Extended Abstract

Pond Water Contamination And Incidence of Disease in Rural Bangladesh

Introduction: Bangladesh is located in the northeastern part of Asia between India and Burma (BBS, 1997). Nearly half of the Bangladeshi villagers use surface water available from sources like ponds to wash their kitchen utensils. The same water is also commonly used for cooking, bathing, fish culture, irrigation and other daily uses. Although 99 percent (97 percent in study area) people have access to tube wells for safe drinking water, recent studies found that a significant percent of tube well water has arsenic beyond the WHO recommended level of 0.01mg/L and the Bangladesh standard of 0.05mg/L (Asaduzzaman et al., 2000). Arsenic in ground water is pushing people to return in using surface water for their daily use including drinking.

About 40 percent of people live under the poverty line (World Bank Atlas, 2001). Due to high poverty, most of the people are malnourished. They do not have access to better health and hygiene including sanitary latrines. It can be assumed that although the level of education of people, particularly among women, has increased, poverty is the reason they cannot maintain their minimum nutrition, health and sanitation for themselves and their children. Considering the environmental and health scenario of Bangladesh, it can be strongly argued that it will be very beneficial for the country to know how environmental degradation and environmental or ecological factors like water quality are associated with human disease patterns.

Several findings of my study of the causes of disease in rural Bangladesh challenge accepted theories, perhaps because the theories are based on European and North American experience rather than third-world experience. Since these theories often have a powerful effect on policy, it is important to check them against measurable realities in the third world. It is not surprising that pond water contamination contributes to incidence of diarrheal disease in rural Bangladesh. But there is less disease with open latrines than with sanitary ones; as population density increases, incidence of disease decreases. There is almost no association between education and incidence of diarrheal disease. However, there is a strong village effect on the incidence of diarrheal disease in the country. To understand the details requires detailed ethnographic work to analyze the village effect and identify the characteristics that differentiate one village from another. For example, is it topography? religion? healthcare service structure (some villages have village based health center/worker other do not) making one village different from another is yet to explore from future detailed ethnographic and related research.

The study: This study is to a) examine the effects of contaminated pond water on incidence of diarrheal disease, and b) explore how Socio Eeconomic Status (SES) is associated with the disease incidence. The '1998 Population, Environment, and Poverty' study of eight villages in rural Bangladesh is used for this research. Survey data, focus group interviews and water samples of tube-well and pond water are used to explore the research questions.

Data for the study were collected from eight villages in Bangladesh, in a 1998 household survey supplemented with laboratory samples of pond water, focus group discussions (FGD), and ethnographic surveys. For the survey, initially, four rural thanas (sub-district = US county) were purposively selected based on high population density and different agro-ecological zones (AEZ) of Bangladesh. After that, from each thana, two villages were selected randomly. A total of eight villages (two from each sub-district) were selected randomly for the study. From each village 65 households were randomly selected and a total of 520 households/household heads were selected for interview. Of the interviewees, 95 percent are male. In addition, forty surface water samples (five from each village) were collected; eight FGDs and eight ethnographic surveys (one in each study village) were conducted as part of data collection. The lab samples of pond water helped to determine how level of faecal coliform (fc) contribute to incidence of diarrheal disease, data from FGDs and ethnographic surveys also helped to understand the health behavior and culture of the villagers, for example from the FGD it came out the slab latrine are not really sanitary since they are not water sealed. The data were collected in six months from July to December of 1998. Chi-

square analysis of variables is used to see the association between dependent and independent variables.

Pathway of Pond water contamination: According to a study by Asaduzzaman et al. (2000), the pond water in Bangladesh is not safe for drinking, washing, cooking, bathing, fish culture or irrigation as it is highly contaminated (total coliform count $6.0X10^2$ to $1.6X10^6$ cfu/100ml and faecal coliform counts $8.4X10^2$ to $7.3X10^5$ cfu/100), the standard cfu/L should be 0 in drinking water. Several studies suggest that water bodies are the sources of health hazards associated with high-risk life threatening waterborne diseases like diarrhea, typhoid, hepatitis-A, and dysenteries. Several epidemiological studies by International Center for Diarrhoeal Disease Research, Bangladesh (ICDDR, B) shows that the geographical setting and physiography of the country make it vulnerable to water borne diseases.

If people have toilets, they set them up close to their ponds, but in most cases they defecate in open spaces, which are along watercourses, in fields and groves and by the sides of paths and roads. This leads to the pollution of the surface water resources, and eventually even the shallow aquifers. That pollution leads to high incidence of disease like diarrhea.

In the mid-eighties, when the environmental movement in Bangladesh began in earnest, United Nations Children's Fund (UNICEF) personnel in the country said that the biggest threat to a healthy environment was sanitation. In Bangladesh slab latrines, hanging latrines and open latrines are the most commonly used latrine types. Through the assistance of United Nations Development Program (UNDP) and the guidance of UNIVEF an NGO-GOB campaign for acceptable means of sanitation has increased access to sanitary means for excreta disposal by the rural population from 16 percent of the population in 1990 to 37 percent in 1997 (UNICEF, 1998). As of now only half (48%) of the population has access to sanitation (PRB 1997, BBS 1997), however in the study, slab latrines have been reported as sanitary latrines although examination shows that they do not function as sanitary latrines as most of the slab latrines are not water sealed.

Slab latrines should be water sealed but in reality they are usually not sealed well due to lack of a water seal or leakage between the slab and the ground, and as they are usually located close to ponds, so the ponds are vulnerable to contamination. Some people are discouraged from using slab latrines due to bad smell.

The hanging latrine is set on a lower place like on a ditch, sometimes right on top of a ditch. Ditches are connected with ponds. The hanging latrine is a piece of bamboo hung on another bamboo or tree located in the lower/ditch side. The other end of the bamboo is put on the ground. People hold another piece of bamboo or rope while they use this type of latrine.

The open latrine is just using an open place usually close a pond or water body. People usually prefer a tree shaded darker area as an open latrine, so that they can seclude themselves from others while they use the latrine. The children usually use the house yard (back or front) as an open latrine. This type of latrine contaminates pond water as rain washes the fecal matter into the pond. However dogs may scavenge much of the faecal matter before it contaminates the water.

People usually use water to clean themselves after using the latrine. When they go to a latrine (slab or hanging) they carry a small water pot (*badna*). They usually hold the water pot in the left hand while they defecate but hold in the right hand while they wash with the left hand, as dictated by Islamic practice. Moreover, people do not use soap after use of the latrine or before taking food. Although people use mud or ash for cleaning their hands, these cannot disinfect. So, human feces have an easy path from the latrine to the food plate. Epidemiologists argue this path is critical for diarrheal disease.

Study results: The laboratory test results of 40 pond water samples show that all of them are contaminated with faecal coliform (fc); the level of contamination is beyond the permissible limit (standard for fc in drinking water is "0"). The contamination varies by villages and it ranges from 3 cfu/ml to 360 cfu/ml. Data shows the number of people affected by diarrheal disease is associated with highest level of fc, i.e. the incidence of diarrheal disease is higher in areas where the contamination is comparatively high (82-360 cfu/ml) than areas where the level is low (3-52 cfu/ml).

Data show that 52 percent people are exposed to diarrhea that belongs to households with high fc in their ponds and 39 percent are exposed who belongs to households with low fc in their pond water. Table 1 shows that 52 percent of the people who are exposed to diarrhea are from households with higher fc in their ponds while 39 percent of those exposed are from households with lower fc in their ponds. More than 60 percent of the people who are not exposed to diarrhea and belong to households with low fc. The bivariate results (Chi-square 12.938; df 2; p .002) indicate that there is significant association between diarheal disease and level of faecal coliform (see table 1).

Effect of socioeconomic status on diarrheal disease: Table also shows that the level of education and occupation really do not affect the incidence of diarrheal disease. About half (48%) of the population with primary or less than primary education suffer from diarrheal disease while the rest did not; similarly 46 percent people with more than primary education had diarrhea in last 12 months and the rest did not. The bivariate results (Chi-square .098; df 1; p > .10) show there is no association between diarrheal disease and level of education (table 1).

About half of (49%) of the people occupied in agriculture had diarrheal disease in one year but the other half did not. Forty five percent people in non-agriculture occupations had diarrhea during the same period but the rest (55%) were did not. So occupation as an independent variable does not affect the occurrence of the disease. The bivariate results (Chi-square value = .496; df = 1; P = .481) also indicate that there is no association between diarrheal disease and occupation (see table 1).

Among socioeconomic status (SES), the annual household income shows some relationship with diarrheal disease. People with higher income (more than $360 per year) have 11 percent less diarrheal disease (39%) than that of people with income below US $360. I use the $360 figure because it is the average per capita income per year. More than 6 out of 10 households with higher income are not exposed to diarrheal disease, 50 percent of households with low income also are not exposed to diarrheal disease. The cross-tabulation results show that average household income affect diarrheal disease incidence. The bivariate results (Chi-square value = 3.779; df = 1; P = .052) indicate that there is an association between average annual household income and diarrheal disease, and the association is significant at 10 percent level (see table 1).

Established theory suggests that health status will be better in low population density areas than high population density areas. This study results show the reverse - as there is more (55%) incidence of disease in the low-density areas and less (29%) disease in the higher density areas. More than 7 out of 10 people who live in high density (7597-9556/Sq mile)) areas are not being exposed to. This unexpected outcome is also supported by the bivariate results (Chi-square value = 23 .967; df = 2; P = .000), which indicate a significant association between diarrheal disease and population density (see table). In Bangladesh, population density in the urban areas is more than that of rural areas because civic facilities like health services are better in urban areas.

The public health experts believe that use of sanitary latrine decreases incidence of disease like diarrhea. The higher the use of sanitary latrines, the better the health scenario. Data shows that more people use sanitary latrine (water sealed slab) in the study area but the cross-tabulation of disease by village shows that half (50%) of the population who use sanitary or slab latrine are exposed to diarrhea and less (46%) people using open latrine are exposed to diarrhea. Unexpectedly, about 60 percent of hanging latrine users is not exposed to diarrhea. It seems hanging and open latrines are better than sanitary or slab latrines.

The FGD and ethnographic data clarify the confusion and proved the established public health theory is right i.e. use of sanitary latrine reduces diarrhea. The qualitative data show that toilet reported as sanitary (in the survey data) are not really sanitary. The water-seal make the slab latrine a sanitary latrine. Because villagers face difficulty cleaning the narrow channel of the water seals using small pot of water, they break the water seal and the pan of the slab becomes open and is no longer sanitary.

Village culture more influential than education: Village effect refers to impact of certain characteristics such as geography, topography, belief system, culture, and religion of each village.

These characteristics are different in each village and affect the incidence of disease differently. However, I have not yet determined whether the village characteristics make a higher contribution than SES to the incidence of disease.

The bivarate results (shown in table) indicate that there is significant association between diarrheal disease and village (Chi-square 39.902; df 7; p .000). This strong village effect varies by village. The FGD and participant observation findings show the villagers believe that pond water is given by God and is therefore better to use for any purpose. However, they did not understand contamination or its negative effect on health. The religious beliefs might be one of the reasons for the strong association. Although what specific village-characteristics contribute to this effect need to explore in future research particularly through detailed ethnographic surveys.

Conclusion

The study shows that faecal coliform is contributing higher incidence of diarrhea in rural Bangladesh. Surprisingly other SES factors like education, occupation do not have significant impact to decrease the disease incidence, which challenges the theory on 'SES and disease incidence' i.e. higher the SES lower the incidence of disease. There is village effect on the incidence of disease but it remains to explore what specific factor or group of factors contributes to this effect. To understand the details requires detailed ethnographic work to analyze the village effect and identify the characteristics that differentiate one village from another. For example, is it topography? religion? healthcare service structure (some villages have village based health center/worker other do not) making one village different from another is yet to explore from future detailed ethnographic and related research.

Table 1: Percent of People Exposed to Diarrheal Disease by Independent Variables

Variable	N	Diarrhea (%)		Chi-square/df/P value
		Exposed	Not exposed	
Level of Faecal Coliform (cfu/ml)	**520**	**47 (246)**	**53 (274)**	**Chi=9.082;df=1; P=.003**
Low (3-52 cfu/ml)	187	39 (72)	61 (115)	
High (82-360 cfu/ml)	333	52 (174)	48 (159)	
Level of education	**520**	**47 (246)**	**53 (274)**	**Chi=.098; df=1; P=.755**
Primary or less	375	48 (179)	52 (196)	
More than primary	146	46 (67)	54 (78)	
Occupation	**520**	**47 (246)**	**53 (274)**	**Chi=.496; df=1; P=.481**
Agriculture	296	49 (144)	51 (152)	
Non-agriculture	224	45 (102)	55 (122)	
Household income (per year)	**520**	**47 (246)**	**53 (274)**	Chi=3.779 df=1; P=.052
Taka 22,000 (US $ 370)	410	50 (203)	50 (207)	
Taka 20001 and more (US $ 370+)	110	39 (43)	61 (67)	
Population density (pop/sq mile)	**520**	**47 (246)**	**53 (274)**	Chi=23.967 df=2; P=.000
Low (2660-2923 /sq mile)	194	55 (107)	48 (87)	
Medium (3536-4886 /sq mile)	195	52 (101)	48 (94)	
High (7597-9556 /sq mile)	131	29 (38)	71 (93)	
Types of latrine	**520**	**47 (246)**	**53 (274)**	**Chi=1.896 df=2; P=.388**
Slab/Sanitary	313	50 (155)	50 (158)	
Hanging latrine	114	42 (48)	58 (66)	
Open latrine	93	46 (43)	54 (50)	
Village	**520**	**47 (246)**	**53 (274)**	**Chi=39.902 df=7; P=.000**
Badhadia	65	46(30)	54 (35)	
Basantaput	65	65 (42)	35 (23)	
Chak Amuata	65	48 (31)	52 (34)	
Charpara	65	37 (24)	63 (41)	
Kamar khola	65	68 (44)	32 (21)	
Mirzapur	65	45 (29)	55 (36)	
Radhanagar	64	50 (32)	50 (32)	
Sharifpur	66	21 (14)	79 (52)	