Fig. 2 with arrow
134 marks.

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136 It can be seen from Table 1 that till 1995 there were only three industries in the study area.
137 But, the number of industries gradually increased from 1996 and since then to 2005 total 29
138 industries developed, among them 11 were in red category and 18 were in orange - B
139 categories. But, from 2006 to 2010 the number of industries massively increased in the study
140 area. During this time total 59 industries were developed in the study area, which were
141 mostly in red and orange - B category. During this period 30 red category industries
142 established against 23 orange - B category industries. As the survey was done till March
143 2013, therefore the number of industries from 2011 to March 2013 was not big enough
144 compared to previous time due to the short period of time. This time total 16 industries were
145 developed and among them, 08 industries were in red and 03 industries were in orange - B
146 categories. Therefore, it is pity to say study area is now a hub of polluting industries (Fig. 2)
147 which are mostly liable to pollute the environment of the study area. It is to be noted here
148 that out of 120 industries the year of establishment of 13 industries was not known. Most of
149 the industries (49.17%) developed during the period 2006-2010. The majority of the red
150 category and orange-B category industries discharge the liquid waste by their individual
151 pipeline or a common pipeline involving other industries which finally connected to the
152 nearby canal.

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Table 1. Detailed information about the industrial establishment in the study area (up to 2013)

SL No.	Name of the Industry	Type	Category (according to ECR [1])	Presence of ETP (Yes/No)	Mouza	GPS point	Estab. year	Area in Acre
1	Unilliance Group	Composite	Red	Yes	Sreepur	24 ⁰ 11'39" 90 ⁰ 21'59.3"	2008	20
2	Hams Garments Ltd.	Knit composite	Red	Yes	Sreepur	24 ⁰ 11'33.8" 90 ⁰ 27'09.1"	2010	2
3	Aman Textile Ltd.	Composite	Red	Yes	Sreepur	24 ⁰ 11'21.3" 90 ⁰ 26'29.5"	2008	13.2
4	AnwaraMannan Textile Mills Ltd.	Spinning	Red	No	Kewa	24 ⁰ 11'02.1" 90 ⁰ 26'30.4"	2012	11.22
5	Ishraque Spinning Mills Ltd.	spinning	Orange-B	No	Sreepur	24 ⁰ 10'49.1" 90 ⁰ 26'14.3"	2006	36.3
6	Chittagong Denim Mills Ltd.	Denim/ Fabrics	Red	Yes	Kewa	24 ⁰ 11'22.6" 90 ⁰ 26'22.4"	2007	7.26
7	Fakruddin Textile Mills Ltd.	Textile composite	Red	Yes	Kewa	24 ⁰ 11'22.8" 90 ⁰ 26'22.5"	2007	13.53
8	Power Mann Limited	Transformer	Red	No	Kewa	24 ⁰ 11'36.0" 90 ⁰ 26'09.0"	2001	1
9	Fashion Makers Ltd.	Fashion	Green	-	Kewa	24 ⁰ 11'44.1" 90 ⁰ 24'10.3"	2010	1.65
10	Skynet Power Company Ltd.	Textile division	Red	No	Kewa	24 ⁰ 11'48.1" 90 ⁰ 26'12.1"	2008	1.81
11	Denimach Washing Ltd.	Washing	Red	Yes	Kewa	24 ⁰ 11'12.1" 90 ⁰ 25'52.1"	2006	17.82
12	Denimach Ltd.	Oven bottom	Orange-B	No	Kewa	24 ⁰ 11'16.2" 90 ⁰ 25.5'51"	2006	3.96
13	Crystal Industries Private Bangladesh Ltd.	Sweater, Jumper	Orange A	No	Sreepur	24 ⁰ 11'17.0" 90 ⁰ 25'47.2"	2010	4.68
14	Mita Textiles Ltd.	Spinning/ Yarn	Orange-B	-	Kewa	24 ⁰ 11'17.0" 90 ⁰ 25'47.3"	1992	19.18
15	How Are You Textile Industries Ltd.	Textile	Red	Yes	Kewa	24 ⁰ 11'11.7" 90 ⁰ 25'40.9"	2006	2.8
16	Meghna Knit Composite Ltd.	Knit composite	Red	Yes	Kewa	24 ⁰ 11'10.2" 90 ⁰ 25'31.2"	2006	3
17	Onetex Ltd.	Yarn/ Dyeing	Red	Yes	Kewa	24 ⁰ 11'04.7" 90 ⁰ 25'22.6"	2003	55
18	Eco-Cotton Mills Ltd.	Cotton	Orange-B	-	Kewa	24 ⁰ 11'04.9" 90 ⁰ 25'18.2"	1996	39.6
19	Sabnam Textile Mills Ltd.	Textile	Orange-B	-	Kewa	2401101.5 9002519.3	1996	2
20	Pandora Sweaters Ltd	Sweater	Orange-B	Yes	Kewa	2401115.0 9002527.9	2005	1
21	Your Fashion Sweater Ltd.	Sweater	Green	-	Kewa	24 ⁰ 11'16.7" 90 ⁰ 25'13.4"	2008	1
22	Welldone Apparel Ltd.	Sweater	Orange- A	-	Kewa	24 ⁰ 11'17.0" 90 ⁰ 24'58.0"	2011	11
23	Perfetti Van Melle Bangladesh Pvt. Ltd.	Candy, Gum	Orange-B	Yes	Kewa	24 ⁰ 10'53.4" 90 ⁰ 24'55.2"	2009	11.38
24	Westeria Textiles Ltd.	Textile	Red	Yes	Kewa	24 ⁰ 10'53.4" 90 ⁰ 25'01.9"	2007	1.23
25	Synergey Textile Ltd.	Textile	Red	No	Kewa	24 ⁰ 10'45.9" 90 ⁰ 25'06.0"	2012	1
26	Integrated Textile Resources Ltd.	Printing	Orange- A	Yes	Kewa	24 ⁰ 10'50.6" 90 ⁰ 25'10.6"	2012	15
27	Dignity Textile Mills Ltd.	Textile	Red	Yes	Kewa	24 ⁰ 10'48.7" 90 ⁰ 25'09.0"	2011	4
28	Argon Denims Ltd.	Denim/ Fabrics	Red	No	Kewa	24 ⁰ 11'25.7" 90 ⁰ 24'57.5"	2008	8

SL No.	Name of the Industry	Type	Category (according to ECR [1])	Presence of ETP (Yes/No)	Mouza	GPS point	Estab. year	Area in Acre
29	Colour and Fashion Industries Ltd.	Sweater	Red	No	Sreepur	24°10'37.9" 90°26'25.7"	2010	2.86
30	Uniglory Cycle Components Ltd.	By-cycle	Red	Yes	Maona	24°10'32.5" 90°25'33.5"	2003	5.61
31	SM Knit Wears Ltd.	Knit composite	Red	Yes	Maona	24°35'35.4" 90°25'27.5"	2000	21.12
32	SM Knitting Industries Ltd.	dyeing	Red	-	Maona	24°10'34.4" 90°25'28.1"	2000	11.68
33	Meghna Cycles Ltd.	By-cycle	Red	Yes	Maona	24°10'37.9" 90°25'24.7"	2010	9.24
34	Aswad Composite Mills Ltd.	Composite	Red	-	Kewa	24°11'48.7" 90°24'45.0"	2008	16.5
35	Shekhor Sweaters	Sweater	Orange-A	-	Kewa	24°11'50.1" 90°24'48.4"	2010	8.25
36	Phoenix Home Textiles Ltd.	Bed sheet	Red	Yes	Kewa	24°11'50.3" 90°24'49.1"	2013	6.6
37	Taqwa Fabrics Ltd.	Knit composite	Red	Yes	Kewa	24°11'44.5" 90°24'25.2"	2009	24.42
38	X Ceramics Ltd.	Tiles	Orange-B	Yes	Kewa	24°11'32.7" 90°24'12.6"	2010	4.95
39	Abcott Industries Ltd.	Cotton (medical)	Orange-B	-	Kewa	24°11'33.3" 90°24'25.2"	2013	13.86
40	Shaharish Composite Home Textile Towel Ltd.	Home textile	Red	No	Kewa	24°11'43.8" 90°24'15.6"	2012	2.92
41	Knit Horizon Ltd.	Knitting & dyeing	Red	No	Kewa	24°12'01.3" 90°24'02.4"	2011	4.12
42	KSS Knit Composite Ltd.	Knit composite	Red	Yes	Sreepur	24°12'02.1" 90°24'08.1"	2010	4
43	Crown Wool Wear Ltd.	Yarn/Dyeing	Red	Yes	Maona	24°13'36.1" 90°23'37.5"	2007	12
44	Yasmin Spinning Mills Ltd.	Spinning	Orange-B	-	Maona	24°12'43.1" 90°25'02.6"	2001	15
45	SQ Celsius Ltd.	Sweater	Orange-B	Yes	Kewa	24°12'38" 90°25'02.2"	2002	20
46	Noman Weaving Mills Ltd.	Weaving	Orange-B	-	Maona	24°12'57.7" 90°24'49.1"	2006	22.37
47	Reedisha Knitex Ltd.	Knit & dyeing	Red	Yes	Dhanua	24°15'32.1" 90°23'50.5"	2004	33
48	Hongkong Shanghai Manjela	Spinning	Orange-A	-	Dhanua	24°15'31.1" 90°23'46.4"	1990	14.08
49	Nayanpur Hatchery (Kazi Farms Group)	Hatching	Orange-B	-	Dhanua	24°15'29.6" 90°23'41.2"	*NK	1.81
50	Confidence Knit Wear Ltd.	Knitting	Orange-A	-	Dhanua	24°15'19.7" 90°23'20.8"	2011	5.28
51	Salvo Alkali Chemi- ca Industry Ltd.	Chemical	Red	Yes	Dhanua	24°15'18.4" 90°23'18.9"	2004	7.5
52	Brac Seeds/Feeds	Seed, feed meal	Orange-B	-	Dhanua	24°16'16.0" 90°23'56.7"	2000	4
53	ML Steel Mills Ltd.	Tubes, Furniture	Orange-B	-	Dhanua	24°16'08.1" 90°23'46.5"	2010	42
54	RAK Ceramics (Bangladesh)	Tiles	Orange-B	Yes	Dhanua	24°15'56.2" 90°23'48.1"	2002	7.1
55	RAK Pharmaceuticals Private Ltd.	Medicine	Orange-B	Yes	Faridpur	24°15'46.2" 90°23'51.5"	2008	*NA
56	KEA Printing and Packaging Ltd.	Packaging	Orange-A	-	Faridpur	24°15'44.6" 90°23'52.1"	2007	2.3
57	Roshawa Spinning Mills Ltd.	Spinning	Orange-B	-	Dhanua	24°15'45.4" 90°23'50.4"	*NK	8.25
58	Otto Spinning Ltd.	Spinning	Orange-B	-	Faridpur	24°15'26.6" 90°23'56.9"	1998	2.3

SL No.	Name of the Industry	Type	Category (according to ECR [1])	Presence of ETP (Yes/No)	Mouza	GPS point	Estab. year	Area in Acre
59	M and U Cycles Ltd.	By- cycle	Red	No	Dhanua	24°15'24.5" 90°23'55.9"	*NK	85.8
60	HA-MEEM Denim	Denim	Red	Yes	Maona	24°15'12.0" 90°24'00.8"	2007	0.99
61	Century Spinning Mills Ltd.	Spinning	Orange-B	-	Uttarpara	24°15'07.8" 90°24'02.0"	*NK	6.5
62	MIR Ceramics Ltd.	Tiles	Orange-B	Yes	Uttarpara	24°15'06.3" 90°24'06.9"	2003	14.85
63	Jaber Spinning Mills Ltd.	Spinning	Orange-B	-	Uttarpara	24°14'58.3" 90°24'02.2"	2006	0.34
64	Shamsuddin Knitwear Ltd.	Knitting	Orange-A	-	Uttarpara	24°14'59.8" 90°24'02.9"	2013	*NA
65	Summit Uttaranchal Power Company Ltd.	33 MW Power generation plant	Red	No	Uttarpara	24°14'55.3" 90°24'03.1"	*NK	*NA
66	Monica Fashion Ltd.	Garments	Orange-A	-	Mulaid	24°14'42.6" 90°24'08.0"	*NK	9
67	Sufia Cotton Mills Ltd.	Cotton	Orange-B	-	Mulaid	24°14'39.5" 90°24'07.0"	2000	33
68	Nice Denim Mills Ltd.	Denim	Red	No	Uttarpara	24°14'39.6" 90°24'08.5"	2013	6.6
69	Zarba Textile Mills Ltd.	Cotton	Orange-B	-	Uttarpara	24°14'26.9" 90°23'45.7"	2007	13.2
70	Asia Composite Mills Ltd.	Composite	Red	-	Uttarpara	24°14'23.3" 90°23'45.7"	2006	2.64
71	Ashfaq Textiles Ltd.	Textile	Orange-B	No	Uttarpara	24°14'21.1" 90°23'52.3"	2002	5
72	Premiaflex Plastics Ltd.	Plastic materials	Orange-B	--	Uttarpara	24°13'29.5" 90°24'27.1"	2008	6.6
73	Uniglory Cycles Industries Ltd.	By-cycle	Red	No	Mulaid	24°14'20.9" 90°24'13.4"	2009	1.74
74	Meghna Associates Ltd.	Steel Rim	Red	-	Mulaid	24°14'18.0" 90°24'14.1"	2012	5.61
75	Ismail Textile Mills Ltd.	Cotton	Orange-B	No	Mulaid	24°14'21.8" 90°24'31.4"	2008	3
76	Ekota Composite Mills Ltd.	Composite	Red	No	Mulaid	24°14'21.6" 90°24'31.3"	2000	5
77	Haseen Apparels and Knit Composite	Yarn/ Dyeing	Red	Yes	Mulaid	24°14'15.8" 90°24'13.1"	2008	2.51
78	Blue Seal Composite Textile	Composite	Red	Yes	Mulaid	24°14'15.6" 90°24'21.8"	2006	*NA
79	Talha Spinning Mills and Saad-Saan Textile Mills	Spinning	Orange-B	-	Mulaid	24°14'12.3" 90°24'16.5"	NK	5.135
80	Siraj Cycles Industries Ltd.	Tire, tube etc.	Red	No	Mulaid	24°14'08.4" 90°24'18.5"	2010	0.7342
81	Adib Dyeing Ltd.	Knitting/ Dyeing	Red	Yes	Mulaid	24°14'07.0" 90°24'17.5"	2004	3
82	The Welltex Ltd.	Sweater	Orange-A	-	Mulaid	24°14'04.5" 90°24'19.2"	2005	9.9
83	Super Meat Ltd.	Meat processing	Orange-B	-	Mulaid	24°14'02.5" 90°24'19.7"	*NK	1.326
84	Paradise Spinning Mills Ltd.	Spinning	Orange-B	-	Mulaid	24°13'56.2" 90°24'24.3"	*NK	3.63
85	Anwara Knit Composite Ltd.	Composite	Red	Yes	Mulaid	24°13'45.0" 90°24'27.7"	2006	0.41
86	Golden Times Sweater & Dyeing Ltd.	Sweater and dyeing	Orange-B	No	Mulaid	2401335.2 9002435.4	2009	8

SL No.	Name of the Industry	Type	Category (according to ECR [1])	Presence of ETP (Yes/No)	Mouza	GPS point	Estab. year	Area in Acre
87	Viyellatex Spinning Ltd.	Spinning	Orange-B	-	Mulaid	24°13'56.5" 90°24'57.4"	2005	4.62
88	Badar Spinning Mills Ltd.	Spinning	Orange-B	-	Mulaid	24°13'49.3" 90°25'00.3"	*NK	6.6
89	Noman Textile Mills Ltd.	Cotton	orange-B	-	Mulaid	24°13'45.4" 90°24'52.8"	*NK	1.62
90	ABL Design and Fashions	Knit	Orange-B	Yes	Kewa	*RNT	2006	2.8
91	Greenfield Composite Ltd.	Composite	Red	Yes	Kewa	*RNT	NK	21.5
92	Great Wall Ceramic Ind. Ltd.	Tiles	Orange-B	Yes	Kewa	24°11'31" 90°25'39"	2006	15+5.85
93	DIRD Composite Textile	Composite	Red	Yes	Doladia	*RNT	2007	35
94	ACI Formulation Ltd.	Agro-chemicals	Red	Yes	Gojaria	*RNT	1998	10.125
95	Alpha Agro Ltd.	Agro-chemicals	Red	Yes	Atlora	*RNT	2000	4.62
96	FS Sweater Ltd.	Sweater	Orange-B	Yes	Kewa	*RNT	2002	22
97	Nestle Bangladesh Ltd.	Food item	Orange-B	Yes	Baroipara	*RNT	1998	33
98	Paramount Textiles Ltd.	Dyeing	Red	Yes	Gilarchala	24°11'33" 90°25'36"	2009	*NA
99	Health Care Pharmaceuticals Ltd.	Medicine	Orange-B	Yes		*RNT	2000	*NA
100	DaDa Zipper	Dyeing	Red	Yes	Dhanua	*RNT	2008	13.2
101	Padma Paper Mills Ltd.	Dyeing	Red	Yes	Satiabari	*RNT	2008	0.75
102	Organic Health Care Ltd.	Medicine	Orange-B	No	Kewa	24°11'30" 90°25'33"	2007	4.29
103	Vintage Denim Ltd.	Denim/Fabrics	Orange-A	No	Gilarchala	24°11'33" 90°25'29"	2008	26.4
104	Zubair Spinning Mills Ltd	Spinning	Orange-B	-	Gilarchala	24°11'38" 90°25'30"	2008	2.64
105	Miracle Industries Ltd.	Plastic bag	Orange-B	No	Gilarchala	24°11'45" 90°25'28"	1993	2.3
106	Bangladesh Master Pack Ltd.	Plastic bag	Orange-B	-	Gilarchala	24°11'46" 90°25'28"	2007	2.64
107	Package stone Ltd.	Lebel medicine	Orange-B	-	Kewa	24°11'55" 90°25'24"	2003	2.38
108	Sk Sweaters Ltd	Sweater	Orange-A	-	Sreepur	24°12'00" 90°25'30"	2012	14
109	Spring Knit Wears Ltd	Sweater	Orange-A	-	Ansar rd.	24°12'05" 90°25'49"	*NK	3.63
110	Noman Home Textile Mills Ltd.	Fabrics	Red	-	Ansarrd	24°12'03" 90°26'02"	2009	9.5
111	New Hope Feed Mill Bangladesh Ltd.	Cattle/poultry Feed	Orange-B	-	Bhangnahati	24°12'29" 90°27'14"	2008	23
112	Nourish Poultry and Hatchery Ltd.	Poultry	Orange-B	-	Patka	24°11'38" 90°29'28"	2001	2
113	Gentry Pharmaceuticals Ltd.	Medicine	Orange-B	-	Bhangnahati	24°12'27" 90°27'12"	2013	6.6
114	CRC Textile Mills Ltd.	Yarn	Orange-B	-	Bhangnahati	24°12'35" 90°26'48"	2008	*NA
115	Markup Cotton (Square Group)	Cotton	Orange-B	-	Ujilabo	24°12'43" 90°27'05"	2006	13.2
116	Sarah Composite Mills Ltd.	Jute goods	Orange-B	-	Kewa	24°12'37" 90°26'27"	2012	3.63

SL No.	Name of the Industry	Type	Category (according to ECR [1])	Presence of ETP (Yes/No)	Mouza	GPS point	Estab. year	Area in Acre
117	Nikki Thai Aluminium Industries Ltd.	Aluminium	Red	-	Kewa	24 ⁰ 12'49" 90 ⁰ 26'03"	2009	5
118	Nakib Spinning Mills Ltd.	Spinning	Orange-B	-	Kewa	24 ⁰ 12'58" 90 ⁰ 25'34"	2007	8.58
119	MM Spinning Mills Ltd.	Spinning	Orange-B	-	Kewa	24 ⁰ 13'09" 90 ⁰ 25'18"	2006	40
120	Out Pace Spinning Mills Ltd.	Spinning	Orange-B	-	Kewa	24 ⁰ 13'11" 90 ⁰ 25'13"	2009	*NA
Total land								1223.75

159 *RNT = Reading Not Taken; *NA = Not Available; *NK = Not Known and Estab. = Establishment

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161 3.2 Development Scenario and Density of Industries at the Study Area

162 Among the 120 industries at least 20 textile dyeing and washing industries were close to the
163 water sampling points. These industries and others also discharge their wastewater to the
164 nearby canal through the pipeline or drain close to each of the sampling points. This pipeline
165 or drain either constructed by the individual industry up to the canal or joined the individual
166 pipeline/drain to a common pipeline/drain by which water ultimately goes to the canal.
167 Different clusters of industries close to the sampling points are shown in Fig. 2. The pipeline
168 or drain networking system so far identified in the field are also shown in Fig. 2 with arrow
169 marks.

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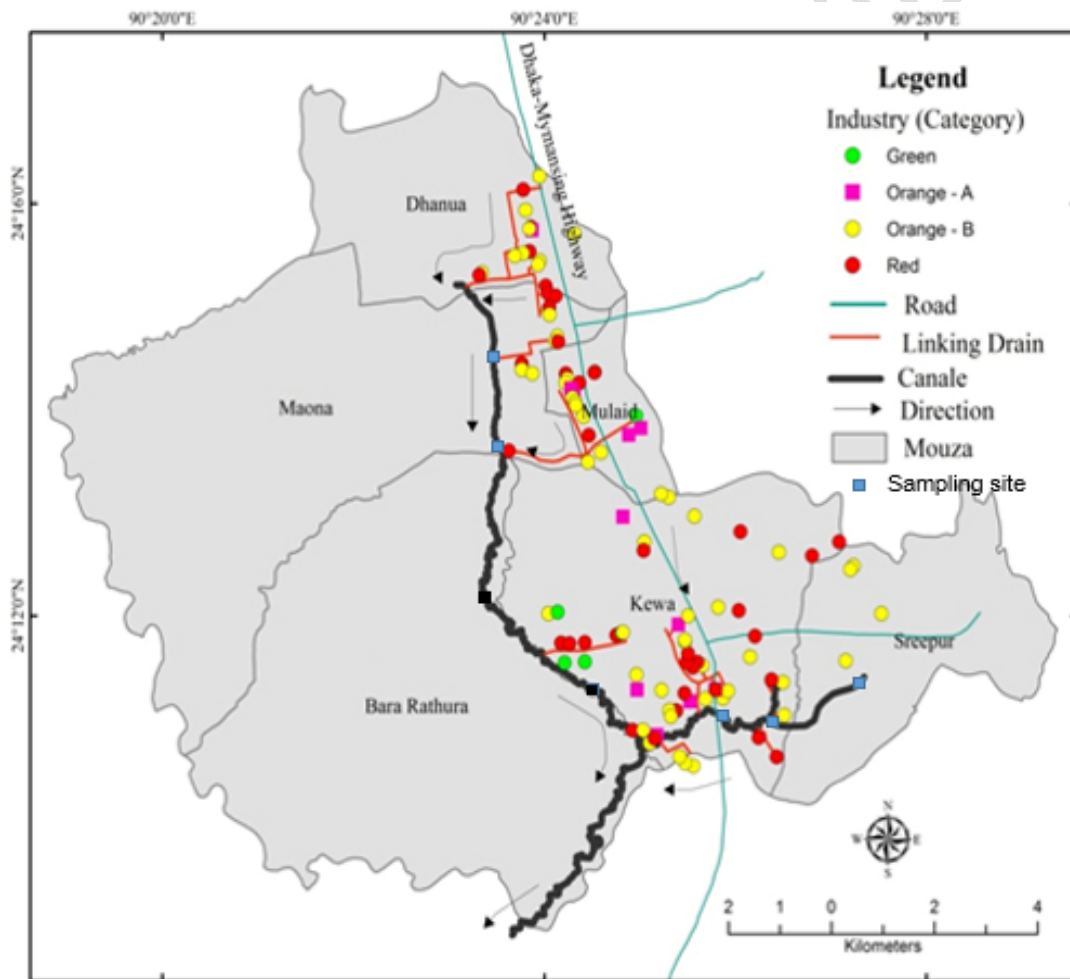
171 It can be seen from Table 1 that till 1995 there were only three industries in the study area.
172 But, the number of industries gradually increased from 1996 and since then to 2005 total 29
173 industries developed, among them 11 were in red category and 18 were in orange - B
174 categories. But, from 2006 to 2010 the number of industries massively increased in the study
175 area. During this time total 59 industries were developed in the study area, which were
176 mostly in red and orange - B category. During this period 30 red category industries
177 established against 23 orange - B category industries. As the survey was done till March
178 2013, therefore the number of industries from 2011 to March 2013 was not big enough
179 compared to previous time due to the short period of time. This time total 16 industries were
180 developed and among them, 08 industries were in red and 03 industries were in orange - B
181 categories. Therefore, it is pity to say study area is now a hub of polluting industries (Fig. 2)
182 which are mostly liable to pollute the environment of the study area. It is to be noted here
183 that out of 120 industries the year of establishment of 13 industries was not known. Most of
184 the industries (49.17%) developed during the period 2006-2010. The majority of the red
185 category and orange-B category industries discharge the liquid waste by their individual
186 pipeline or a common pipeline involving other industries which finally connected to the
187 nearby canal.

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189 3.3 Status of Effluent Treatment Plant (ETP) of the Existing Industries

190 Among the surveyed industries, 68 industries needed effluent treatment plant (ETP), but
191 during the survey it was found 45 industries installed ETP of different capacity and 23
192 industries didn't install ETP. Therefore, about 33% of surveyed industries didn't have ETP.
193 Installation of ETP has been made mandatory in liquid waste generating industries by the
194 Department of Environment (DoE) and DoE is not supposed to issue any environmental
195 clearances to industries running without ETP. The monitoring team of DoE penalizes the
196 violator following the "polluter pay principle" and DoE also has made a big change in the law
197 through amending the Environmental Conservation Act, 1995 in the year 2010 and also
198 enacted the Environment Court Act, 2010 repealing the Environment Court Act, 2000. Amid
199 these manifold stringent measures still there were many industries without ETP. Although

200 some of the industries have ETP, but either that was not fully functioning or not up to the
 201 proper capacity. But there was also a limitation during the survey, it was not possible to see
 202 how many industries ETP was fully functional or had optimum capacity.
 203 During the period 13 July 2010 to 29 January 2013 through enforcement drive of DoE
 204 penalized some industries in Sreepur area for non-compliance of environmental rules and
 205 regulations. 12 effluent releasing industries were visited and found that four industries had
 206 no ETP and five industries those had ETP either ineffective or closed. Among the rest of the
 207 industries, two were dumping solid wastes to the nearby agricultural lands and the other
 208 industry was discharging liquid wastes to the environment without mentioning status of ETP
 209 [16]. From the above instances, it can be assumed that in the long run, a good result from
 210 the concept of ETP installation can only be ensured by proper monitoring and environmental
 211 audit by the government. But, the reality is that the success of this initiative could not be
 212 possible alone by the government, the integrity and sincerity of the industrial owner or the
 213 management is most important.
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 217 Figure 2: Cluster of some industries nearby sampling points along with the direction of
 218 linking drain/ pipeline
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 221 **3.4 Physicochemical Characteristics of Water Samples**

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3.4.1 pH of water sample

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Average pH of canal waters for the sites was comparatively high in both pre-monsoon (7.28 ± 0.29) and dry (7.70 ± 0.35) seasons than monsoon season (6.70 ± 0.58) (Table 2). The range of pH was 6.78-7.52 in pre-monsoon season, 6.40-7.30 in monsoon season and 7.30-8.70 in dry season. The higher pH value in pre-monsoon and dry season was because of high base saturation with low volume of water during this period. On the other hand, the pH was slightly low during monsoon season in all sites due to dilution effect. During bleaching and mercerizing processes in textile process wastewater produce high pH [17]. The seasonal variation of pH values obtained in this study supports with some other studies. Haque [18] reported that the maximum pH has observed in the winter and minimum in the rainy season.

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The pH variation is primarily caused by different kinds of dye stuff used in the dyeing process in different industries. In textile dyeing industries H_2O_2 and NaOH is used as bleaching and kier agents. Higher pH approaches in effluents owing to the waste composition of textile mills such as: NaOCl, NaOH, Na_2SiO_3 , surfactants, sodium phosphate [19]. A study conducted by Moniruzzaman et al. [20] on the water of Buriganga river found that the pH of water was slightly alkaline from December to April (7.4 to 7.6) and the highest average pH value found during the month of April (pH = 7.6). This is due to high base saturations with low volume of water during dry season. On the other hand, the pH of water was slightly lower in wet season from June to October (7.3 to 7.4) than dry season due to dilution effect and the lowest average pH value found during the month of August (pH = 7.3). But all these pH values at different times of year were within the permissible limit. Though there was minor seasonal variation of pH, but all the values were within permissible limit of DoE standard for inland surface water (6.0-9.0) and irrigation water (6.5-8.5).

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3.4.2 Electrical conductivity (EC)

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Electrical conductivity (EC) is an estimate of the total amount of dissolved ions in the water. The EC of water is an indicator of salinity and hazard gives the total salt concentration in water [21]. The mean EC value was comparatively high in pre-monsoon (2.64 ± 0.53 ds/m) and dry (1.82 ± 0.66 ds/m) season than monsoon season (1.15 ± 0.43 ds/m) (Table 2). The range was 2.16-3.30 ds/m in pre-monsoon season, 0.25-1.8 ds/m in monsoon season and 1.14-2.27 ds/m in dry season. In pre-monsoon and dry season EC values in all sites and in monsoon season EC values in two sites were beyond DoE permissible limit (1.2 ds/m). Such a high value of EC is not suitable for aquatic life and irrigation purposes. On the other hand, the EC value was relatively low during monsoon season due to dilution effect, although in three points (1, 2 and 3) EC values were within permissible limit during monsoon season (0.25 , 0.77 and 1.2 mg L^{-1}) but in another two points EC (4 and 5) values were beyond permissible limit (1.8 and 1.74 mg L^{-1}). The lower value of EC of three points might be because of upstream site where accumulation of ions was less than downstream points. The sites 4 and 5 were just adjacent to the industrial effluent releasing point, therefore, the effluent got less time for effect of dilution and it might be another reason of higher value of EC in these two sites. Another reason might be addition of urban or construction wastes as these two sites have been just adjacent to the roadside where some construction activities also occurred. Furthermore, at site 4 there was an end point of municipal drainage line. Through this line many pollutants also come out which add to the canal water. Apart from above reasons these two sites were located downstream level. Therefore, accumulation of substances from different upstream flows to the downstream could be the reason of higher values. The higher value of EC indicates that a large amount of ionic substances was released from the different industries in the study area. A difference in the conductivity in effluent, wastewater or surface water is mainly as a result of difference in the concentration of charged solutes [22]. Haque [18] reported that high tide and winter season have shown

275 the maximum values of EC, and low tide and rainy season have shown the minimum value
276 in the Sundarban area.
277

UNDER PEER REVIEW

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279 **Table 2: pH, EC and TDS of wastewater discharged from industries of Sreepur, Gazipur at different seasons**

Site	pH of water					EC of water (dS m ⁻¹)					TDS of water (mg L ⁻¹)				
	Pre- monsoon n	Monsoon	Dry	Mean ±SD	Range	Pre- monsoon	Monsoon	Dry	Mean ±SD	Range	Pre- monsoon	Monsoon	Dry	Mean ±SD	Range
1	7.52	7.30	8.70	7.84 ±0.75	7.30 – 8.70	2.96	0.25	2.27	1.83 ±1.40	0.25– 2.96	1512	114.9	1286	970.96 ±749.93	114.9 - 1512
2	6.78	6.60	7.60	6.993 ±0.53	6.6 0– 7.60	2.74	0.77	1.95	1.82 ±0.99	0.77 – 2.74	1384	339	1068	930.33 ±535.92	339 - 1384
3	7.31	6.40	7.60	7.106 ±0.62	6.40 – 7.60	2.04	1.2	2.01	1.75 ±0.47	1.20 – 2.04	1123	580	1080	927.67 ±301.85	580 - 1123
4	7.36	6.50	7.30	7.053 ±0.48	6.50 – 7.36	3.30	1.8	1.74	2.28 ±0.88	1.74 – 3.30	1763	855	933	1183.67 ±503.23	855 - 1763
5	7.42	6.70	7.30	7.14 ±0.38	6.70 – 7.42	2.16	1.74	1.14	1.68 ±0.51	1.14 – 2.16	1118	809	601	842.67 ±260.13	601 - 1118
Average	7.28	6.70	7.70	-	-	2.64	1.15	1.82	-	-	1380	539	993	-	-
SD	0.29	0.35	0.58	-	-	0.53	0.66	0.43	-	-	273.32	313.97	253.13	-	-
Range	6.78 – 7.52	6.40 – 7.30	7.30 – 8.70	-	-	2.16 - 3.30	0.25- 1.8	1.14 – 2.27	-	-	1118 - 1763	114.9 - 809	601 - 1286	-	-
Standard (DoE)	6.0 – 9.0 (Inland surface water) 6.5 – 8.5 (irrigation water)					1.2 dS m⁻¹					2100 mg L⁻¹				

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Table 3: DO, COD and BOD of wastewater discharged from industries of Sreepur, Gazipur at different seasons

Site	DO of water (mg L ⁻¹)					COD of water (mg L ⁻¹)					BOD of water (mg L ⁻¹)				
	Pre- monsoon n	Monsoon	Dry	Mean ±SD	Range	Pre- monsoon	Monsoon	Dry	Mean ±SD	Range	Pre- monsoon	Monsoon	Dry	Mean ±SD	Range
1	2.81	trace	0.65	1.73 ±1.53	Trace - 2.81	469.14	51.0	288.0	269.38 ±209.69	51.0 - 469.14	50	trace	42	46.0 ±5.66	trace - 50.0
2	1.11	trace	0.47	0.79 ±0.45	trace - 1.11	74.07	56.0	152.0	94.02 ±51.01	56.0 - 152.0	72	trace	38	55.0 ±24.04	trace - 72.0
3	1.12	trace	0.14	0.63 ±0.69	trace - 1.12	74.07	362.0	271.0	235.69 ±147.17	74.07 - 362.0	60	12	70	47.33 ±31.00	12.0 - 70.0
4	1.08	trace	0.85	0.96 ±0.16	trace - 1.08	98.88	184.0	119.0	133.92 ±44.53	98.77 - 184.0	144	4	23	57.0 ±75.95	4.0 - 144.0
5	1.96	trace	1.59	1.775 ±0.26	trace - 1.96	370.37	109.0	194.0	224.45 ±133.32	109.0 - 370.37	84	trace	71	77.5± 9.19	trace - 84.0
Average	1.61	trace	0.74	-	-	217	152.4	204.8	-	-	82	8	48.8	-	-
SD	0.76	-	0.54	-	-	188.35	128.83	73.44	-	-	36.93	5.66	21.04	-	-
Range	1.11 - 2.81	trace	0.14 - 1.59	-	-	74.07 - 469.14	51.0 - 362.0	119.0 - 288.0	-	-	50 - 144	trace - 12	23 - 71	-	-
Standard (DoE)	4.5 – 8.0; ≥ 5 (for irrigation purposes)							200			≤ 10 for irrigation; ≤ 6 for fishing; ≤ 2 for drinking				

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287 **3.4.3 Total dissolved solids (TDS)**

288 The TDS values were also comparatively higher in pre-monsoon ($1380 \pm 273.32 \text{ mg L}^{-1}$) and
289 dry season ($993.6 \pm 253.13 \text{ mg L}^{-1}$). Similar to EC it was relatively lower during monsoon
290 season ($539.58 \pm 313.97 \text{ mg L}^{-1}$). The range was $1118\text{-}1763 \text{ mg L}^{-1}$ in pre-monsoon season,
291 $114.9\text{-}809 \text{ mg L}^{-1}$ in monsoon season and $601\text{-}1286 \text{ mg L}^{-1}$ in dry season (Table 2). The
292 higher TDS value in pre-monsoon and dry season was because of high base saturation with
293 low volume of water during dry and pre-monsoon time. On the other hand, the TDS was
294 lower during monsoon season in all sites due to dilution effect. But, TDS during monsoon
295 season in two sites (4 and 5) was comparatively higher than other three sites as because the
296 sites were just adjacent to the industrial effluent releasing point and therefore the effluent got
297 less time for effect of dilution. Another reason might be addition of urban or construction
298 wastes as mentioned earlier. Furthermore, at site 4 there was an end point of municipal
299 drainage line. Through this line many pollutants also came out which add to the canal water.
300 Apart from above reasons these two sites were located downstream level. Therefore,
301 accumulation of substances from different upstream flows to the downstream and this could
302 be the reason of higher values of TDS. The result supports with studies done by Haque [18],
303 he found that TDS value increased in the order: rainy season < summer < winter. High TDS
304 elevates the density of water, influences osmo-regulation of fresh water organisms and utility
305 of water for drinking and irrigation purposes. Primary sources for elevated TDS level water
306 pollution discharge from industrial and sewage line, particularly during dry and pre-monsoon
307 season with low water level. Textile, dyeing and printing processes release huge amount of
308 suspended solids and dissolved solid which are mixed in the wastewater during desizing,
309 dyeing and printing stages [17, 23]. Though there was seasonal variation of TDS, but all the
310 values were within permissible limit of DoE standard (2100 mg L^{-1}) of Bangladesh.

311

312 **3.4.4 Dissolve oxygen (DO)**

313 Average DO value was 1.61 ± 0.76 ; $0.74 \pm 0.54 \text{ mg L}^{-1}$ and trace in pre-monsoon, dry and
314 monsoon season, respectively. The range was $1.11\text{-}2.81 \text{ mg L}^{-1}$ in pre-monsoon season,
315 $0.14\text{-}1.59 \text{ mg L}^{-1}$ in dry season (Table 3). Adequate DO is necessary for good quality of
316 water. As DO levels in water drop below 5.0 mg L^{-1} , aquatic life is put under stress. The
317 lower the concentration, the greater the stress [24]. DO concentration in all sampling sites
318 significantly lower than the DoE permissible limit ($4.5\text{-}8.0$ for inland surface water and ≥ 5 for
319 irrigation water) and unsuitable for drinking, fisheries and irrigation purposes. This may be
320 due to high organic and microbial activities with low volume of water. High amount of organic
321 wastes discharged from textile and dyeing industries into the canal. The dye effluent
322 disposed into the canal water reduces the depth of penetration of sunlight into the water
323 environment, which in turn decreases photosynthetic activity and dissolved oxygen (DO).
324 From the above DO values it is clear that the water is totally unsuitable for drinking, fishing
325 and irrigation purposes in all seasons in all sampling sites. This result is at par with the
326 findings reported by Zakir et al. [25] for the Mayur river water of Khulna, Bangladesh.
327 Textiles and dyeing mills of the study area release a huge amount of BOD and COD wastes,
328 which consume the DO of water. In natural waters DO concentration is greatest at 0°C and
329 decreases with increasing temperature; again, solubility of oxygen decreases with increasing
330 salinity of water [26].

331

332 **3.4.5 Biological oxygen demand (BOD)**

333 BOD is a direct measure of the oxygen uptake in the microbiologically mediated oxidation of
334 organic matter. In other words, it measures the amount of oxygen consumed by an organic
335 compound undergoing decomposition [27]. The BOD average in the study area is relatively
336 higher in pre-monsoon ($82 \pm 36.93 \text{ mg L}^{-1}$) and dry season ($48.8 \pm 21.04 \text{ mg L}^{-1}$) than
337 monsoon season ($8 \pm 5.66 \text{ mg L}^{-1}$). The range was $50\text{-}144$; $23\text{-}71$ and $4\text{-}12 \text{ mg L}^{-1}$ in pre-
338 monsoon, dry and monsoon season, respectively (Table 3). Different steps in the textile

339 processing before the cloth is taken for bleaching, it is subjected to kier boiling to remove
340 natural impurities, such as grease, wax, fats, etc. Chemicals used are caustic soda, soda
341 ash, sodium silicate and sodium peroxide. The effluent water from this process is brown in
342 colour and highly alkaline and high in both BOD and COD [28]. Freeman et al. [23] reported
343 that the major pollution indicator parameters for textile wet finishing effluents were the COD,
344 BOD, TDS, suspended solids (SS), colour and heavy metals levels. Wynne et al. [29] stated
345 that textile effluents are highly coloured and saline, contain non-biodegradable compounds,
346 and are high in BOD and COD. Ahmed et al. [30] reported that tannery and textile industries
347 use organic substances as raw materials and high levels of dissolved organic matter
348 consume large amounts of oxygen and increase BOD level, which undergoes anaerobic
349 fermentation processes leading to formation of ammonia and organic acids. High base
350 saturation with low volume of water during dry and pre-monsoon time was the reason behind
351 to increase the BOD in the study area. On the other hand, the BOD is slightly low during
352 monsoon season due to dilution effect. Overall, the BOD value is higher in all sites in all 3
353 seasons and beyond DoE permissible limit (4.5-8.0 for Inland surface water, ≤ 10 for
354 irrigation and ≤ 6 for fishing). The determined values were not suitable for irrigation, fishing
355 and drinking purposes, though some farmers of the area use the canal water in their lands
356 for irrigation purposes.

357

358 **3.4.6 Chemical oxygen demand (COD)**

359 Average COD value was higher in pre-monsoon season ($217 \pm 188.35 \text{ mg L}^{-1}$) and dry
360 ($204.8 \pm 73.44 \text{ mg L}^{-1}$) season than monsoon season ($152.4 \pm 128.83 \text{ mg L}^{-1}$). The range
361 was $74.0\text{-}469.14 \text{ mg L}^{-1}$ in pre-monsoon season, $119.0\text{-}288.0 \text{ mg L}^{-1}$ in dry season and 51.0-
362 362.0 mg L^{-1} in monsoon season (Table 3). COD and BOD are often used to estimate the
363 total quantity of organic matter present in water. Textile industries release a lot of chemical
364 oxygen demanding wastes. The COD levels obtained from garment washing show that
365 detergents, softeners and impurities on the fabrics contributes a significant portion of the
366 COD. The highest COD levels were obtained on dyeing indicating that in addition to fabric
367 impurities removed during scouring or desizing and the contribution of detergents and
368 softeners. Dyes contain high concentrations of salts, and exhibit high BOD/COD values [17].
369 Among the sampling sites 1 and 5 sites during pre-monsoon season and 3 site during
370 monsoon season had COD values excessively higher than other. Each of these sites, heavy
371 construction activities were going on during sampling and such activities could mix different
372 types of pollutants into the canal water which might be the reason of increasing COD.
373 Increase organic loadings due to construction activities would increase COD and reduce DO
374 levels [31]. According to Firdissa et al. [32] the mean COD value of effluent from selected
375 industries was significantly above the maximum permissible limit value and effluent with high
376 COD load are released from beverage and followed by paint, food, soap, tannery, textile and
377 pharmaceutical industry. Sivakumar et al. [33], calculated a ratio of COD : BOD for effluent
378 samples collected from 3 different textile dyeing and bleaching industries, resulting in 1.87,
379 1.90 and 1.84, respectively. This indicates that these effluents are high in recalcitrant and
380 hardly degradable compounds and may not undergo more than 50% substrate
381 biodegradation, as it is known that organic matter with 50-90% substrate biodegradation has
382 a COD : BOD ratio between 2 and 3.5 [33]. However, on the basis of COD value the canal
383 water in the study area was not suitable for any domestic uses and also not fit for irrigation
384 purposes.

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386

387 **4. CONCLUSION**

388

389 This study has explored trend and pattern of industrial growth with spatial distribution of
390 industries and seasonal variation in physicochemical properties of wastewater. Total 120
391 medium to large industries was surveyed in the study area of which 52 were in red category

392 and 53 were in orange-B category and 13 were in orange-A and only 2 were in green
393 category. The study revealed that these industries discharge their wastewater into the
394 nearby canal through the pipeline or drain. Number of industries massively increased in the
395 study area during the period 2006-2010 and most of them were in red and orange-B
396 categories. Although installations of effluent treatment plants (ETP) has been made
397 mandatory in liquid waste generating industries by the Department of Environment (DoE),
398 Bangladesh but about 33% industries were found without ETP. The pH of wastewater
399 collected from the study area was slightly alkaline in pre-monsoon and dry season and near
400 neutral during monsoon season. Average EC values were much higher than DoE standard in
401 pre-monsoon and dry season. TDS value was higher in pre-monsoon and dry season, but
402 comparatively lower in monsoon season though the values were within permissible limit of
403 DoE standard. DO level in wastewater in all season was much lower than the DoE standard.
404 BOD and COD values were comparatively higher in pre-monsoon and dry season, and in
405 both seasons average values were much higher than the DoE standard of Bangladesh.
406 Finally the study results inferred that the area is now a hub of polluting industries which are
407 mostly liable to pollute the surrounding environment. Therefore, to overcome the present
408 situation integrated action plan is necessary. Enforcement and monitoring from the
409 government side alone will not give a concrete solution although political commitment of the
410 ruling government is very important. Thus, action together by the government agencies, non-
411 government organizations and community people will give a fruitful result to make the
412 situation tolerable.

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417 **COMPETING INTERESTS**

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“Authors have declared that no competing interests exist.”

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COMPETING INTERESTS DISCLAIMER:

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Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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