The Effects of Untreated Textile Effluents on Groundwater near Kodda Gazipur Industrial Area in Bangladesh

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Abstract

As a part of rapid expansion in the economy our RMG and textile industries are increasing at a high rate, but due to lacks in our environmental law and regulation, proper disposal of wastewater still remains questionable. Many factories still didn't implement ETPs manyfactories occupied ETPs but the use of it on regular basis is still dubious. So, it's pretty much hard to guess our groundwater is still safe from contamination. We select two zones one is effected zone and another was non-effected zone and compare their salt concentration and TDS level where the salt concentration is our decision parameter. As most of the textile dyes have a proportional relationship with the Salt level. We selected Kodda Gazipur is our effected zone. We do two-step analysis to make our research done first we do aGIS analysis to illustrate the spatial variation of TDS and Salt concentration for both affected and non-effected zones. Then we do statistical analysis to find out our hypothesis is statisticallysignificant or not. As a result, we found a surprising outcome **$t(11) = 2.171$, $p = .053$** which means the relationship between textile effluents and groundwater are statistically insignificant.

Key words – *Groundwater Contamination, Textile Effluents, Statistical Analysis, GISAnalysis*

Introduction

Textile industries are one of the most rapidly growing sectors in Bangladesh. The Bangladesh Garment Manufacturers and Exporters Association has recently set an ambitious target for thetextile sector to double its exports and reach $50 billion of exports by 2021(2030 Water

Research Group, 2015, p. v). 45% of industrial manpower is occupied by textile industries & more than 4 million people of the country's total population especially the women, are pretty much attached to these industries (Dey & Islam, 2015, p. 15). So the biggest upcoming challenges are to deal with water demand and proper effluents disposal for these textile industries. In this study, we mainly focus on effluents treatment effectiveness and their long- term effects on groundwater.

In Bangladesh there are many limitations in environmental related laws and their regulation. Many textile industries take these limitations as their opportunity for maximizing profit by releasing untreated effluents directly. These effluents consist of high concentrations of dyestuff, biochemical oxygen demand, total dissolved solids, sodium, chloride, sulfide, hardness, heavy metals, and carcinogenic dye ingredients (Tchobanoglous & Burton, 2003) Therefore a number of factories with an ETP vary from 40% - 80% besides their management and performance also highly dubious in terms of pollutant removal (2030 Water Research Group, 2015, p. 6).

The present scenario shows us there is a high chance of groundwater contamination due totextile discharges. Several studies were done on textile effluents characterization. Most of the studies show that the treatment process is not working properly. One of the study says textile is the number one big issues of water pollution and that shows physicochemical parameters of textile effluents in Bangladesh as, Temperature (25-65°C), pH (3.9-14), TDS (90.7 – 5980 mg/L), DO (0-7 mg/L), COD (41-2430 mg/L), BOD (10 – 786 mg/L), TSS (24.9 – 3950mg/L) and EC (250-63750µS/cm) from 2005 to 2014. From the available data originated from the study depicts the present pollution scenario in Bangladesh with tremendous violation of laws to meet the requirement of waste discharge quality standards (Dey & Islam, 2015, p. 15-44). According to Guha(2010) textile effluents in Gazipur has PH 9.8, TDS 3100 mg/l, which depictan alarming situation.

In another study on characterization PH - 8-10, Heavy metals 10-15 mg/l, Suspended Solids 200-300 mg/l, TDS 5000-6000 mg/l, COD 1500-1750 mg/l, BOD 500-600 mg/l Surfactants 10-40 mg/l, and Sulphide as S 50-60 mg/l (Hassan et al., 2016, p. 451).

In our study, our main focus is to find out if the groundwater is really safe from textile effluentscontamination.

We used all previous study as our reference and found out the real scenario by sampling groundwater from Kodda (as an effected industrial zone); Chhota Deora, Uttar Chhayabithy, Sahapara, Chapulia (as our rural non effected zone). Then we do a statistical analysis of salt concentration and TDS to find out it is statistically significant or not. Similar type studies weredone in our neighboring country India but there was no such type of study in Bangladesh. In one of the studies in Chinnalapatti Tamil Naru India, the researcher found the serious level of salinity high EC value (Noel et al., 2014). Another study in Bandi River Rajasthan showed that the groundwater of the area was highly polluted and had TDS above 3000 mg/l. No source in the study was found to be suitable for irrigation as well as drinking purposes (Husain&Hussain, 2012, p.100). That made us curious; as Gazipur is a too much textile industry congested area and most of ETPs do not work properly in there and the area may show some symptoms of groundwater contamination. Besides there may be a relation in groundwater contamination with rainfall pattern, soil filtration rate, a distance of groundwaterlocation from the textile zone, and most importantly depth of aquifers (Velusamy et al., 2015,p.73). So in this study, we will be trying to investigate the relationship between groundwater contaminations with these parameters.

Materials & Methods

Study Area

We all know that most of the textile industries of Dhaka district are situated in Gazipur. So wehave decided our first study zone to be near the Kodda, Gazipur as these areas are densely congested with textile industries and most of the industries discharge their effluent around these areas. Technically we can conclude that the most venerable zones have a high tendency of contaminated groundwater.

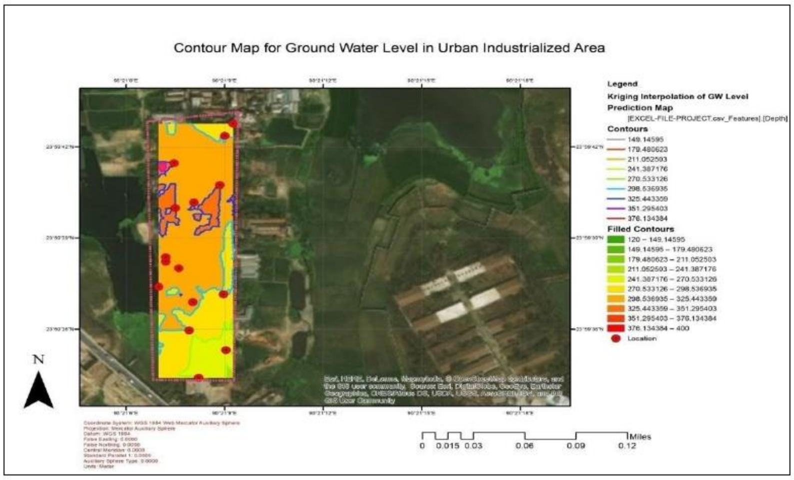

Figure 1: Selected Effected Zone, Sampling Location and Contour Map of Ground WaterLevel Map in Kodda Gazipur.

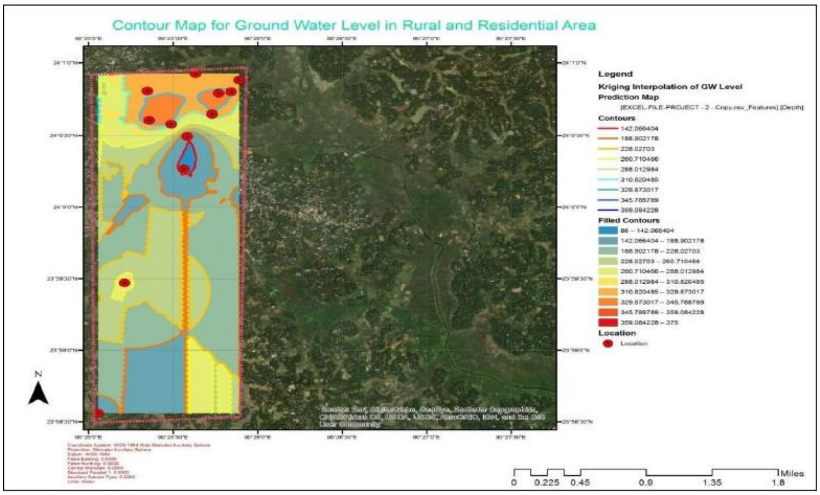

Figure 2: Selected Non-Effected Zone, Sampling Location and Contour Map of GroundWater in Rural area in Gazipur

Our second study will be on the rural non effected areas are Chapulia, and some parts of East Joydebpur (Uttar Chhayabithy, and Sahapara) where the chances of having contaminated groundwater were minimum.

Study Population

In Kodda Gazipur total urban household is 1172 (Bangladesh Bureau of Statistics, 2011, p. 107). We assumed that 40% of house use deep tube well. So our maximum possible populationsize is (0.4 * 1172) = 469.8 .

In our rural residential zone East Joydebpur, Chapulia and Chhota Deora total household (8361+596+1113) = 10078 (Bangladesh Bureau of Statistics, 2011, p. 105). We assumed that40% of house use deep tube well. So, our tentative population size is (0.4 * 10078) = 4031.2

Sampling Technique

As this is an experimental research so, we will be going for probability sampling mainly focused on simple random sampling technique.

Sample Size

We decided to take a total of 28 samples 16 from industrial zone and 12 from the residential zone. Therefore, our sample size is 3.41% of our total population for Kodda industrial zone and 0.29% for the rural residential zone. As both satisfy the condition of less than or equal to 5% condition. So, the sample size is okay.

Sampling Procedure

For sampling purpose, we plan to go to Kodda Gazipur which is our primary study area. First,we will be choosing a location in Kodda which is very near to textile mill zone. Then we planto collect the water sample from 16 locations within that zone and also record the GPS locationof each sample zone from where we will be collecting water samples, besides we will also collect deep tube well depth by through consultation with the owner. After collecting all the water samples we have decided to come to the lab for completing future procedures.

Again we have to choose a different location which is far from the textile zone but in Gazipurarea and do the same procedure there.

Chemical Analysis

In the lab, we plan to use a portable meter to EC, TDS, and Salinity level. Initially, a standard solution will be made and a calibration curve will be plotted. Then the instrument will be set according to the calibrated value. The probe will be placed in each sample and EC, TDS, Salinity data will be recorded.

Software Analysis Procedure

In arc GIS a map will be designed showing a spatial variation of groundwater quality. The color codes used to show the variation of in-depth and distance. A paired T-test and correlation will be done to determine the relationship between groundwater contamination and textile effluent is statistically significant or not.

Result & Discussion

Spatial Distribution Map for Salt Concentration.

The salt concentration is the main/decision parameter for our study. So, in our lab, we have tested the salt concentration in percentage but those values were not sufficient to observe the salt concentration whole influential zone. Therefore, we have also used our Kriging interpolation tools to visualize a surface map for salt for both of the zones.

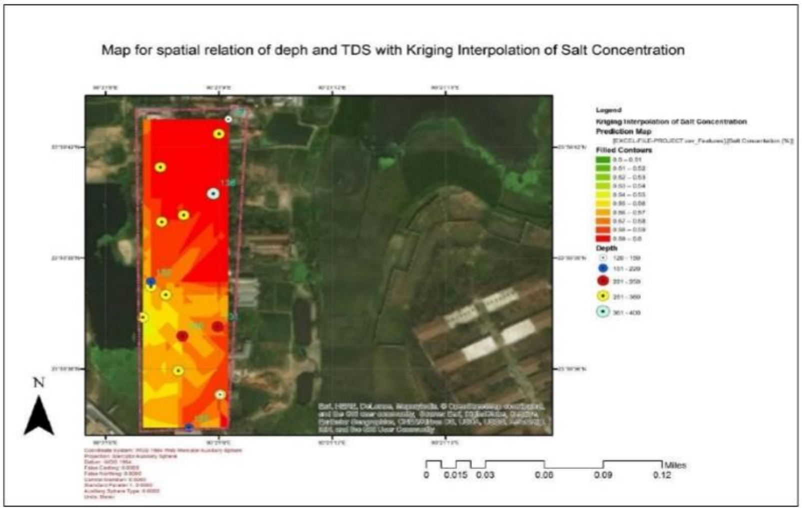

Figure 3: Kriging Interpolation Map of Salt Concentration for Selected Effected Zone, Kodda Gazipur

In this study we used ordinary type Kriging and select maximum 5 neighbor minimum 2 neighbor and sector type 4 sectors with 45° offset. Anything else which we do not mentionhere was kept as default.

Fig (3) shows the Kriging interpolation values for salt concentration besides we also show thedepth and TDS values for each sampling point. Here, the surface map shows our salt concentration for the influential zone in the urban area. We used the different color band to show the area of the similar salt level. In our map, the lowest range for salt concentration is (0.5-0.51) % coded with dark green and highest range is (0.59-0.6) % and coded with the dark red transition between other range also depicted in different color code. The point file shows the position of each sampling location. The depth of water level in each location also illustrated with multiple color point file with variable sizes. The values of TDS are directly atlevels near each location.

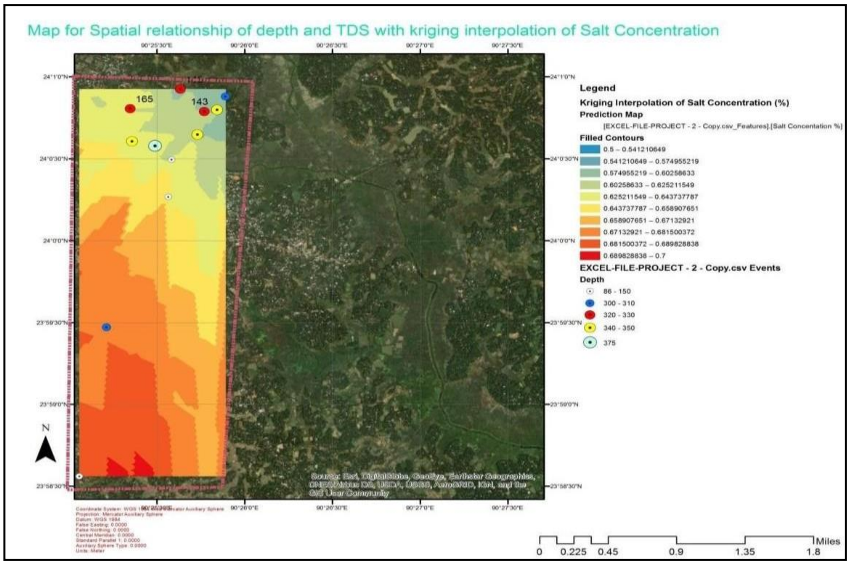

Figure 4: Kriging Interpolation Map of TDS for Selected Effected zone, in Kodda Gazipur

Fig (4) also shows the same Kriging interpolation values for salt concentration but only for residential & rural location. Here also the surface map shows different salt concentration levelusing a different color code. (0.5-0.54) % is the lowest range for salt concentration which illustrated in dark blue color while (0.689-0.7) % is the highest level of salt concentration. Besides that, all location data are illustrated with varying colors and sizes point files to show the depth of water level in each location TDS values directly level at each point shape files.

Spatial Distribution Map for Salt Concentration

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In this study we used ordinary type Kriging and select maximum 5 neighbor minimum 2 neighbor and sector type 4 sectors with 45° offset. Anything else which we do not mention here was kept as default.

In the fig (5) the TDS level of different location is portrayed with a different color range in a Kriging surface map where the lowest range is (129-130) mg/l which labeled with a dark bluecolor. Highest range (144-149) mg/l labeled with a dark red color. All other ranges also labeledwith a different color code.

In the fig (6) the lowest range for TDS surface map is (139-140.8) mg/l labeled with a dark green color. But the highest range is (241-288) mg/l labeled with a dark orange color. Other ranges also distinguished with different color code.

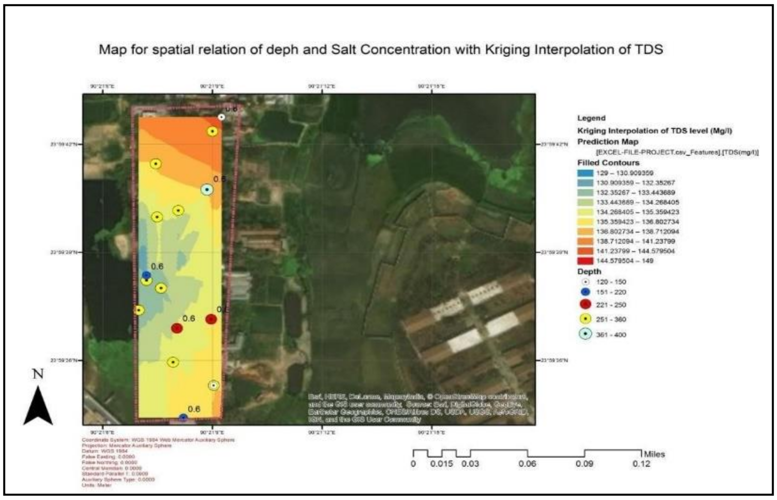

Figure 5: Kriging Interpolation Map of TDS for Selected Effected zone, in Kodda Gazipur

Both of map location data showed along with point shape file where different color and size of point file labeled different depth of water label in sampling location. The salt concentration is directly labeled near each point file.

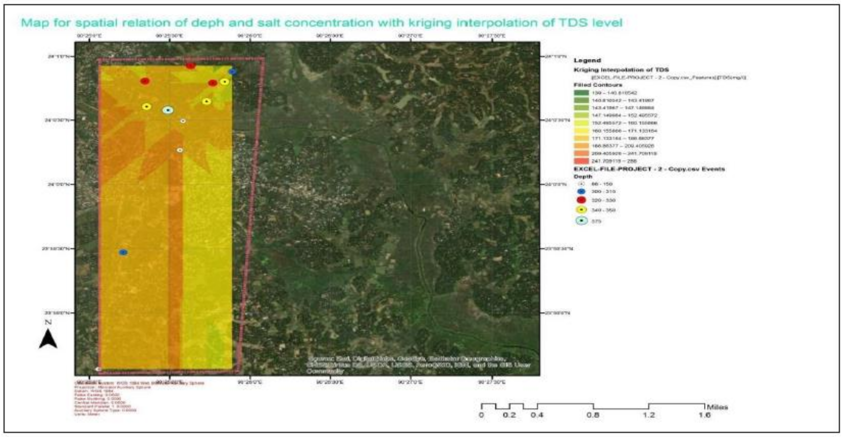

Figure 6: Kriging Interpolation Map of TDS for Selected Non-Effected zone, Rural Area inGazipur

Statistical Analysis

For statistical analysis, we use the statistical software "IBM SPSS". This is the most crucial part of our entire study project. Without proper statistical analysis, we cannot detect the level of significance of our decision parameter. The whole analysis procedure is divided into three part frequency analysis to find the distribution of our data set, hypothetical test by comparingmean of decision parameter, correlation analysis between depth and both our decision parameter and additional parameter. During the whole analysis process, we consider "salt concentration" as our decision parameter for hypothetical analysis

Table 1: Pared Sample T Test

Paired Samples Test										
		Paired Differences					t	df	Sig . (2- tailed)
		Mean	Std. Deviation	Std. Error Mea n	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	TDS for Urban Samples (Mg/L) - TDS f	-36.333	42.111	12.156	-63.089	-9.577	-2.989	11	.012

	or Residential & Rural Samples (Mg/L)								
Pair 2	Salt Concentration for Urban Samples (%) - Salt Concentration for Residential & Rural Samples (%)	-0.05000	0.07977	0.02303	-0.10068	0.00068	-2.171	11	.053

Result

To test the hypothesis that the decision parameter of urban sample's salt concentration (M=.5813, SD =.04031) and residential & rural sample's salt concentration (M=.6250, SD =.06216) was compared through a dependent sample/paired t-test. Prior to conducting the analysis, the assumption of normally distributed different data sources was examined. The assumption was considered satisfied, as the skew and kurtosis levels were estimated at -1.722and -.170, respectively, which is less than maximum allowable values for a t-test (i.e., Skew<|2.0| and Kurtosis<|9.0|; Posten,1984). Additionally, the assumption of homogeneity of variance tested and satisfied via Levene's F test, $F(26) = 3.088$, $p = .091$. The dependent samplet-test was associated with a statistically insignificant effect, $t(11) = 2.171$, $p = .053$. Thus, thereare no significant negative impacts on groundwater due to untreated effluents from textile industries near Kodda Gazipur.

Conclusion

In our research, we have found that there is no influence of textile effluents in Kodda Gazipurarea. Which is definitely good news, but in all previous studies related to the characterization of textile, effluents showed that there are several serious contaminants are present there. So definitely there are some barriers which restrain polluted effluents percolate into groundwater.After trying to find the study related to soil formation in Gazipur area we found very little data,but we come to a conclusion that Gazipur area is under Modhupur tract and the soil type in thistract are mostly clay formation. As we all know clay layer has very low percolation rate, thereis a high chance that this blessing layer of clay is the main fact of retaining effluent water to mix with groundwater layer.

Another interesting thing came out in our study the mean value of our decision parameter salt concentration is found higher in residential & rural samples (M= .6250, SD= .06216) and slightly lower in the urban area (M= .5813, SD= .04031). Though these values are statisticallyinsignificant, typically urban salt concentration should be higher than rural residential salt level. Similar things also found when we consider TDS. So, these things indicate that there must some other influences which increase these parameters in the rural residential area. Excessive use of pesticides & fertilizers can be a reason, but can't be sure without further study.So, it is still inconclusive.

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