Health Impacts of Industrial Pollution

Final Research Report - Section 4

Contents

Acronyms and Abbreviations

BOD_5	Biological Oxygen Demand
BRAC	Bangladesh Rural Advancement Committee
COD	Chemical Oxygen Demand
EPZ	Export Processing Zone
DFID	Department for International Development
DoE	Department of Environment
GDP	Gross domestic product
GNP	Gross national product
GOB	Government of Bangladesh
iPRSP	Interim Poverty Reduction Strategy Paper
MACH	Management of Aquatic Ecosystems through Community Husbandry
PAH	Polyaromatic hydrocarbons
PCB	Polychlorinated biphenyls
PCP	polychlorinated phenols
PRA	Participatory rural appraisal
PHC	Primary health care
RMG	Ready-made garment
RRA	Rapid rural appraisal
SEHD	Society for Environment and Human Development
THC	Thana Health Complex
UHC	Upazila Health Complex
USAID	United States Agency for International Development

Beel	Shallow, seasonal lake
Khal	Canal
Imam	Islamic priest

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1 Introduction

Bangladesh is one of the most densely populated countries in the world with approximately 895 people per square kilometre, and a projected population of around 146 million by the year 2010. It is also one of the world's poorest countries, with a per capita Gross National Product (GNP) of $260, and in which approximately 60 percent of the population live below the poverty line (WB, 1993). The population remains largely rural with only around 20 percent living in urban areas. Rural livelihoods are dominated by agricultural production but people's livelihood systems are diverse with fishing either for purely subsistence use or small commercial sales being common. Fish accounts for approximately 63 percent of the animal protein in people's diet (BBS, 2004). Less than 40 percent of the rural population has access to modern primary health care (PHC) services beyond child immunisations and family planning (BBS, 2000; Abedin, 1997).

The high population growth rate and poverty levels have led Bangladesh to set a development target in the Interim Poverty Reduction Strategy Paper (iPRSP) of a seven percent growth in GDP to achieve its development goals by 2015. The iPRSP calls for a "focus on employment-intensive industrialisation with emphasis on small and medium enterprises and export oriented industries" (iPRSP, p.?).

The country still has a relatively small industrial sector contributing about 20 percent of the GDP between 1996 and 1997 but it is growing rapidly. The manufacturing sub-sector accounts for about half of this and grew at a rate of five percent between 1972 and 1992 (Bhattacharya et al, 1995). There are now over 24,000 registered small-scale industrial units in Bangladesh (SEHD, 1998) and it is generally accepted there are an equivalent number unregistered. The growth of small-scale industrial activities in Bangladesh has a positive development dynamic in macro-economic terms, for example, the ready-made garment (RMG) sector accounts for a little over 75 percent of national export earnings and 9.5 percent of GDP, providing US$ five billion in revenue and employing around 10 million people. However, industrialisation has also brought with it a range of problems. The industries tend to be clustered together and are highly polluting. As a consequence of their rapid and largely unregulated development, many aquatic ecosystems are now under threat and with them the livelihood systems of local people (Chadwick and Clemett, 2002). Consequently, whilst Bangladesh is, in industrial terms, a relatively undeveloped country, "the problem of localised pollution is alarming" (SEHD, 1998); a situation that is compounded by the high population density of the country.

Kaliakoir Thana in Gazipur District to the north-east of Dhaka is one such industrial cluster where rapid, unplanned industrial expansion has led to serious local pollution. This area was historically an important rice growing area but its close proximity to Dhaka has gradually led to more industries locating there over the past 15 years. There are now several types of industry in the area including a tannery, poultry farms and pharmaceutical industries but it is dominated by textile manufacturers, including dyeing and printing units.

The Management of Aquatic Ecosystems through Community Husbandry (MACH) project, funded by the GOB and USAID, which aims to enhance community-based wetlands and water resource management, first reported water pollution[1] problems in the Kaliakoir area in 1999 (MACH, 2001). The project undertook some initial pollution studies of the area, which identified the local industries as the main polluters.

Further water quality analysis was conducted under the Department for International Development (DFID) funded project "Managing Pollution from Small Scale Industries in Bangladesh". Samples were taken at various stages of the production process, at the outlets of factories, the *khal* (canal) that forms the main conduit for waste for the industries, and Mokesh *beel* (shallow lake), into which the *khal* discharges. During the dry season the *khal* is the only source of water to the *beel*. The *beel* then links to the Pungi River. These results of sampling from the production processes show that effluent from the factories generally have high biological oxygen demand (BOD), very high chemical oxygen demand (COD) levels, and also contain high levels of sodium sulphate, ethanoic acid, reactive dyes, and detergents (Chadwick *et al.*, 2003). Sampling in the beel whilst not as high due to the addition of water from washing and rinsing processes which serves to dilute the levels of pollutants also shows high levels for the same pollutants.

The projects also observed that the livelihoods of the people who live in Kaliakoir are seriously affected by the pollution. Discussions with community members revealed problems with agriculture and fish production, as well as health impacts. The discussions identified the need for a more systematic rapid health assessment.

2 Industrial Sector and Pollution in Bangladesh

Industrialisation began at a very slow pace in Bangladesh in the 1950s with the primary focus on agro-based industries such as jute, cotton and sugar. After independence in 1971, interest grew but it was not until the late 70s that industrialisation increased rapidly driven primarily by the ready-made garments (RMG) industry, following several government initiatives to promote industrial growth including the establishment of industrial estates and export processing zones (EPZ). By late 1990, 60 industrial estates and two EPZs had been established. Growth was particularly marked in the RMG sector. From a pollution point of view, sugar, pulp and paper, dyeing and leather industries are the major contributors. Non-renewable local resource based industries include industries based on mineral resources such as limestone, hard rock, gravel, glass, sand and various types of clays. In this category, major polluters are the cement and fertilizer factories. Imported resource based industries includes textile, pharmaceuticals, plastic, petroleum and metal works. Many of these are found to be highly polluting.

[1] Water pollution is the degradation of water quality, as measured by biological, chemical, or physical criteria, that can make water unsuitable for desired uses such as bathing, drinking or fishing, and can have serious effects on the health of humans and animals through contact or ingestion (Mason, 2002)

For many years policy planners have been under the impression that since Bangladesh is one of the less developed countries, pollution is yet to be an issue of concern (SEHD, 1998). However, several studies undertaken in the last decade have dispelled such beliefs. The Department of Environment (DoE) in the early 1990s carried out a survey of industries, principally tanneries. The report found that acidic emissions from effluents had the potential to cause serious respiratory disorders to the employees and residents of the area and damage to buildings (GoB, 1997). Similarly, the Society for Environment and Human Development (SEHD) published a report in 1998 which provided an overview of the key environmental issues in Bangladesh. It showed that treatment of industrial waste was considered a low priority and that due to the absence of strong preventative measures and lack of awareness, the practice of discharging untreated industrial waste into water bodies was almost universal. The serious public health hazards this could create has so far been minimized as the waste was diluted and flushed from water bodies during the rainy season. However, as industrial expansion has continued at a rapid pace since the 1980s, acute pollution is now threatening the sustainability of the resource base and increasingly impacting the health of the population.

To address rising concern the National Environmental Policy was approved in 1992 and the National Environmental Action Plan was developed. In 1995, the Bangladesh Environment Protection Ordinance was enacted. Environmental objectives were also contained in the government's Fourth Five Year Plan (1990-1995) and are present in the Perspective Plan (1996-2010). A plan of action for food safety and an inter-ministerial committee for coordinating and monitoring food safety are operational. Yet, despite these policy initiatives, little has changed in practice. One of the main difficulties is that environmental governance is limited with the principle institution, the Department of the Environment (DoE), having limited human and financial resources to tackle the problem.

3 Health Assessment Purpose and Objectives

Based on the findings from the initial pollution analysis of the MACH project and continued concern of the local population over the health implications of the industrial water pollution in Kaliakoir, particularly in Ratanpur Khal and Mokesh Beel, a rapid assessment was conducted to try to determine whether any of the current health problems currently occurring in the area could be attributed to the industrial pollution.

The overall objective of this study was to better understand the disease profile of the study population and determine if any of this profile could be attributed to the pollutants found in the local water bodies. The specific objectives were to:

- Assess the prevalent health conditions of the people living around Mokesh Beel and prepare a health profile;

- Identify potential or evidence derived environmental factors associated with those prevalent health problems; and
- Identify potential pollution related health indicators.

3.1 Methodology

The research involved two key elements. The first involved a serious of focus group discussions (FGDs) and in-depth interviews with community members to identify their perceived current and historical health problems. The second involved the gathering of secondary data and the undertaking of interviews with health workers in the area to determine whether these perceived changes to health expressed by the local population matched the health trends observed by local health professionals, and what was their opinion as to the likely causes of the health problems they did currently observe in the area.

The field research was undertaken in four steps. The first involved capacity development. A two-day training workshop was held to explain and discuss with local staff the purpose and process envisaged for the work. This included the development of the research methodologies. Following the training and piloting of methodologies, the collection of secondary data in the form of reports and statistics of the local health facilities, and the FGDs and IDIs with the local communities and health care professionals, were undertaken. Following analysis of the data, a series of consultation workshops were held with local communities to present the findings.

3.1.1 Community Perceptions of Health Trends

The project identified 15 villages in the Kaliakoir area that are located within a few kilometres of the industries and whose residents are partly or wholly dependent, directly and indirectly, on *Mokesh Beel*, *Kalidoho Beel* and adjacent water sources. The methodologies applied for the community assessment of health hazards were both qualitative and quantitative. These were:

- A comprehensive review and analysis of relevant secondary data;
- Focus group discussions (FGDs);
- In-depth-interviews (IDIs); and
- Interviewers' observations.

A total of 18 FGDs were conducted including one in each of the 15 villages (

Table 1) and three with women in Shinaboho, Kaliadoho and Sholahati villages. Sixteen IDIs were also conducted, one in each village and one with the Upazila Health and Family Planning Officer from the Kaliakoir Upazila Health Complex (UHC).

Table 1: Selected Villages and Population in 2001

Village	Total population	Male	Female
Harin Hati	3947	2246	1701
Ratanpur	-	-	-
Purba Chandra	7454	4335	3119
Shafipur	10883	5883	5000
Mazukhan	1399	715	684
Karalsurichala	1495	817	678
Amdair	1196	601	595
Sholahati	520	263	257
Matikata	1279	686	593
Bagambor	665	340	325
Kaliadaho	460	240	220
Gobindapur/Gopinpur	919	486	433
Taltali	760	405	355
Kouchakuri	431	222	209
Sinaba/Sinaboho	1548	799	749

Note: no data was available for Ratanpur
Source: Bangladesh Bureau of Statistics (BBS), 2001

The participants of the FGDs and IDIs were drawn from a wide range of villagers from a variety of primary professions. Most of them were involved in agriculture (47 percent) or small trade and other businesses (17 percent). About one-fifth of the respondents were teachers, other government employees or involved in the private sector. The vast majority of the female participants were housewives. Table 2 presents the range of occupations of the FGD participants.

Table 2: Occupation of the respondents in the FGDs and IDIs

Occupation	Number (N=106)	Percent
Agriculture	50	47
Trade/Business	18	17
Teacher/Educationist/Imam	13	12
Fishermen	10	10
Service– Government or Private	10	10
Others	5	5

Focus Group Discussions

About 12 people were invited to attend each FGD. These people were selected on the basis of their key occupation and on the recommendation of staff involved in the MACH project who identified people from each village who they considered to be responsive and well informed in terms of what occurred in the village. Three additional FGDs were conducted specifically with women, to explore issues of maternal and child health.

In-Depth Interviews with Key Community Members

The purpose of the IDIs was to gather rapidly information on specific issues that otherwise may have to be collected from the population using time consuming and costly questionnaires. The participants for the IDIs were selected and were either school teachers, village leaders, *Imams,* village elders, farmers, fishermen, traders, businessmen, teachers and factory workers.

3.1.2 Interviews with Health Care Professionals

A second phase of IDIs was conducted with health workers in the area including: doctors, pharmacists, nurses and "local doctors". These people were identified by asking the villagers whom they went to see when they had a health problem. In general people visit the pharmacy or local doctor for minor complaints such as diarrhoea and skin problems, but travel to the UHC for more serious health problems. There are also two Thana Health Complexes (THCs) in the area but discussions with community members suggested the villagers living around Mokesh Beel rarely visited these. Ten health professionals were interviewed in the study area and one from a nearby area where the local population do not use the water bodies impacted by the industrial waste.

The respondents were asked to identify the five most common health problems that they saw in the past year. They were then given 50 counters and were asked to make piles next to each disease according to its predominance. For those health workers who had been in the area for several years, this process was repeated for five and 10 years ago so that the trend in diseases could be seen.

4 Analysis

4.1 Community Perceptions of Health Profile

In an open question on predominant health problems in the community, the respondents mentioned that diarrhoea, skin diseases, gastric ulcers, gastroenteritis, respiratory illnesses (common cold, asthma), anaemia, high blood pressure and jaundice were the most common diseases amongst the population in the area. In addition, people also suffer from gout, rheumatism, conjunctivitis, pneumonia, malaria, tuberculosis and cancer. At least 70 percent of the people involve din the discussions reported to have personally suffered from skin diseases, gastric ulcers or other gastric problems at the time that the research was taking place.

When the respondents were then asked to list what are, in their opinion, the five most common diseases, putting the most common disease first and the least common fifth.

Diarrhoea and dysentery[2] were mentioned in 14 of the 15 FGDs. Skin diseases were also considered common, being cited in the list of five most common diseases in 13 villages (Figure 1). The IDIs confirmed that diarrhoea, dysentery and skin disease were, in their opinion, the most common health problems in the area.

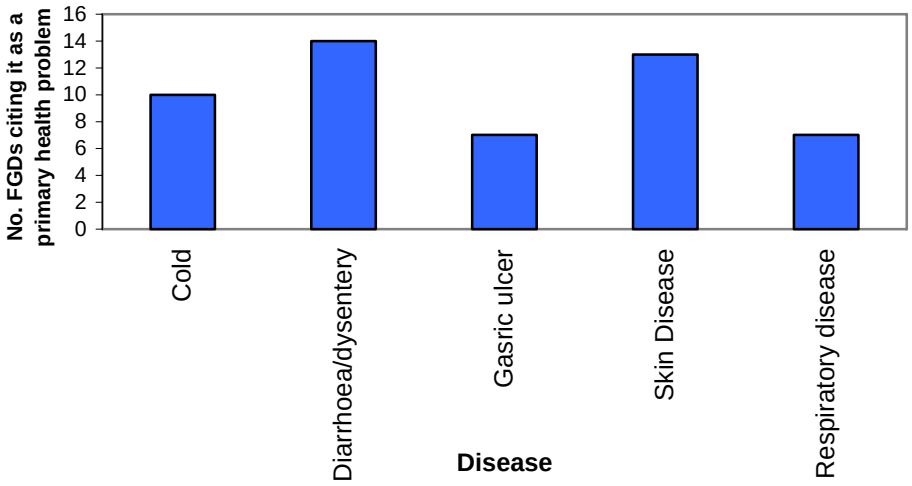

Figure 1: Health problems cited most frequently by the 15 Focus Groups

Figure 2 shows the distribution ranks of the most commonly cited health problems. Colds and skin diseases were the health problems ranked as most frequently occurring in the area by over a quarter of the village FGDs. Diarrhoea and dysentery are considered the most frequent illness by one fifth of the FGDs and is considered the second most frequent by nearly half of the FGDs.

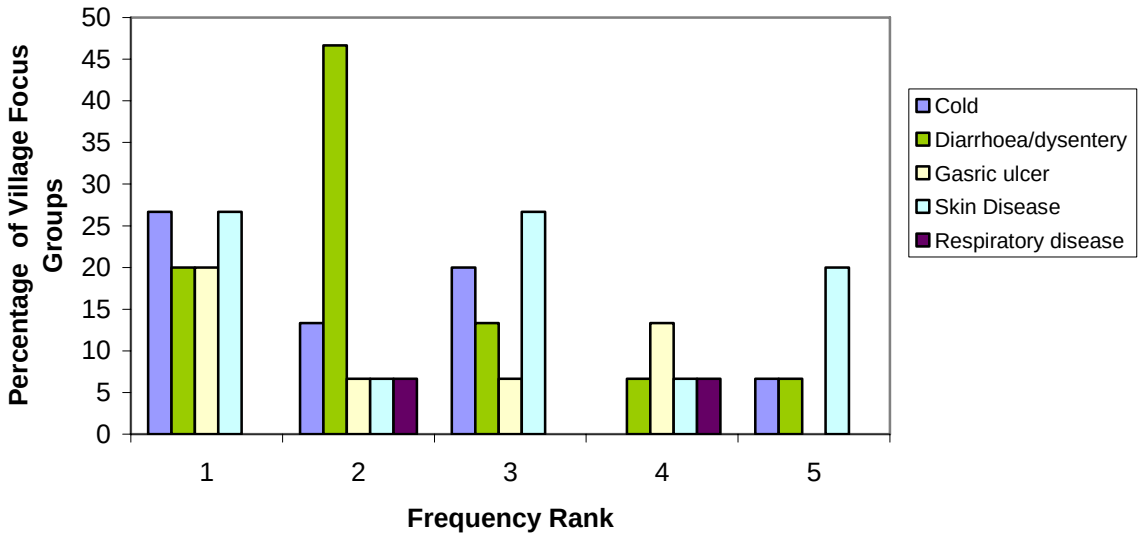

Figure 2: Percentage of Villages Ranking health problems by perceived frequency

[2] These two health problems were often not differentiated by the respondents and therefore are kept as one category in the analysis.

The disease pattern recorded in the UHC reflects the prevalence and trend of the diseases identified during interviews. Diarrhoea, acute respiratory infection (ARI), skin diseases and ulcers were amongst the health problems experienced by the most number of people who attend the health complex (Table 3). However, the total number of patients in the UHC does not reflect the magnitude of the problem, because the vast majority of the patients in the study area were found to be using local private doctors, traditional doctors or pharmacists as the first point of contact and would tend to attend the UHC for serious medical matters or if they were referred there. The UHC covers a much larger area that the Mokesh Beel system and therefore will also show broader health patterns that do not necessary reflect those specifically occurring in Kaliakoir. Nonetheless it provides a useful insight into the changing pattern of health issues in the area.

Table 3: Number of patients presenting symptoms of six major diseases in Kaliakoir UHC (1998 to 2002)

Year	Common Diseases						
	Diarrhoea	Peptic Ulcer	Acute respiratory illness	Skin Diseases	Malnutrition	Anaemia	Total
1998	7659	4670	5375	3840	10879	4072	36495
1999	7227	5480	6280	4280	9580	3890	36737
2000	6798	5990	7540	5060	8690	8180	42258
2001	6219	6578	8367	6611	7052	4743	39570
2002	5773	10821	11492	8723	5080	6666	48555

Source: UMIS, 2001, Draft Kaliakoir UHC Report, 2002/03

Figure **3** shows that malnutrition and diarrhoea appears to have declined relative to other diseases recorded at the UHC, whilst acute respiratory illness (ARI), peptic ulcers and skin diseases have increased.

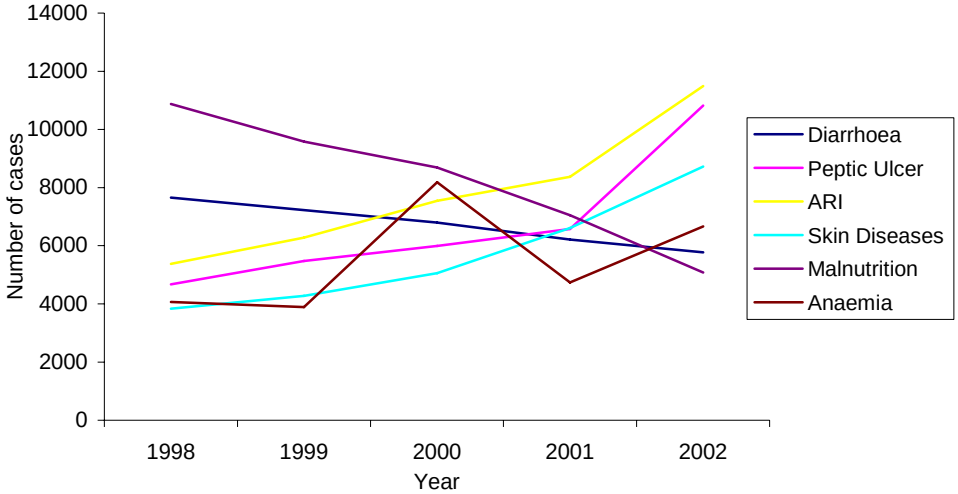

Figure 3: Prevalence of main health problems based on symptoms presented at the UHC (Source: UMIS, 2001, Draft Kaliakoir UHC Report, 2002/03)

The situation is of course also dependent on population growth, migration, and levels of awareness, which makes it impossible to conclude there has been an actual increase in the frequency of these diseases amongst the population. National statistics do show a substantial increase in the population but unfortunately these statistics are not available for the same time periods – the UHC data being for the period 1998 to 2002 and the national census for 1991 and 2001 (Figure 4).

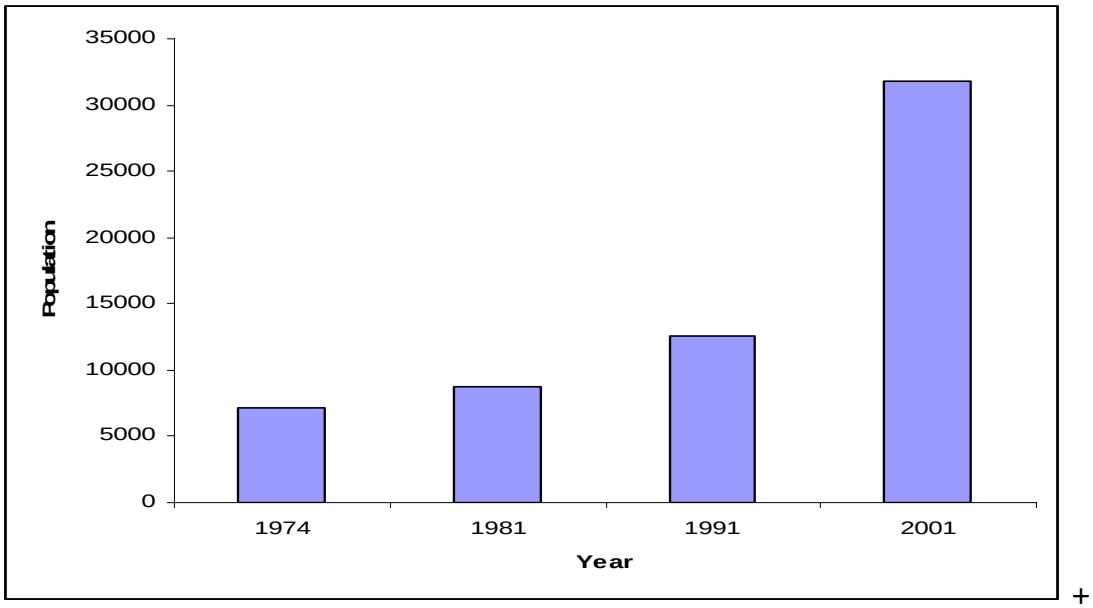

Figure 4: Trend of population in Kaliakoir between 1974-2001 based on 14 villages (Source: Bangladesh Bureau of Statistics)

That said, a linear annual population increase between 1991 and 2001 gives an annual increase of six percent. This translates into a population increase between 1998 and 2001 of approximately 19 percent. Over the same period there has been an overall decline in the number of reported cases of diarrhoea (down 19 percent) and of malnutrition (down by 35 percent) but an increase in the reported cases of anaemia (up 14 percent), peptic ulcers (up 29 percent), and skin diseases, which was up by 42 percent. This implies that the rate of increase in cases of peptic ulcer and anaemia may have increased above the rate of population increase but that other health problems have declined in relative terms.

Community-based discussions provide anecdotal evidence that the prevalence of diseases is increasing in general. For example, during both group and individual interviews respondents mentioned that “illness” had been a common phenomenon in their community for the past couple of years. Local villagers expressed concern at the increased frequency of “attacks of sickness” from one or more of the diseases. They referred to increasing morbidity over the last 10 years.

4.2 Health Workers View of Health Profile

The interviews conducted with health workers in the area provided similar results in terms of the five most prevalent health problems in the area to those given in community FGDs. The health workers identified a total of 20 health problems that were prevalent in the area at the time of the interview. Of these the five most frequently cited were diarrhoea, skin diseases, gastric ulcers, cough and cold, and fever, with the first two being mentioned in nine of the 10 interviews. The next most common health problem was dysentery[3], which was mentioned four times; all others were only mentioned once or twice (Table 4).

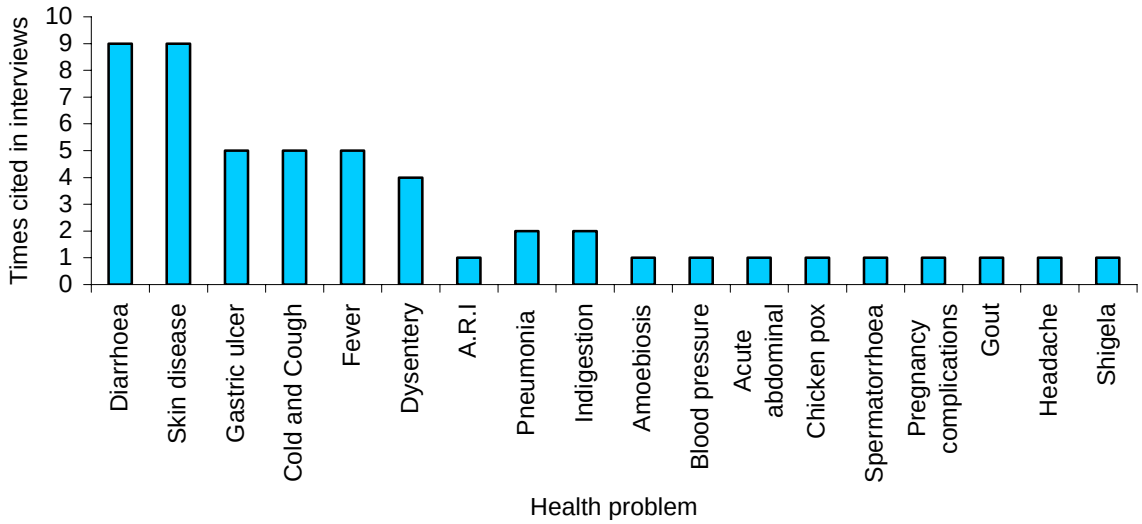

Figure 5: Number of times each health problem was cited among the five most common problems

The health workers then scored these, distributing a possible total score of 50 across the five health problems. The mean of these scores shows that skin disease, diarrhoea and gastric ulcer are not only cited the most number of times but also gains the highest mean score (Table 4), it can be seen that, therefore being perceived as both frequent within villages and common across the area.

4.2.1 Association with Industrial Pollution

Qualitative information suggests that there may be a link between the pollution and health problems. The majority of the respondents reported that children and factory workers suffer the most from skin diseases, and some respondents noted that fishermen and those who have frequent contact with *beel and khal* water also tended to suffer more from these problems. The symptoms of the skin diseases include a rash, boils and irritation. There are two main reasons given by the communities as to the source of the problem. The fist is that it is spread by contact especially among

[3] Unlike the village interviews the health workers were able to clearly distinguish between diarrhoea and dysentery and therefore these problems have been kept separate. Simple addition will however provide easy comparison with village FGD results.

children who are living in unhealthy environments. The second and more frequently reported cause is contact with the chemicals used in the factories. This cause was also cited by a community that is far from the factories (Barai bari) but it may be that the people here come into contact with the *beel* and river water whilst using it for agricultural purposes or when they come fishing.

> *"Skin disease has increased in this area. Farmers, children and fishermen are mainly affected as they work in the water. The pollutants from industries are responsible for it. Pollutants from industries enter in the Turag River through the khal and beel and end up here. Local Health Complex and Department of Environment should take the initiative to stop the pollution" (Barai bari health worker).*

Table 4: Average score given by health workers for prevalence of health problems

Disease	Sum of score	Mean score ± SD[a]	Rank
Skin disease	78	7.80± 3.52	1
Diarrhoea	76	7.60 ± 4.62	2
Gastric ulcer	75	7.50 ± 8.09	3
Fever	50	4.10± 5.67	4
Cold, cough	44	4.40± 5.82	5
Dysentery	40	4.00 ± 5.72	6
Cold cough and fever[b]	8	0.80 ± 2.53	7
A.R.I	16	1.60± 5.06	8
Pneumonia	15	1.50± 3.17	9
Indigestion	14	1.40± 2.95	10
Amoebiosis	12	1.20 ± 3.7	11
Chicken pox	10	1.00 ± 3.16	12
Hypertension	10	1.00± 3.16	12
Acute abdomen	10	1.00± 3.16	12
Spermatorrhoea	8	0.80± 2.53	13
Gout	8	0.80± 2.53	13
Pregnancy	8	0.80± 2.53	13
Dysentery and diarrhoea	6	0.60± 1.90	14
Head ache	5	0.50± 1.58	15
Shigela	5	0.50± 1.58	15

Notes:

n = 10 (total number of interviewee),

SD- standard deviation

[a]Mean score and standard deviation was calculated using Minitab 12

[b]In this interview cold, cough and fever was treated as a single health problem as even after questioning the health worker was unable to separate them and considered them to be a problem that always occurred together.

The majority of the respondents also blamed the lack of proper sanitation systems, poultry farm waste and lack of knowledge about hygiene for diarrhoea and dysentery, which are frequent among children, slum dwellers and factory workers. Gastric ulcers have been identified as a common health problem for workers in the area, including factory workers. The doctors and health workers interviewed felt that this was due to irregular eating habits and the length of time between meals.

The trend of health problems over the past 10 years was also researched in the interviews and it appears that the five health problems cited as being the most prevalent now have increased in their relative prevalence over that period (Figure 6). Some of the health workers felt that in absolute terms there were fewer cases of health problems such as dysentery and diarrhoea simply because there were fewer people living in the area, as many people have migrated in to work in the factories. However, in relative terms they felt that diseases have increased.

> *"I did not see many patients with skin diseases in the past, and dysentery and diarrhoea have increased a lot in the area… The lack of cleanliness and also eating fish from polluted water is the main cause of this disease…Polluted water from industry is responsible"* (Sinaboho interview).

The disparity between this anecdotal evidence relating to diarrhoea and dysentery and the data collected from the UHC may be that the UHC covers an area much larger than the Mokesh Beel area and includes villages that come into contact with less polluted water resources. It may also relate to the fact that only the most serious cases are referred to the UHC by these health workers and that large numbers of people suffering from less acute symptoms do not visit there.

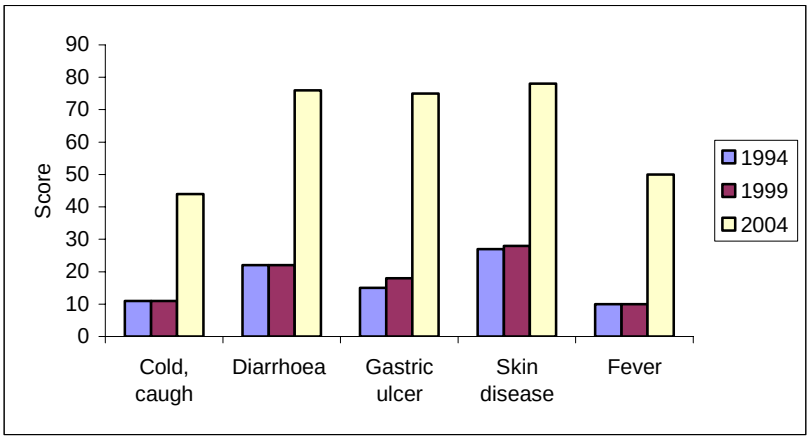

Figure 6: Trend of health problems in the area between 1994 and 2004 according to local health workers

Only one interview was held with a health worker from a site outside the project area, where the community does not use Mokesh Beel. However, skin diseases, diarrhoea and fever were also reported to be the predominant diseases at this site.

4.3 Key Focus Group Discussion Issues

The study also investigated longer-term implications of toxic chemicals and organic wastes in the area. Although no causal links can be made with pollution, cases were reported of health problems in two areas, Sinaboho and Sholahati, which could be the result of industrial pollution.

4.3.1 Malnutrition

The majority of participants in the FGDs claimed that the diseases that occur most commonly in the area are either because of direct ingestion of contaminated water or because of reduced food intake, which some attribute to the pollution. Respondents said rice and fish production has decreased markedly in the area and from the beel and this is, in their opinion, due to water pollution. This they believe is causing a serious depletion of food and nutrition for the community.

> "*We were well-off because we used to supply fish to whole region of Dhaka and Gazipur but now there is less fish in the Mokesh-Kalidoho beels. Moreover, if people know that these fish are from Mokesh Beel, they do not buy because the taste is not good. We are now suffering - both physically (due to illnesses and lack of fish) and financially"*. (Fisherman in Gupinpur)

The respondents generally agreed that the fish from Mokesh Beel do not taste good and smell of a "Kerosene-like" substance. Participants said that this problem started about 10 to 15 years ago after the establishment of the industries.

Effects of malnutrition such as anaemia, protein deficiency syndrome and general weakness were found to be common amongst adults and children in the study area. Malnutrition can also aggravate the risks of other diseases caused by water pollution and may increase vulnerability to the effects of exposure.

4.3.2 Skin Problems

Skin diseases, allergic conditions, itching and other skin lesions are contact-type diseases. The generally alkaline nature of the *khal* and *beel*, and the presence of the alkalis soda ash and caustic soda, which are used extensively in the textile dyeing industry, are likely to be the main source of the skin irritations reported by local communities. These symptoms reported in the FGDs, only manifest themselves when their skin had come into physical contact with *beel* water or sediment. The research team having come into direct contact with the polluted water bodies can attest to its ability to cause the skin to itch.

The research team observed that skin problems were very widespread in the study area. Almost all FGD participants claim to have experienced skin problems because of their frequent contact with *beel* and *khal* water, and some participants were currently suffering from skin problems. They willingly showed the team the skin lesions in their body parts, particularly in hands and legs. While talking to the local

doctors and village practitioners, it was found that the drugs for skin problems, both traditional and allopathic, were the highest selling drugs in the locality.

4.3.3 Maternal and Child Health

Specific questions asked about maternal health care suggested that there has been an increase in complications during childbirth. Respondents in all FGDs except one (where no children had been born in the past six months) stated that the number of pregnancy and childbirth complications had increased including: abdominal pain during pregnancy; labour pain but "delayed delivery" or births requiring caesarean, and sometimes still births. Swelling of the hands, feet and legs during pregnancy (oedema); abnormal bleeding, anaemia and malnutrition were also more common. There is medical evidence that suggest the view is at least plausible. For example, oedema, a condition when too much fluid, usually water, has accumulated in the body is linked with poor kidney function and lack of protein. Protein reduces the osmotic pressure of the blood and if blood protein levels drop significantly, there will be little or nothing to draw the water back into the blood from the tissue spaces through the capillary walls. The result is an accumulation of fluid in the tissue, called oedema. Generalised oedema may result from inadequate intake of protein; kidney disease, such as nephrotic syndrome where protein loss in the urine is considerable; acute glomerulonephritis, which also causes protein loss; and liver disease, such as cirrhosis, in which the production of protein is reduced. One impact of the pollution reported in the area is that the fish yields have declined. Fish, on average, accounts for 63 percent of the animal protein and eight percent of the total protein intake in people diet in Bangladesh.

Health problems during pregnancy are common in Bangladesh and it is therefore difficult to determine whether or not there are statistically higher problems in the project area. National health statistics (2000) suggest that during pregnancy 25 percent of women suffer from abdominal pain which is followed by swelling of the legs or body. Of these over 23 percent reported swelling of the leg (oedema) and 20 percent anaemia. Other ailments included convulsions (two percent), haemorrhaging during pregnancy (four percent) and bleeding prior to delivery (three percent). Bleeding after delivery was reported by 22 percent, prolonged labour by 19 percent and injuries during delivery by 6 percent.

Consequently there has been an increase in the number of mothers giving birth in hospital due to the rise in the problems being faced by them. People in 11 of the 15 FGDs stated that the majority of births now took place at medical centres, with many respondents saying that approximately 80 percent of births take place there, whereas in the past they would have been delivered at home. The community members with whom discussions were held in the villages of Amdair, Harinhati and Sinabaha, specifically said that the reason for going to hospital was the rise in the number of caesareans that were required. However, discussions at the UHC revealed that caesareans have only taken place there since 2001.

There are cases of physically deformed children in the study area but with out comparison with statistics across Bangladesh it is difficult to determine whether these were above average. The participants of the female FGDs in Sinaboho said that there were three cases of deformed children in their village. In Taltoli village the FGD participants reported that there were at least three disabled babies (two were unable to stand, walk or speak) born in their village but they later died at the age of one, three and five years. In Amdair the participants mentioned that a child had been born one month before the interviews with only one leg and hand. There were several such cases report across the village but it is difficult to determine the cause or true extent of the problem.

Infants in the area were reported by the FGD participants to be suffering from a number of health problems on a regular basis. These problems were similar across the area with all 15 FGDs. Diarrhoea is one of the most prevalent health problems suffered by children, being ranked first in six of the FGDs. Respiratory disorder was highlighted as a major problem in 11 FGDs and participants in Bagambar village also mentioned the problem of asthma. The same number of villages felt that skin diseases were a major problem amongst children, with participants complaining of *khosh pachra*, blisters on the bodies of their children, and lesions on their hands and feet.

4.3.4 Domestic Water-based Activities

Currently more than 95 percent of the villagers were found to be using tube well water for drinking and day-to-day household activities, and respondents said that there were no problems collecting water from a tubewell if they did not have their own. Only in Gupinpur was it found that the number of tube wells was less than adequate and people were using *beel* and river water for household activities including washing cloths and utensils.

Culturally open water bodies have been the most common source of water for bathing. People generally bathe at least once a day. However, in the project area the local community complain that the local *beel* water is no longer of a quality in which people can bathe.

> *"I used to bathe and drink water from the ponds and beels when I was a young boy, but now I can not even think of doing that in these ponds and beels"*. Local School Headmaster

It is not only the bathing of people that has been impacted by the pollution. Many villagers have their own ponds, which along with the beel were used for cattle washing and for fish cultivation. However the majority of the FGD's reported that cattle suffer from "sore mouth" when they drink the *beel* water and therefore many people are reluctant to use it to wash livestock.

> *"In the past, ponds and beels were the main sources of water for this community and we used to use the water for all purposes, but now we can*

not do that. The quality of water has deteriorated so much that it has become absolutely black, oily, and it irritates when it comes in touch with our skin. Nobody would want to use that water. Now we have to depend on the tube wells – these tube wells cost us to install, more so, extra hassle to collect and store water". (Respondent, Harinhati village)

4.3.5 Diarrhoea and Dysentery

Although there has been a clear shift of water intake behaviour in the study area from *beel* water to tube-well water, the villagers have still been found to be suffering from the potential "intake-type" effects of water pollution. The incidence of problems including diarrhoea, gastric ulcers, respiratory illnesses, hepatitis, and anaemia, are common amongst the study population although no comparison was made to a larger population size as national health datasets are limited. World wide epidemiological studies have conclusively shown that these diseases can potentially occur due to intake of water contaminated with toxic industrial chemicals, as well as human excreta and organic wastes.

The villages around Mokesh Beel are exposed to water pollution through both direct ingestion of toxicants through the intake of polluted water and via the food chain, including rice, vegetables and fish. In the dry season the wetland area of *Mokesh – Kalidoho* ecosystem is reduced from 4,500 ha to only 37 ha and the land is then used for agricultural production. Land is also irrigated with water from the *beel* and in this way agricultural production is being impacted by the industrial pollution and may be accumulating pollutants. Several respondents involved in agriculture stated that the polluted sediment is responsible for their poor crop yields.

4.3.6 *Economic Migrants and Lack of Infrastructure*

The population around *Mokesh Beel* ecosystem is about 300,000 with an average family size of 5.3. The inhabitants are mostly farmers or fishermen but there are an increasing number of economic migrants living in the villages. An important trend appears to be people embarking on new income generating activities. For example, some people are shifting away from agricultural production and instead are establishing, and renting out, *semi-pucca* "barrack-type" accommodation to factory workers on land that was previously cultivated (CAN WE GET A PICTURE?) . However, the accommodation is generally of poor quality and facilities such as sanitation, inadequate. As a result, the local environment is being polluted due to the waste and excreta created by the additional people in the village. It was observed by the field teams that certain areas around villages in the area do appear to be acting as areas for open defecation with unusually large amounts of excreta visible.

"We had only 13 families with average 6 or 7 members per family in our village about 10 years ago, now we have more than 500 inhabitants, most of them are industry-related workers and traders who have come from outside. They are living in overcrowded, congested, rented accommodation with limited facilities. In some

cases, around 50 people share only one tube-well and two or three latrines". (Elderly resident, Harinhati village)

Several respondents also referred to the problem of increasing promiscuity and increase in sexually transmitted infections.

4.4 Health Services Delivery and Awareness Raising Activities

Villagers usually consult a village doctor first for any minor illnesses. If they are not cured, they then go to registered private practitioners, often ……..(MBBS) doctors, in the local village pharmacy or in the private clinics. Those who can afford the cost of treatment in the private sector, usually go to the private clinics straightaway. Some villagers, often poorer patients, choose public facilities, such as the Kaliakoir UHC, for their more serious health care needs but the time and costs of travel discourage people from using the UHC immediately. Moreover, there is a general belief that the health care in private clinics is of better quality than in the Kaliakoir UHC.

In the study area, the villagers' receive limited health awareness messages from Bangladesh Rural Advancement Committee (BRAC), Proshika, Pollimangal and Grameen Bank who occasionally run campaigns and sanitation programmes. The respondents also mentioned that they do not see any activities from government health and family planning workers at the village level.

4.5 Community Responses to the Aquatic Pollution

It was revealed in both the FGDs and IDIs that there had been several attempts at joint discussions between community leaders and the factory owners about how to minimise pollution. At these meetings apparently actions were agreed with the factory owners but no action was taken. The MACH project has taken various initiatives with both villagers and the factory owners to control pollution, and to mitigate the pollution related problems in the community. The respondents believed that only joint and collaborative efforts between the local community and the industry owners could bring a sustainable solution of this pollution problem.

5 Conclusions and Recommendations

The research undertaken with the community and health workers in Kaliakoir provides qualitative and quantitative evidence that local communities are suffering from a variety of health problems that could be a direct or indirect result of the activities of local factories. These problems include skin diseases, diarrhoea, dysentery, respiratory illnesses, anaemia and complications in childbirth.

Members of the community and health workers are of the view that the incidents of various health problems are relatively high in the area and are increasing. In some cases this is corroborated by statistical information.

Many community members believe that these problems are a result of an increase in number of industrial units in the area. It is their opinion that effluent entering the surface water bodies in the area, including the *khal* and *beel,* is reducing the quality of water and as a result they are unable to use it for the purposes for which it was used in the past, such as bathing and washing cattle. When they do they (and their livestock) suffer direct health impacts such as skin rashes and sores.

Not only do community members feel that industrial pollution is affecting their health directly but also that it is impacting on the productivity of the *beel* and land, which is in turn affecting their health. They now catch fewer, smaller fish, which they say taste bad. Furthermore, many fish traders will no longer purchase their fish. They are also of the view that their crop yields and taste are negatively impacted by the irrigation water from the *beel* and the polluted sediment that is deposited on their land during the monsoon season.

Whilst no direct linkages have been proven between industrial pollution and ill health their is evidence to suggest that they may be related. Skin problems may for example be related to the high pH of the water, which has been found to be as high as pH 10.9 in some places in the *khal* (Chadwick and Clemett, 2003). Such alkaline conditions could certainly irritate the skin and result in sores. The high pH levels are likely to be the result of the large quantities of caustic soda and soda ash used in the dyeing process to achieve a pH of between pH 10.5 and pH 11.5.

It is more difficult to attribute the stomach problems to industrial pollution as people in the area do not drink surface water. However gastric ulcers and other similar gastric problems may be related to diet and the impacts of the pollution on crops and fish consumed by people living around Mokesh Beel. It is also possible that groundwater is being polluted by infiltration of industrial effluent but similarly there has been no empirical research into this. The problems of diarrhoea and dysentery are unlikely to be caused directly by the industrial effluent, as they are usually the result of microbial contamination. However, the high level of in-migration to the area is putting considerable pressure on poor sanitation infrastructure and may be increasing the risk of contracting communicable diseases.

None of these findings have been confirmed with rigorous epidemiological studies. Further research studies, including epidemiological studies, are necessary to determine better the impact that industry is having on the environment and the people who interact with it.

In order to improve the situation interventions both at the national and local levels are required. The implementation of legislation on safety precautions, banning toxic chemicals and pollutant concentrations in industrial discharges into water sources

are all required. Currently, most dyeing industrial units in the Kaliakoir area and across Bangladesh are in breach of the Environmental Conservation Act. However, the Department of Environmental due to financial, human and political reasons does not act.

Epidemiological evidence of the effects of water pollution is required to substantiate anecdotal evidence and to convince and influence the policy makers and industry owners to control and mitigation of environmental pollution.

An Information, Education and Communication (IEC) campaign would be beneficial in providing an understanding in the community about risks and possible ways to minimise them.

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Annex A: Population Census Data 1974 - 2001

	Total population			
Year	**1974 (published)**	**1981 (published)**	**1991 (published)**	**2001 (unpublished)**
Village : Harin Hati Union : Mouchak Thana : Kaliakair District : Gazipur	Not available	203	330	3947
Village : Ratanpur Union : Mouchak Thana : Kaliakair District : Gazipur	Not available	Not available	Not available	Not available
Village : Purba Chandra Union : Mouchak Thana : Kaliakair District : Gazipur	Not available	538	1524	7454
Village : Shafipur Union : Mouchak Thana : Kaliakair District : Gazipur	615	2362	2788	10883
Village : Mazukhan Union : Mouchak Thana : Kaliakair District : Gazipur	1139	587	1412	1399
Village : Karalsurichala Union : Mouchak Thana : Kaliakair District : Gazipur	501	678	967	1495
Village : Amdair Union : Madhyapara Thana : Kaliakair District : Gazipur	Not available	961	1179	1196
Village : Sholahati Union : Mouchak Thana : Kaliakair District : Gazipur	Not available	Not available	Not available	520
Village : Matikata Union : 4 No. Muchak Thana : Kaliakair District : Gazipur	104	121	235	1279
Village : Bagambor Union : 4 No. Muchak Thana : Kaliakair District : Gazipur	305	399	525	665
Village : Kaliadaho Union:Mouchak Thana:Kaliakair District: Gazipur	341	401	471	460
Village: Gobindapur/Gopinpur Union:Madhyapara Thana:Kaliakair	Not available	871	1147	919

District: Gazipur				
Village: Taltali Union: Mouchak Thana:Kaliakair District: Gazipur	416	528	684	760
Village: Kouchakuri Union: Mouchak Thana:Kaliakair District: Gazipur	2958 clarify	210	350	431
Village: Sinaba/Sinaboho Union: Mouchak Thana:Kaliakair District: Gazipur	816	928	964	1548
TOTAL	7195	8787	12576	32956