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IMPACT OF INDUSTRIAL WASTES ON SOIL AND WATER

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Abstract

Soil and water of industrial areas have been contaminated at different levels for a long time. There is increasing demand against the pollution of soil and water but still is going on full swing. The objectives of the study were to assess the impact of industrial wastes on soil and water according to farmers' response and to find out the socio-economic problems caused by industrial wastes. The study was carried out at Mirzapur union of Gazipur sadar upazila in Gazipur district. Data were collected from a sample size of randomly selected 90 respondent farmers by using a pre-designed interview schedule during November, 2009 to March, 2010. Almost 100% of the respondents reported that untreated industrial wastes deteriorated the quality of low land soil and surface water. The differences of low land soil and surface water quality between pre and post establishment of industry were significant. "Low yield of rice", "deterioration of tin made houses", "bad smell in the air", "dermal disease of human being" and "limited availability of fish" were identified as the major socio-economic problems caused by industrial wastes. The above findings lead to recommend that immediate action should be taken by the concerned authorities to overcome the problems.

Key words : Industrial wastes, soil, water

Introduction

Industrial waste is a serious source of soil pollution. Besides it may also contaminate surface and ground water, air or its contact to any other substances. Prolonged use of wastewater is hazardous for soil as it may deteriorate the soil structure (Kahlown *et al.*, 2007). Bangladesh has now more than 30,000 industrial units of which about 24,000 are small and cottage industries (Nuruzzaman *et al.*, 1998). These wastes consist of number of toxic chemicals along with non-biodegradable materials. These non-biodegradable materials accumulate in

the soil and reduce its filtering capacity and destroy bacteria and beneficial microorganisms present in soil (Gopal, 2010). Disposal of untreated wastewater into drains and ultimately into the rivers, deteriorates the water quality and harms the aquatic life. Industries discharge organic and inorganic pollutants. The organic pollutants are both biodegradable and non-biodegradable in nature. The biodegradable organic components degrade water quality during decomposition by depleting dissolved oxygen. The non-biodegradable organic components persist in the water system for a long time and pass into the food chain. Inorganic pollutants are mostly metallic salts, and basic and acidic compounds. These inorganic components undergo different chemical and biochemical interactions in the river system, and deteriorate water quality (Ahmed and Reazuddin, 2000). Soil ecosystems throughout the world have been contaminated by various anthropogenic activities resulting in health hazards through food chain (Tu *et al.*, 2000; Dahmani-Mueller *et al.*, 2001; McGrath *et al.*, 2002).

It is therefore, necessary to investigate what are the farmers' responses regarding impact of industrial wastes on soil and water? What are the socio-economic problems caused by industrial wastes? Considering the above problems and circumstances the present study got its direction with the following specific objectives: i) To determine farmers' responses regarding impact of industrial wastes on soil, water and ii) To find out the socio-economic problems caused by industrial wastes.

Materials and Method

The study was carried out in Mirzapur union, an industrial area of Gazipur sadar upazila of Gazipur district. A total of 9560 farm families constituted the population of the study. Of them 22% being directly affected were considered as the target population. From the target population 90 respondents were selected randomly as the sample of the study. Data were collected through face to face interview by the researcher using a pre-designed interview schedule during November, 2009 to March, 2010. Collected data were used to measure the impact of industrial waste on the basis of the extent of change occurred in soil and water quality. To measure farmers' response on the soil quality, the color and odor of low land soil for before and after situation were computed. Score of 1, 2, 3, and 4 were assigned against each of the statement of very bad, bad, good and very good, respectively. Each score of color and odor was added up to obtain the final scores of low land soil

quality following before and after situation. On the basis of the obtained scores, respondents were classified into three categories based on their responses on soil quality. The categories were - low quality (up to 3), medium quality (4 to 6) and high quality (7 and above). Farmers' response on water quality was measured in terms of color and odor of surface and ground water for both the period of pre and post establishment of industry. For each of the statement score of 1, 2, 3, and 4 were assigned against very bad, bad, good and very good, respectively. Each score of color and odor was added up to obtain the final scores of surface water quality following before and after situation. On the basis of obtained scores, respondents were classified into three categories based on their responses on surface water quality - low quality (up to 8), medium quality (9 to16) and high quality (17 and above). Same method was followed for ground water quality. Collected data were compiled and coded for processing and analysis. The SPSS version 12.0 was used to analyze the data. The typical variation between two time periods was determined by testing the following null hypothesis: there is no significant difference between pre and post establishment of industry in respect of changes in soil and water. Paired-t-test was used to test the significant difference of before-after data.

Results and Discussion

Impact of industrial wastes on soil and water

Industrial waste was supposed to cause changes in soil and water quality. This section attempts to discuss these changes sequentially.

Impact on soil quality

Land of the studied area was mostly divided into high land and low land categories. It was observed that the high land soil was unaffected both in color and odor as no discharge was reached over there. Respondents also opined the same. On the other hand, in case of low land different scenario had been observed. As per the responses of the respondents, before establishment of industry color of low land soil was typical grey (66% very good and 34% good) (Table 1). But most of the respondents (81%) reported that after the establishment of industry low land soil became very black in color (very bad) due to contamination by industrial discharges. The odor of soil also became unpleasant (77% very bad and 23% bad) after establishment of industry.

Low land soil was in high quality

Table 1. Distribution of the respondents according to their response for color and odor of soil during pre and post establishment of industry

Types of land	Categories	Color				Odor			
		Before		After		Before		After	
		F*	P*	F	P	F	P	F	P
Low land	Very good	59	66	-	-	61	68	-	-
	Good	31	34	-	-	29	32	-	-
	Bad	-	-	17	19	-	-	21	23
	Very bad	-	-	73	81	-	-	69	77

F* = Frequency, P* = Percentage

Therefore, it can be said that low land soil has been affected by industrial discharges.

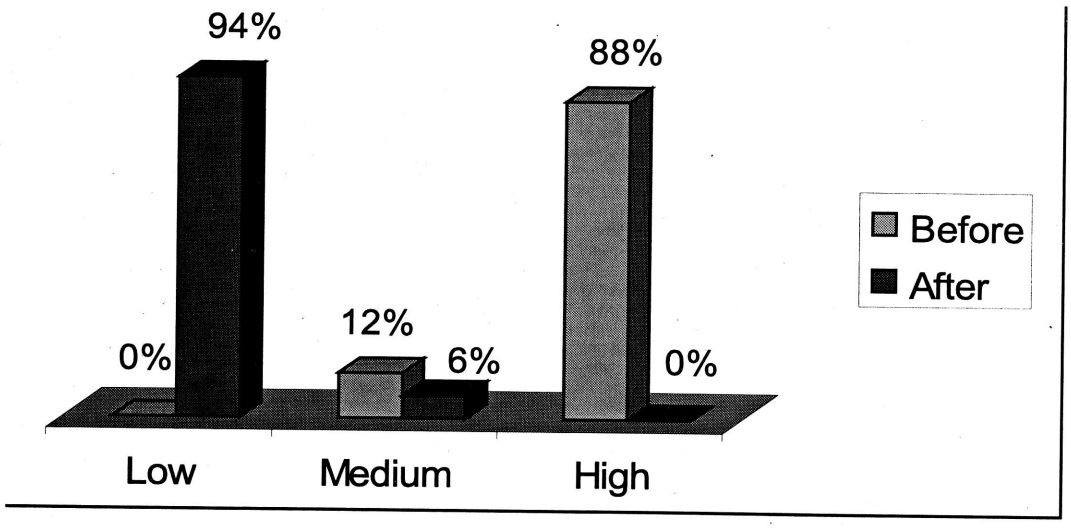

Figure 1. Comparison of low land soil quality between pre and post establishment of industry.

before establishment of industry as stated by 88 percent respondents, whereas 94 percent respondents stated that soil quality of low land has decreased after establishment of industry (Figure 1). Islam *et al.* (2006)

in a study reported that the impact of industrial effluents was similar regardless of distances from the Bangladesh Thai Aluminum (BTA) factory.

The typical variation between before and after establishment of industry in respect of soil quality was tested by testing the following null hypothesis: "There is no significant change in low land soil quality of the studied area between pre and post establishment of industry". The calculated t-value was 53.58, which was significant at 1% level with df 89. Based on the results the null hypothesis was rejected. Hence, it can be illustrate that low land soil quality of the study area changed significantly after establishment of industry. McLean and Bledsoe (1992) in a study reported that long-term deposition of untreated industrial effluents increase concentration of trace metals in soil which generally reflects the contamination of soil.

Impact on water quality

Due to indiscriminate discharge of industrial wastes both surface and ground water are likely to be affected. The respondents' responses in this regard have been furnished below.

Impact on quality of surface water

Information presented in Table 2 demonstrate that during pre establishment of industry the quality of the surface water which was used for drinking or cooking was good (54%) to very good (46%) in terms of color but after establishment of industry the most of the respondents (67%) reported that the color of surface water was deteriorated (very bad). Such water was considered unusable for drinking and cooking due to noxious odor (78% very bad and 22% bad).

Previously surface water was used for domestic animal considering good (53%) color and very good (51%) odor but such water was become unusable (very bad) currently in both color (89%) and odor (82%). A substantial portion of the respondents (76% for color and 80% for odor) also reported about deterioration of the suitability of surface water for irrigation purposes due to contamination by industrial wastes.

Findings presented in Figure 2 disclose that before establishment of industry, surface water quality was high (100%). On the other hand, after establishment of industry a vast majority of the respondents (99%) stated the quality as low. Therefore, a conclusion can be drawn that surface water quality deteriorated after establishment of industry due to accumulation of industrial wastes.

The difference between before and after establishment of industry in respect of surface water quality was evaluated by testing the following null hypothesis:

Table 2. Distribution of the respondents according to their response for color and odor of surface water during pre and post establishment of industry

Types of use	Categories	Color				Odor			
		Before		After		Before		After	
		*F	P	F	P	F	P	F	P
Drinking or cooking	Very good	41	46	-	-	38	42	-	-
	Good	49	54	-	-	52	58	-	-
	Bad	-	-	30	33	-	-	20	22
	Very bad	-	-	60	67	-	-	70	78
Use for domestic animal	Very good	42	47	-	-	44	51	-	-
	Good	48	53	-	-	46	49	-	-
	Bad	-	-	10	11	-	-	16	18
	Very bad	-	-	80	89	-	-	74	82
Irrigation	Very good	48	53	-	-	26	29	-	-
	Good	42	47	-	-	64	71	-	-
	Bad	-	-	22	24	-	-	18	20
	Very bad	-	-	68	76	-	-	72	80

*F=Frequency, P= Percent

From the above discussion, a severe change in color and odor of surface water had been observed after establishment of industry.

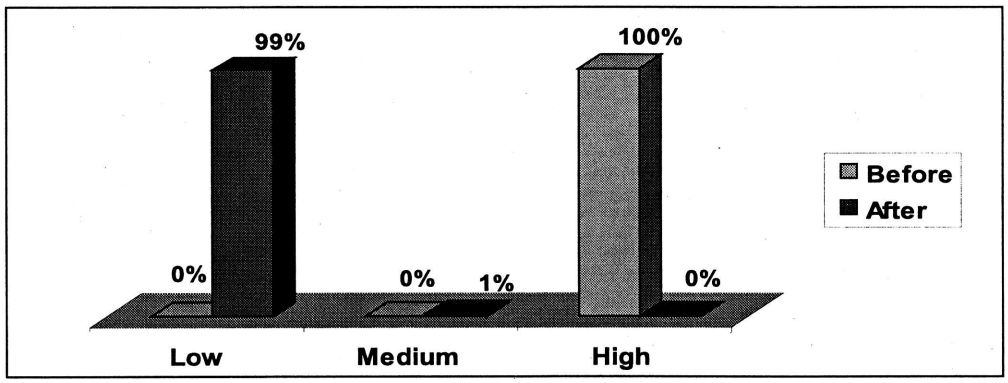

Figure 2. Comparison of surface water quality between pre and post establishment of industry.

"There is no significant change in surface water quality of the study area between pre and post establishment of industry". The calculated t-value was 74.59, which was significant at 1% level with df 89. Based on the results the null hypothesis was rejected. Hence it can be concluded that surface water quality of the study area changed significantly after establishment of industry. In a study Chowdhury and Clemett (2006) found deteriorated water quality at Mokesh Beel Wetlands where pollution by industrial wastes was very significant.

Impact on quality of ground water

Ground water is the most important source of drinking water. Respondents also depend on ground water for the purpose of cooking, rearing domestic animal, irrigation in the crop field etc. The results were displayed in Table 3 reveal that ground water used for drinking or cooking was found in very good (67%) to good (33%) category terms of color during pre establishment of industry. Such water also ranged from very good (56%) and good (44%) in terms of odor.

Table 3. Distribution of the respondents according to their response for color and odor of ground water during pre and post establishment of industry

Types of use	Categories	Color				Odor			
		Before		After		Before		After	
		*F	P	F	P	F	P	F	P
Drinking or cooking	Very good	60	67	56	62	50	56	51	57
	Good	30	33	34	37	40	44	36	40
	Bad	-	-	-	-	-	-	3	3
	Very bad	-	-	-	-	-	-	-	-
Use for domestic animal	Very good	57	63	55	61	52	58	54	60
	Good	33	37	35	39	38	42	33	37
	Bad	-	-	-	-	-	-	3	3
	Very bad	-	-	-	-	-	-	-	-
Irrigation	Very good	55	61	56	62	49	54	51	57
	Good	35	39	34	38	41	46	39	43
	Bad	-	-	-	-	-	-	-	-
	Very bad	-	-	-	-	-	-	-	-

*F=Frequency, P= Percent

However, a mentionable portion of the respondents (62% for color and 57% for odor) reported that ground water still remains uncontaminated (very good). Similar results were obtained in case of ground water used for domestic animal and irrigation purposes.

From the discussion it is clear that color and odor of ground water remains almost similar during pre and post establishment of industry.

industrial wastes.

The typical variation in ground water quality between before and after establishment of industry was tested by applying the following null hypothesis: "There is no significant change in ground water quality of the study area between pre and post establishment of industry". The calculated t-value was 1.752, which was insignificant. Based on the results the null hypothesis was

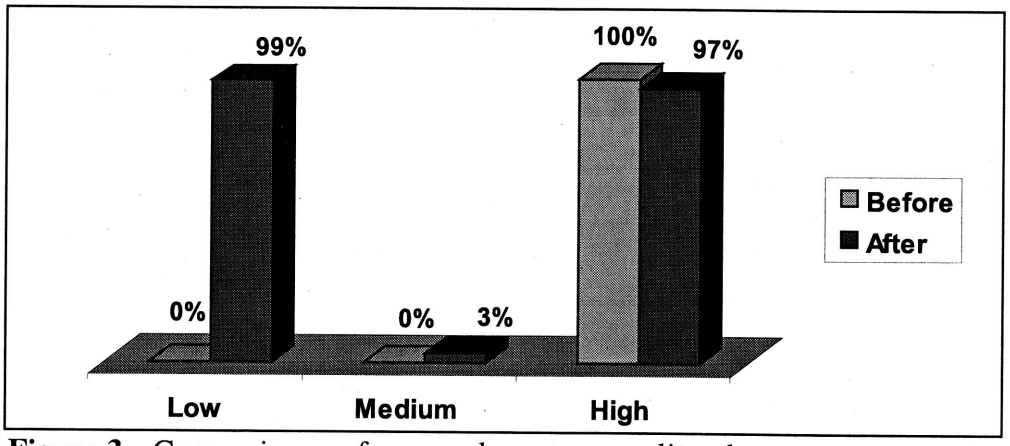

Figure 3. Comparison of ground water quality between pre and post establishment of industry.

Results displayed in Figure 3 describe that before establishment of industry ground water was of high quality (100%). It was also high in quality after the establishment of industry stated by a vast majority of the respondents (97%). No respondent mentioned it as of low quality. Thus it can be concluded that ground water was not affected by

accepted. Thus, it is clearly understood that ground water quality of the study area was not deteriorated after establishment of industry. But according to USGS (1982) groundwater can get contaminated by industrial wastes. It might be due to farmers don't perceive the contamination of ground water.

Socio-economic problems faced by the respondents due to industrial wastes

Problem refers to the difficulties that the farmers encounter in their practical life for production of crops amidst industrial pollution and want to the solution of the same. In order to develop strategies for improvement of farmers' livelihood, identification of the problems and its solution is the crucial aspects. So, the purpose of this section is to find out the problems and their probable solution. In this regard, the respondents were asked to mention the problems faced by them due to indiscriminate discharge of industrial wastes. The responses were weighted as 3 for high problem, 2 for medium problem and 1 for low problem. After compiling their responses, a problem index (PI) was computed to get the extent of individual problem and thus rank order of each problem was assessed according to the importance given by the respondents. The problems as mentioned by the respondents along with their rank were presented in Table 4.

Information furnished in Table 4 show that among the enlisted problems "low yield of rice" ranked first, "deterioration of tin made houses" ranked second, "bad smell in the air" ranked third and "dermal disease of human being" ranked fourth while "limited availability of fish" ranked fifth.

Table 4. Rank order of the problems caused by industrial wastes

Sl No	Description of the problems	Extent of problems			Total (PI)*	Rank order
		Low	Medium	High		
1	Low yield of rice	4	13	73	249	1st
2	Deterioration of tin made houses	9	12	69	240	2nd
3	Bad smell in the air	13	6	71	238	3rd
4	Dermal disease of human being	7	24	59	232	4th
5	Limited availability of fish	15	20	55	220	5th
6	Bad taste of fish	10	51	29	199	6th
7	Bad odor of water	28	17	45	197	7th
8	Respiratory disease	19	60	11	172	8th
9	Bad taste of crops	31	48	11	160	9th
10	Discoloration of ornaments	35	44	11	156	10th

PI= Problem index

Most of the respondents in the study area depend on rice production for their livelihood. But due to accumulation of untreated industrial wastes in their rice field rice production reduced to almost half or in many cases no rice was produced. As a result production costs become higher for the respondents. Thus, "low yield of rice" was evident as the most important problem. Industries not only discharge excreta into soil and water but also in the air. Gaseous discharges come under certain chemical reactions with tin and tin made furniture causing their quality deterioration leading to financial loss. Therefore, "deterioration of tin made houses" came as the second problem. Fresh air for breath is essential for a healthy life but now it is unimaginable in the studied area where offensive smell persists in the air. Consequently the problem "bad smell in the air" was ranked as third. Respondents also suffer from various dermal diseases as they come into contact with industrial wastewater in their crop field. Avoidance of this contact is impossible. Thus, it becomes another important problem ranking fourth. Untreated industrial wastes make surface water toxic for fish living. As a result, fishes die in that water and people suffer from availability of fish protein. Fishermen of that area become workless. These drawbacks might prompt "limited availability of fish" to appear in the fifth rank.

Considering different problems caused by industrial wastes, respondents were asked to suggest some solutions against their problems. Suggested solutions of the aforesaid problems are presented below:

From their responses it was clear that most of the respondents (41%) expected to restrict the discharge of wastewater to their cultivated land.

Table 5. Suggested solutions of the aforesaid problems

	Possible solutions	F*	P
1.	Factory should not be established in the vicinity of cultivated land	3	3
2.	Industrial wastewater should be purified	25	27
3.	Wastewater should be passed through a drainage system	21	23
4.	Government should take initiative	3	3
5.	Wastewater discharge into the cultivated land should be restricted	37	41
6.	Compensation should be given	1	1

*F=Frequency, P=Percent

About 28 percent respondents suggested the purification of wastewater. Above one-fifth of the respondents (24%) stated that proper drainage system should be used by the industry owners for passing effluents. Some other suggestions also come out from discussion such as Government should take initiative against those industry owners who don't obey environmental act, compensation should be given by industry owners to the victims and factory should not be established at the vicinity of cultivable land.

From the above results it can be concluded that after establishment of industry quality of lowland soil and surface water was found to be deteriorated. Many other major problems like low yield of rice, deterioration of tin made houses, and bad smell in the air, dermal disease of human being and limited availability of fish were also faced by the respondents. Environmental Impact Assessment (EIA) for new industries and implementation of environmental act might help to overcome these problems.

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