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Impacts of Industrial Pollution on Human Health: Empirical Evidences from an Industrial Hotspot (Kaliakoir) in Bangladesh

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Abstract: Water pollution impact on human health is a rising global concern. This pollution is largely caused by agriculture runoff, disposal of solid waste, sewage especially in the urban areas and discharge of untreated industrial waste. These have both direct and indirect adverse impacts on human health. There are about 1176 industrial units in the country of different types that pollute the river and wetlands especially around the urban areas. This study was conducted to explore health hazards from industrial pollution in Kaliakoir, Bangladesh. Based on the authors' analysis of primary and secondary data, the study reveals that the industrial pollution has caused several health problems for the local community in the vicinity of this industrial zone. Empirical evidence indicates that the incidence of skin diseases, ARI, anemia, peptic ulcer in the region, have been found to have increased between 1998 and 2003. This implies that there are clear linkages between the negative impacts of water pollution due to rising industrial waste and effluents on human health.

Key words: Water pollution, health, Bangladesh, industrial waste.

Introduction

While there is a growing concern for adequate provision of water supply and sanitation in many urban and rural areas, there is equal concern towards addressing wastewater generated by both industrial and domestic effluents affecting urban areas and their hinterlands. It is estimated that by 2015, 80 percent of the world's population will be living in cities in developing countries. The Sub-Saharan Africa has the highest growth of 4.58 percent, followed by South-Eastern Asia (3.82%), Eastern Asia (3.39%), Western Asia (2.96%), Southern Asia (2.89%) and Northern Africa (2.48%). Asia and Africa will continue to dominate global urban growth through 2030, with Asia alone accounting for more than half the world's urban population. These have not only created a major challenge for meeting the growing demand for clean water supply, sanitation and food security, but also a growing need for disposal of wastewater generated across urban and peri-urban regions. These stresses have contributed to wide-spread ecological problems in and around cities.

The unprecedented urbanization and industrialization is associated with exerting pressure on the quality of water resources placing human health at risk. The situation is no different for Bangladesh that has about 1176 units that heavily pollute the environment; of these pulp and paper, textiles and leather industries were the dominant sources of wastewater pollutants. Of these industries, tanneries and textile (dyeing) industries are examined to understand the linkage between water pollution and its influence on human health.

One of the major initiatives of the Government of Bangladesh was to implement management of aquatic ecosystem through community husbandry project, which recognized water pollution problems caused by the

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industries in areas like Kaliakoir. This project identified the local industries as the main polluters in this area.

This paper taking a case of industrial hot-spot (Kaliakoir) in Bangladesh examines the health implications from rapid industrialisation in the South Asian region.

History of Industrial Development in Bangladesh

Bangladesh is one of the most environmentally vulnerable countries in the world, with a population of about 140 million in an area of 147,000 km^2 (GoB, 2008). It appears that most of the people are involved in agriculture sector. In fact, 48.4 percent of the population are involved in agriculture sector, 24.3 percent in industrial activity (small to large scale) and 14.2 percent are working in the service sector (GoB, 2008). The agricultural and industrial sectors together have significant contribution to the national GDP. It shows that the contribution of agriculture in GDP was 21.37 percent in 2007 while it was 29.66 percent from the industrial sector in the same year. On the other hand, the contribution of industrial sector to GDP increased from about 18 percent in the year 1980 to 30 percent in 2007. Thus, the industrial sector has emerged as an important player for generating income for growth and development in the country.

Industrialization in Bangladesh territory actually started in 1947 (Ahmed and Reazuddin, 2000). The main industries at that time included jute, cotton and sugar (Reazuddin, 1994). But there was rapid growth in these industrial sectors at the post-independence period especially during late 1970s. In fact, the government took a number of initiatives including establishment of industrial estates, export processing zones etc. to promote industrial growth during the mentioned period. By late 1990s, the industrial infrastructure of the country earmarked establishment of 60 industrial estates and two Export Promotion Zones (EPZs). This facilitated the growth of readymade garment (RMG) (small to large) industry in a rapid manner. The RMG industry of Bangladesh concentrates mainly in manufacturing of shirts, T-shirts, trousers, sweaters and jackets. The development of RMG industry has enormous contribution to export earnings, employment creation, poverty alleviation and the empowerment of women in the country. It shows that the number of the RMG industrial units had increased to 4107 in 2005 from 30 in 1980 (Zafar Ullah et al., 2004). The other types of industries including textiles, chemicals and pesticides, rubber and pulp, pharmaceuticals, tanneries, cement, food and sugar, fertilizers were also established in a rapid manner in different areas of the country.

To continue the process of industrial growth, the government of Bangladesh took successive initiatives. Evidently, the government provided about 6470 million USD (as loan) to establish small and medium scale industries in 2006-2007 in the country (GoB, 2008). Thus the number of EPZs increased to eight in 2008 from two in late 1990s. These are in Dhaka, Chittagong, Mongla, Comilla, Ishwardi, Uttara (Nilphamari), Adamjee and Karnaphuli. The investment of the government in these EPZs was over 1262.16 million USD in 2007-2008 (until December 2007). The total amount of export from these EPZs was 2.064 billion USD last year, which was expected to be 2.3 billion in the year 2007-2008. These EPZs accommodate about 264 industries, of which, 22 percent are RMGs and 9.5 percent are textiles. More than 60 percent workers are women in these industries.

Overview of Industrial Hotspots in Bangladesh

Bangladesh is known to be a land of rivers and canals. The country receives 1000 to 5000 mm of rain in various regions annually. It has a network of over 200 large and small rivers that discharge about 175 billion cubic metres of water to the Bay of Bengal (BBS, 2005). The main sources of water for the country are the rivers Ganges, the Brahmaputra and the Meghna. The rivers of Bangladesh carry water from a catchment area of about 1.7 million square kilometres, only eight percent of which lies within Bangladesh. Additionally, these rivers carry about 2.4 billion tons of sediment annually to the Bay of Bengal.

The prominent well run industrial estates in Bangladesh are Tongi, Konabari and Gazipur (Kaliakoir) in Dhaka division, Kalurghat, Foujdarhat and Sholashahar Estate in Chittagong, Jessore and Shiromoni in Khulna and Hossiery Estate at Narayangonj. The North Central region accommodates the highest number of industrial spots in the country. About 33 percent of the industries in the NC region are textiles, finished garments and tanneries. Of these, Dhaka district accounts for almost half and Narayanganj about 32 percent (UNEPRRC AP, 2001).

This recent rapid industrialization is affecting surrounding environment, may be due to lack of proper planning and management. Discharge of untreated waste of the industries deteriorates surface water quality and affects environment and human health. In other words, industrial pollution has become an added factor that

affects human health, especially of those who live in close proximity to the industrial hotspots like Kaliakoir in Gazipur, Hazaribag in Dhaka, Kalurghat in Chittagong, Shiromony in Khulna etc.

The Department of Environment (DoE) of the Government of Bangladesh identified over a thousand of polluting industries. All these identified industries are not equipped with effluent treatment facilities. Therefore, the untreated effluents and wastes reach the nearby ponds, lakes, canals and rivers. This ultimately affects human health, especially for the people living nearby.

The DoE has identified 1176 major polluting industries by sectors (Table 1). These industries are polluting the surrounding surface water which results affecting human health.

Table 1: Major polluting industries in Bangladesh

Sector	*Number*
Tanneries	198
Textiles	365
Cement	35
Jute	92
Chemicals and pesticides	118
Distilleries	4
Rubber and plastic	63
Paper and pulp	10
Food and sugar	38
Engineering	129
Pharmaceuticals	149
Fertilizers	8

Source: BBS, 2005

Impact of Water Pollution on Human Health in Kaliakoir

Bangladesh is already vulnerable to outbreaks of infectious, water-borne and other types of diseases (World Bank, 2000). The record shows that the malaria incidences increased from 1556 in 1971 to 15,375 in 1981, 30,282 in 1991 and 42,012 in 2004 (WHO, 2006). Other diseases like diarrhea, dysentery, etc. are also on the increase, especially during the summer months. Water pollution is one of the major factors that increase and aggravate the risks of human health in the rural areas of the country. Kaliakoir is one of the examples of the country which indicates deterioration of human health due to industrial pollution.

Kaliakoir Upazila (sub-district) is a well-off part of Gazipur District, located close to Tongi and Dhaka city. Kaliakoir has a population of 10,374; among them 57.61% are male and 42.39% are female (BBS, 2001; Banglapedia, 2003). Density of population in this area is 1932 per square kilometre. The literacy rate in the town is 51.2%. The inhabitants are farmers, fishermen, boatmen, daily labour, and service holders in government and non-government sectors etc. But it appears from the discussion with the local people that the previous main professions of agriculture farming and fishing has gradually shifted to industrial labour in recent years (community meeting).

As mentioned above, Kaliakoir is one of the major industrial hotspots of the country. In early 1990s, the rapid growth of industrial units changed the overall environment of Kaliakoir, about 50 km away from Dhaka. The main types of industrial units include tanneries, pharmaceuticals, textiles and dyeing and printing. Discharge of untreated waste of these industrial units cause deterioration of surface water quality, which is still being used by the local residents for domestic, agriculture and other relevant purposes.

It has been reported that different pollutants have already affected the water bodies including Mokesh beel and Kalidoho beel and other water sources such as ponds (Zafar Ullah, 2004). The main polluters of these beels and other water bodies are the local industries, especially textiles and tanneries. The toxic substances discharged by these type of industries are degrading the aquatic ecosystem of the nearest areas. Tables 2 and 3 state two scenarios of surface water pollution in Kaliakoir.

Table 2: Median values of heavy metals in sediments in different locations of Mokesh Beel Ecosystem

Parameter	*Median values (mg/L) (n = 6)*	*Range values (mg/L)*
Cadmium	1.35	0.6–4.2
Chromium	44	21.5–56.40
Lead	77.25	46.5–189.5
Zinc	450	90–882

Source: MACH, 2001 in Zafar Ullah, 2004

Table 3: Median values of different parameters in water in different locations of Mokesh Beel Ecosystem

Parameter	*Median values (mg/L) (n = 6)*	*Range values (mg/L)*	*Bangladesh standard (mg/L)*
BOD	407	380–500	50
COD	960	350–1600	200
DO	1	0.6–1.2	4.5–8.0
TSS	195	115–427	100
Sulphide	3.1	1.6–10.2	1.0
Oil and Grease	27	17–45	10.0

Source: MACH, 2001 in Zafar Ullah, 2004

It appears that the local people living close to Kaliakoir industrial spot are suffering from a number of diseases (Zafar Ullah et al., 2006). The nearby local communities suffer from diarrhea, skin diseases, gastric ulcers, respiratory illness, anaemia, high blood pressure and jaundice (Zafar Ullah et al., 2004 and 2006). On the other hand, according to the disease profile of Kaliakoir Upazila Health Complex, incidences of some of the diseases including anaemia, skin diseases and ARI are on the increasing trend (1998 to 2002), while diarrhea is on a decreasing trend (UHC, 2003 in Zafar Ullah et al., 2006) (Table 4).

Table 4: Incidences of diseases in Kaliakoir

Year	*Number of disease incidences*			
	Diarrhea	*ARI*	*Skin disease*	*Anemia*
1998	7659	5375	3840	4072
1999	7227	6280	4280	3890
2000	6798	7540	5060	8180
2001	6219	8367	6611	4743
2002	5773	11492	8723	6666

Source: Kaliakoir UHC Report in Zafar Ullah et al., 2006

Findings of a Recent Study

A study was conducted to explore the implications of surface water pollution on human health in Kaliakoir area during October 2007**.** The study included the households in three villages close to Kaliakoir industrial area. The following steps were taken to conduct the study:

- **Conceptual development:** A small team of BCAS discussed the industrial pollution issues in Kaliakoir and developed their understanding to initiate a case study research on human health implications and industrial pollution.
- **Selection of the study area:** Three villages were identified to explore the pollution and its associated impacts on human health. The locations (Majukhan, Sholahati and Gopinpur) were selected based on the distance between the village and industrial hotspot and the river.
- **Development of data collection tools:** A short questionnaire was developed to collect information from households of the selected villages. An expert (who was involved in Managing Industrial Pollution from small and medium scale industries in Bangladesh project) on industrial pollution issues was consulted during development of the questionnaire. A number of issues including occupation, health problems, trend of diseases, health expenditure, causes of diseases (perception) etc. were covered in the questionnaire.
- **Sample survey:** The sample survey was conducted by interviewing the households of the selected three villages. The total respondents for sample survey in each village were 50. Thus 150 respondents were surveyed in total. The households in each village were randomly selected. The head of the family/household was given priority to respond to the questions. In the absence of the head of the family, any other senior and informed person of the family/household was requested to respond. However, in many cases either an elderly male or female member responded in the presence of all members of the family. Occasionally they discussed amongst themselves before responding to a question, particularly on health issues.

The secondary data/information was also reviewed to enrich the paper further.

The study findings are given below.

Household Occupation

The occupation of household members was examined under this survey. Among the total study population in three villages over 60 percent were found to be involved in agriculture with highest in Majukhan (75%) and the lowest in Gopinpur (62%). In contrast, the percentage of fishermen and daily labour were found to be higher in Gopinpur than both Majukhan and Sholahati. Table 5 gives details of occupations of the households.

Table 5: Village-wise occupation of the households

Occupation	*Village-wise occupational distribution*		
	Majukhan	*Sholahati*	*Gopinpur*
Agriculture	75	65	62
Fisherman	10	12	15
Daily labour	2.5	13	14
Business	5	3	5
Boatman	2.5	4	3
Others	5	3	1
Total	**100**	**100**	**100**

Major Diseases' Incidence

The households in the study area were affected by various diseases including diarrhea, dysentery, skin diseases, mental disorders, malnutrition, common cold/cough/fever, typhoid, asthma, jaundice, anemia, pneumonia etc. The analysis was mainly on some of the diseases which were mentioned frequently by the respondents although

the household respondents identified various diseases. Detail findings based on the major disease incidences are given below (please see Figure 1 for details):

(i) *Diarrhea:* According to response of the households, diarrhea was identified as one of the major diseases in each of the villages, with highest (72%) in Gopinpur while the lowest was 54% in Majukhan. It was found that 64% households of Sholahati village suffer from diarrhea. It indicates that the incidences are higher in the closest area of the polluted water streams. Gopinpur is the closest village to the main polluted water streams.

(ii) *Skin diseases:* It was found that most of the people especially in Gopinpur and Sholahati suffer from skin diseases. The study indicates that 88% of the households of Gopinpur village suffer from skin problems while it is 70% in Sholahati. Skin disease is one of the major diseases in Majukhan, as mentioned by 52% respondents.

Incidences of diarrhea and skin diseases are higher; may be due to direct contact of polluted (both microbial and chemical) water.

(iii) *Cough/Fever:* Many people of the study villages were found to be suffering from cold/fever problems. It is again highest (70%) in Gopinpur, followed by 68% in Sholahati.

(iv) *Asthma:* Many of the households mentioned that they suffer from asthma. It was found that more than 55% households face this health problem in each of the study villages. The highest was 62% in Sholahati while the lowest was 56%, in both Gopinpur and Majukhan.

(v) *Pneumonia:* Pneumonia is one of the major health problems in each study location, mentioned by more than 30 percent respondents, with highest in Majukhan (44%) and lowest in Sholahati (34%).

(vi) *Other diseases:* Over 30 percent respondents stated about "other diseases/health problems" which include anemia, gastric problems, headache, malnutrition, blood pressure, eye infections etc.

Causes of Health Problems in the Study Areas

The possible causes for some of the major diseases mentioned by respondents for all the study locations were analyzed together. Most of the respondents in all the study areas identified industrial pollution as the worst cause for local health problems. During the rainy season this polluted water spreads over the low lying agricultural fields, small water bodies, canals etc. The local communities are exposed to this pollution in different pathways including working at the agricultural fields, spraying water at the vegetable garden, fishing, washing utensils and clothes, bathing in the rivers etc. Since agriculture is the main occupation of the studied villages, farmers remain the most victims.

Various other causes were also identified by the respondents. These were improper sanitation, lack of quality food, smoking, seasonal changes etc. The "others" option includes unavailability of food, lack of safe water, poor living condition (too many people in one room), indoor pollution etc. In Majukhan village, 52 percent respondents mentioned that industrial pollution is the main cause of their health problems followed by unhygienic behaviour or improper sanitation stated by 18 percent. About eight percent said seasonal changes

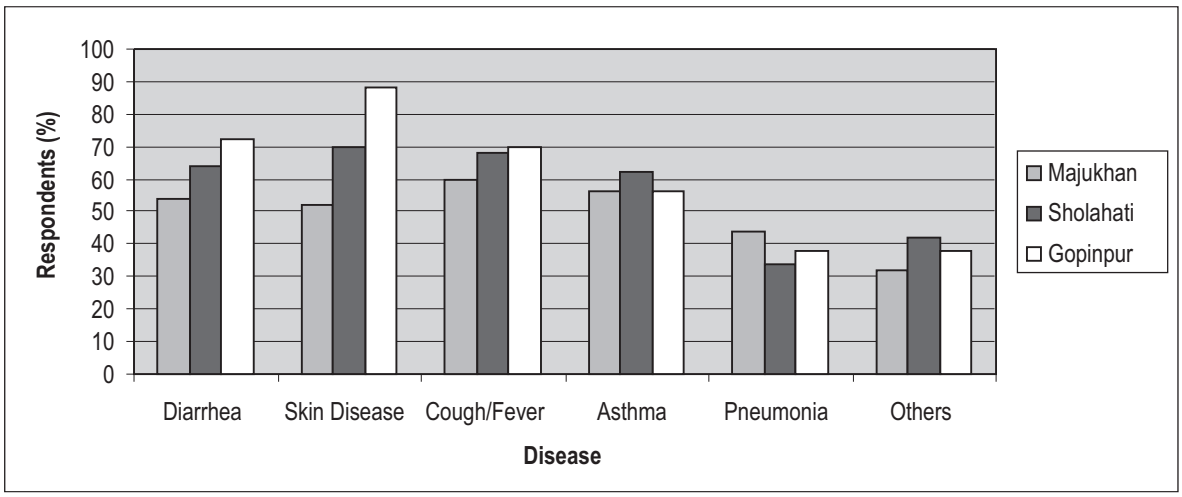

Figure 1. Incidences of diseases in % of sampled population.

would be one of the major causes for such health disorders. On the other hand, 14 percent of the respondents mentioned the other causes to be indoor pollution, lack of safe water etc. In Sholahati, industrial pollution became the main reason for health problems for the local communities, as told by 54 percent respondents, while 50 percent respondents said the same in Gopinur (Figures 2a and 2b).

Who Suffer more within the Household

In response to the question "who suffer (from any diseases) more in your family", 69 percent respondents (in all study areas) mentioned that female are the most affected group in the households, followed by male 64 percent. On the other hand, 76 percent respondents in Majukhan said that female populations suffer more than others in the households, while it was 62 (highest) percent

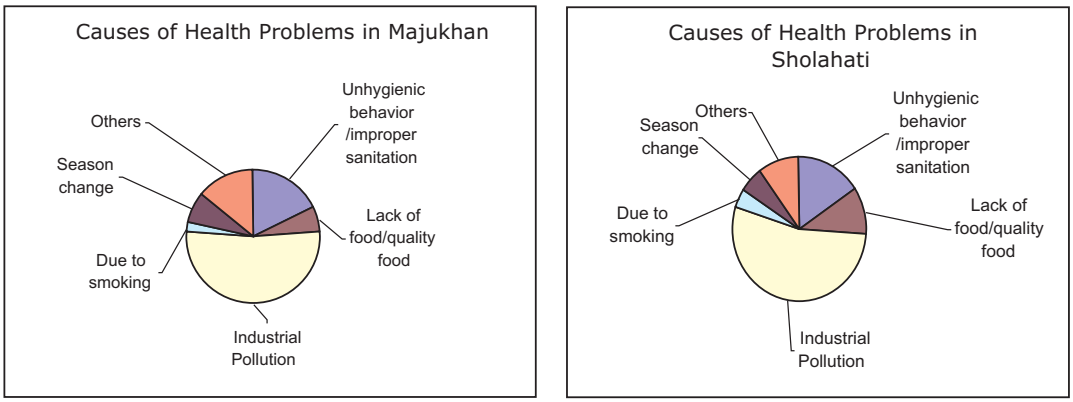

Figure 2a. Causes of diseases in the % of sampled for villages Majukhan and Sholahati.

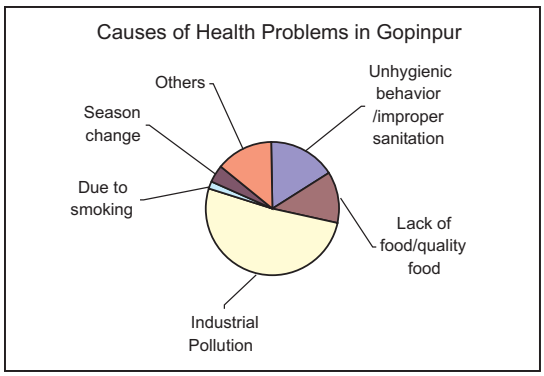

Figure 2b. Causes of diseases in the % of sampled population for village Gopinpur.

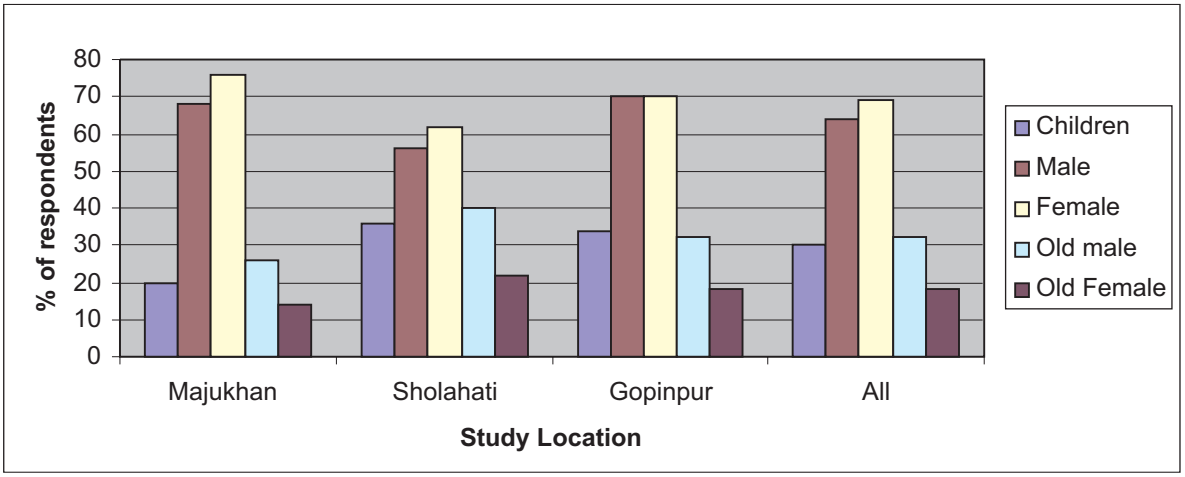

Figure 3. Age-wise distribution of population affected by water pollution (in % of sampled population).

and 70 (highest) percent in Sholahati and Gopinpur respectively.

The study indicates that the female suffer more from disease occurrences. This may be due to working nature/ condition/habit of the people in Bangladesh. In fact, women usually cook, wash clothes and kitchen utensils, take care of children, water home gardens etc. Most of the water-related jobs at home are done by the female anywhere in the country. The adult males are also worst victims; may be due to daily activities in the agricultural fields with direct contact with polluted water.

Conclusion

Water quality is dependent, in various ways, on the quantity of water available at a particular time and space on a regular basis. Both pollution and scarcity of water have harmful effects on the aquatic environment. The water pollution issue has become one of the major agendas for both water management and health management for communities and institutions. The three major sources of water pollution in Bangladesh are from industrial wastes, agro-chemicals (fertilizer and pesticides) and human solid waste pollution. All these are from different sources and can affect different locations and water bodies disparately though often they can even have a combined effect. Though the government has dedicated ministries and departments for pollution management with mandates and legal structures, the capacity for implementation and resources are often lacking. This results in the suffering of the nearby communities. The government has to look into this problem seriously and take measures in enforcing existing rules and regulations to reduce the health risks of the communities.

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