AN INVESTIGATION ON APPROPRIATE SANITATION TECHNOLOGIES FOR ENVIRONMENTALLY CRITICAL AREAS OF BANGLADESH

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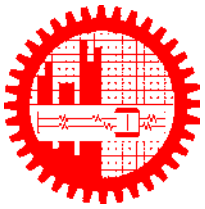

DEPARTMENT OF URBAN AND REGIONAL PLANNING
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DHAKA, BANGLADESH

AUGUST 2010

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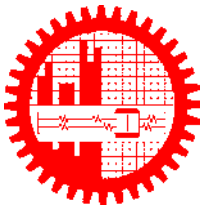
By

TAHMID ARIF

MASTER OF URBAN AND REGIONAL PLANNING



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The thesis titled, "AN INVESTIGATION ON APPROPRIATE SANITATION TECHNOLOGIES FOR ENVIRONMENTALLY CRITICAL AREAS OF BANGLADESH" submitted by Tahmid Arif, Student No: 100615009 (F), Session: October 2006, has been accepted as satisfactory in partial fulfillment of the requirements for the degree of MASTER OF URBAN AND REGIONAL PLANNING (MURP) on 07 August, 2010

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated to

My family

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ABSTRACT

Although Bangladesh government claims that sanitation coverage in the country in 2007 was about 87% in rural areas and 84-97% in urban areas, however, the effective sustainable sanitation coverage is far below than the reported coverage. According to Joint Monitoring Programme of WHO and UNICEF this rate is about 53% on average in both urban and rural areas of the country. Therefore, the sanitation coverage all over the country is not satisfactory at all. Several studies also show that this coverage is even poorer in the environmentally critical areas of Bangladesh. This study is a kind of investigation which focuses on low cost, appropriate, sustainable and environment-friendly area-specific sanitation technological options (hardware) for environmentally critical areas of Bangladesh. The Environmental Conservation Rules 1997 of Bangladesh identifies 12 environmental critical areas. The hill tracts of Chittagong, Hakaluki *haor* area at Kulaura and Sariakandi *char* area at Bogra were three of these areas. Besides, the hard soil area of Majira union at Bogra district was considered purposively for its unique soil formation. Therefore, the aim of the study was to investigate the appropriate sanitation technologies for environmentally critical areas of Bangladesh. Data were collected through questionnaire survey, FGDs, in-depth interviews and observation. Literature review, organization visits and interviews were done. The study found that there were no area-specific appropriate sanitation technologies (hardware) in practice; some options were present but in experimental level; only ring slab system was not appropriate for all the areas and water sealed technology would not be appropriate for all the critical areas.

ABBREVIATIONS

ADB	=	Asian Development Bank
BBS	=	Bangladesh Bureau of Statistics
BUET	=	Bangladesh University of Engineering and Technology
DANIDA	=	Danish International Development Agency
DECC	=	Disaster Environment and Climate Change programme
DGHS	=	Directorate General of Health Services
DPHE	=	Department of Public Health and Engineering
FGD	=	Focus group discussion
GED	=	General Economic Division
GO	=	Government Organization
GOB	=	Government of Bangladesh
HFL	=	High Flood Level
HIES	=	Household Income Expenditure Survey
IDB	=	Islamic Development Bank
ITN-BUET	=	International Training Network-BUET
JICA	=	Japan International Corporation and Agency
JMP	=	Joint Monitoring Programme of WHO and UNICEF
LGD	=	Local Government Division
MDG	=	Millennium Development Goal
MLGRD&C	=	Ministry of Local Government, Rural Development and Cooperatives
NGO	=	Non Government Organization
PRSP	=	Poverty Reduction Strategic Paper
PVC	=	Poly Vinyl Chloride
RCC	=	Reinforced Concrete Cement
RED	=	Research and Evaluation Division
SRDI	=	Soil Research and Development Institute
UNDP	=	United Nation Development Programme
UNEP	=	United Nations Environment Programme
URP	=	Urban and Regional Planning
VIP	=	Ventilated Improved Latrine
WASH	=	Water supply, sanitation and Hygiene programme
WHO	=	World Health Organization

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CHAPTER ONE: INTRODUCTION

1.1 Background of the study

One gram of human feces can contain 10 million viruses, 1 million bacteria, 1,000 parasite cysts and 100 parasite eggs (Water Aid 2007). Thus, it is easily understood that how much dangerous it will be if a gram of human excreta has contact with any human, animal or insects. Open defecation 'in the bush or in the fields' spreads disease. Any latrine, provided it is used, is an improvement on no latrine. But it will not be considered as that kind of improvement if the latrine is responsible for degrading environment. There must be some appropriately designed sanitary latrines to reduce open defecation, to prevent environmental degradation and water borne diseases. Introduction of heavy, high quality equipments for constructing sanitary latrines may or may not be cost effective for poor people. Appropriately designed sanitary latrines should be available within the buying limit of the poor.

In Bangladesh a large number of population is habituated in open defecation and using hanging latrine. Although Bangladesh government claims that sanitation coverage in the country in 2007 was about 87% in rural areas and 84-97% in urban areas; however, the effective sustainable sanitation coverage is far below than the reported coverage (LGD 2008). But national and international non-government organizations (NGO), working in this sector, differ with this data and according to them sanitation coverage is not more than 39% (BBS 2005; UNDP 2006; GED 2007 and RED 2008). However, the overall scenario did not consider practical scenario of the ground realities regarding disparities amongst the communities and physiographic conditions of the country. Absence of appropriate sanitation technological options may be one of the main reasons behind this under coverage.

Environmental issue is very much related to the sanitation technology in Bangladesh. Appropriate sanitation technology refers to the system of safe disposal of human excreta which is intended to prevent contamination of soil, ground and surface water and thus to improve the environment and quality of life (WHO 1987). But most of the existing sanitation technological practices in Bangladesh are degrading the

environment due to their improper design and maintenance. There are several types of defecation practices available in Bangladesh, viz. indiscriminate and/or open defecation, hanging latrine, simple pit latrine, ring-slab latrine (with or without water seal), service latrine, pour-flush latrine, miscellaneous pit latrines (propositions by NGOs), septic tank, small bore sewerage system, etc. Some of the negative impacts of these practices can degrade natural resources, surface water as well as aquifer, etc. if their environmental consequence is not addressed in the design of the technology.

Sanitation is at present considered as one of the vital issues behind ensuring healthy environment of living. It gets priority in the Millennium Development Goals (MDG) of United Nations and Bangladesh as a signatory is obligated to achieve sanitation for all by 2013 (UNICEF 2010). It has been earmarked also in Poverty Reduction Strategic Paper (PRSP) of Bangladesh as one of the central factors affecting health and economic development of poor people (GED 2005). There is a need for technological innovations to convert existing unhygienic latrine to hygienic one. Improving sanitation coverage is a complicated challenge, which involves action on several fronts. And this complex sector includes both hardware and software interventions. Significant improvements in the sanitation sector will have large positive impacts on poverty reduction by improving health status and productivity, and therefore, should have a central role in country's poverty reduction strategies.

Bangladesh is a country with a large geographical (physiographical) diversification. There are coastal areas, *haor*s, rivers, high water table areas, *chars*, hills, tough soil areas, and different other critical areas which define the landform of the country (Rashid 1991). The Environmental Conservation Rules 1997 has considered these *haor*, hilly area and *char* area (high water table area) as ecologically critical areas of Bangladesh due to their unique physiographic formation and characteristics (Farooque and Hasan 2004). Beside the government a good number of NGOs (both local and international), donor agencies and research organizations have interventions in sanitation. But unfortunately the sum of all government, non-government and private sector efforts to date has not been effective to address the physiographic diversification as well as ecologically critical areas delivering safe affordable sanitation technological options. Most of the GoB sanitation programmes are

hardware-focused ignoring the environmental consequences of the technologies (Sabud 2006). Therefore, in other words, the environmentally critical areas of Bangladesh are not addressed in sanitation hardware intervention, and that is why it fails to address the pressing needs of communities deprived of sanitation (Appendix 4).

The government and NGOs work both in urban and rural areas with some different courses of intervention. In terms of 'hardware' these include direct hardware support and technological assistance and in terms of 'software', hygiene promotion, education, etc. The government is mainly working on the hardware part. However, these organizations have separate visions but centered to meet the MDG for Bangladesh. They prescribe some sanitation technologies which are almost uniform for all the areas of the country. In other words, area-specific sanitation technological proposition for unique physiographic conditions (critical areas) of the country is yet to get popularity. Hill tracts, *haor*, *char* and hard soil areas of Bangladesh are considered as critical areas in this study. In most of the cases the same sanitation is proposed for all these critical areas. As a result these uniform technologies cannot work properly. But there are some organizations that have compiled and prescribed some area-specific sanitation hardware options but these are still at experimental stage.

1.2 Objectives

This study aimed to:

1. Investigate sanitation practices in the environmentally critical areas (hilly areas, *char* lands, *haor* and hard soil areas) of Bangladesh,
2. Investigate the reasons for choosing the particular sanitation option by the people of environmentally critical areas,
3. Examine environmental consequences of the sanitation technologies currently being practiced and/or prescribed in the environmentally critical areas, and
4. Compare sanitation options prescribed and offered by the government, NGOs, and research organizations for environmentally critical areas

1.3 Scope and limitation of study

As per Environmental Conservation Rules 1995 there are 12 types of ecologically critical areas in Bangladesh. Of these, three were selected for investigation in this study. These included *haor*, *char* and hill tracts. Though there were several *haor*s, *char* lands and hilly areas in Bangladesh, due to time and resource constraints only Hakaluki *haor*, Sariakandi *char* area and hills of Rangamati and Bandarban districts were surveyed. Hard soil area at Majira union of Bogra was considered as another critical area although it was not among the 12 ecologically critical areas. Considering its nature of soil formation it was included here.

There are a good number of government organizations, research organizations, local, national and international NGOs working in the field of sanitation in Bangladesh. However, not all of them were contacted. Interventions of only some purposively selected organizations were investigated. Respective officials of these organizations were interviewed and some of the project areas were visited. Also only the hardware intervention was considered, not the software (Appendix 1).

CHAPTER TWO: METHODOLOGY OF THE STUDY

2.1 Introduction

This chapter describes how the study was initiated. It illustrates all the methods for study area selection, sampling technique and data collection to data analysis.

2.2 Selection of the study areas

Kulaura *upazila* for Hakaluki *haor*, Sariakandi *upazila* for *char* area, Rangamati sadar *upazila* and Bandarban sadar *upazila* for hilly area, and Shahjahanpur *upazila* for hard soil area were selected purposively considering their respective environmental criticality as well as physiographic uniqueness (Fig. 1). Moreover, during reconnaissance some organizations were contacted which mentioned about these areas as their sanitation intervention areas and they have their physiographic area specific sanitation proposition for these above mentioned areas. Cultural heterogeneity of the inhabitants and communication convenience, dispersed pattern of human settlement and finally reducing time and budget constraints were the factors behind selection of these study areas.

2.3 Sampling and data collection

After purposively selecting the four study *upazila*s, simple random sampling was followed in selecting all the surveyed villages (Appendix 2). Multi-stage sampling procedure was followed to estimate sample size. Before estimating sample size, population size of the respective unions was collected from the 'Geographical reconnaissance (GR) data-2002: an analytical report 2004' of the Directorate General of Health Services (DGHS 2004). From this population size household numbers for respective unions were again calculated with the BBS standard of household size of 4.85 (BBS 2005). Finally, the sample size (sample household number) was calculated as 360 for *char* area, 341 for hard soil area, 359 for *haor* area, 137 for Rangamati hilly area and 199 for Bandarban hilly area, and thus, the total sample was 1,407 (Appendix 3). The level of significance was set at 5% with admissible error of 5% and design effect of 1.5.

In selecting the villages, simple random sampling method was used. In the first stage, all the villages within the selected *upazila* were listed. In the second stage, the first village was selected randomly from the list. Then households were selected using interval sampling method from the selected village. For doing this, the interval size was estimated by dividing the total number of households of that particular village by calculated sample household size for that particular area. If the required number of sample household was not obtained from the first village then the second village was selected from the list using the same simple random sampling method. Whenever the required household number was obtained, no more villages were selected from the list.

Both primary and secondary sources of information were investigated. Primary information was collected through direct field visit, consulting local people and local NGOs. A quantitative study was done during April – May 2009 in these four areas. A pre-designed questionnaire was used after field testing (Appendix 8). For convenience of verbal communication in the hilly areas, two local tribal research assistants were employed. Observation was conducted with a checklist and photographs were taken during the process. Secondary information was collected through visiting some specific organizations working on sanitation hardware options and interviewing sanitation experts. Some related journal articles, books were reviewed as well for secondary information.

2.5 Data analysis

Information of the household questionnaires was analyzed using SPSS 16.0. Frequency, cross-tabulation, Pearson's chi-square test and Spearman's rho correlation were done to analyze the data.

CHAPTER THREE: LITERATURE REVIEW

3.1 Introduction

This part of the study is mainly elaboration of key words mentioned in objectives. Some related studies and published journal articles were reviewed to get ideas to conclude with the study problem and get theoretical ideas about environmental critical areas, sanitation, sanitation practices in some other countries, sanitation technology, poverty structure, etc.

3.2 Environmental critical areas

In general, the word may be appeared as the area which has environmental criticality or the area which has environmental uniqueness or sophistication in terms of its physical characteristics, composition, and even diversification. It is a kind of natural setting which can be wildlife habitats or wetlands that has agricultural, social, cultural, historic, archaeological, recreational or educational values. Environmentally critical areas have an inherent ecological, geological or hydrological sensitivity to change that and may be adversely affected by any change. It refers to such an area where the extent and/or rate of environmental degradation preclude the continuation of current human-use systems or levels of human well-being, given feasible adaptations and societal capabilities to respond (Kasperson et. al. 1995). This definition suits the environmental critical areas considered in this study viz. Chittagong hill tract areas, *char* (high water table) areas of Sariakandi, Bogra and Hakaluki *haor* (long natural wetland depression) areas of Kulaura, Moulvibazar. According to the Environmental Conservation Rules 1997 of Bangladesh these areas are considered as ecologically critical areas which need special treatment for any type of physiographic change or alteration (Farooque and Hasan 2004). In fact, these areas are restricted for any type of gross changes. The unique physiographic compositions of these critical areas are also addressed in different books and papers of geography and environmental science. Therefore, these critical areas are unique in terms of their physiographic compositions like, composition of soil and water; land form; flood level; etc. (Rashid 1991). In this study these three critical areas along with a hard soil area have been selected.

3.3 Sanitation

Sanitation needs a broad definition, rather than a narrow one. It is more than simply having a suitable latrine; it also means that all people are using it (Hanchett and Nahar 2003). No doubt, sanitation is one of the primary drivers for improving public health. According to Mahatma Gandhi, "*Sanitation is more important than independence*". Improvements in access to safe water and adequate sanitation, along with the promotion of good hygiene practices (particularly hand-washing with soap), can help prevent childhood diarrhea (UNICEF and WHO 2009). As estimated 10,000 people every day worldwide die from sanitation-related diseases and thousands more suffer from a range of debilitating illnesses and thus, sanitation-related sicknesses put severe burdens on health services (RED 2008). According to Joint Monitoring Programme (JMP) of WHO and UNICEF, that inadequate sanitation is one of the responsible agents for 88% of childhood deaths from diarrhea (WHO and UNICEF 2008). Every year, the failure to tackle this deficit claims the lives of 1.5 million children and results in severe welfare losses – waste of time, reduced productivity, ill health, impaired learning, environmental degradation and lost opportunities – for millions more (WHO and UNICEF 2008).

It has been observed that improved sanitation not only brings advantages for public health but also it has positive effects on livelihoods and dignity. Therefore, it is obvious to initiate effective action regarding sanitation and a successful sanitation programme requires a thorough assessment of social, cultural, environmental and technological factors that guide the identification and selection of appropriate technology options. Sanitation facilities interrupt the transmission of much fecal–oral disease at its most important source by preventing human fecal contamination of water and soil. Sanitation is likely to be particularly effective in controlling worm infections (WHO and UNICEF 2000). Building a latrine is the first step on the sanitation ladder in developing countries where majority of the population defecate in open or public areas (RED 2008). And the latrines should be sanitary, hygienic, cost effective, and of course area-specific for the critical environmental areas.

3.4 Sanitary latrine

There are a number of government and non-governmental organizations at national and international level who have hardware and software interventions regarding sanitation in Bangladesh. All the organizations define sanitary latrines in their own way for intervention or estimating the coverage or for any policy level actions. Local Government Division (LGD) under MLGRD&C of Bangladesh government in their national sanitation campaign report of 2003 defined sanitary latrines as hygienic latrines which were water sealed and pit latrines (LGD et. al. 2004). It also mentioned the criteria of unhygienic latrines that included open or hanging latrines, latrines with broken rings, and latrines connected with water bodies. This report addressed the necessity of special sanitation technologies for the hilly areas of Chittagong hill districts other than those used in the lowlands of Bangladesh along with the unique cultural heritage and political history of the tribal populations. This same governmental organization in national sanitation strategy defined it as a sanitation facility, the use of which effectively breaks the cycle of disease transmission and included (LDG 2005):

1) Confinement of feces away from the environment,
2) Sealing of passage between squat hole and pit to effectively block the pathways for flies and other insect vectors thereby breaking cycle of disease transmission, and
3) Venting out of foul gases generated in the pit through a properly positioned vent pipe to keep the latrine odor free and encourage continual use of hygienic latrine.

According to BBS definition for coverage, access to improved sanitation facilities include flush toilets connected to sewer system, septic tank, ventilated improved pit (VIP) latrine, pit latrine with slab and composting latrine (BBS and DPHE 2009). According to DPHE definition for coverage, access to all improved toilets include offset pit, pit latrine with slab having water seal, pit latrine with slab as well as shared latrine (BBS and DPHE 2009). Both of the organizations considered pit latrine without slab or platform, hanging latrine and bucket latrine as unimproved latrines.

In international arena WHO and UNICEF in their different reports and articles defined the term sanitary latrine. In a report in 1987, WHO stated sanitation as the means of collecting and disposing of excreta and community liquid waste in a hygienic way so as not to endanger the health of individuals and the community as a whole (WHO 1987). In another report in 2006 it defined sanitation as the provision of facilities and services for safe disposal of human urine and feces (WHO 2009). According to UNICEF it is the facility that reduces the chances of people coming into contact with human excreta and includes latrine with flush or pour flush to piped sewer system, septic tank and pit latrine, VIP latrine, pit latrine with slab and composting toilet (UNICEF 2006). In another joint report WHO and UNICEF stated sanitary latrine as facilities that hygienically separate human excreta from human, animal and insect contact (WHO and UNICEF 2000).

BRAC in 2006 lunched a programme named Water, Sanitation and Hygiene (WASH) with the motto of improving the level of sanitation (access and practice) especially in rural Bangladesh. This programme defines sanitary latrines as latrines with septic tank or three to five concrete rings and one slab with water seal (RED 2008). In National Baseline Survey 2003, the government of Bangladesh (GoB) considered three rings and one slab latrine as minimum standard of sanitary latrine, but it did consider water seal. DPHE is practicing this concept countrywide (DPHE 2007). Therefore, there are a number of definitions on sanitary latrine. All of these are concerned with dispose and separation of human excreta in a safe and hygienic way although these are different in mode and technology.

3.5 Appropriate sanitation technology

Appropriate sanitation technology can be referred to such sanitation hardware option or latrine construction method that is appropriate in terms of cost effectiveness, physiographic variation, environmental consequences, health safety, etc. According to WHO an appropriate technology in terms of sanitation includes the followings (WHO 1987):

- As inexpensive as possible without jeopardizing the effectiveness of improvements sought,
- Easy to operate and maintain at village, community or municipal level,
- Does not require a high level of technical skill or deployment of highly professional engineers,
- Relies on locally-produced material rather than on externally provided equipments and spare parts where this is practicable,
- Makes effective use of local labour, especially in areas where there is a surplus of labour,
- Facilitates and encourage local manufacture of equipment and parts under the leadership of entrepreneurs,
- Facilitates participation of village communities in its operation and maintenance,
- Compatible with local values and preferences.

Appropriate sanitation technology aims at safe disposal of excreta and according to WHO it aims to prevent excreta that is – a) coming into direct contact with human being, b) contaminating ground or surface waters, c) being accessible to animals or insects, d) coming into contact with food, and e) creating public or private nuisance (WHO 1987).

3.6 Sanitation and MDG

In September 2000, UN millennium summit declared the Millennium Development Goals (MDG) where access to basic sanitation was addressed in the target 10. It states that the number of people without access to basic sanitation should be halved by 2015. It is the part of 'Goal 7' which is to ensure environmental sustainability (GED and UNDP 2009). Bangladesh is one of the signatories of this millennium declaration and obligated to meet the goals by 2015. However, the GoB expects to achieve this target and has targets of sanitation for all by 2013 while the year 2008 has been declared the "Year of Sanitation" (IRIN 2009 and UNICEF 2010). However, the conventional sanitary latrines, practiced by GoB is being implemented with three rings and one slab only, are not suitable for all the physiographical as well as environmental critical areas mentioned earlier. Although sanitation programmes have been implemented since 1970, but success in improving coverage has been far less compared to other development sectors (GED and UNDP 2009). People's awareness regarding benefits of improved and appropriate sanitation technology may be one of the reasons for this. Moreover, economic and social benefits of improved sanitation services are not always clearly visible to the policy makers especially in facing growing hydro-geological as well as physiographical challenges and it results slow-pace in technological innovations in sanitation (GED and UNDP 2009). Therefore, sanitation is crucial to the achievement of all the MDGs. If we become serious about reaching these and reducing poverty then sanitation must be given as high a priority as health and education (Water Aid 2009).

3.7 Sanitation situation in some developing countries

MDG aims at achieving 100% sanitation coverage in developing world. This obligation is mainly resulted from their backwardness in sanitation coverage. It is found that almost half of the developing world lacks access to basic sanitation (Jenkins and Curtis 2005). According to Water Aid over 40% of the world's population do not have a safe, clean or private place to go to toilet (Water Aid 2010). The situation is worst in Afghanistan, Nepal, India, Chad, Ethiopia, Cambodia, Ghana, Namibia and Somalia where more than 70% of the total population are lacking

sanitation (Water Aid 2007). On average, in South Asia this rate was 51% in 2002 (UN 2005). Water Aid also reported that water-related diseases (diarrhoeal diseases such as dysentery) caused by a lack of adequate sanitation are the second biggest killer of children in the world today, killing 5,000 children every day; that is five times the number dying from HIV/AIDS (Water Aid 2007). According to a MDG assessment report by WHO and UNICEF's Joint Monitoring Programme, in 2004 about 955 million people in South Asia were living without improved sanitation while it was 403 million in Sub Saharan Africa, 125 million in Latin America, Caribbean Islands and seven millions in developed region (WHO and UNICEF 2006) (Fig. 4.2).

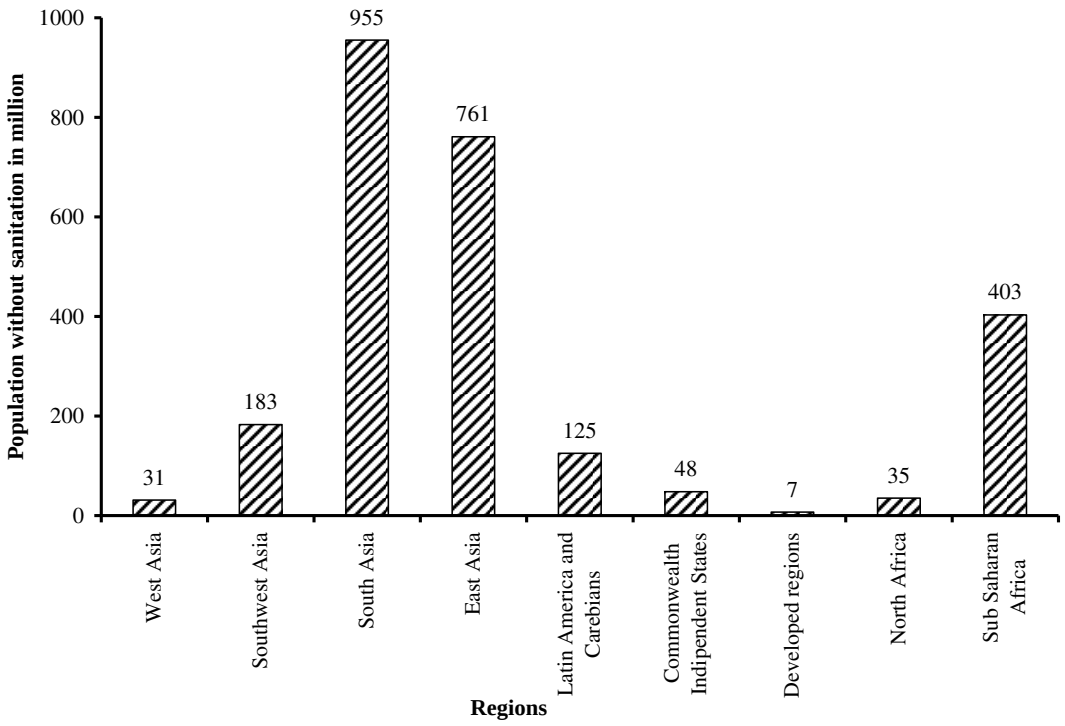


Figure 3.1. Population without improved sanitation around the world in 2004

Therefore, it is a matter of great regret that still many developing countries in the world are apathetic towards investing in sanitation sector. This cost of not investing in sanitation and water includes infant deaths, lost work days, and missed school. It is estimated to have an economic value of around $38 billion per year, with sanitation accounting for 92% of this (Water Aid 2007). This ailing sanitation situation does not mean that these developing countries are not doing anything to confront this problem.

Although it looks like that they are reluctant to some extent, however, there are some other issues behind this confrontation. Lack of money (poverty in other word) and space, political issues, physiographic variation, environmental criticality, etc. are some prominent issues in this regard. Worldwide there are a good number of organizations like Water Aid, UNICEF, Red Cross/Crescent, World Bank, ADB, IDB, WHO, DANIDA, JICA are fighting to improve sanitation situation in these developing countries. Their interventions cover both hardware (installation of latrine) and software (counseling, advocacy, hygiene education, training, etc.). In many cases these international organizations work with respective national organizations at government as well as non-government level. Sometimes they come up with low cost, area-specific and environment-friendly sanitation options.

3.8 Low cost sanitation options practicing in the environmental critical areas in some developing countries

Both on-site and off-site low cost sanitation systems can be found to be in practice by some developing countries in the world as mentioned by a number of research papers. Rachelle G. Navarro in 1994 mentioned in his research paper that there were some specific low cost sanitation options which can be practiced in the flood prone or waterfront areas (that is *haor* areas). These include communal toilets, septic tanks, cesspools, composting toilets and sewerage systems. Most of these latrines were in practice in some areas of Philippines, Jakarta, Bangkok, Koki, Kampung and Vietnam (Navarro 1994). In India, Sri Lanka and Nepal eco-san latrine is one of the sanitation options for flood prone areas. This is a kind of compost pit latrine with two separate chambers to defecate and urinate and later use this after minimum six months as fertilizer (Rajbhandari 2008 and Patabendi et.al. 2010). Such latrines are built in relatively high lands and help to avoid air, water and soil pollution. In Bangladesh some NGOs are working on promotion of this latrine in flood prone areas. However, considering the cost, handling the waste as fertilizer, unusual pan design and other socio-cultural settings, this option is yet to get popularity (Mazeau and Delepiere 2007).

Eco-san and VIP latrines are found in some literatures to be used in the hilly areas where water is scarce. Since water is not used in such latrines these can be some effective sanitation options in the hilly areas. In some hilly areas of Africa and Nepal Water Aid is promoting VIP latrines built with vent pipe. Such latrines restrict odor and flies and offer less use of water which make it environment-friendly and hygienic (Water Aid 2009).

3.9 Sanitation coverage in Bangladesh

According to DPHE, sanitation coverage in Bangladesh in 2003 was 33% while UNDP reported it as 39% in 2004 (UNDP 2006 and DPHE 2007). Bangladesh Bureau of Statistics (BBS) in 2005 reported 31% sanitation coverage where only sanitary and water sealed *pucca* latrine were considered (BBS 2005). According to the baseline survey of BRAC WASH programme in 2006-07 this coverage was about 32% and about 29% people were found to defecate in open places (RED 2008). The survey was done in 75 *upazila*s in the country with 45,000 sample size. The sanitation coverage was found 32% where ring-slab with water-sealed latrines was considered as minimum requirement of sanitary latrine. According to Bangladesh National Baseline Survey 2003, among 21.04 million households 13% used water-sealed latrines, 30% used pit latrines, 34% used hanging latrines, and 23% continued open defecation (IRIN 2008). The same survey reported that the access to sanitary latrines was 29% in rural areas, 53% in municipalities and 70% in city corporations in 2003 which increased to 44% in rural areas, 69% in municipalities and 73% in city corporations in 2004 (Water Aid 2005 and DPHE 2007).

On the other hand, the Bangladesh Millennium Development Goals Progress Report 2007 reported that by June 2007, sanitation coverage in urban areas had jumped phenomenally to around 88% in urban areas and 85% in rural areas from 56% and 15% of 1991 respectively, and the nationwide 'Community Led Total Sanitation' campaign of 2003 accelerated this coverage (GED 2007). However, in calculating the coverage it considered simple pit latrines that can hygienically separate human excreta from human, animal and insect contact as minimum standard of sanitary latrine whereas it did not mention any water sealed or ring slab or any other ways to separate feces.

In rural areas of Bangladesh people usually install latrine away from their dwelling houses. Also traditionally people tend to construct latrines in low lying areas which go under water during floods. Intention of such activity is to wash out the excreta easily during flood so that they can avoid cleaning it by themselves. GoB along with some national and international NGOs in Bangladesh is working hard to resolve this sanitation problem. They come up with several sanitation hardware interventions for the country. Some of them are working in the critical areas considered in this study and rushing to meet the MDG target. However, according to some, this rush to meet national and international sanitation targets is resulting in construction of latrines only, that is, so called 'latrinization' and not in 'total sanitation'.

3.10 Poverty structure

According to National Sanitation Strategy 2005 the following are the eligible criteria for defining hardcore poor which is also used in this study (LGD 2005):

1. Landless households, or
2. Pavement dwellers or homeless, or
3. The main earning person or the head of the family is a day labourer, owning less than 50 decimal of agricultural land or residing in a rented premise lesser than 200 square feet and having no fixed source of income, or
4. Households headed by disabled or female or older (65+ years) persons.

But, if the households have more than one acre of land (cultivable and homestead) or the income level of the household is greater than the income corresponding to the 'poverty line' definition of BBS in HIES, would be excluded from the list. This definition of poor includes the following criteria (RED 2008):

1. Having up to 100 decimal of land (agricultural and homestead), and
2. Sells manual labour for living.

Households that do not fall in any of these two categories are considered as non-poor in this study.

CHAPTER FOUR: STUDY AREA PROFILE

4.1 Geographical profile of the study areas

4.1.1 *Haor* area

Area and location

Vukshimoil union of Kulaura *upazila* of Moulvibazar district was one of the four study areas. The *upazila* occupies an area of 679.25 sq. km. including 116.25 sq. km. of forest. It is located between 24°20´ and 24°40´ north latitudes and between 91°54´ and 92°14´ east longitudes. The area is bounded on the north by Barlekha and Fenchuganj *upazila*s, on the east and south by India, and on the west by Rajnagar and Kamalganj *upazila*s.

Physiographic features

The area is located in the basin of the largest *haor* of Bangladesh that is Hakaluki *haor*. It is a wetland ecosystem in the north eastern part of Bangladesh. Physically it is a bowl or saucer shaped shallow depression with more than 80 interconnecting beels. It is also known as a back-swamp. The area is a marsh wetland ecological system of eastern Bangladesh, located in an area bordering Assam of India. It is one of Bangladesh's largest and one of Asia's larger marsh wetland resources. Also it is a protected Ramsar site of international importance for conservation and sustainable use of wetlands. This area is within the flood plain of Surma-Kushiara river basin and extensive alluvial plain supporting a variety of wetland habitats (BARC 2004).

In some low lands of this area drainage quality of soil is very poor. In some areas soil remains wet even in dry season. Most of the upper crust of the soil of this area is reddish gray or greenish gray silty clay soil and highly acidic (BARC 2004). Not all the areas of this region are with same type of soil texture. But in the areas where heavy clay soil is found, water is drained out most slowly and the effects of saturation therefore persist longer (Bennett et. al. 1995).

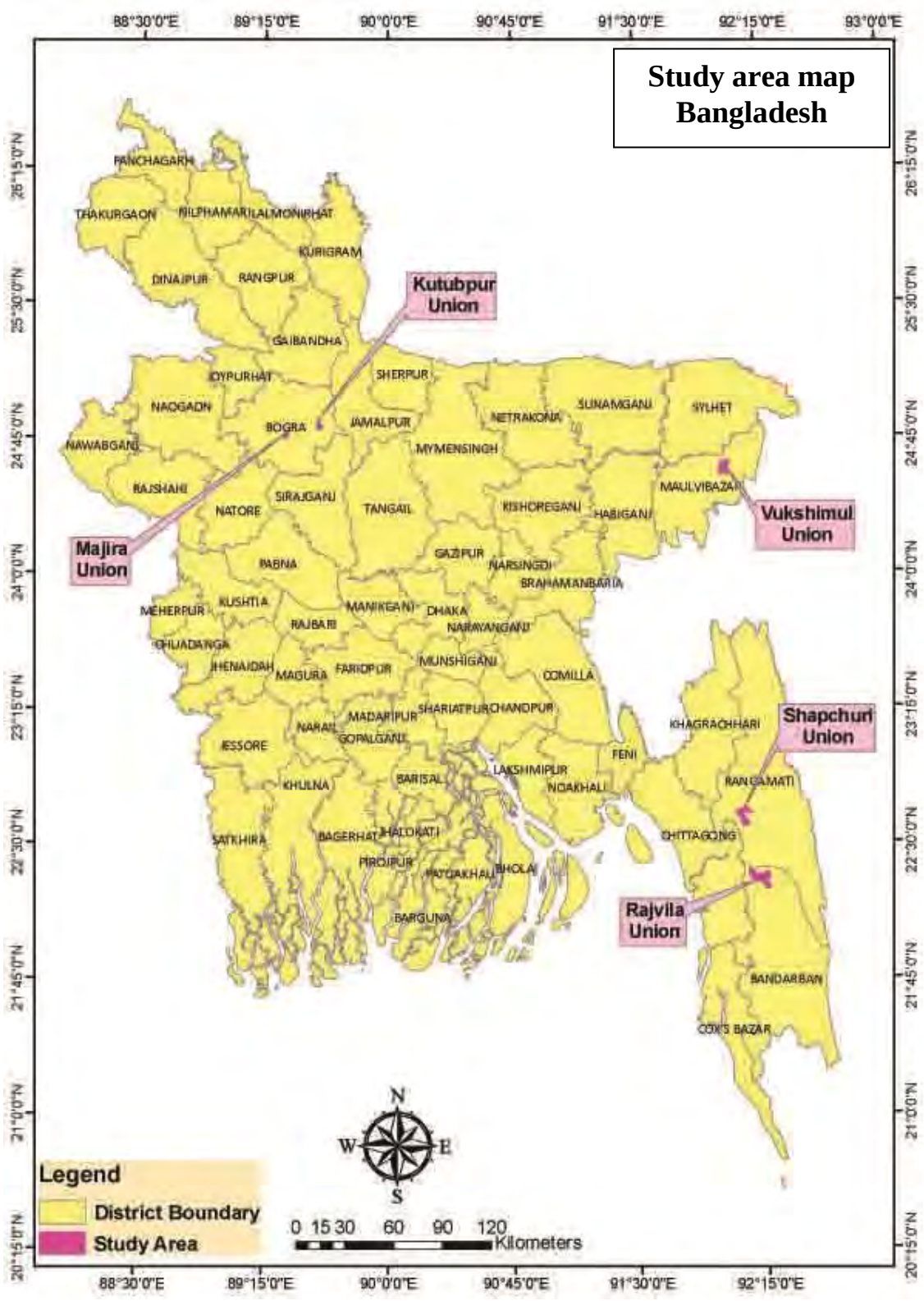


Figure 4.1. Study area map

This area is a low lying flood lake that grows up to 700 km^2 during monsoon season (May to October) every year and is used as paddy field or a meadow during dry season (Oka et. al. 2002). People usually build their houses on high lands as lower areas are submerged during monsoon. As the water level rises, individual residential sites become small isolated islands and this situation usually lasts for six months in every monsoon.

4.1.2 *Char* area

Area and location

Kajlar *char* at Shariakandi *upazila* of Bogra district was selected as the study area. This area is located at the northern part of the country. The *upazila* occupies an area of 408.45 sq.km. including 2.10 sq km. of forest. It is located between 24º44' and 25º 04' north latitudes and 89º 31' and 88º45' east longitudes. It is bounded on the north by Sonatala *upazila* and on the east by Islampur and Madarganj *upazila*s. On other flank, Sarishabari and Kazipur *upazila*s boarder is on its south and Shibganj *upazila* skirts on its west.

Physiographic features

The six kilometers wide river Jamuna has been subdivided here into several narrow and meandering flows that crisscross the dry river bed, while rest of the river has turned into huge sand dunes and sand bars (IRIN 2008). Home to 2,23,789 inhabitants (about 50,000 households) the *char* is prone to acute erosion and flood and a by-product of the rivers' hydro-morphological dynamics are periodically submerged.

The rivers are flooded in July as rainwater from the Himalayas rushes southwards, only to reappear in November. Most of the river islands become displaced during flood and people have to live along the river banks until rains stop and rivers begin to recede. Others move to neighbouring *chars* where they may have to wait for months or even years before being able to return. During annual monsoon floods many tubewells and latrines along with homesteads become submerged. Soil is granular type and loamy here and sub-surface water level is relatively high.

4.1.3 Hard soil area

Area and location

Majira union of Shahjahanpur *upazila* under Bogra district was selected as hard soil area. The area is also at the northern part of the country and with 2,47,814 population in 61,607 households with 1,140 population per sq. km. The *upazila* occupies an area of 221 sq. km. It is located between 24°41' and 24°59' north latitudes and 89°16' and 89°30' east longitudes. It is bounded on north by Bogra Sadar *upazila* and on east by Gabtali and Dhunat *upazila*. On other flank, Sherpur *upazila* boarders its south and Kahaloo and Nandigram *upazila* surround its west.

Physiographic features

The area is within the red bed Barind tract and characterized by hard red soil with low moisture content that comprises slightly elevated landform terraces within the alluvium (Banglapedia 2006). The area belongs to an old alluvial formation which is usually composed of massive agrillaceous beds of pale reddish brown that often turns yellowish on weathering. Locally the soils are rich in lime. About 60% of the soil is composed of semi-consolidated older Madhupur clay, which forms the Barind and Lalmai terraces (Banglapedia 2006). The remainder of the soil is developed in unconsolidated recent and sub-recent alluvial deposits laid down by the rivers Bangali and Karatoa.

Drainage is very low here due to hardness of soil. Slightly elevated landform terraces are found sometimes within the alluvium. The area is higher in elevation than the surrounding flat plains and forms a distinct, relatively flood-free physiographic unit (Banglapedia 2006).

4.1.4 Hilly areas

Area and location

Rangamati sadar and Bandarban sadar ***upazilas*** were selected as the study areas under the hilly area category. Rangamati Sadar ***upazila*** with an area of 546.49 sq km is located at the south-west of Chittagong hill districts. The area is bounded by Naniarchar ***upazila*** on the north, Kaptai and Belaichhari ***upazila***s on the south, Barkal and Juraichhari ***upazila***s on the east and Kawkhali ***upazila*** (Rangamati) on the west. Kaptai Lake took the one-third area of the ***upazila***. It is located between 22°30' and 22°49' north latitudes and 92°04' and 92°22' east longitudes (SRDI 1999).

Bandarban Sadar ***upazila*** with an area of 501.99 sq km is located at the north-west of Chittagong hilly areas. The area is bounded by Rajasthali ***upazila*** on the north, Lama ***upazila*** on the south, Rowangchhari and Ruma ***upazila***s on the east, and Rangunia, Chandanaish, Satkania and Lohagara ***upazila***s on the west. Most of the parts of the ***upazila*** is covered with hill ranges. There are a few rivers and fountains. Shankha (Sangu) is the main river of the ***upazila***. It is located between 21°96' and 22°21' north latitudes and 92°08' and 92°21' east longitudes (SRDI 1992).

Physiographic features

The area is comprised of two types of land viz. hill and valley with alluvial soil. There are three types of heights of hills – high, medium and low. Most of the hilly area is composed of alluvial rock which also ranges from high to low according to strength or solidity or hardness (SRDI 1992). Soil and hill structure of this area is almost similar to Bandarban Sadar ***upazila,*** but the hills are surrounded with or beside the Kaptai Lake (SRDI 1999). In both the regions, in the high hill ranges, soils are very shallow to deep, pale brown and lightly to strongly acidic, sandy loam to clay, usually overlying decomposing bedrocks at variable depths (Uddin and Shaheed 1995). And In the low hills, soils developed in soft rock materials are usually deep, brown to red-brown, strongly to very strongly acidic, sandy loam to clay loam, locally overlying plinthite or hard lateritic substrata (Uddin and Shaheed 1995).

4.2 Socioeconomic profile of the study areas

This study was conducted in four physiographic regions as stated earlier where the total sample households were 1,407. A brief on the socioeconomic profile of these four study areas is presented in the Table 4.1.

Table 4.1. Socioeconomic profile of the surveyed areas

Sl. no.	Socio demographic indicators	*Char*	Hard soil	*Haor*	Hill tracts	Total
1	Mean household size	3.97	3.87	6.24	4.16	4.57
3	Male female ratio	51:49	51:49	49:51	52:48	50:50
4	NGO membership (%)	58.90	56.90	48.50	43.20	52.00
5	Major employment-1 (Day labour)	51.7	28.3	15.9	40.8 *	34.1
6	Major employment-2 (Farmer)	27.5	19.4	26.2	49.4 **	30.4
7	Literacy[1] (%)	37.69	46.09	62.63	29.07	46.30
8	Sanitation coverage – 1 [2] (%)	38.3	24	29.3	0.6	23.4
9	Sanitation coverage – 2 [3] (%)	71.1	65.7	62.2	17.5	54.6
10	Ultra poor (%)	2.8	2.3	2.8	2.4	2.6
11	Poor (%)	48.9	26.3	14.8	38.8	32.1
12	Median income (taka/month)	3,500	4,500	9,000	6,000	5,000
	N	**360**	**350**	**359**	**338**	**1407**

[1] At least who passed 'Class I' and excluding 'Kaomi Madrasha' education

[2] Sanitary and three rings one slab with water seal

[3] Sanitary and three rings one slab with and without water seal

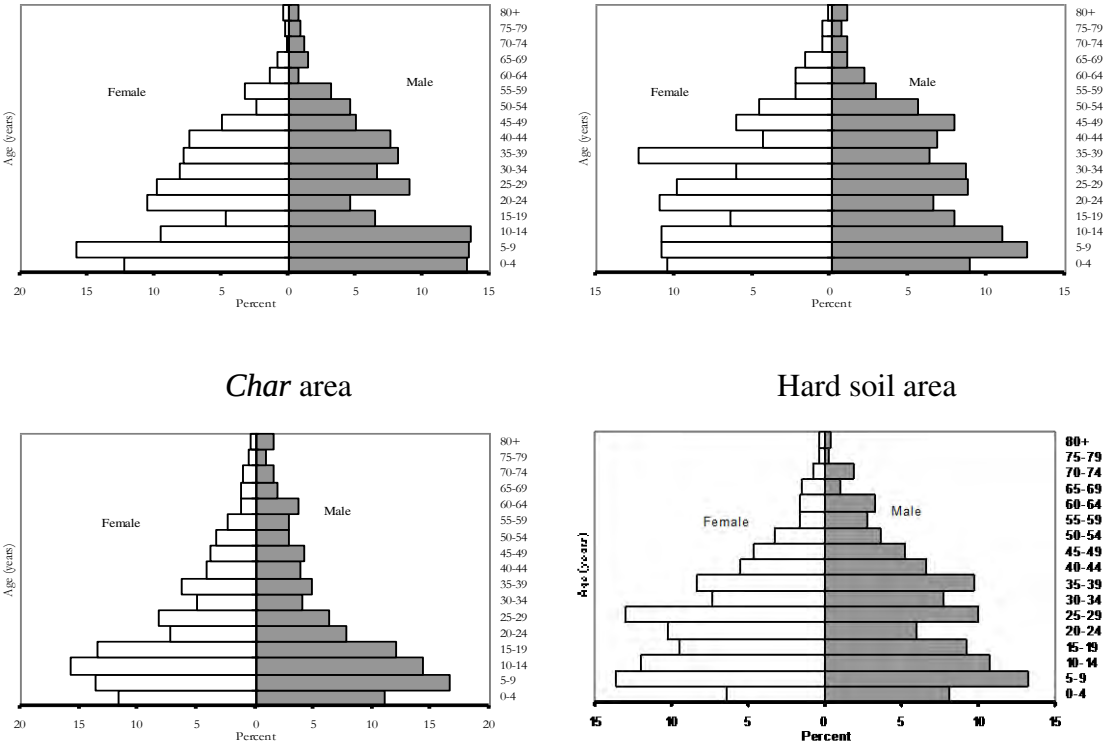
** Day labour in hills is mainly who collects resources from forest and sells daily*

*** Here farmer means jhum farmer*

4.2.1 Household composition

Average household size in the four study areas was 4.57 and it was found larger in the *haor* area (6.24) and smaller in hard soil area (3.87) (Table 4.1). A total of 6,431 people were enumerated from 1,407 households during the survey. Male female ratio was almost 50:50. But in *haor* area it was 49:51.

Population distribution among different age groups in the age-sex structure shows that more people belong to the younger age groups for both sexes in c*har* and hilly area (Fig. 4.2). But in *haor* area the percentage of adolescents was higher than that of all other areas. In hard soil area most of the people were within 0-54 years age group (Fig. 4.2). According to this survey, 36.9% of the total population was aged below 15 years, which was almost similar to the national estimate of 36.7% (BBS 2005). On the contrary, 3.72% of the total surveyed population was above 65 years old and the corresponding HIES by BBS figure was equal to 4.3% (BBS 2005).



Char area Hard soil area

Haor area Hilly area

Figure 4.2. Area specific age-sex structure

4.2.2 NGO membership

Around 52% population of the study areas was NGO members (both current and previous attachment). It was highest in *char* area (58.9%) and lowest in hills (43.2%).

4.2.3 Occupation of household heads

Day labour was found to be the most common primary occupation of the household heads in all regions (about 34%). Individually in *char* area it was the highest (52%). There was about 30% of household heads who were farmers. The highest percentage of occupation of household head was farmer in hilly regions (49%) (Table 4.1).

4.2.4 Educational enrollment

About 46% of the population was found in all the study areas enrolled in educational institutes (Table 4.1). This percentage was highest in *haor* area (63%) and lowest in hills. People who passed at least 'Class-I' were considered here and those who were educated from a *Kaomi Madrasha* were excluded.

4.2.5 Income structure and poverty

Considering the poverty definition mentioned in the National Sanitation Strategy of Bangladesh, 2003 (in chapter three) only 2.6% of the total population was identified as ultra poor and about 32% as poor (Table 4.1). The highest percentage of poor people was enumerated in *char* area (49%) and the lowest was enumerated in *haor* area (15%). The median income (per household in all the regions) was Tk. 5,000 per month. It was lowest in *char* area (Tk. 3,500) whereas it was highest in *haor* areas (Tk. 9,000) (Table: 4.1). On the other hand as reported by the households, 2.6% of them in all the areas were earning below Tk. 2,000 per month. This group was considered as ultra-poor. Households with the income range of Tk. 2,001 - 5,000 was the highest in all four areas and individually it was highest in *char* area (85%) (Table 4.2). This group was within the 'poor' category.

Table 4.2. Income structure of the households by physiography

Income range in taka	***Char* (in %)**	**Hard soil (in %)**	***Haor* (in %)**	**Hilly (in %)**	**Total (in %)**	**Remarks**
Below 2,000	6.1	1.1	0.6	2.7	2.6	Ultra poor
2,001 to 5,000	84.7	70.9	29.0	21.3	51.8	Poor
5,001 to 10,000	9.2	23.4	34.3	71.0	34.0	Non-poor
Above 10,000	0	4.6	36.2	5.0	11.6	
N (frequency)	**360**	**350**	**359**	**338**	**1407**	**-**

4.2.6 Sanitation practice across economic class

All the ultra poor and poor families of hilly areas were found to use un-sanitary latrines. Here most of the households from all economic classes were mainly habituated in closed pit latrines. About 60% of the ultra poor and 49% of the poor households in *haor* area were found to defecate in open pit latrines. Using the Pearson's chi-square test it was found that there were significant difference across the economic classes in terms of sanitation choice in *haor* and hilly areas. The sanitation choice was also found significant across the critical areas (Table 4.3).

Table 4.3. Sanitation practice across economic class and critical areas

Defecation practice	***Char***			**Hard soil**			***Haor***			**Hilly**		
	Ultra poor	***Poor***	***Non-poor***	***Ultra poor***	***Poor***	***Non-poor***	***Ultra poor***	***Poor***	***Non-poor***	***Ultra poor***	***Poor***	***Non-poor***
Sanitary	**40**	**35.2**	**41.4**	0	13.04	28.80	0	9.43	33.78	0	0	1.01
Ring-slab without water seal	20	31.2	35.1	**62.50**	**48.91**	**38.40**	40.00	37.74	31.76	12.50	10.69	21.11
Closed pit	40	19.9	14.9	25.00	25.00	22.40	0	1.89	1.01	**87.50**	**54.20**	**57.79**
Open pit	0	10.8	8	12.50	10.87	9.60	**60.00**	**49.06**	**33.45**	0	6.87	9.05
Open defecation	0	2.8	0.6	0	2.17	0.80	0	1.89	0	0	28.24	11.06
Chi-square (across poverty level)	P> 0.05			P>0.05			P<0.01			P<0.01		
Chi-square (Across area)	P<0.001											

CHAPTER FIVE: SANITATION PRACTICE IN THE ENVIRONMENTALLY CRITICAL AREAS

5.1 Latrine use type

In all four study areas 23.2 % of the total households were found to use sanitary as well as hygienic latrine (sanitary and ring-slab with water seal) (Fig. 5.1). It was the lowest in hilly areas (0.6%) and the highest in *char* area (36.8%) (Fig. 5.2). On the other hand, about 31% of the people were found to use ring slab latrine without water seal which was highest in hard soil area (42%) (Fig. 5.1 and 5.2). However, about 40% of the population was found to use un-sanitary latrines (closed pit, open pit, hanging latrines) and 6% were habituated in open defecation. Individually in *haor* area – highest percentage of people (36%) were using open pit latrine (Fig. 5.1 and 5.2). The use of un-sanitary latrine was highest in hilly areas (83%) (Fig. 5.2).

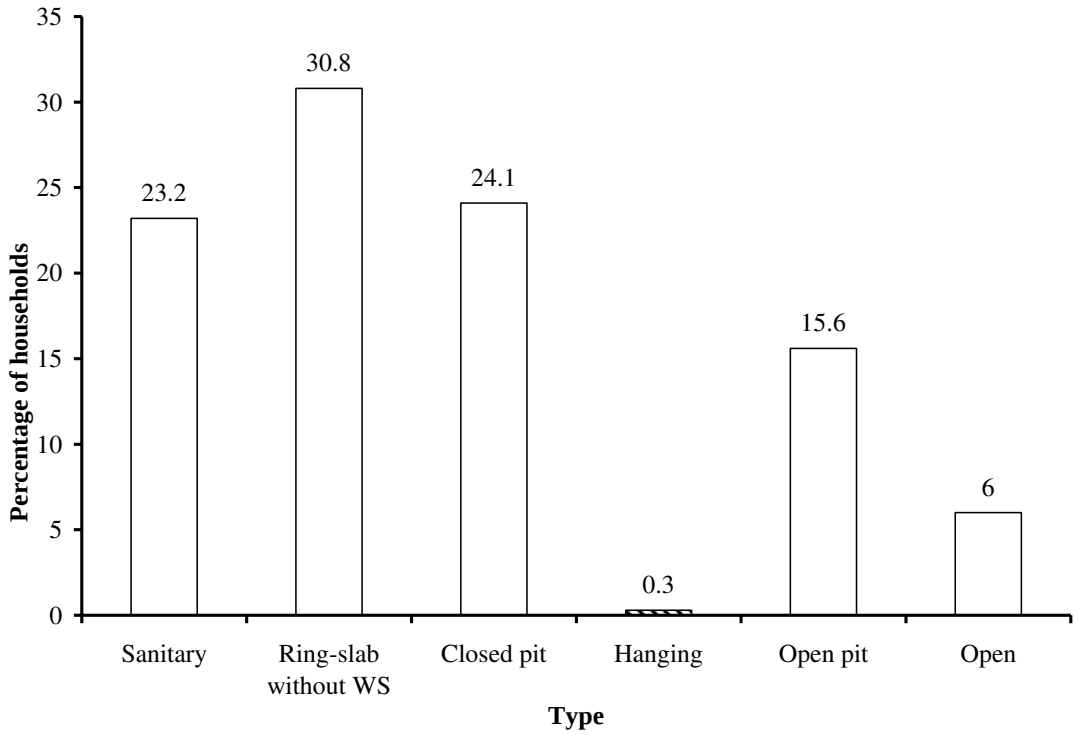
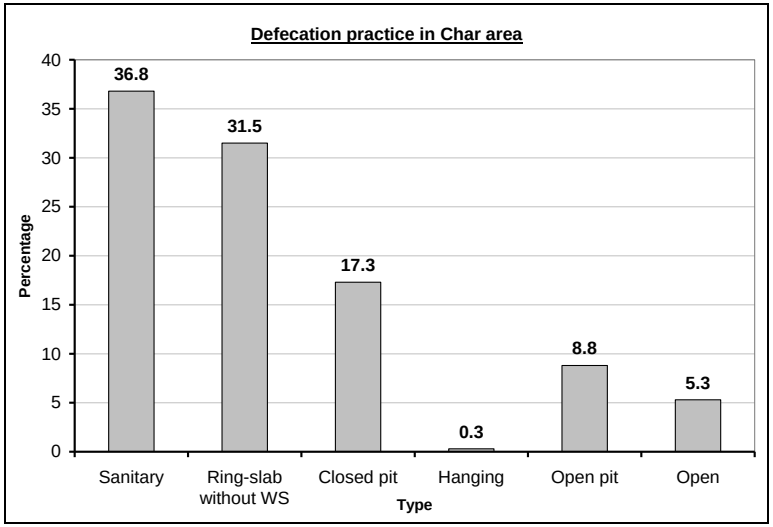
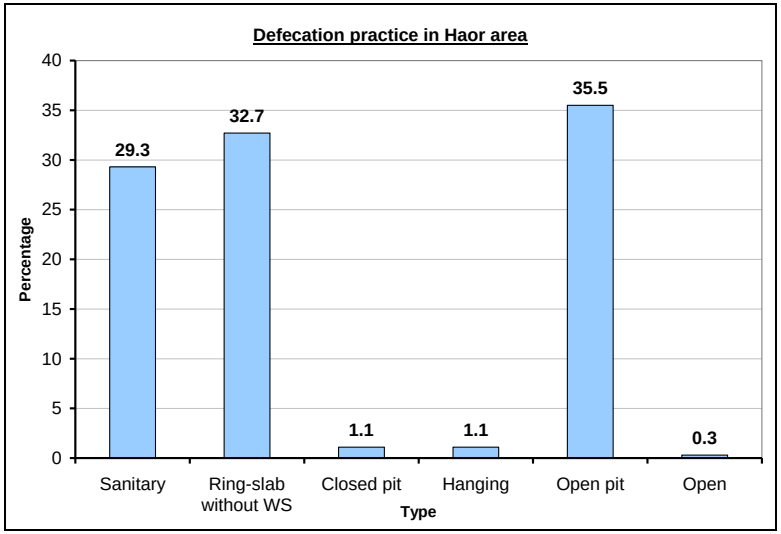
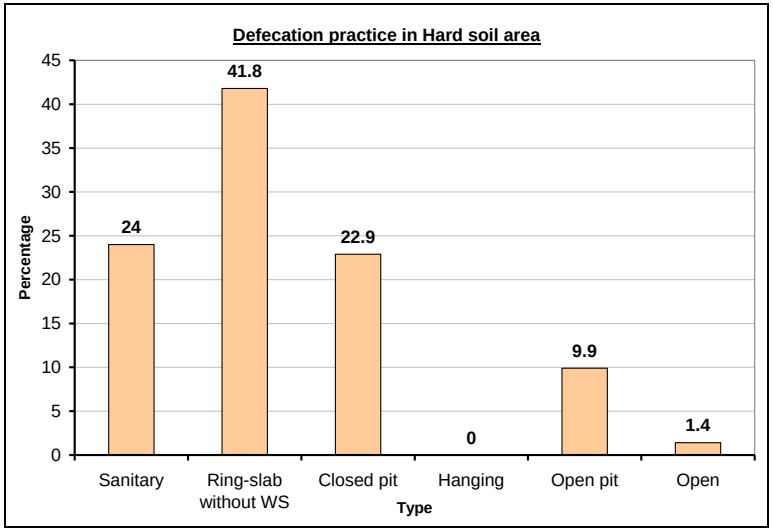


Figure 5.1. Defecation practices in all four areas







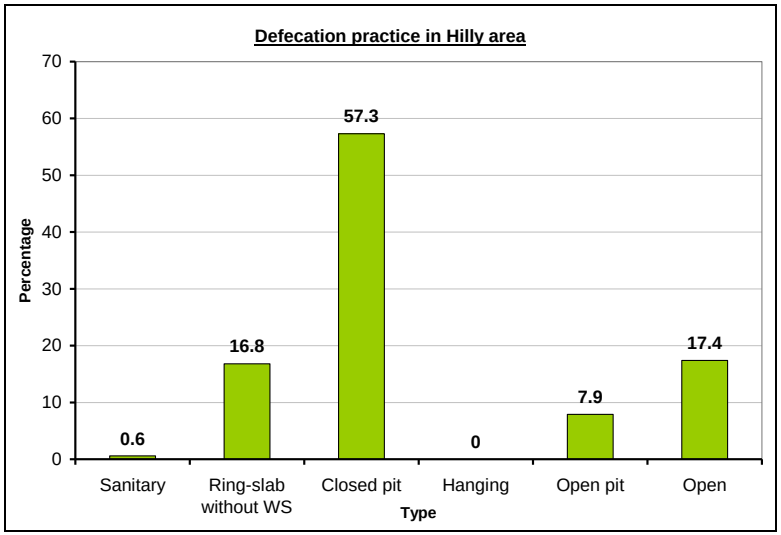


Figure 5.2. Defecation practice in physiographic areas

Figures 5.1 and 5.2 show the information on use of latrines by individual households and multiple answers were considered. On the other hand, Table 5.1 shows types of latrine used by male, female and children. About 37% of both male and female in *char* area were using sanitary latrine while it was lowest in hilly areas (0.6% and 0.3% respectively) (Table 5.1). The rate of defecating in open spaces in hilly areas for male and female (about 16%) was the highest while it was highest for the children in *haor* area (68%) (Table 5.1).

Table 5.1. Individual latrine use in main three categories by sex

Latrine type	***Char***		**Hard soil**		***Haor***		**Hilly**	
	Female	Male	Female	Male	Female	Male	Female	Male
Sanitary	37.60	37.10	25.80	26.70	32.00	30.40	0.60	0.30
Ring-slab without water seal	31.20	33.10	40.60	40.20	33.00	32.10	17.80	16.80
Closed pit	18.60	19.40	22.80	23.20	0.50	0.80	58.00	59.30
Open pit	10.30	8.60	9.70	9.10	34.10	35.70	7.60	7.50
Open defecation	2.30	1.80	1.20	0.80	0.40	1.00	15.90	16.10
Children (< 5)								
Sanitary	16.4		10.7		14.1		0	
Ring-slab without water seal	20.2		15.3		7.1		10.8	
Closed pit	13.7		10.7		0.4		30.4	
Open pit	6.0		3.8		11.0		2.0	
Open defecation	43.7		59.5		67.5		56.9	

It was found that in all the four areas level of education was correlated with types of latrine used by individual household members and these were found significant (Table 5.2). Therefore, in these critical areas, the higher the education level, the higher the percentage of sanitary latrine user (Table 5.2).

Table 5.2. Individual latrine users by education

Critical areas	Latrine option	Never been to school	Primary	Secondary	Above secondary	Correlation coefficient	P-value
Char	Sanitary	34.0	40.0	30.5	57.0	0.104	P<.001
	Ring-slab without water seal	33.0	30.0	36.4	29.8		
	Closed pit	20.5	17.7	22.0	9.9		
	Open pit	10.3	10.3	10.2	3.3		
	Open defecation	2.2	2.0	0.8	0		
Hard Soil	Sanitary	22.3	23.4	27.0	46.1	0.092	P<.01
	Ring-slab without water seal	44.6	37.8	41.1	27.7		
	Closed pit	20.5	28.8	22.7	21.3		
	Open pit	11.2	9.4	9.2	3.5		
	Open defecation	1.4	0.6	0	1.4		
Haor	Sanitary	25.7	26.2	32.9	48.9	0.166	P<.001
	Ring-slab without water seal	32.1	34.5	30.9	31.9		
	Closed pit	0.6	0.9	0.7	0.3		
	Open pit	40.8	37.8	35.5	18.9		
	Open defecation	0.8	0.5	0	0		
Hill	Sanitary	0.2	0.4	0	4.6	0.198	P<.001
	Ring-slab without water seal	14.3	23.3	24.2	30.8		
	Closed pit	57.8	64.5	63.6	49.2		
	Open pit	8.4	2.9	8.1	9.2		
	Open defecation	19.3	9.0	4.0	6.2		

About 44% of the NGO members in *char* area were found to use sanitary latrine and, on average, this percentage was 22% in all four areas (Table 5.3). However, in hilly area about 10% were habituated in open defecation (Table 5.3).

Table 5.3. Latrine-use type by the NGO members

Latrine type	*Char*	Hard soil	*Haor*	Hilly	All
Sanitary	43.8	22.8	18.2	0.5	22.4
Ring slab without water seal	32.0	40.1	44.3	40.4	40.2
Closed pit	15.1	28.1	0.3	41.9	14.8
Open pit	8.2	8.6	36.6	7.1	20.7
Open defecation	0.9	0.3	0.6	10.1	1.8
N	**175**	**172**	**102**	**100**	**549**

During disaster 1% of the households were found who had access to another type of latrine and the percentage. It was 4% in *char* area and 0% in hard soil, and hilly areas although most of these were unsanitary.

Table 5.4. Regular and alternative latrine use by the households

Use type	*Char*	Hard soil	*Haor*	Hilly	All
Regular	95.4	100.0	97.6	100.0	98.1
Alternative use	0.5	0	1.4	0	0.5
During disasters	4.1	0	1.1	0	1.4
N	**393**	**354**	**370**	**340**	**1457**

5.2 Latrine ownership

Households were found to use mainly their own latrines and on average, the percentage was almost 70 (Fig. 5.3). In hill tracts most of the people (98%) use their own latrine and this was highest among the four areas. Besides, a good percentage of people other than hilly areas used shared latrines. About 21% of the households used other's latrine in hard soil area and these latrines were owned by their relatives, GO, NGOs or neighbours (Fig. 5.3).

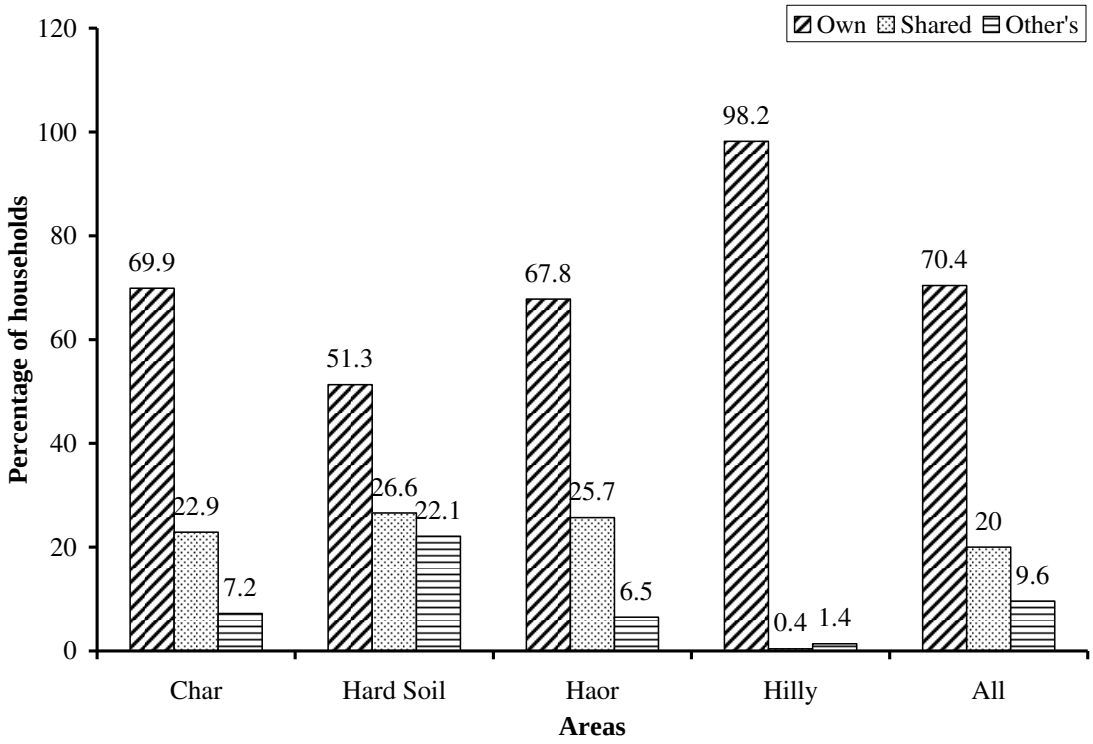


Figure 5.3. Latrine ownership by households

In *char* area about 39% of the households were using their own sanitary latrines and in hilly areas it was 0.7% (Table 5.5). However, in hilly areas almost 69% of the households were found using their own closed pit latrines (Table 5.5).

Table 5.5. Type of latrine among households using their own latrines

Latrine type	*Char*	Hard soil	*Haor*	Hilly	All
Sanitary latrine	39.0	24.3	29.3	0.7	24.6
Ring-slab without water seal latrine	33.3	42.2	33.0	20.4	32.8
Closed pit latrine	18.4	23.4	1.1	69.2	25.7
Open pit latrine	9.3	10.1	36.6	9.7	16.9
N	**354**	**346**	**358**	**279**	**1,337**

5.3 Type of latrine technologies being practiced

No area-specific technology was found to be practiced in constructing latrine in any of the four physiographic areas. On average about 37% were using indigenous type of latrine that includes closed pit latrine, open pit and hanging latrine, and the rest were using ring slab latrine (Table 5.6). Use of indigenous type of latrine was highest in hilly areas (79%) whereas in other three areas ring slab latrine was being used by 68 to 76% households (Table 5.6).

Table 5.6. Household distribution by type of latrine technology

Type of latrine technology	*Char*	Hard soil	*Haor*	Hilly	All
Area-specific	0	0	0	0	0
Indigenous	24.0	32.1	23.8	78.5	37.4
Ring slab	76.0	67.9	76.2	21.5	62.6
N	**354**	**346**	**357**	**279**	**1336**

5.4 Latrine technology ownership

Almost 51% of the respondents replied that they built their latrines following the technologies suggested by union *parishad* chairmen, members and officials, and the rate was highest in *haor* area (88%) (Table 5.7). About 27% answered that NGOs suggested them to build their latrines. Most of these latrines were ring slab.

Table 5.7. Household distribution by ownership of latrine technology

Technology ownership	*Char*	Hard soil	*Haor*	Hilly	All
NGOs	34.0	2.6	10.6	61.1	26.6
Government organizations	44.2	71.7	88.1	1.6	51.2
Nobody/Traditional	21.8	25.7	1.3	37.3	22.2
N	**321**	**311**	**227**	**252**	**1111**

5.5 Latrine construction materials

More than 73% of the households of hard soil and hilly areas answered that they collected most of the latrine construction materials from the surroundings of their homesteads at free of cost (Fig. 5.4). These materials were mainly wood, bamboo, tree branches, mud, etc., which resembles that these latrines were either *kutcha* or semi-*pucca* but not *pucca*. However, about 52 to 60% of the people in hard soil and *char* areas used to collect latrine construction materials from local markets whereas in *haor* area almost 66% of the respondents purchased some of the materials from markets outside their locality and most of these latrines were *pucca* (Fig.5.4). About 41% in *char* area and 46% in hilly area mentioned that they received some of the construction materials like rings, slabs, pipes, water seals, pans and even the entire latrine at free of cost from NGOs and GOs (union *parishad*) (Fig. 5.4).

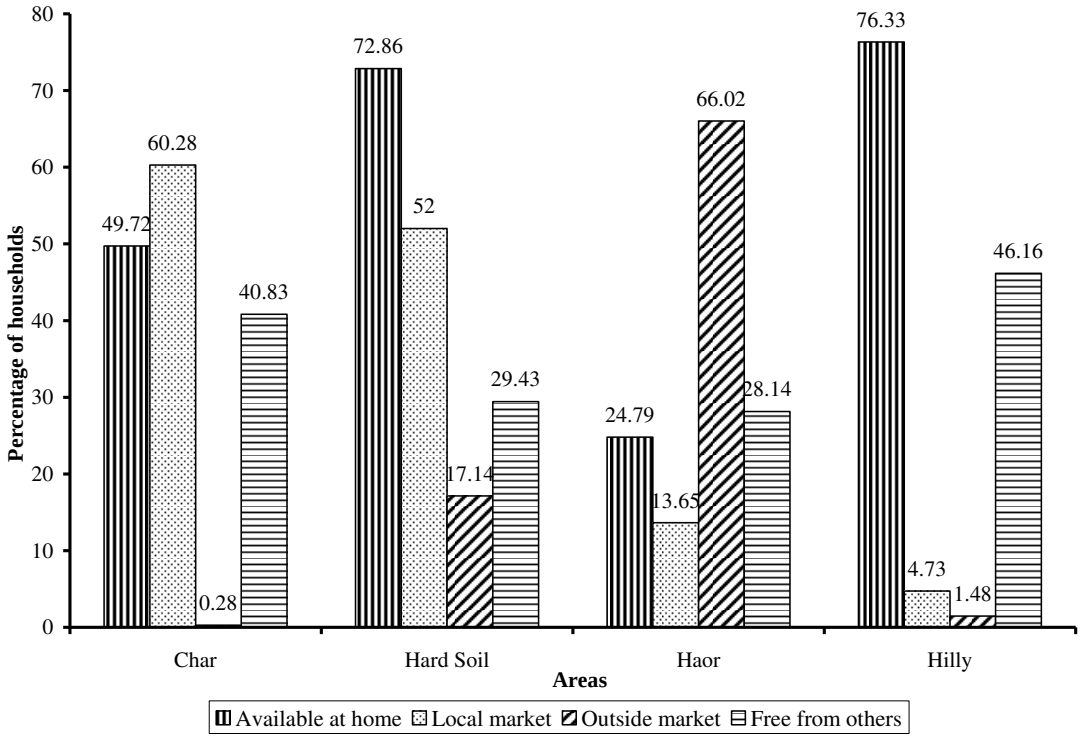


Figure 5.4. Household distribution by sources of latrine construction materials

5.6 Latrine construction and maintenance cost

Cost of installing a new latrine mentioned by the households in all the four areas, ranges from Tk. 50 to 1,000 or more depending on the type of latrine they use. Almost half of the households (49%) from all the areas mentioned that they did not spend a single penny to construct a new latrine whereas 54 to 65% of the households in *char*, hard soil and *haor* areas were using latrines provided by NGOs and the government which were at free of cost (Table 5.8). In hilly areas about 17% of the surveyed households did not spend anything on latrine construction (Table 5.8). It was found that 52% of the households in hilly area used close pit latrine and most of them had to reconstruct it in every six months. This was one of the reasons for which people of hilly area did not want to pay for latrine construction.

Table 5.8. Household distribution by latrine construction cost

Construction cost (Tk.)	*Char*	Hard soil	*Haor*	Hilly	All
Below or equal to 500	20.60	20.90	11.70	39.90	23.00
501 to 1,000	7.50	12.60	14.20	24.00	14.40
Above 1,000	4.5	9.1	15.0	1.8	7.8
No expenditure/free	65.3	56.3	54.3	16.9	48.6
N	360	350	359	338	1407

On the other hand, about 52% of the households did not spend any money for latrine maintenance and it was 89% and 83% respectively in hard soil and *char* areas (Table 5.9). On average, 40% of the household spent above Tk. 100 per year for latrine maintenance, while it was almost 81% in hilly area (Table 5.9).

Table 5.9. Household distribution by latrine maintenance cost

Maintenance cost (in Taka)	*Char*	Hard soil	*Haor*	Hilly	All
Do not spend	82.80	89.10	33.10	0.50	52.00
Below 100	1.70	0.30	3.60	0.60	1.60
Above 100	13.9	9.1	59.8	81.4	40.7
N	**360**	**350**	**359**	**338**	**1,407**

5.7 Assistance during latrine construction

On average, 56% of the surveyed households mentioned that they built latrines by their own means while the rest received assistance from the government or NGOs (Fig. 5.5). This rate was highest in hard soil area (64%) and lowest in hilly area (41%). In fact, in all the three areas other than hilly areas, people were found to be less dependent on GOs or NGOs in latrine construction.

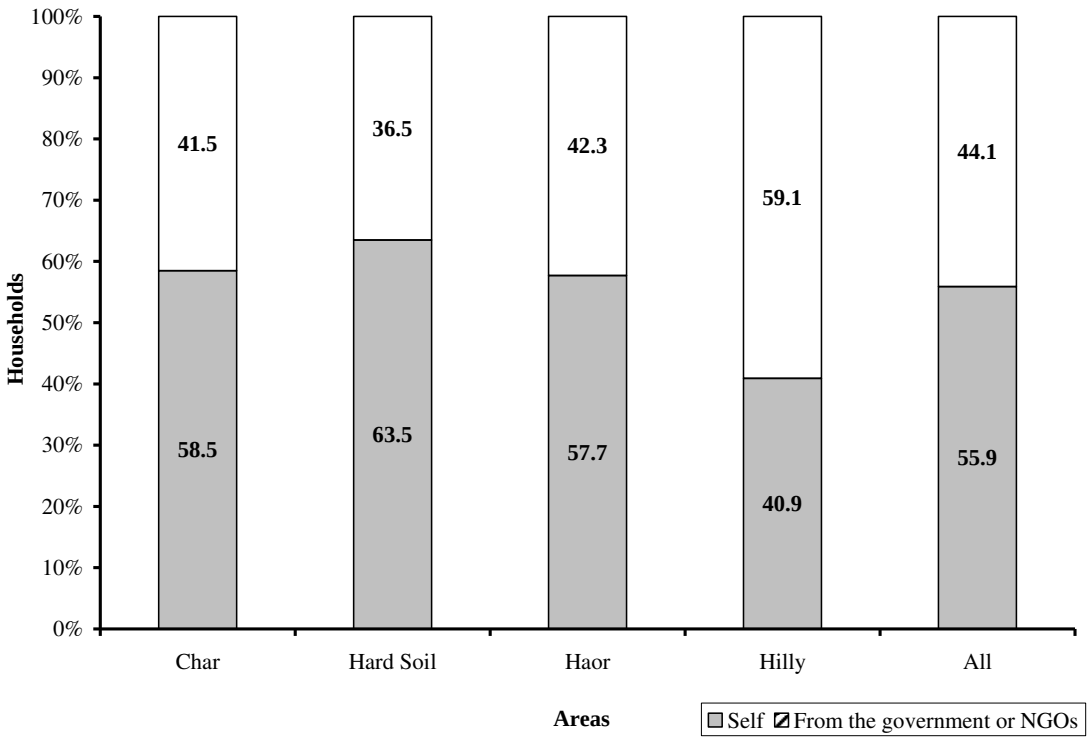


Figure 5.5. Assistance taken by the households for installing construction

Respondents from all the four areas answered that none of them received any financial or technological assistance during installing their latrines. About 61% of the households did not receive any materials like ring slab or labour (Table 5.10). On the other hand, about 30% of the households in *char* area answered that they received entire latrine free of cost while this was almost less than 1% in *haor* and hilly areas (Table 5.10). About 69% of them owned completely free latrines while the rest were sharing their latrines with their neighbours.

Table 5.10. Assistance received during latrine installation by the households

Assistance	*Char*	Hard soil	*Haor*	Hilly	All
Financial	0	0	0	0	0
Technology	0	0	0	0	0
Ring slab	12.7	20.2	24.7	56.5	27.0
Labour	0.3	0	0	1.1	0.3
Complete latrine	30.3	11.6	0.9	0.4	11.4
Nothing	56.7	68.2	74.4	42.0	61.3
N	**353**	**346**	**348**	**276**	**1323**

On average, 27% of the households got free ring slab of which 57% were found in hilly area and 13% in *char* area. Among these latrines, 10% were sanitary and water sealed, 43% without water seal, and 47% unsanitary type of latrine (Table 5.11). These unsanitary latrines included both closed and open pit latrines. However, no households in hilly areas were found to use sanitary or water sealed latrine who received free ring slab, rather 64% of them were using closed pit latrine. Only in *char* area, about 42% of the households were found to use water sealed latrine who received free ring slab (Table 5.11).

Table 5.11. Latrine type of the households who received free ring-slab

Latrine type	*Char*	Hard soil	*Haor*	Hilly	All
Sanitary	2.20	0	2.40	0	0.80
Ring slab with water seal	42.20	8.60	6.00	0	8.50
Ring slab without water seal	42.20	58.60	46.40	35.30	43.40
Closed pit	2.20	24.30	0	64.10	33.20
Open pit	11.10	8.60	45.20	0.60	14.10
N	**355**				

5.8 Age of the latrines

The age of latrine (pit) found to be ranged from one month to 15 years depending on the type of latrine. In hilly areas about 70% of the households responded that their latrine pits had age of less than two years (Table 5.12). None of these latrines were sanitary or water sealed, rather most of them (85%) were closed pit and open pit latrines. For hilly areas in terms of pit use duration the median value was 'less than two years' and mode value was same that means in both cases this value was centered to "less than two years". But in *haor* and hard soil areas mode value as well as the most occurring value of pit age was 'more than two years'. In hard soil area about 50% households responded that their latrine pits usually lasted for more than two years and here mode value was 'more than two years' (Table 5.12).

Table 5.12. Household distribution by latrine (pit) use duration

Latrine use duration	***Char***	**Hard soil**	***Haor***	**Hilly**	**All**
Less than 1 year	47.6	24.4	40.1	10.7	31.8
Less than 2 years	28.9	26.4	17.0	69.9	33.8
More than 2 years	23.5	49.3	42.9	19.4	34.4
N	**353**	**345**	**347**	**279**	**1324**

5.9 Ring slabs used in the present latrines

In hilly areas about 57% latrines had no ring slabs. Most of these were closed pit latrines. This rate was highest in haor area which was around 63%. However, ring slabs were found in most of the latrines (87%) of *char* and hard soil areas (Table 5.13).

Table 5.13. Household distribution by ring slab latrine

Ring-slab option	*Char*	Hard soil	*Haor*	Hilly	All
Not a ring lab latrine	13.1	24.3	62.4	56.8	38.9
Ring slab latrine	86.9	75.7	37.6	43.2	61.1

5.10 Water seal used in the present ring slab latrines

Water seal option was not used in most of the latrines (ring slab, closed pit) of hilly area (92%). This rate was 72% in hard soil areas. Therefore, among the four areas water sealed option was used in highest percentage (48%) in *char* area (Fig. 5.6).

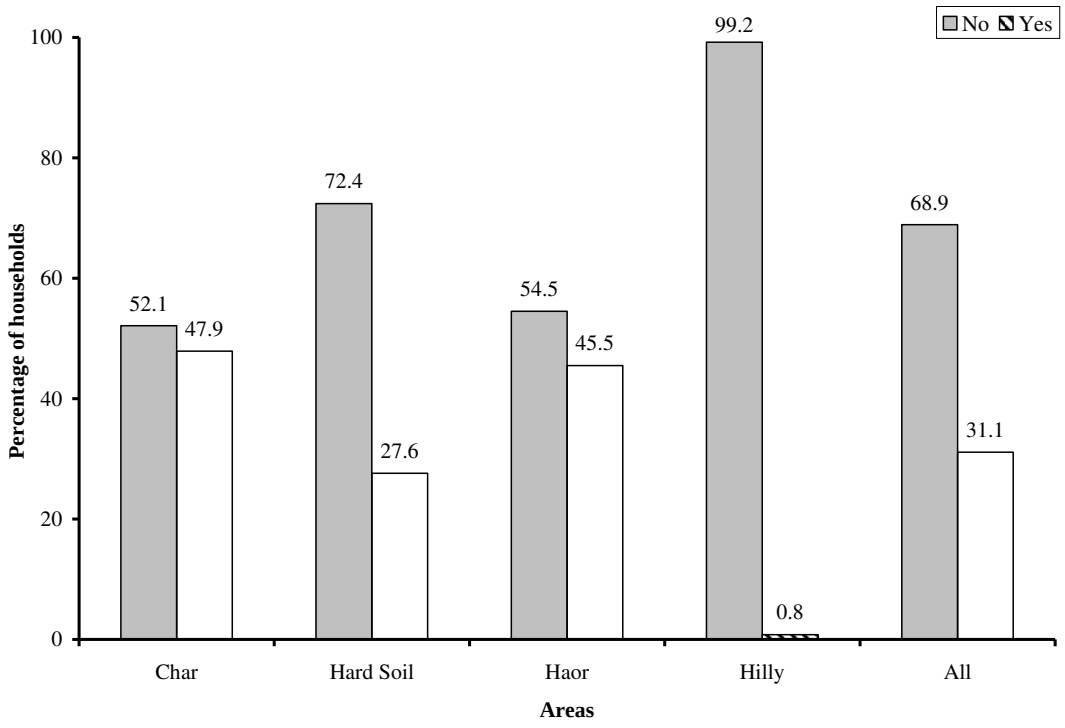


Figure 5.6. Latrines (ring-slab, closed pit) with water seal

5.11 Distance of the latrine from living space

Around 61% of the households were found who had latrine within 11 to 50 feet distance from their main living space (Table 5.14). For hilly area this rate was about 74%. On average, 13% of the households had latrine within 10 feet distance which was 0.3% in hill tracts and 31% in *haor* areas (Table 5.14).

Table 5.14. Household distribution distance of latrine from the main living room

Distance (in foot)	***Char***	**Hard soil**	***Haor***	**Hilly**	**All**
Below 11 ft (including attached)	7.5	12.9	30.9	0.3	13.1
11 to 50 ft.	67.2	55.4	49	74.3	61.3
51 to 100 ft	17.5	22.6	17	7.7	16.3
100 ft +	6.1	8	2.8	0.3	4.3
N	**360**	**350**	**359**	**338**	**1407**

5.12 Distance of water source and time to go to there

To reach to the water sources about 64% of the households in *char*, 62% in hard soil, and 56% in *haor* area had to go short distance of 11 to 50 feet, while around 91% of the households had to travel for more than 50 feet distance in hilly areas (Table 5.15). Very few latrines in the hilly and *haor* areas were found which had attached water source.

Table 5.15. Distance of the nearest water source from latrine

Distance (in feet)	***Char***	**Hard soil**	***Haor***	**Hilly**	**All**
Attached	4.4	6.2	0.2	0.2	2.3
1 to 10	24.7	14.1	16.1	0.7	13.9
11 to 50	63.7	62.0	55.6	8.4	47.5
Above 50	7.2	17.7	28.1	90.7	36.3
N	**360**	**350**	**359**	**338**	**1407**

CHAPTER SIX: REASONS FOR CHOOSING PARTICULAR SANITATION OPTION

6.1 Introduction

The choice of latrine options of the households was discussed in the pervious chapter. Here, the reasons behind those choices are described in terms of their satisfaction and dissatisfaction with the latrines.

6.2 Satisfaction and dissatisfaction with the present type of latrine use

Level of satisfaction and dissatisfaction among the households in using their current type of latrine was on average 57% and 43% respectively (Fig. 6.1). About 34% of the satisfied households were using sanitary latrine (Table 6.1). In hilly areas, about 91% of the respondents answered that they were happy with their present type of latrine even if 99% of these were unsanitary (Fig. 6.1 and Table 6.1).

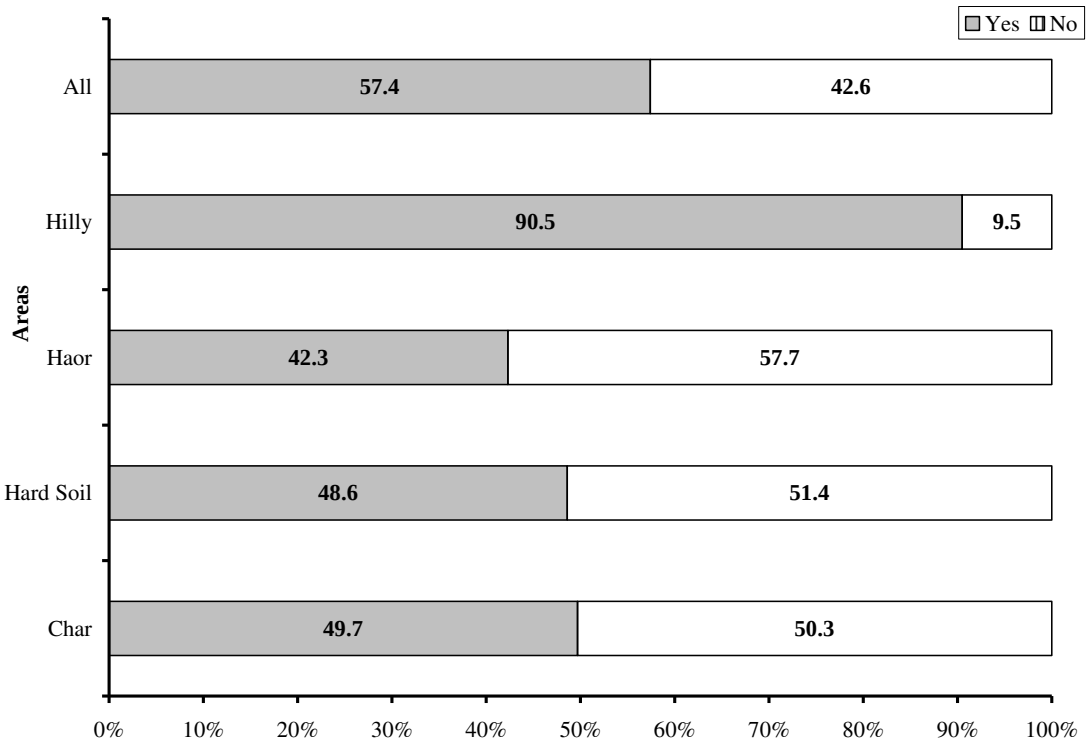


Figure 6.1. Households satisfied or not with the present use of latrine

Table 6.1. Distribution of satisfied and dissatisfied users by latrine use type

Satisfied with the latrine		*Char*	Hard soil	*Haor*	Hilly	All
Yes	Sanitary	60.9	41.8	57.9	0.7	33.5
	Ring slab without water seal	32.4	35.9	34.2	18.0	28.0
	Closed pit	6.1	19.4	0	61.8	28.9
	Open pit	0.6	2.9	7.9	6.9	4.8
	Open defecation	0	0	0	12.7	4.8
No	Sanitary	16.0	7.2	8.2	0	9.8
	Ring slab without water seal	33.1	47.2	31.9	6.2	35.5
	Closed pit	29.8	26.7	1.9	12.5	18.3
	Open pit	17.7	16.7	57.5	18.8	31.2
	Open defecation	3.3	2.2	0.5	62.5	5.2
N		**360**	**350**	**359**	**338**	**1407**

6.3 Reasons for dissatisfaction with present latrine use type

Almost half (49%) of the households from all the four areas mentioned unhygienic condition of their latrines as a reason for dissatisfaction, while individually it was 67% in *char* and 53% in *haor* area (Table 6.2). Unhygienic latrine conditions here considered as latrines which were open, broken, filled with waste, no water seal and one or no ring. Multiple answers were considered. About 36% of the 'dissatisfied' households were using ring slab latrine without water seal and 31% open pit latrine (Table 6.1). On the other hand, 30% of the households mentioned that they were dissatisfied with their latrines as they had to share latrines with other people (in other words use of community latrine) (Table 6.2). In *haor* area this rate was highest (38%). On the other hand, 22% of the households mentioned that their latrines were not user friendly for which they did not like those. In hilly area roughly 69% of the households mentioned that their latrines could not be used during disasters for which they did not like their latrines (Table 6.2).

Table 6.2. Households by reasons for dissatisfaction with present type of latrine

Reasons	***Char***	**Hard soil**	***Haor***	**Hilly**	**All**
Not user friendly	15.5	41.7	14.0	0	22.00
Not easy to construct/maintenance or costly	8.8	1.1	6.8	6.2	5.67
Cannot be used during disasters	10.5	0.6	3.4	68.8	8.17
Aesthetically not sound	13.8	19.4	26.1	3.1	19.17
Far from the house	7.7	25.6	1.4	0	10.50
Unhygienic*	67.4	28.9	53.1	21.9	48.50
Community latrine/used by many people	23.8	33.3	37.7	0	30.17
N	**181**	**180**	**207**	**32**	**600**

** unhygienic = open, broken, filled with waste, no water seal, less or no ring, etc.*

6.4 Reasons for satisfaction with the present latrine use type

On average, 44% of the households mentioned user-friendliness about their satisfaction with the latrine while it was around 80% for both *char* and hard soil area (Table 6.3). About 53% of these households were using sanitary latrines. On the other hand, 33% responded cheap construction cost as one of the reasons behind satisfaction with their latrine and this was highest in hilly area (64%). Both closed and open pit latrines were commonly used latrines by these people (73%) (Table 6.3).

Table 6.3. Households by reasons for satisfaction with present latrine

Reasons	*Char*	Hard soil	*Haor*	Hilly	All
Habituated with the latrine	17.3	8.8	61.2	33.3	29.86
User friendly	79.9	82.4	45.4	0.3	43.74
Cheap construction	16.2	6.5	21.7	64.7	33.58
Can be used during disasters	3.4	8.2	28.3	0.7	8.05
Easy to maintenance/clean	31.8	10.6	3.3	0	9.91
Near to house/at a safe distance	35.8	20.0	31.6	1.0	18.46
Hygienic	16.8	0.6	1.3	0	4.09
Others	14.5	22.3	35.9	0	14.49
N	**179**	**170**	**152**	**306**	**807**

6.5 Reasons for open defecation

Most of the people of *char*, *haor* and hard soil area who were habituated in open defecation did not want to answer about their choice for open defecation, while in hilly area about 63% answered about their habituation in preferring such defecation practice (Table 6.4). Multiple responses were considered.

Table 6.4. Distribution of households satisfied with open defecation

Reasons	*Char*	Hard soil	*Haor*	Hilly
Habituated with the latrine type	0	0	6.8	62.8
User-friendly	0	7.7	5.3	0
Construction is cheap	0	5.1	2.3	7.0
Near to house	0	2.6	1.5	0
Not answered	97.4	87.2	90.9	30.2

6.6 Opinion about improved latrine (willingness to pay)

Here improved latrines were considered which were sanitary or had water seal option with ring slab. In hilly areas most of the households (94%) opined that they wanted an improved latrine even though most of them were satisfied with their present use whereas it was about 51% on average (Fig. 6.1 and 6.2). In this demand curve, households of *haor* area were at the bottom (28%) (Fig. 6.2).

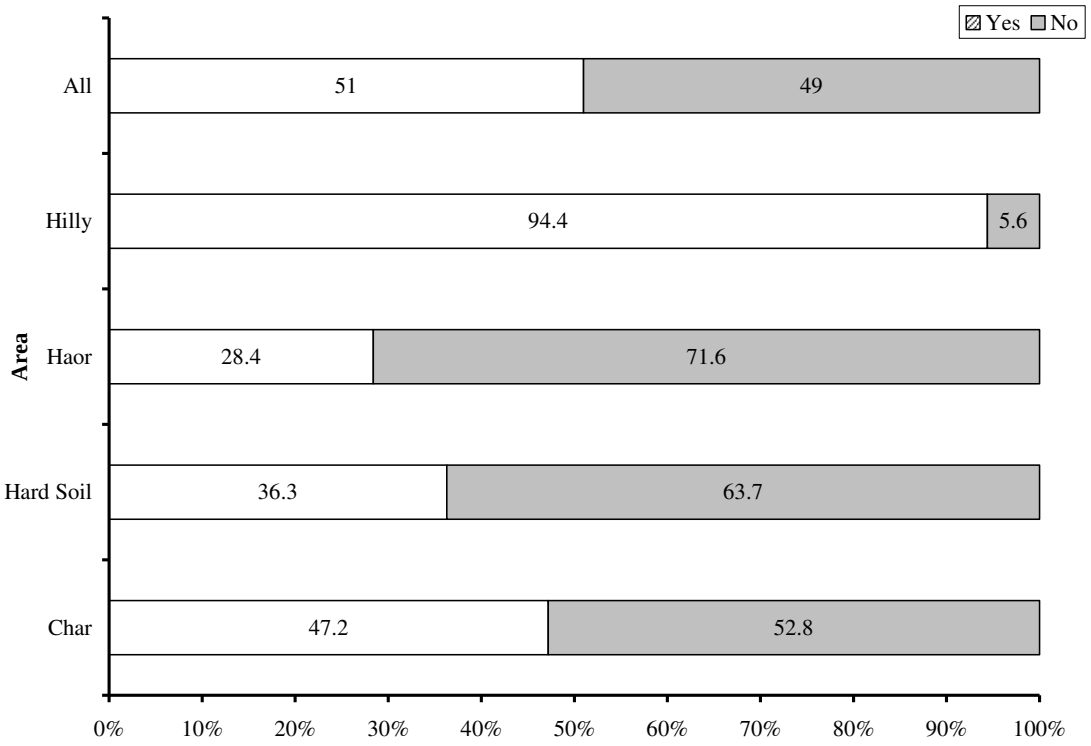


Figure 6.2. Households want improved latrine

But in terms of economic status in *haor* area 10% of the ultra poor people wanted a better latrine. This rate was 11% for poor class and 32% for non-poor (Table 6.5). On the other hand, in hilly areas about 88% the ultra poor, 92% of the poor, and 96% of the non poor wanted improved latrine since 99% of them were using unsanitary latrine and all these values were found significant using the Pearson's chi-square test (Table 6.5).

Table 6.5. Distribution of households, want a better latrine by economic class

Economic class	Want an improved latrine	*Char*	Hard soil	*Haor*	Hilly	P-value
Ultra poor	Yes	50.0	25.0	10.0	87.5	P<0.01
	No	50.0	75.0	90.0	12.5	
Poor	Yes	49.4	32.6	11.3	92.4	P<0.001
	No	50.6	67.4	88.7	7.6	
Non-poor	Yes	44.8	38.0	32.1	96.0	P<0.001
	No	55.2	62.0	67.9	4.0	

Among the households who did not want an improved latrine, about 50% of them mentioned about lack of money and 47% was satisfied with their present use (Table 6.6). In *haor* area around 65% mentioned lack of money behind their unwillingness to construct an improved latrine while 67% in *char* area mentioned their satisfaction with the present latrine use. In hilly areas about 16% did not want an improved latrine (water seal) as it required more water (Table 6.6).

Table 6.6. Distribution of households who doesn't want an improved latrine

Reasons	*Char*	Hard soil	*Haor*	Hilly	All
Does not have money	33.2	47.5	65.4	42.1	50.1
Satisfied with the present latrine use	65.8	48.9	32.3	42.1	47.2
Requires more water	0	0	0	15.8	0.4
Space scarcity	0	1.8	2.3	0	1.4
Others	1.1	1.8	0	0	0.9
N	**190**	**223**	**257**	**19**	**689**

On the other hand, 5% of the households who wanted an improved latrine did not want to pay for this while almost half of them (53%) mentioned their ability to pay less than Tk. 1,000. Most of the households (96%) of hilly areas did not have the ability to pay above Tk. 1,000 for an improved latrine while about 91% in *haor* area mentioned their ability of paying above Tk. 1,000 (Table 6.7).

Table 6.7. Distribution of households, want to pay for an improved latrine

Money want to pay	***Char***	**Hard soil**	***Haor***	**Hilly**	**All**
Do not want to pay any	10.6	8.7	0	3.1	5.4
As per need	0	0	1.0	0.3	0.3
Below 1000 tk.	27.1	15.7	7.8	95.6	52.8
Above 1,000 tk.	62.4	75.6	91.2	0.9	41.5
N	170	127	102	319	718

Among the 51% households who wanted an improved latrine, 18% opined for ring slab type, 11% sanitary latrine, 10% improved super structure, and 2% mentioned that they needed water seal in their latrines (Table 6.8). Individually in *char* and hard soil areas about 30% households answered about ring slab as additional features with their present type of latrine.

Table 6.8. Responses of wanting additional features with improved latrine

Features*	***Char***	**Hard soil**	***Haor***	**Hilly**	**All**
Anything, necessary for a better latrine	0.2	0	1.0	21.3	9.66
Ring slab	31.0	29.9	6.2	11.1	18.43
Sanitary latrine	15.5	12.9	23.9	3.1	10.72
Improved superstructure	23.3	20.7	7.5	0.1	10.31
Water seal	3.9	1.0	0	1.0	1.58
Others	2.6	1.3	7.5	0.1	1.94
Not answered	20.8	34.2	48.7	63.2	45.96
N	**510**	**381**	**306**	**957**	**2154**

** Multiple responses were considered.*

6.7 Reasons for choosing particular latrine option by the people

Most of the people of hilly areas were found to use unsanitary type of latrine which mainly included closed pit latrines (Fig. 5.1). These were built using locally available bamboo/bamboo fence, dry banana leaves and wood without ring slab and water seal option (Fig. 5.4). Most of the households in hilly areas mentioned about cheap construction and convenience of using the latrine as factors behind choosing respective latrine type (Table 6.3). It was expected that since the latrine construction materials were locally available and people of these area got them free of cost, they would prefer this unsanitary type of latrine.

In *char* area, most of the households mentioned user-friendliness as one of the reasons behind using particular latrine type (Table 6.3). Most of these were ring slab latrines which they purchased or received from the government or NGOs. But still there were a good number of households in this area who were using un-sanitary latrines and satisfied with the use (Fig. 5.2). User-friendliness was also mentioned by the households of hard soil area (Table 6.3). The area is a plane land and bears relatively less physiographic sophistication compared to other three areas. Lack of awareness or ignorance might be one of the reasons behind this higher rate of satisfaction with un-sanitary type latrine (RED 2008). On the other hand, in *haor* area, households mainly mentioned 'habituation' and 'user-friendliness' as reasons for using particular latrine type and 29% of them were using sanitary latrine (Fig. 5.2).

6.8 Demand for sanitary latrine

Demand for improved and healthy latrines was highest in hilly areas as most of them were found to use un-sanitary latrines (Fig 5.2 and 6.2). Although most of them were satisfied with their present type of latrine, hence they opined that they wanted improved latrines if they could be provided with some better options (Fig. 6.1). As people of this part mainly relied on free or locally available resources for their latrines, most of them, irrespective of all economic classes, did not want to pay more than Tk. 1,000 for the improved latrine (Table 6.6). In fact, they believed that they could manage to install an improved latrine by less than Tk. 1,000 and using locally

available materials which they got free of cost. Therefore, it can be said that if they were provided with some low cost options of sanitary latrine, sanitation coverage in this part would be improved.

But in *haor* area, most of the households did not want an improved latrine and they mentioned about their economic inability which restricted them to install an improved latrine, although a small portion of them were using sanitary latrines (Fig. 5.2, 6.2 and Table 6.6). Major employment of these people was mainly agriculture (farmer) and day labouring who remained unemployed during monsoon flood every year (Table 4.1). About 42% of them were satisfied with their present latrine type (Fig. 6.1). During in-depth interviews people of this area mentioned that they were usually concerned about their livelihood and protecting houses during flood rather than latrines. According to almost half of the households, they received latrines every year from the government and NGOs and about half of them spent nothing for latrines (Fig. 5.5). Construction of an improved latrine in *haor* area requires elevating the latrine floor, cemented rings for leaching durable side walls, mounding the sides with sand which requires money more than what they usually spends (Kazi and Rahman 1999). Introduction of low cost area-specific latrine option would be useful for this area as well.

Almost half of the people in *char* area were found who wanted an improved latrine (Fig. 6.2). People living in this area experienced floods regularly every year and about half of them were poor (mainly daily labourer in occupation) (Table 4.1). Moreover, flood washed out their homesteads along with latrines every year and during this time they had to reside on the embankments (HKI 2003 and Kazi et. al. 2003). After getting back to their homes, these poor people have to reconstruct their houses along with latrines. During in-depth interviews they reported that sometimes they relied on free assistance from the government and NGOs to construct latrine, otherwise they chose un-sanitary options for defecation or even open defecation. For these reasons they did not want to invest on new improved or sanitary latrine every year and this results their less demand about improved latrine (Fig. 6.2).

CHAPTER SEVEN: COMPARISON AMONG SANITATION TECHNOLOGIES

7.1 Introduction

In this chapter the sanitation technological options which were being practiced in the selected environmental critical areas of the country are discussed along with the proposed as well as prescribed options. Most of these sanitation options mentioned here are low-cost to medium cost. These discussions are mainly based on the secondary sources of information collected from different books, journals, articles, and electronic reports from internets. Some of these were identified from some recent studies on sanitation. These were mainly some excreta-disposal systems that offer different degrees of user convenience, protection against the spread of diseases and water demand for their operation (Navarro 1994). There are on-site and off-site systems of sanitation option. On-site sanitation systems include those in which safe disposal of excreta takes place on or near the plot or site of the toilet whereas off-sites include those in which excreta are collected from individual toilets and carried away from the plot to be disposed of (Navarro 1994). In this chapter all the sanitation technologies are discussed and compared are mainly on-site systems, only few of them are off-site (Appendix 4).

7.2 Sanitation technologies (hardware) used in Bangladesh

A good number of organizations, both government and non-government have propositions regarding area-specific sanitation technology (Appendix 1). To conceptualize on sanitation technologies a number of organizations were contacted. Most of the organizations were practicing conventional ring slab sanitation technological options. Only few organizations were found who have area-specific intervention regarding sanitation technological options (hardware). Though these organizations had several sanitation technological options but in this study technologies which were low cost and appropriate for critical areas, were considered. Not all the mentioned technologies were implemented. Some area-specific technologies were there but very few of these were implemented and few were in the

experimental level. All these propositions were reviewed and it was found that to some extent there were some similarities in the latrine designs prescribed by different organizations though they differed in name. Sanitation technological options practiced/mentioned by the organizations along with the project area and status of the technology are discussed below.

7.2.1 Pour flush latrine

Water seal (pour-flush) latrines are almost similar to simple pit latrines, but instead of having a squatting hole in the cover slab, they have a shallow toilet pan with a water seal. In the simplest type, excreta falls directly into latrine pit when pan is flushed with a small quantity of water. Pour-flush latrines can be connected at a later stage either with a septic tank, from which effluent can be disposed of by means of subsurface-soil absorption, or with a small-bore sewer system. It may be possible to install such latrines, depending on its location and availability of pour-flush pans.

This type of latrine can be built with super structure of tree/bamboo fencing with tin or wooden shed, plastic pan with water seal, pipe, bamboo/wooden/clay/cement platform and eight to ten feet direct pit and without ring support. It costs about Tk. 75 excluding super structure and labour, and lasts about four to five years. If three rings can be used then it will cost around Tk. 550. The latrine can restrict odor from pit, and mosquitoes and flies cannot go inside the pits. It is easy to keep clean and construction process is comparatively simple. People can use locally available materials to construct this type of latrine. But the latrine requires availability of sufficient water and regular cleaning. This type of latrine technology is being practiced by Water Aid Bangladesh and its partner NGOs viz. NGO forum for drinking water supply and sanitation, Greenhill and Tahjingdong in Chittagong hilly areas along with other plain land areas of the country.

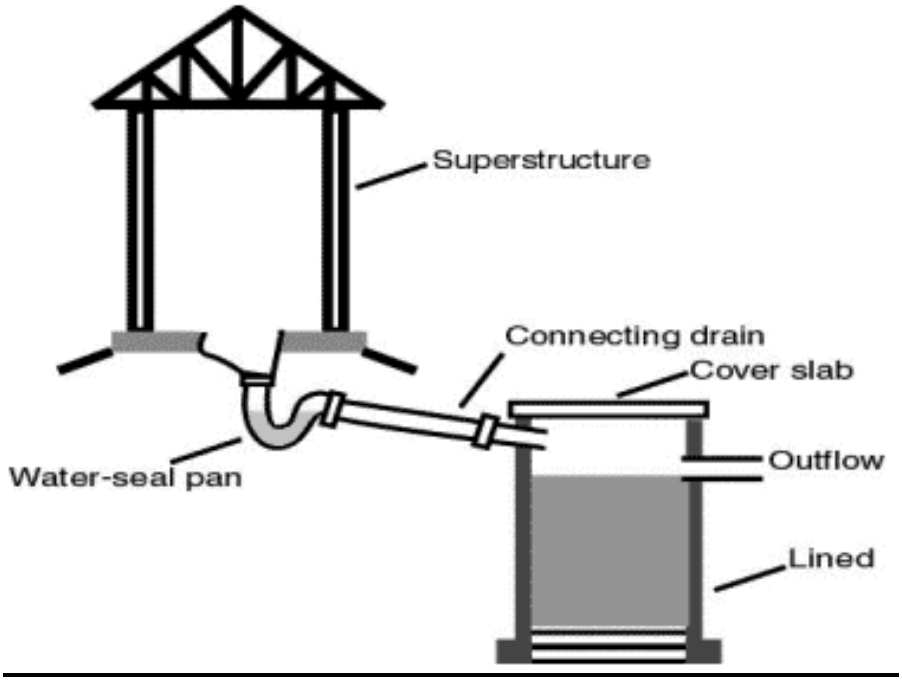


Figure 7.1. Pour flush latrine

7.2.2 Offset pit latrine bend with lid and without water seal

This type of latrine is built like the pit latrine but water seal is not used here. Pan, bend pipe and air pipe (made of plastic) is used here along with bamboo or wood built latrine platform, pit cover and superstructure. Ring is not used and pit is dug with four to five feet deep hole using slope of hill so that excreta can enter to the pit from pan through a pipe with minimum water use. This type of latrine is useful for hilly areas where water is scarce. The latrine is built with bend pipe with lid for which it is able to restrict odor, mosquito and flies. It has all the merits like water sealed pit latrine but comparatively requires more space and construction procedure is cumbersome as well. Due to use of local wooden materials, super structure of latrine cannot last long. During *jhum* cultivation when the ethnic people leave their houses for four to six month, white ants destroy all these. For this, they need to change upper part of the latrine in every six months. This type of latrine costs about Tk. 85 to 100 (excluding super structure and labour) and lasts about four to five years. This type of latrine technology is also being practiced by Water Aid Bangladesh and its partner NGOs viz. NGO forum for drinking water supply and sanitation, Greenhill and Tahjingdong in Chittagong hilly areas.

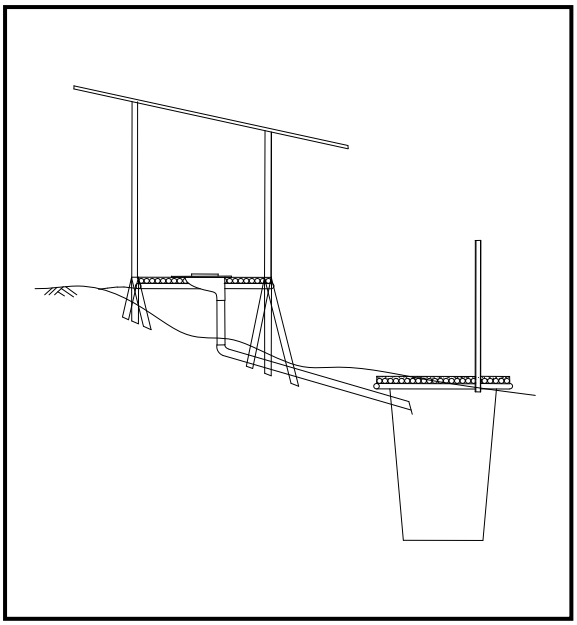


Figure 7.2. Offset pit latrine bend with lid without water seal

7.2.3 Community innovated offset pit latrine

VERC, one of the NGOs working in sanitation in hilly areas, has prescribed this latrine technology. This is mainly an offset pit latrine which is invented by community people. Glass shape six feet deep pit, four inches diameter and four feet long PVC pipe from pan to pit, five feet long PVC pipe of 1.5 inches diameter as air pipe, bamboo-made pit cover, and plane sheet pan are required. Bamboo-built super structure is used in this type of latrine which costs only Tk. 110 and requires less water as waste follow the pipe slope. It is comparatively sustainable and mosquitoes and flies cannot enter the pit. Construction materials are locally available. Usual life span of this latrine is maximum two years. Bamboo-built pit cover may collapse during heavy rain and it requires comparatively more space than other options. Therefore, reinforced concrete cement (RCC) pit cover can be used instead of that. There is a chance of odor during use of this latrine option.

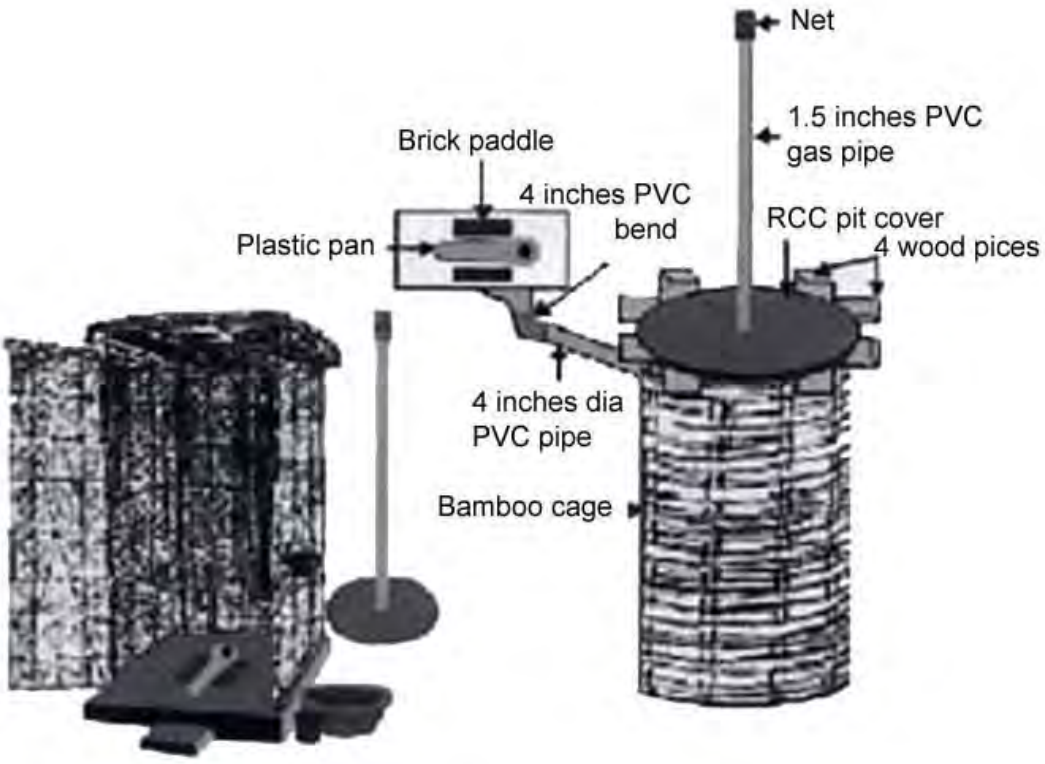


Figure 7.3. Community innovated offset pit latrine

7.2.4 Earth stabilized raised pit latrine

This type of latrine is useful for flood-affected areas. The latrine is built with earth raised platform after measuring the highest flood level. One RCC slab and eight rings in eight feet deep pit are used. Stair is provided with it. NGO Forum for Drinking Water Supply and Sanitation and its associate organizations has prescribed this latrine technology for flood-affected areas of Bangladesh. It costs Tk. 1,500 excluding superstructure. The latrine can be converted to community latrine so that more than one family can be benefited during floods.

International Training Network (ITN) of BUET also has prescribed another type of 'Earth Stabilized Raised Pit Latrine'. This latrine is built with earth raised platform (one foot above the flood water level and three to four feet from ground level), porous lining, 30-45 degree slope, squatting slab, eight rings, stair and eight feet deep pit. Any type of pit lining (porous/non-porous) can be used above the ground level for

raising the pit. This technology can be used in combination with any other type of pit latrine such as single pit, double pit and pour-flush latrine. On average, the cost of each latrine is Tk. 1,220 to 1,246 with Tk. 232 every year for repair. Therefore, this type of latrine is relatively costly. Convenient space may not be available to construct this latrine and determination of flood water level may cause problem.

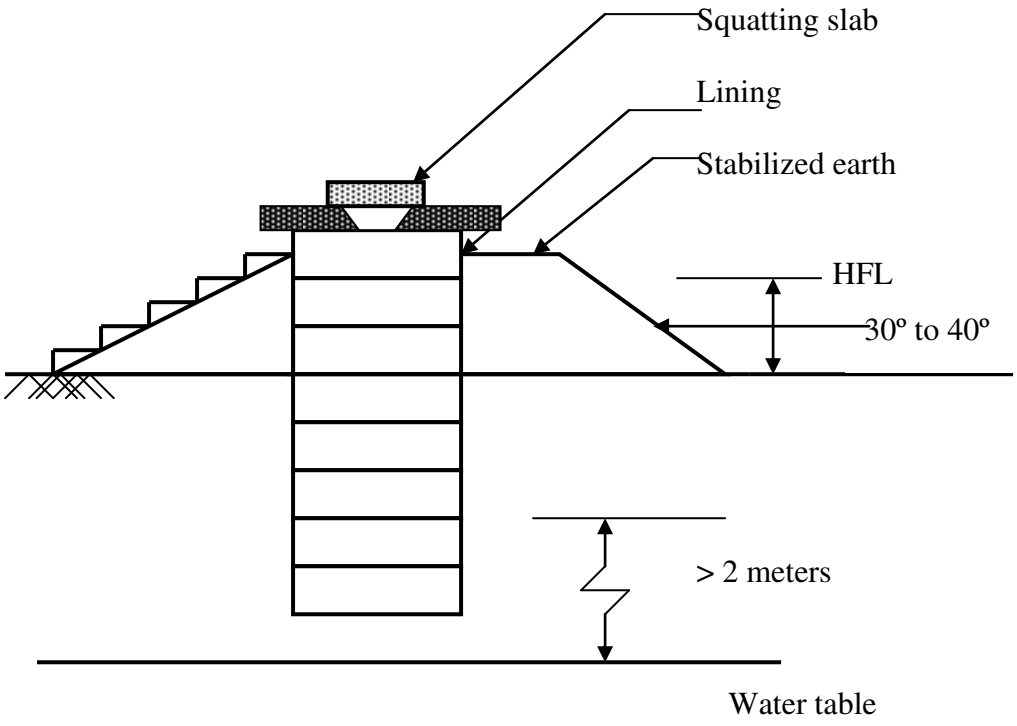


Figure 7.4. Earth stabilized raised pit latrine

7.2.5 Sand enveloped pit latrine

This latrine design is suitable for high water table and flood-affected areas. It is built with 500 millimeters thick sand envelope, impermeable pit bottom, made of plastic sheet or puddle clay. Minimum horizontal distance from drinking water source is 10 meters (Kazi and Rahman 1999). Sand envelope is taken up to 0.3 meter above the top of inlet pipe to exclude any surface drainage directly entering the sand envelope. Life span of this latrine is two years. This latrine costs Tk. 1,140 which is comparatively costly. Convenient space may not be available and huge sand is needed for this type of latrine. This latrine technology is practiced by ITN-BUET and NGO Forum for Drinking Water Supply and Sanitation.

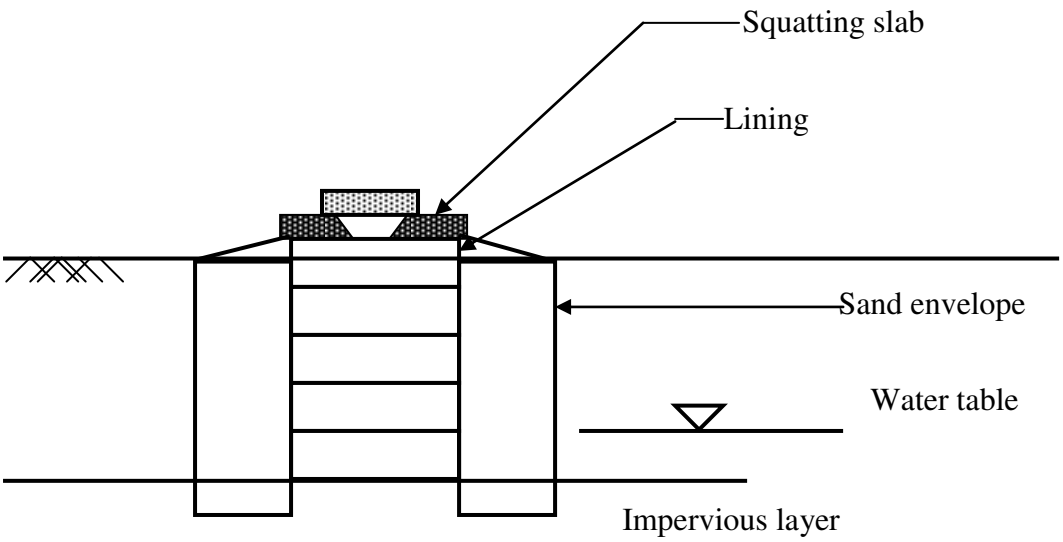


Figure 7.5. Sand enveloped pit latrine

7.2.6 Step latrine

Step latrine is prescribed by ITN-BUET for flood-affected areas. Design of this latrine is same as earth stabilized raised pit latrine. Pit is excavated during dry season. Non-porous lining is used with water sealed extended portion by plastering both sides. Water sealed section of the lining is extended one to one and half feet immediately below the ground water level. The latrine costs Tk. 930. It is durable and requires relatively smaller horizontal space than earth stabilized raised pit latrine. Lining of the latrine above ground level is needed to make it strong and durable to support the infrastructure. Step is provided with the latrine.

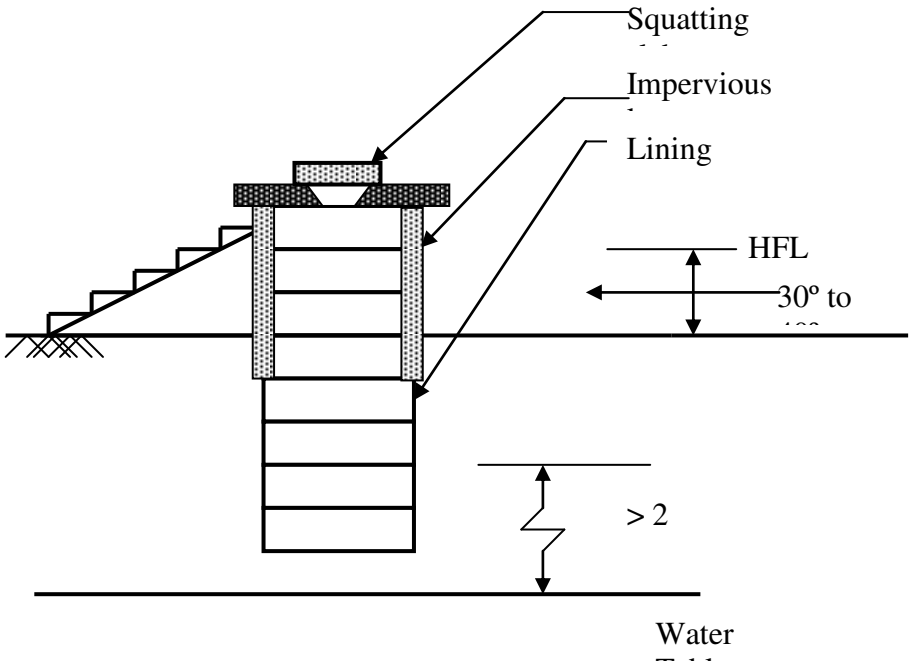


Figure 7.6. Step latrine

7.2.7 Mound latrine

This is another latrine option effective for flood prone area. This option is prescribed by ITN-BUET. A thick mound of soil surrounds the extended portion of the pit. Mound of permeable soil in a part of the section of the lining is used as leaching area. Pit lining is extended above ground level and side slope is built stable. This latrine is easy to construct and earthen steps can be used. This latrine option is suitable for the areas where space is limited and watertight linings are not available. It costs Tk. 838 and not recommended for the clay soils.

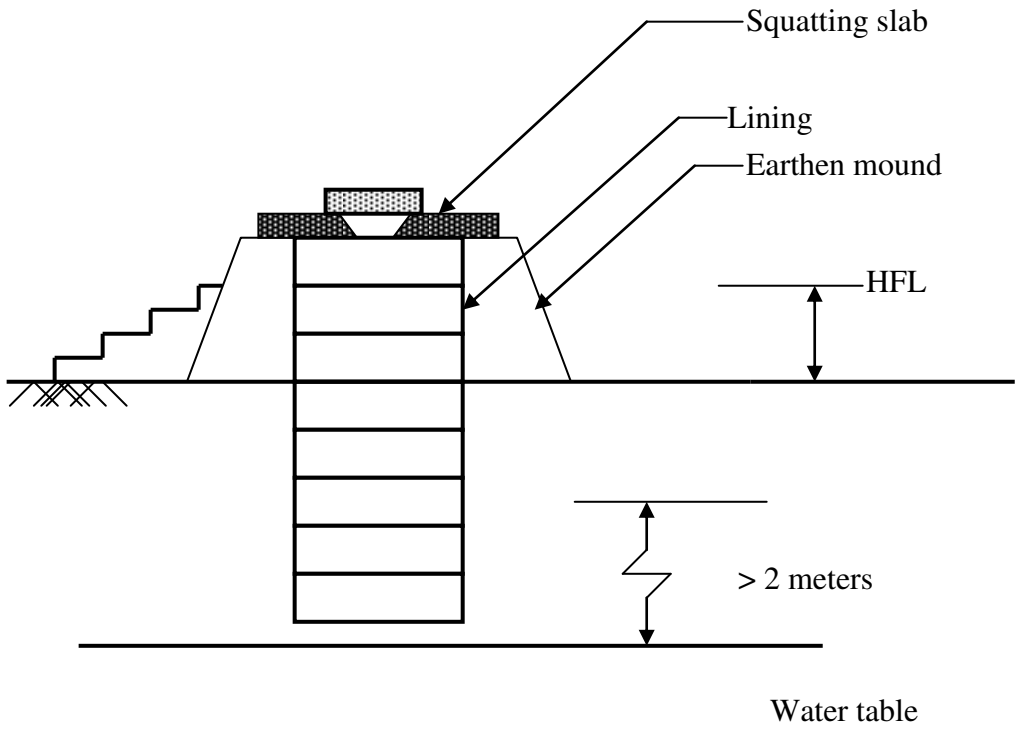


Figure 7.7. Mound latrine

7.2.8 Raised latrine

This latrine option is prescribed by a GOB/UNICEF project implemented by DPHE for flood-affected areas. The latrine is built with glass shape six feet deep pit hole, three to five rings, and one slab. Rings are set aboveground level and sealed with cement, and sand coat to prevent seepage. Earthen mound is used with certain slope. The latrine costs Tk. 550 to 600 including Tk. 50 to 100 for yearly maintenance. The latrine is usable during floods and there is a less chance of contamination of nearest water body if safe distance is followed. It is relatively easy to construct but may not be comfortable for children and old people. It requires relatively large space. Its maximum life span is three years.

7.2.9 Sand enveloped raised pit latrine

In the areas that experience seasonally high groundwater table or that are prone to flood, constructing affordable on-site sanitation facilities, can be problematic (Parry-Jones et al. 2005). Therefore, in these areas sand enveloped raised pit latrine will be effective. Sariakandi *char* area of Bogra is one of such areas which experiences both flood and high water table problem. This type of latrine option is basically envelop of sand around the pit of earth stabilized raised pit latrine, step latrine and mound latrine. It costs around Tk. 1,500.

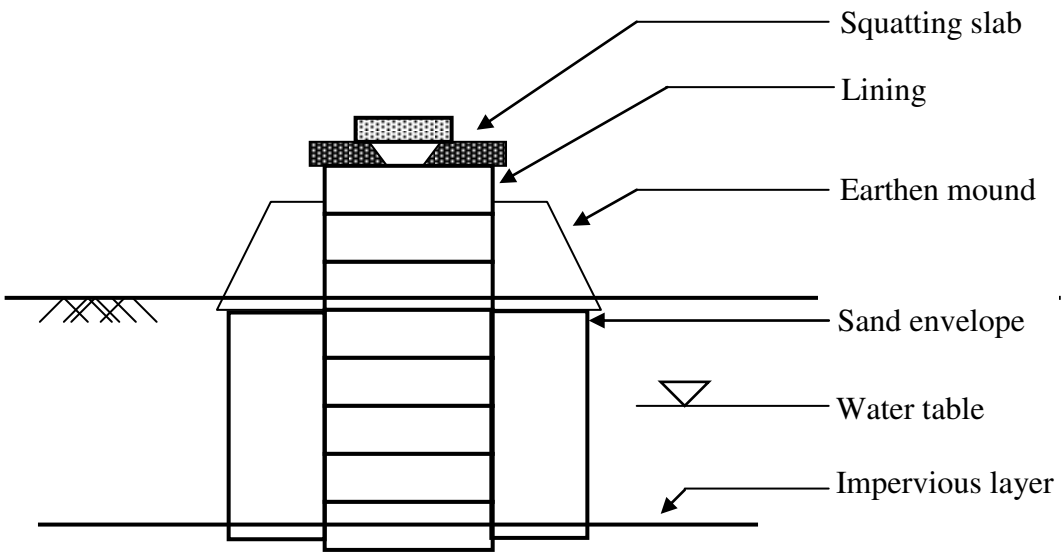


Figure 7.8. Sand enveloped raised pit latrine

CHAPTER EIGHT: ENVIRONMENTAL CONSEQUENCES OF THE SANITATION TECHNOLOGIES CURRENTLY BEING PRACTICED AND/OR PRESCRIBED

8.1 Introduction

One of the main objectives of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease. This results in the removal of harmful pathogens from the environment which has broad health benefits. It is well know that human waste (excreta) is smelly, attracts flies, and unless it is managed effectively diseases can spread quickly killing thousands. Human feces may contain a range of disease-causing organisms including viruses, bacteria and eggs or larvae of parasites (Wisner and Adams 2002). One gram of feces can contain 10 million viruses, 1 million bacteria, 1,000 cyst parasites and about 100 worm eggs; so the danger of disease is massive (Global Education 2010). Therefore, whenever for any ill designed sanitation option this danger comes into contact of human beings, it degrades environment and causes health hazard. Having and using a latrine therefore, can protect and improve health of our families and communities (WSP 2009).

During the field investigation a number of sanitation options were found to be practiced by the people of study areas. Some of these were sanitary and some were un-sanitary. In this chapter environmental consequences of both these options were examined and these were done using secondary information. Besides, some prescribed 'area-specific sanitation technologies' were also examined and their environmental consequences were briefly described.

8.2 Environmental consequences of current technologies practiced

From the field investigation it was found that there were six broad categories of latrine options currently being practiced in the study areas. These were:

1. Sanitary latrine (including septic tank and water sealed ring-slab latrines)
2. Ring slab latrine without water seal
3. Closed pit latrine
4. Open pit latrine
5. Hanging latrine
6. Open defecation (including defecation in bush, road/river side, here and there).

These six categories can be divided into two broad categories of sanitary and un-sanitary latrine options. However, except the first one, all others are the un-sanitary options. Environmental consequences of these currently practiced options are mentioned in the following section:

8.2.1 Ring slab latrine

About 31% of the population in all the four areas was found to use ring slab latrines. There is no doubt that a well-designed ring slab latrine can restrict human or animal contact from human feces, and this must include water seal and cemented rings. In fact, some reports indicate ring slab latrine as a low-threshold technology of sanitary latrine (Governance World Watch 2006). Also ring slab latrine is such a low cost latrine option that is very much helpful to reduce environmental degradation as well as diarrhoea diseases caused by ill-sanitation. Still a good number of people in Bangladesh consider ring slab latrine or *chaka paikhana* as one of the safe and hygienic latrine options (Choudhury and Hossain 2006). But there is a common practice in Bangladesh that people install latrines but do not use them. They break the middle ring and allow contents to flow out into a nearby ditch, break the water-seal and let the contents overflow (Hanchett and Nahar 2003). Whenever, such things happen, that is, excreta is exposed, environmental degradation takes place. However, usually ring slab latrine is considered as minimum level of sanitation practice to protect environment.

In ring slab latrines, usually 2 – 5 rings are used, therefore, the depth ranges from 3 – 7 feet. Sometimes in some areas people also dig ten feet deep pit their latrines. Contamination of soil and ground water through such pits depends on the soil texture and ground water level of the respective area. In *haor* and *char* areas water table is relatively high. So, if this water level is not measured or considered in putting the rings and sealing them with cement, chances of water contamination will increase.

8.2.2 Closed pit latrine

The conventional pit latrines where ring or concrete slab or water seal is not used, is termed as 'closed pit latrine'. Excreta are deposited in a fixed and closed place. Such latrines are often found in the rural areas of Bangladesh and some other developing countries of the world to be built with 4 – 10 feet deep pits (direct or offset) (Kazi et. al. 2003). Sometimes these are found to be covered with concrete or wooden logs or bamboo built slabs and in most of the cases the water seal is not used, the cost is zero and no specialist skill is used (Farmer 1998). Such latrines collect excreta in a pit dug in the ground beneath the toilet structure. During storage in the pit decomposition of organic substances takes place under anaerobic conditions and it releases gases (carbon dioxide, methane and sulphuric gases) and reduces the volume of sludge (UNEP 2010). Since no water seal is used, these gases come out easily from the pit, produce unpleasant odor and allow flies to breed easily (UNEP 2010).

Rings or any other protected side wall are used in the closed pit latrines which allow seepage of water into the surrounding soil at the sides and bottom of the pit (UNEP 2010). During seepage further decomposition of organic matter by soil bacteria takes place reducing BOD (Biochemical Oxygen Dissolved) of the water. Bacteria and viruses will also die during storage as the water percolates through soil. Bacteria under these conditions generally do not remove nutrients, so pollution of groundwater will occur. These latrines pose problems when groundwater is shallow and pit is beneath the groundwater or close to it. There is no soil barrier to protect the water quality of the groundwater, and mosquitoes may breed inside the pit. In Bugiri town, Uganda, it was found that pit latrines were the key determinants to groundwater contamination (Kabongo and Kabiswa 2008). Although these latrines are much better

than open pit, hanging latrine or open defecation, nevertheless from health and environmental points of view these latrines are not recommended generally for any of the areas in this study (Kazi et. al. 2003).

8.2.3 Open pit, hanging latrine and open defecation

Open pit latrine, hanging latrine and open defecation, all these three types have same kind of environmental consequences. In such latrines, excreta come directly into the contact of human being or animal and thus transmit pathogens into the environment. These are such unsafe defecation practices which are noticed by many people of Bangladesh (Choudhury and Hossain 2006). Excreta are found in open places, uncovered, spreading odors and other germs to spread diseases. Air pollution, foul smell and unclean places are resulted from these defecation practices. And this is well known that how dangerous these can be if these get contact with human being or other animals. It degrades environment through mixing with the nature, contaminates soil, air and water resources (most of the cases both surface and ground water sources) (IDS 2008).

More specifically, if only open defecation is considered then it has been found that environmental effects of open defecations are many. This is like eating own and neighbour's shit (IDS 2008). It pollutes ground water, contaminates agriculture procedure and spread diseases like diarrhoea, cholera and bilharzias (Water Aid 2010). Prevalence of diseases due to open defecation is one of the commonly mentioned issues since it spreads diseases like diarrhoea, dysentery, worm infection, cholera, jaundice and some other skin diseases (Choudhury and Hossain 2006). Apart from these, open defecation in Africa is also responsible for malaria. Pit latrines, used by a majority of Tanzanians in rural and urban areas, are healthy breeding grounds of mosquitoes that transmit malaria (The Citizen 2010).

Due to open defecation, hanging latrine and open pit latrines, human excreta is directly exposed to the environment and the pathogens they contain are being disposed into the general environment where they can contaminate water sources or be spread by insect, human or animal vectors causing oral-fecal route disease

(Howard et al. 2006). Sometimes it provides nutrients to the soil and used as fertilizer but whenever it saturates, it starts to degrade environment (Phuc et al. 2006). Hanging latrines are normally built besides low lands, ditches, ponds, canals, rivers, etc. It degrades two most valuable items of environment that is soil and water. Like soil, whenever it saturates water, it becomes polluted, contaminates groundwater and thus leads to public health risks from drinking water (Howard et al. 2006).

In all four study areas, about 22% of the population was habituated in all these three types of defecation which were degrading environment. In *haor* areas about 38% of the people were using such latrines with a belief that these waste as well as excreta would be washed out during floods which would ultimately work as natural fertilizer for fish. But, since they used these latrines for at least six to eight months, it severely pollutes the environment. Almost similar situation was observed in *char* areas. Here, people moved from the *char* lands to the highlands during floods and since they built their houses in temporary location, they were not concerned about their defecation-related pollution. However, in hilly areas, as people left their house for *jhum* cultivation for about six months they believed that within this period the excreta would be mixed with the soil which would have no harm when they would return.

These three defecation practices result such environmental degradation that directly affects environment as well as health and quality of lives. The contaminated surface water can infect people through contamination of their hands, utensils, or source of drinking water supply. Children are particularly exposed to infection when playing or bathing in contaminated water.

8.3 Environmental consequences of current technologies prescribed for critical areas

A number of technologies were investigated which were prescribed as area-specific technologies by different organizations working in the field of sanitation. Following are some brief information on the environmental consequences of these prescribed latrine options.

8.3.1 Pour-flush latrine

This type of latrine is suitable for the hard soil areas where water is not a scarce. One of the compulsory options of such latrine is water seal. Since water (2 – 3 letters) is poured into this latrine, it easily breaks the cycle of diseases by restricting the passage of pathogen, bacteria, flies, mosquitoes and bad smell with a water seal (a U-shaped conduit partly filled with water) in the defecation hole (Brikké and Bredero 2003). However this type of latrine is not suitable for the areas with high water table like *char* or *haor* areas and where drainage quality of soil is high (Kazi et. al. 2003). In these areas, construction of pour-flash latrine will increase the chance of seepage of waste to the nearby water sources (both ground and surface) since more water percolates through the soil surrounding the pit. A pour-flush toilet with a pit is, therefore, not suitable when groundwater table is close to the surface therefore, these latrines should be built 15 to 30 meters from water source (Brikké and Bredero 2003). Moreover, if double pit is used in such latrines then excreta may not decompose completely, because the pits will be too close to each other without an effective seal between them and liquids will percolate from one pit to the other (Brikké and Bredero 2003).

8.3.2 Offset pit latrine bend with lid and without water seal

This type of latrine is suitable for hilly areas where slope of land can be used to use for offset pit, elevated latrine platform and thus excluding water seal option. Therefore, less water is used here and usually locally available materials are used to construct the latrines. Even though this option is useful for hilly areas but as water seal is not used. There is a chance of easy passage of pathogens, mosquitoes and other bacteria through the bend pipe. Moreover, if the lid is displaced then it will degrade environment. Usually in hilly areas people leave their houses for *jhum* cultivation for a few months and during that period it remains unused (no maintenance in other words) and destroyed by the white ants. Also, if the soil is not compacted then the pit can be damaged and excreta will come out and degrade the environment.

8.3.3 Community innovated offset pit latrine

This latrine option has almost same mechanism of construction like offset pit latrine bend with lid and without water seal. Therefore, it will include all the environmental impacts mentioned for that option. Besides, due to use of bamboo-built pit cover this latrine may collapse during heavy rain and comparatively it requires more space than other options. There is a chance of odor during use of this latrine option.

8.3.4 Raised latrines for *haor* and *char* areas (flood and high water table areas)

All the latrines mentioned (prescribed) in this study for *haor* and *char* areas includes the same concepts of raising pit, mounding with sand to resist water thrust and lining to restrict water seepage (from and to) (Kazi and Rahman 1999). These raised latrines are so designed that it does not percolate to the ground water or surface water sources, the proper provision is made to prevent direct contact of vectors to human excreta stored in the pit. The mounded sand around the pit and its increased depth prevent the expulsion of pungent smell to the environment. Clay soil is not suitable for such latrines as they require more space which may not be available during floods (Kazi and Rahman 1999).

CHAPTER NINE: DISCUSSION

9.1 Access to sanitation and practice

Sanitation coverage is not satisfactory at all in the surveyed environmentally critical areas. However, the percentage of ring slab latrines without water seal was found relatively large in all the four areas (Fig. 5.1 and 5.2). The reasons for not using water sealed option varied region-wise. In *char* area water was available but people reported that they did not use water seal as they had to carry more water to the latrine. They were not used to in such practice. Also they did not like water in the siphon of the latrines because during defecation this water splashed on to their body and made them filthy. On the other hand, in hilly areas water was not that much available. About 91% of the households responded that they had to travel more than 50 feet every day to reach the nearest water source (Table 5.15). For these families it was too tough to manage water for the water sealed latrines. In Bandarban Sadar area, people responded that they had to rely on stored rain water during dry season. Therefore, it was not always possible for them to use extra water for water seal. As such, seldom they did not use this option or break the water seal.

In terms of open defecation, hilly areas had the highest rate (17%) compared to the other three critical areas (Fig. 5.2). Besides low sanitation coverage, this high rate of open defecation replicates the severe backwardness of the hilly regions in terms of sanitary latrine coverage. Habituation in such practice was reported as one of the reasons behind high rate of open defecation (Table 6.4). On the other hand, most of the houses in Rangamati Sadar area were found on the steep hill tops, slopes and valleys. Here, sometimes one hill top was found to own by one family, and on average 16 to 54 households (varies according to ethnic groups) form a village (Rafi and Chakma 2001). Moreover, during *jhum* cultivation people moved from their houses for four to six months. During this period, white ants damaged their latrines as those are built with wood branches or bamboos (Rafi and Chakma 2001; NGO Forum 2006). This made the hilly people reluctant to reinstall latrine twice a year (at least). If they wanted to use plastic or concrete materials for the durability of latrines, they had to travel to outside market to purchase these which was both time and money

consuming. During in-depth interview some respondents of hilly areas reported that these markets were about 5 – 10 kilometers away from their living places. Moreover, this part of hilly area was found as remote in terms of communication and it might be one of the possible reasons for the government organizations and NGOs not to reach there and motivate them for using sanitary latrine.

Apart from the households, at the individual level of defecation practice, sanitation coverage was almost same as the household level. This was highest in *char* area and lowest in hilly areas (Table 5.1). This individual level of sanitation coverage was found to be correlated with the level of education in all the four areas and these were significant ($p<0.001$). Access to improved sanitary latrine was found among the people who were educated (who passed at least Class I) (Table 5.2).

Significant difference was found in terms of choice of sanitation practices across the economic classes in *haor* and hilly areas (Table 4.3). It seems that choice of latrine (other than open defecation for hilly areas) with respect to economic class was improving. A good number of the ultra poor and poor were using some sort of structured latrines (with or without water seal) in *char* and hard soil areas (Table 4.3). During the survey a good percentage of people were found to reside in the embankments and road sides where they were provided with sanitary latrines (most of these were community latrines). This might be one of the reasons behind higher percentage of structured latrine (minimum ring slab) users among all economic classes in *char* area (Table 4.3). However, the percentage of open pit users open defecation was still at higher rate in all economic classes respectively in *haor* and hilly areas. Since people of *haor* area had to live in water from six to eight months every year, they could not but defecate direct into water which might be one of the reasons behind this higher rate (NGO Forum 2006). Like this people of hilly areas had to defecate in open places during *jhum* cultivation. Therefore, physiographic variation had much more effect on sanitation accessibly rather than economic status of the people.

9.2 Sanitation technology and physiographic features

No physiographic area-specific sanitation hardware options were found during the field survey though there were a number of latrine options proposed and prescribed by different organizations working on sanitation technology (Chapter Seven and Table 5.6). But in reality most of these options were found only in papers and in experimental level whereas only a few of them were implemented. These were yet to be practiced at mass level. Ring slab latrines were found to be practiced mainly in *char*, hard soil and *haor* areas but not in hilly areas (Fig. 5.2).

Households in hilly area were mainly using indigenous type of latrine options that include simple pit latrine built with a 5 – 10 feet pit, bamboo, wooden or earthen platform. No ring, slab, water seal, siphon pipe and pan were used in this type of latrine. Ring slab option was not popular in hilly areas because of the weight and material quality of ring slab, although a good number of households in this area received free ring slab from the government and it was the highest among all the study areas (Table 5.2). Even if they were provided with free ring slab, they could not take and use them as these heavy weight items were stressful to lift to their hill top houses (Table 5.11). In many cases these rings were found to be used as chicken coop. For these reasons, 'closed pit' type latrine was found as the most popular option practiced by the hilly people. Considering this problem of ring slab option, some NGOs were found to suggest 'offset pit' or 'twin offset pit' latrines bend with lid and without water seal (Chapter Seven) (NGO Forum 2007). All these latrines were considered within the 'closed pit' latrine type. In contrast, open pit latrine was found as the most used latrine option in *haor* area (Fig. 5.2). These latrines had no pit or ring pit and built with open bottom or cantilevered latrine base (platform). Such latrines were built to the rear side of homesteads to let the excreta washed out during rains or regular floods of monsoon.

Photo 9.1. Latrines in *haor* areas

Mainly traditional latrine construction materials were being used by people of all the critical areas. People who were using *kutcha* and semi-*pucca* latrines, they mainly used wood, tree branches, straws, bamboo, dry leafs (banana, palm, coconut), tin sheets, mud, brick, husk, polythene for constructing the super structure. And for sub-structure they used ring, slab, plastic pan, air pipe, angle pipe or even sliced wood for footing. Conventional latrine construction procedure was followed to construct all the *pucca* latrines. These included rings, slab, septic tank, pipe, ceramic/cemented pan, RCC superstructure, etc.

In hilly areas most of the people used locally available materials like bamboo, wood, banana leaves and for these simple and less durable items, their latrines did not last for more than two years. As the latrine pits did not have side wall protected by rings, these collapsed easily and did not last more than two years (Table 5.12). Moreover, the white ants also destroyed them. But in hard soil area a good percentage of latrines were reported to last maximum for two years. In *haor* area, the respondents reported that their latrines became unusable as soil (mounded around the pit of rings) washed away by flood water. Also the pits were found to be filled by silt every year after recession of flood water as most of the pit depth was not more than 10 feet.

The government suggested ring slab option was mainly found to be practiced in the plain lands (*haor*, *char* and hard soil) but not in hilly areas (Table 5.7). This might be due to very limited access of the government to hilly people in terms of service provision (sanitation) (Rafi and Chakma 2001). On the other hand, about half of the surveyed households in hilly areas reported that they were using latrines suggested by the NGOs and these were not 'ring slab' type (Fig. 5.7). The government was suggesting conventional ring slab option countrywide and it had no separate or area-specific latrine prescription for hilly area. Moreover, as the ring slab option was not popular and acceptable in hilly area the government had very limited access to the hilly people in terms of sanitation hardware intervention.

In hard soil area the pit was never destroyed but in *haor* and *char* areas most of the pits were filled with silt or washed away and in hilly areas the pits were collapsed. However, they did not reconstruct their latrines even if these were damaged considering the same to happen every year. From the in-depth interviews it was found that during this period somehow they managed their latrines in spite of reconstructing new one. Most of these temporary latrines were unsanitary and this practice contributed to the less sanitation coverage in these areas.

9.3 Environmental criticality of the areas and poor sanitation coverage

People of *char* area reported that every year during flood they had to save their homesteads, cattle and other assets along with latrines. Moreover, most of these latrines went under water during floods and sometimes they had to shift their homes. After floods these latrines were filled with silt and became out of order. In such cases they defecated elsewhere and failed to use sanitary latrine. Even those people, who could afford the ring slab water sealed latrine, could not install or re-install due to scarcity of highland (water-free lands). These people also reported that after flood when they tried to reinstall latrines, water came under the sub-surface after putting one ring. Therefore, using such pit would increase the chance of ground water contamination by human excreta and thus degradation of environment and spread of waterborne diseases (Kazi et. al. 2003). On the other hand, even if they built a sanitary latrine it became out of order after flood which demoralized people to rebuild

latrine after flood. In such situation, somehow they managed their defecation in unsanitary options. In addition, there were some areas which were so remote that sometimes the government organizations and NGOs could not reach people for any kind of sanitary latrine interventions (software and hardware).

Almost similar situation was reported by the people of *haor* area during in-depth interviews. During floods they had to move to high lands or boats for living. A piece of high land became scarce. Those who lived in boats use bamboo cantilevered triangle hanging latrines and defected directly into the water. After flood in dry seasons, some families of these area defecated in open pit latrines which had connections with the nearby low lands or passages like canals. Behind such practice their principle was to wash the excreta automatically during the next flood. In most cases they used backside of their homesteads. During field visit several such passages of human excreta were found behind the neighbourhoods which were contaminating the surface water, ground water, soil, air as well as entire environment (Photo 9.2). These can result massive environmental degradation and outbreak of waterborne diseases.

Photo 9.2. A passage of human waste behind a neighbourhood

In hilly areas of Rangamati and Bandarbans, different environmental criticality was found like the *haor* and *char* areas. Water was found scarce in the hilly area of Bandarban. In both the areas most of the households had to climb steep hills to reach to nearby water sources which often did not permit them for easy water collection. In the in-depth interviews it was reported that those who lived beside hilltops of Kaptai Lake at Rangamati had to travel about 1,200 feet distance (up and down) to go to the bottom of the hill for water. In most of the cases this hassle of carrying water demoralized them to use water sealed latrine. Since the water sealed latrines require a good amount of water to flash out the excreta, this option was not popular in hilly areas (NGO Forum 2006). Moreover, undulating landform of hilly areas was not convenient to construct ring slab latrine.

Communication was found cumbersome in hilly areas. According to the Executive Engineer of DPHE at Rangamati Sadar each of the ring/slab weighted 22 kg. Therefore, the total weight of the hardware became about 88 kg. People of hilly areas had to carry this by themselves with the help of bamboo. This imposed huge physical stress to them. During in-depth interviews people reported that it was even stressful to carry the rings by rickshaw, van or country boat. In most of the cases these vehicles could not reach their houses on the hilltops. During field visit it was found that some families left their rings slabs on road sides as they could not take them to their houses.

Photo 9.3. Rings slab of a house is left on the boot bottom of a hill

Moreover, some people reported that quality of ring slab was so poor that they easily broke down during dragging to the hill top houses. So, people of the hilly areas avoided ring slab latrines and water seal option which was reflected in the low sanitation coverage rate of the area (Fig. 5.2). Also, many tribal people were found to live in remote hilly areas and disseminating health/hygiene education in such areas, was quite troublesome (Photo 9.4)

Photo 9.4. A house in a hill which lacks proper access to sanitary facilities

In hard soil area a different type of problem was found to be associated with poor sanitation coverage as well as choosing unsanitary latrines. People of this area reported that the soil was so hard that they were reluctant to use rings (as the ultimate intention of using ring was to protect the sidewall of the pit). Here side wall did not collapse. They used only the slabs. And for not using the rings, the human excreta were easily mixed with the soil and contaminated underground water table.

Therefore, it can be said that lack of appropriate and area specific sanitation facilities in all these environmentally critical areas of Bangladesh is one of the important contributing factors for health and environmental degradation in these critical areas (Kazi and Rahman 1999). The major problems of sanitation in these areas are surface

water contamination and lack of accessibility to latrines during flood. Moreover, in *char* area the ground water table is so high that problems like lack of latrine pit capacity and ground water contamination is resulting more frequently (Kazi et. al. 2003).

9.4 Economic affordability of the people and poor sanitation coverage

Economic inability was one of the reasons for which a large number of people living in all these four critical areas did not practice sanitary latrine. About 32% of the people living in these areas were living below poverty line while in *char* area about half of the surveyed people were found poor according (Table 4.1). Therefore, it was pretty tough for the poor people to spend for latrine rather spending on their other basic needs. From the in-depth interview it was found that in *char* areas, every year due to flood people had to remain unemployed for two to four months and relied on relief. A constant threat of riverbank erosion and flooding, combined with a lack of physical infrastructure, government services and employment opportunities in the *char*s, makes for a vulnerable, difficult and fragile way of life of these *char* people (HKI 2003). However, in *haor* area this period is six to eight months (NGO Forum 2006). After flood if they got any latrine as relief, they installed that otherwise they defecate in open places or manage unsanitary latrine options. On the other hand, people of hilly area reported during the in-depth interview that they had to depend on forest resources and *jhum* cultivation for living (Rafi and Chakma 2001). From these they could earn a little which they spent to meet their basic needs. Therefore, these people also could not save sufficient money to construct latrine.

9.5 Difference of definition behind poor sanitation coverage rate calculated by different organizations

On average sanitation coverage in all the four areas was found as 23% which was poor compared to the national sanitation coverage of 87% (Table 4.1) (LGD 2008). It was even poorer than the sanitation coverage calculated by WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (53%), BRAC and BBS (39%) (RED 2008; BBS and DPHE 2009; WHO and UNICEF 2010). This coverage was found to be very poor (0.6%) in the hilly areas, which was the lowest among the four environmental critical areas (Table 4.1). However, the highest percentage was found in *char* area (38%) and it might be due to interventions by NGOs with community or individual latrines (Table 4.1).

Therefore, there are differences among the sanitation coverage calculated by different organizations. One of the reasons behind this gap might be the difference of definition on sanitary latrine. In this study all the latrines built with water seal, septic tank, or three rings and one slab were considered as sanitary latrine. But the national level coverage considered the latrines as sanitary which could effectively break the cycle of disease transmission. These were the flush toilets connected to sewer system, septic tank, VIP, pit latrines with slab and composting latrine, offset pit, direct pit latrine with slab having water seal, etc. (BBS 2005 and LGD 2005). But none of these definitions strictly considered 'water sealed technology' which was one of the most effective ways to restrict odor and mosquitoes, flies and other pathogens as well as disease transmission. Water seal option was considered in calculating the sanitary latrine coverage for all the four areas in this study. If this option was ignored then the coverage (55%) on average would be almost similar to the coverage (53%) reported by the WHO/UNICEF Joint Monitoring Programme for water supply and sanitation (Table 4.1) (WHO and UNICEF 2010). Individually this average would be higher in *char* and hilly areas than the rate reported in this study (Table 4.1). However, this coverage was still poor compared to the national coverage (DPHE 2007). In some cases (other than hills) rings and slab were used in some closed pit latrines, but these latrines could not be considered within ring slab pattern as these used less then three rings. All these latrines were considered as un-sanitary latrines.

9.6 Problems, challenges and potentials for area specific sanitation intervention

9.6.1 Hilly area

Water is scarce in hilly region and people have to carry water to their steep hill top houses (Rafi and Chakma 2001). For this people break water seals of the latrines. During *jhum* cultivation people have to leave their houses for 4 – 6 months (Rafi and Chakma 2001). During this period white ants destroy the superstructures of the latrines which were built of bamboo fences and tree branches. Therefore, only ring slab system (without any modification) will not work in this region.

The government (DPHE, *Upazila Parishad*) was implementing conventional latrine with three rings and one slab for sanitary latrine (LGD 2005). According DPHE, the government is giving latrine free of cost to hard-core poor and in some cases for Tk. 500 to the poor through the union council. The rings were too heavy to lift to the hill top. The respondents reported that the quality of rings was poor and it easily broke during dragging to the hill top. Moreover, communication was cumbersome here. As such the government and NGO interventions were mainly concentrated in road side or lake side areas (NGO Forum 2006). Many tribal people live in some remote hilly areas, and disseminating health/hygiene messages in such areas is quite troublesome (Rafi and Chakma 2001). Also, poverty could be identified as one of the reasons for many people to afford sanitary latrine.

However, hilly land form is suitable for using the slope to permit the passage of excreta using less water (NGO Forum 2007). Offset pits can be excavated using slopes of the hills below the latrine surface level. Thus water seal technology can be avoided. Local materials like bamboo and tree branches are easily available which can be used to install superstructure of the latrine. This will reduce the installation cost. Local people also use bamboo pipe instead of plastic pipe. Space is available in the hilly areas as population density is comparatively low (100 per sq.km) here than the national estimate (979 per sq.km) (BBS 2009). Tribal people are industrious (Rafi and Chakma 2001). They excavate pits and prepare fences for superstructure. They mainly use their own latrines (Fig. 5.3). A good number of NGOs are working in the area for improving the health condition of the people and several hygiene promotion programmes are in action in this area (Rafi and Chakma 2001).

9.6.2 *Haor* and *char* areas

Problems and challenges regarding sanitation intervention was found almost similar in *haor* and *char* areas as both the regions were affected by flood and high water table. Homesteads along with toilet inundated during flood. After flood latrines were filled with silt/sand and became out of order. Chance of ground water contamination by the pit latrines was high in this region due to high water table (Kazi et. al. 2003). No area-specific effective sanitation technology was in practice by the local people (Table 5.6). A large number of people used open pit latrines as after flood no latrines were found usable (Fig. 5.2). Space was scarce in this region especially during flood for about six months. Due to flood in monsoon people moved their houses to the high lands or raise the land of their houses artificially (Kazi et. al. 2003). Communication was cumbersome here as scattered pattern of human settlement was found (Ericksen et. al. 1993). The area was so remote that people of the regions did not like to carry ring slab. Also, health/hygiene promotion programme was obstructed by the poor communication system.

There is a high rate of migration among the people of *haor* and *char* areas (Kabir 2006). During floods people of these areas have to shift their houses to high lands (in slums of the nearby towns or in dams). They migrate from their houses for 2/3 months depending on the duration of the flood (Kabir 2006). This might be one of the reasons for which the houses were found temporary in structures. During flood it is quite difficult for the people to save their houses from drowning. So, in such situation, they do not bother about the condition of their latrines. Poverty is again one of the reasons for many people of the area for not to afford sanitary latrine (Table 4.1). However, some potential in these areas were identified during the field investigation. Sand is available in the *char* area which can be effective to mound the latrine pits. Clay soil in *haor* areas can be used to protect seepage from the pits. In some areas GOs and NGOs were providing free (or at minimum cost) latrines (Ring slab) to the hard core poor as per sanitation policy of the government. Local union *parishad* chairmen and members were also found to be involved in different hygiene promotion programmes.

9.6.3 Hard soil area

In some cases people of hard soil area avoided rings as the soil was hard and the pit walls did not collapse. However, this does not fulfill the minimum standard of sanitary latrine as per definition set by BBS in HIES 2005 (Household Income Expenditure Survey 2005) or LGD in National Sanitation Strategy 2005 (BBS 2005 and LGD 2005). Moreover, people were not aware enough about sanitary latrine and other hygiene messages which was reflected in the sanitation coverage of this area (Fig. 5.2) (RED 2008). In contrast, hard soil of this area would be the potential thing since side wall of latrine pit had less chance to collapse. This would help avoid rings, and thus the construction cost of the latrine would be less. The area is plain and has less physiographic sophistication. Communication is much more convenient than the other three areas. Therefore, people living in this area can be reached easily for any kind of sanitation intervention. Table 9.1 provides a comparison on the problems and challenges in terms of sanitation technology in all the environmental critical areas.

Table 9.1. Comparison matrix of GO/NGOs activities and study findings

Area	Environmental criticality	GO intervention	NGO intervention	Problem areas	Solution/suitable option	Remarks
Char	• Flood • High water table	o Hard ware intervention with three rings one slab o 99% coverage	▪ Both hardware and software focused ▪ Ring slab latrines with water seal ▪ 96% coverage	• Regular flood of four to six months duration • High level of ground water • Distant communication • Scattered pattern of settlement • High rate of migration during flood • Higher level of poverty • River erosion • Interventions mainly in high lands • No area specific sanitation option in practice	▪ Earth stabilized raised pit latrine ▪ Mound latrine ▪ Step latrine ▪ Sand enveloped raised pit latrine ▪ Sand enveloped pit latrine	Every year during and after flood latrines provided by GO and NGOs become out of order and people has to re-install them
Hard soil	• Hard soil (ground and surface	o Hard ware intervention with three rings one slab o 99% coverage	▪ Both hardware and software focused ▪ Ring-slab latrines with water seal ▪ 95% coverage	• Lack or no use of rings as the soil is tough and side walls never collapse • Water sealed are broken as people do not like water in the siphon • Ignorance of the people	▪ Pour flush latrine	GOs and NGOs lack follow up in terms of sanitation. Whenever one household got or installed sanitary latrine later no GO or very few NGOs check the quality of the latrine

Note: GO = the government organizations

Area	Environmental criticality	GO intervention	NGO intervention	Problem areas	Solution/suitable option	Remarks
Haor	• Flood	o Hard ware intervention with three rings one slab o 98% coverage	▪ Both hardware and software focused ▪ Ring-slab latrines with water seal ▪ 89% coverage	• Regular flood of four to six months duration • Flash flood • Distant communication • Scattered pattern of settlement • High rate of migration during flood • No area specific sanitation option in practice	▪ Earth stabilized raised pit latrine ▪ Mound latrine ▪ Step latrine ▪ Sand enveloped raised pit latrine ▪ Sand enveloped pit latrine	Every year during and after flood latrines provided by GO and NGOs becomes out of order and people has to re-install them
Hill tract	• Hilly land form • Scarcity of water	o Hard ware intervention with three rings one slab o 99% coverage	▪ Both hardware and software focused ▪ Offset pit latrine with bend without water seal using the slope of the land ▪ 87% coverage	• During *jhum* cultivation people leave their houses and white ants destroy the latrines • Water scarcity • Steep hill top houses • Remote area • Language problem • Heavy weight of ring slab • Poor construction quality of ring slab • Road side intervention by GOs/NGOs	▪ Pour flush latrine ▪ Community innovated offset pit latrine ▪ Offset pit latrine bend with lid and without water seal	After providing latrine (ring slab) to the people GOs do not follow up whether the latrines are installed or not. In most of the cases people leave those on the hill foots or use as chicken coop although those people are listed as user of sanitary latrines.

Note: GO = the government organizations

CHAPTER TEN: RECOMMENDATIONS AND CONCLUSION

10.1 Introduction

The research was aimed at to find the appropriate sanitation technologies in the critical environmental areas of Bangladesh and the followings are the key findings of the research:

10.2 Key findings

10.2.1 No area-specific sustainable/appropriate sanitation technologies (hardware)

From the field visit no area-specific (critical areas) sanitation technologies were found. Some organizations have some technologies, but the options are not implemented yet. Even there were no indigenous sustainable sanitation technological options practiced by the local people.

10.2.2 Some options are present in experimental level

There are some NGOs, research organizations and the government organizations who have some technologies in this regard. But according to them these are not applied as yet. They just compiled some possible technological options which were a kind of stock taking.

10.2.3 Ring slab system is not appropriate for all the areas

Most of the organizations those have sanitation hardware interventions are practicing ring slab technology. But in hilly areas this system is not working as these rings are too heavy to carry to their hill top residences. On the other hand in *haor* and *char* areas it is tough to set more than two rings (in some cases one ring) due to high water table. In such cases, chance of contamination of ground water is more.

10.2.4 Water seal technology will not be appropriate for all the areas

Water seal technology will not be an effective measure to be practiced in the latrines in all the critical areas. This technology requires relatively higher amount of water for flashing excreta, and in hilly areas water is a scarce.

10.3 Selected sanitation technologies

The findings suggest that area-specific sanitation hardware intervention is required for the environmentally critical areas of Bangladesh. This technique is imperative to improve the sanitation coverage of these areas. Therefore, considering the affordability and environmental criticality that is soil condition, water table, flood level, land form some sanitation technologies are recommended for the environmentally critical areas. Though most of the technologies are not implemented, but they can be implemented to examine the cost, sustainability, appropriateness, environmental-friendliness, and finally popularity among the user. Introduction and promotion of these options in all the environmental critical areas will be effective to minimize or even overcome their sanitation problems. Also it is important to ensure the sustainability of the sanitation practices and it is also essential to carefully associate socio-cultural settings and technical prerequisites besides environmental criticality.

10.3.1 Hilly areas

'Offset pit latrine bend with lid without water seal' can be suggested for Chittagong hilly areas. This type of latrine option is recommended to promote here since water is scarce here and slope of the land can be used to passage the human excreta from pan to pit using less water. According to GOB-UNICEF project of DPHE and some NGOs viz. Water Aid Bangladesh, NGO Forum for Drinking Water Supply and Sanitation, VERC and Green Hill such latrines will cost Tk. 85 to 100 excluding the cost for superstructure and labour. Local people can use locally available materials like bamboo, wood and their labour to construct such area-specific low cost latrines. Moreover, plastic ring slab can be used instead of concrete ring slab. It will be lighter, cheaper, more durable, and seepage free than the concrete. These will definitely attract people to install sanitary latrines.

10.3.2 *Char* and *haor* areas

In terms of physiographic as well as environmental criticality both the *char* and *haor* areas face the problems of flood, erosion, water seepage and high water table (Kazi et. al. 2003 and Kabir 2006). Therefore, same latrine option will be appropriate for both the areas. The idea is to protect the side walls of latrine pits, obstacle water seepage in to the pit, and thus make the latrine durable and usable during any environmental circumstances. Therefore, for these areas earth stabilized raised pit latrine, step latrine, mound latrine, sand enveloped latrine and sand envelop raised pit latrine can be recommended to install. All these are low cost latrines which range from Tk. 800 to 1,500. International Training Network-BUET (ITN-BUET) has detail engineering description of these latrine options which are described in Chapter Three. Besides, NGO Forum for Drinking Water Supply and Sanitation and GOB-UNICEF project of DPHE have some propositions regarding latrines for these areas which are conceptually almost similar to the above mentioned options.

10.3.3 Hard soil areas

Simple physiographic as well as environmental criticality was observed in hard soil areas during investigation. In hard soil simple 'Pour flush latrine' will be appropriate. Such latrine will cost Tk. 550 excluding the superstructure and labour cost if minimum three rings and one slab are used. Water seal option should be strictly followed here to meet the requirement of National Sanitation Strategy. BRAC, NGO Forum for Drinking Water Supply and some other NGOs are practicing such proposition.

10.4 Conclusion

Provisioning area-specific sanitation options is not enough to achieve 100% sanitation coverage as well as healthy living environment in all these environmentally critical areas. Some of these are 'hard to reach areas' where integrated approach, that is combining technologies and strategies, is needed for achieving overall success in this sector. Therefore, raising latrines without homestead may not be accepted by the people of *haor* and *char* areas. The government and NGOs working here regarding homestead rising should be integrated with this. Installation cost of some of the latrines may be relatively higher for the poor families. In such cases concept of 'Community latrines' and 'Cluster housing' will be effective and should be guided under a proper human settlement policy. Although it is tough (luxurious in some cases) for the people living in the environmentally critical areas to think about an improved latrine, nevertheless, improvement of their awareness and knowledge on sanitary latrine will accelerate the achievement of 100% sanitation coverage. Because improved understanding of sanitation is the pre-requisite of a successful sanitation programme (Kazi et. al. 2003).

Therefore, training at the local level, local level workshops, films, popular theater, group discussions will be effective mode of actions to increase the knowledge and awareness of the people about sanitation and their implications with health and environment. People of environmentally critical areas should be motivated to use improved latrines. Human settlement policy of the government is required to ensure which areas should be available or not for living, which areas are risky to live in. There should be some policy guidelines or statements in this regard. Upgrading existing sanitation promotion programme of the government and NGOs is necessary. It is reported that sanitation coverage under public programmes is not sufficient (Kazi and Rahman 1999). Therefore, private sector should be encouraged to set up production centers for sanitation equipments in these environmental critical areas to ensure easy access of local people. Moreover, it is essential to ensure that the homesteads are safe during flood, otherwise any sanitation technological proposition will be ambitious. Finally, rigorous research should be conducted to determine the actual, appropriate and sustainable sanitation technology, and testing them on pilot basis in the critical areas.

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APPENDIX: 1

Organizations contacted

1. Government organizations (GO)
    a. GoB/DANIDA project of DPHE
    b. GoB/UNICEF project of DPHE
    c. UGIIP-II project, LGED
    d. Local Partnership for Urban Poverty Alleviation Project (LPUPAP), LGED
2. Research organization
    a. International Training Network (ITN) - BUET
3. Non-government organizations (NGO)
    a. International
        i. CARE Bangladesh
        ii. WaterAid Bangladesh (WAB)
        iii. Bangladesh Red Crescent Society
        iv. Practical Action Bangladesh
    b. National
        i. Dhaka Ahsania Mission
        ii. VERC (partner NGO of WAB)
        iii. NGO Forum: For Drinking Water Supply and Sanitation (partner NGO of WAB)
        iv. DSK (partner NGO of WAB)
        v. SPACE
        vi. CLP
        vii. EPRC
    c. Local
        i. Green Hill (partner NGO of WAB working in Chiitagong Hill tracts)
        ii. Tahjingdong (partner NGO of NGO Forum working in Bandarban)

APPENDIX: 2

Study areas

Category	Areas
Char	**1.** Village: Debdanga (South), Kutubpur union, Sariakandi ***upazila***, Bogra
Hard soil	**2.** Village: Shajapur, Majira union, Shahjahanpur ***upazila***, Bogra
Haor	**3.** Hakaluki ***Haor***, Vukshimul union, Kulaura, Moulovibazar
Hill	**4.** Village: Ara Churi, Dippo Churi, Nakcha Churi of Shapchuri union, Rangamati Sadar ***upazila***
	5. Village: Toinkhali, Kengrachori, Tonchogna Para of Rajvila Union, Bandarban Sadar, Bandarban.

APPENDIX: 3

Sampling

Condition	**District**	***Upazila***	**Union**	**Population (DGHS, 2002)**	**Household Number***	**Sample Size**
Char	Bogra	Sariakandi	Kutubpur	27211	5611	360
Hard soil	Bogra	Shahjahanpur	Majira	14564	3003	341
Haor	Moulovibazar	Kulaura	Vukshimul	26554	5475	359
Hill tracts	Rangamati	Rangamati Sadar	Shapchuri	5272	1087	336 (Shapchuri =137, Rajvila =199)
	Bandarban	Bandarban Sadar	Rajvila	7668	1581	

APPENDIX: 4

Comparison among sanitation technologies

Sanitation technology	Applicable environmental critical area	Construction cost	Maintenance cost	Ease of construction	Water requirement	Required environmental condition	Health benefits	Special feature	Status
Pour flush latrine	Hard soil, Hilly area	Low	Very low	Easy	Water seal	Flood free areas	Very good	- Can be connected with septic tank - Easy to dispose waste	Implemented
Offset pit latrine bend with lid and without water seal	Hilly area	Very low	Very low	Very easy	No	Slope of earth	Good	- Local material can be used	Implemented
Community innovated offset pit latrine	Hilly area	Low	Very low	Easy	No	Slope of earth	Good	- Innovated by the community - Requires more space	Implemented on pilot basis
Earth stabilized raised pit latrine	Flood prone area	Medium	Low	Medium easy	Yes	Availability of sand	Very good	- Can be used in combination with any single pit, double pit and pour flush latrine - Requires convenient space	Implemented on pilot basis

Sanitation technology	Applicable environmental critical area	Construction cost	Maintenance cost	Ease of construction	Water requirement	Required environmental condition	Health benefits	Special feature	Status
Sand enveloped pit latrine	Flood prone area and High water table area	Medium	Low	Medium easy	Yes	Availability of sand	Very good	- Requires convenient space	Implemented on pilot basis
Step latrine	Flood prone area	Medium	Low	Medium easy	Yes	Availability of horizontal space	Very good	- Requires convenient space	Implemented on pilot basis
Mound latrine	Flood prone area	Medium	Low	Easy	Yes	Availability of impervious soil	Very good	- Requires limited space	Implemented on pilot basis
Raised latrine	Flood prone area and High water table area	Low	Low	Easy	Yes	Availability of sand	Very good	- Requires large space	Implemented on pilot basis
Sand enveloped raised pit latrine	Flood prone area and High water table area	Medium	Low	Medium easy	Yes	Availability of sand and impervious soil	Very good	- Requires large space	Implemented on pilot basis

APPENDIX: 5

Questionnaire

An investigation on appropriate sanitation technologies for environmentally critical areas of Bangladesh

Household survey, 2009

1. Identification

1	Household no.										
2	Date										
3	Name of the respondents and line no.										
4	NGO member: 1=Yes, 2= Not now, 3=Never										
5	Name of the Village (Code)										
6	Name of the union/*pourashava* (Code) 1 = Kutubpur 2 = Majira 3 = Vukshimul 4 = Shapchuri 5 = Rajvila										
7	Name of the *upazila* (Code) 1 = Sariakandi 2 = Shahjahanpur 3 = Kulaura 4 = Rangamati Sadar 5 = bandarban Sadar										
8	Name of the district (Code) 1 = Bogra 2 = Moulovibazar 3 = Rangamati 4 = Bandarban										

2. Socio-Economic Status of the Household

Line no.	Name	Sex M=1 F=2	Marital status	Age* (year/month)		Education ≥ 5	Principal employment ≥ 6	Latrine type used by the member
				Year	Month			
1	2	3	4	5	6	7	8	9
01								
02								
03								
04								
05								
06								
07								
08								

4 Marital Status
1=Unmarried
2=Married
3=Widow/widower
4=Divorced
88= N/A

7 Education
00= no class pass
01, 02....= passed class
11=SSC
12=HSC
13=Graduate
14=Technical
88= N/A
99=Others_____

8 Employment
1= Farmer
2= Day labourer
3= Service
4= Business
5= Carpenter/potter/blacksmith/mason
6= Small business
7= Beggar
8= Maid servant on food
9= Housewife/Household work
10= Student
11= Unemployed
88= N/A
99= Others_____

9 Latrine type
1=Sanitary
2=Ring slab with water Seal
3= Ring slab without water Seal
4=Closed pit
5=Hanging
6=Open pit
7=Open defecation
8=River/pond/canal
9=Jungle
10=Road side
Others _____

* Please mention month for the person aged ≥5 years

3. Household income and land asset

3.1 Monthly income

3.2 Land asset (in decimal) Agri-land..... Homestead land.....

4. Household expenditure

Sl. No.	Items	Monthly (Taka)	Yearly (Taka)
1	Food		
2	Clothing		
3	Health/medicine		
4	Education		
5	Maintenance of house		
6	Construction/reconstruction of latrine		
7	Latrine utensils/toiletries		

5. Water use related questions

Sl.	Source of water	Use type: 1 = Regular 2 = Alternate	Purpose of use 1 = Drink 2 = Defecation 3 = Washing 4 = Bathing	Period of Use 1 = Normal 2 = Flood/cyclone 3 = Drought	Distance from the main house 1 = Attached 2 = _____ft	Ownership: 1 = Self 2 = Joint/community 3 = GO 4 = NGO 5 = Neighbor Others_____	How is water collection system? 1 = Easy 2 = Cumbersome	Who collects? 1 = Male 2 = Female 4 = Both	Distance of nearest latrine (of anybody) from the water source	Time to go to the water source from the main house
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1)	Tubewell									
2)	Pond									
3)	Beel									
4)	*Haor*									
5)	River									
6)	Canal									
7)	Dugwell/Ringwell									
8)	Others									

6. (Sanitation -1)

Sl. No.	Type of latrine	Ownership: 1 = Self 2 = Joint/community 3 = GO 4 = NGO 5 = Neighbor 88=N/A Others_____	Use type: 1 = Regular 2 = Alternate 3=Flood/cyclone 88=NA	Season of latrine use 1=Dry 2=Rainy 3=Both	Distance from the main house 1 = Attached 2 = _____ft	Who cleans the latrine? 1=Male 2=Female 3=Both 88=NA	Source of construction materials 1=In house 2=From others 3=Local market 4=Other market 5=GO 6=NGO 88=NA
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1)	Sanitary						
2)	Ring slab (water seal)						
3)	Ring slab (without water seal)						
4)	Closed pit						
5)	Hanging						
6)	Open pit						
7)	Open field						
8)	River/pond/canal						
9)	Bush						
10)	Rode side						
11)	Others						

Sl. no.	Expected life span (in year) 88=NA	For how loch the pit is being used? (Month) 88=NA	Construction cost 88=NA	Maintenance cost (yearly) 88=NA	Type of technology 1=Area specific 2=Indigenous 3= Traditional (Ring slab) 88=NA Others	Ownership of the Technology 1=Self 2=NGO 3=GO 4=Other person 88=NA Others	Who helped in latrine installation? 1=Self 2=Local labor 3=NGO 4=Govt. 88=NA Others	What are the free assistances in latrine installation? 1= Ring slab 2=Pan 3=Pipe 4=Money 5=Labor 6=Technology 7=Entire latrine setup 8=Nothing 88=NA Others	Nearest water source from the latrine? 1=Tubewell 2=Pond 3=Beel 5=*Haor* 6=River 7= Canal 8=Ring/Dug well 88=NA Others	Distance of latrine from nearest water source? (Ft) 88=NA	Time to go to latrine from main house
1	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
1)											
2)											
3)											
4)											
5)											
6)											
7)											
8)											
9)											
10)											

7. Sanitation -2

Sl. No.	Question	Code	Remark
1	Why there is an alternative latrine? (if any)	1= _____ 2= _____ 88=NA	
2	Is there any separate latrine for male or female?	1=Yes 2=No	
2.1	If yes then why?	1 _____ 2 _____	
3	Why there is a disaster time latrine? (if any)	1= _____ 2= _____ 88=NA	
4	Does the HH require new latrine/pit every year?	1=Yes 2=No	
4.1	If yes then why	1= As it is washed out by flood water 2= As it is filled with sand 3= As white ants destroy it 4= Due to softness of soil/side wall collapse 5= Poor quality of construction materials 6= Due to damage by cyclone or other disaster Others _____	
4.2	What do you do when the latrine or pit do not work? (if they try any temporary solution mention it in "Others")	1 = Use latrine of others 2 = Use latrine of NGOs 3 = Use latrine of GOs 4 = Open Defecation 5=Others	
4.3	How do you reconstruct the pit after it is damaged?	1=Reconstruct by own means 2=Take help from NGOs 3=Take help from GOs 4=Take money in credit from others Others_____	
5	Are you satisfied with the present latrine you use?	1= Yes 2= No	
5.1	If yes, then why?	1=Habituated with the latrine type 2=User friendly 3=Construction is cheap 4=Can be used during disasters 5=Easy to maintenance/clean 6=Construction materials are easily/locally available 7=Easy to construct/reconstruct 8=Aesthetically sound 9=Near to house/at a safe distance Others _____	

5.2	If no, then why?	1= Not habituated 2= User unfriendly 3= Construction is costly 4= Cannot be used during disasters 5= Not easy to maintenance/clean 6= Construction materials are not easily/locally available 7= Not easy to construct/reconstruct 8=Aesthetically not sound 9=Far from the house Others _____	
6	Are interested to install an even more improved latrine?	1= Yes 2= No	
6.1	If yes then, How much money you want to pay for this new latrine?	_____ tk	
6.2	If no then why?		
6.3	What should be the additional features of this latrine?	1 _____ 2 _____ 3 _____	
6.4	How much are you willing to pay for this additional feature?	_____ tk	

8. Design Details of the latrine

Sl No.	Code			
	Dry Season		***Rainy Season/Disaster Time***	
1	Depth of Pit: Ft.		Depth of Pit: Ft.	
2	Number of Pit: Nos.		Number of Pit: Nos.	
	Item	***Source (Code)***	***Item***	***Source (Code)***
3	Ring		Ring	
4	Slab		Slab	
5	Water seal		Water seal	
6	Air pipe		Air pipe	
7	Angle pipe		Angle pipe	
8	Base/Floor of the latrine: 1=Clay 2= Cement 3= Wooden		Base/Floor of the latrine: 1=Clay 2= Cement 3= Wooden	
9	Door 1=Open 2=Wood/Tin 3=Jute cloth/Polythene/Leaf		Door 1=Open 2=Wood/Tin 3=Jute cloth/Polythene/Leaf	

10	**Sidewall**		**Sidewall**	
	Item	***Source (Code)***	***Item***	***Source (Code)***
	1=Bamboo fencing		1=Bamboo fencing	
	2=Tin		2=Tin	
	3=Jute stick		3=Jute stick	
	4=Polythene		4=Polythene	
	5=Wood		5=Wood	
	6=Brick		6=Brick	
	7=Mud		7=Mud	
	8=Jute cloth		8=Jute cloth	
	Others		Others	
11	**Roof**		**Roof**	
	Item	***Source (Code)***	***Item***	***Source (Code)***
	1=Bamboo		1=Bamboo	
	2=Tin		2=Tin	
	3= Polythene		3=Jute Stick	
	4=Wood		4=Polythene	
	5=RCC		5=RCC	
	6=Open		6=Open	
	Others		Others	
	<u>Source Code:</u> 1=In house 2=From others	3=Local market 4=Other market 5=GOs	6=NGO 88=N/A Others	