

# **Bangladesh Sensitization Tour Groundwater Governance Project (GGA), Dec. 12-14, 2005**

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## **1. Introduction and background**

The sensitization trip to Bangladesh was conducted with the help of Bangladesh Water Development Board (BWDB) and Group of Professional Services (GPS). There were participants from the Department of Geology (Dhaka University), Health and Environmental Journalists Forum, NGO Protigya Sangstha, Group of Professional Services, Geological Survey of Bangladesh, Center for Environmental and Geographic Information Services (CEGIS). A day-log meeting was organized and participants from the different institutions were invited. The meeting consisted of a presentation made by Dr. Tushaar Shah on “Groundwater Governance problems across the world” followed by a presentation on the project by Sunderrajan Krishnan. Then, Dr Anwar Zahid from BWDB made a presentation on the groundwater issues in Bangladesh and the progress made by BWDB. This was followed by a discussion on the project and how the different institutions could contribute.

## **2. Objectives of trip**

1. Meet and initiate collaboration with organizations and institutions involved in groundwater management, research and media coverage that may provide fellows and participate in action research within the project
2. Present the project, its scope and to advocate for active involvement and commitment
3. Present a draft proposal for a research agenda for the project
4. Make initial steps towards recruiting the fellows for the courses
5. Get feedback from the institutions in terms of capacity building needs and priority research topics that could prove valuable in the more detailed planning of the courses and the research

## **3. Description of groundwater setting/problems**

Bangladesh lies on the deltaic confluence of the Ganges-Meghna-Brahmaputra basin system. A gentle flat topography where the floodwaters from these rivers collect contributes to continuous flooding of large parts of the country for 1-2 months during the monsoon season. The World’s most-densely packed human population of 130 million Bangladeshis (900 per m<sup>2</sup>) have adapted to such flooding. However, harnessing of this

surface water for irrigation or power is not possible for Bangladesh due to the almost flat topography. Groundwater in most parts of the country therefore becomes the only possible source of water for irrigation, domestic and industrial purposes in the dry season. The intensive use of groundwater through tubewells started in the 1980s and has since contributed to increase in rural wealth and source of food security for the poor. From the point of view of groundwater intensification, the main concern seems to be that of higher water table fluctuations which is suspected due to two reasons: 1. increase in lean season groundwater use for Paddy, and 2. decrease in lean season flows of the Ganges due to intensifying surface and groundwater use in upstream India. But one major concern in groundwater is that of arsenic which threatens to affect human health in the southern parts of the country and also hamper further growth in the development of groundwater. The challenge for groundwater in Bangladesh is therefore to find mechanisms to maintain the progress in agriculture on one hand and at the same time keep this sustainable for ecological and human health.

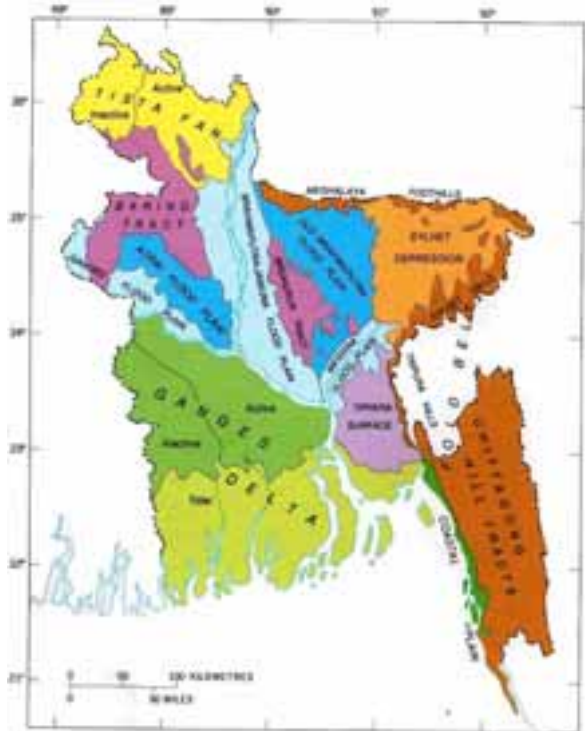


Figure 1: Geography of Bangladesh

### 3.1 Geography and Hydrogeology

Bangladesh has 7 physiographic units(Figure 1):

- a) Hilly regions (east and north): Chittagong Hill Tracts, Hill Ranges of northeastern Sylhet and Hills along the narrow northern strip of Sylhet and Mymensingh, b) Pleistocene uplands: Barind Tract in the north western part, Madhupur Tract in the central part and the Lalmai Hills, c) Tippera Surface (in the west-central part), d) Tista Fan (in the northern part), e) Flood plains: Ganges, Atrai, Brahmaputra-Jamuna, Old Brahmaputra flood plain, and the Meghna flood plain, f) Deltaic plain of the Ganges-Brahmaputra-Meghna Delta Complex: Inactive delta, Active delta and the Tidal delta, g) Sylhet Depression and Inland marshes (Scattered all over Bangladesh)

The Alluvial plains of Bangladesh (covering which of the seven physiographic units above?) are less than 10 m above sea level throughout. The Chittagong hills range from 600 m to 900 m above sea level. The country has a total number of around 700 rivers, including tributaries, with total length of 24,140 km. Mainly the four river systems are (1) the Brahmaputra-Jamuna, (2) the Ganges-Padma, (3) the Surma-Meghna, and (4) the Chittagong Region river system(Figure 2).



Figure 2: Rivers of Bangladesh

Regionally, the aquifers can be divided into three layers(Figure 3): a) The upper shallow aquifer: the aquifer below a surficial clay layer. The thickness of this aquifer varies from few metres in northwest to 60 m in the southern parts, b) the main aquifer: This is the primary aquifer of water withdrawal throughout the country. The thickness ranges from less than 5 m in the northwest to more than 75 m in the south. This layer is a complex combination of confined to semi-confined, leaky aquifers comprised of medium and coarse grained sediments. and c) The deeper aquifer: This deep layer is separated from the second main layer by thick clay layers and can range from 100m to 1500 m in thickness. At present, there is not much water extraction from this layer.

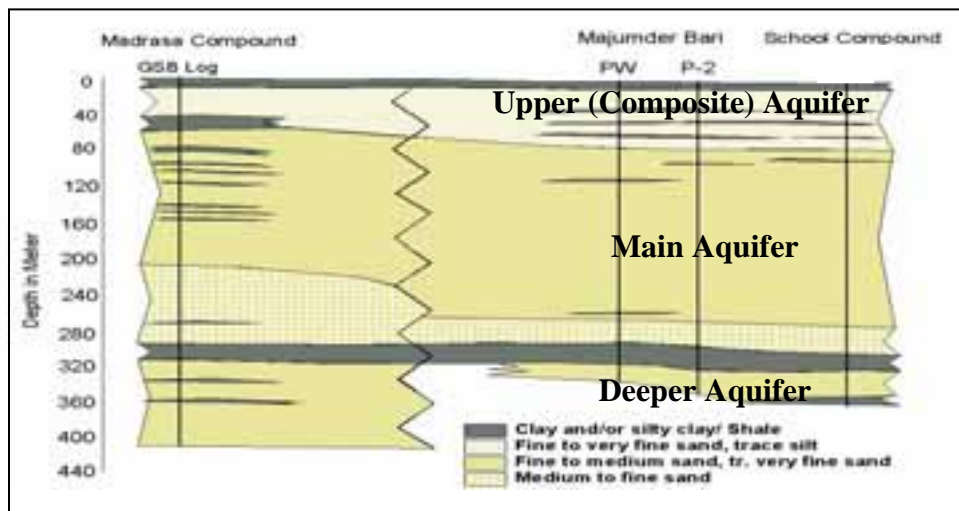


Figure 3. Aquifer system in lower delta floodplain, Sreerampur, Chandpur (Zahid et al, 2005)

The Ganges basin and the delta carry a large flux of groundwater from land to sea. Estimates of fluxes range upto  $2 \times 10^{11} \text{ m}^3/\text{year}$  flowing to the Bay of Bengal (from both India and Bangladesh parts of the delta), but these figures have been disputed by other authors as being unrealistic (Bose et al, 2001, Harvey et al, 2002). However, what is true is that a massive amount of groundwater flows through the system, offering a conduit of flushing of solutes such as arsenic from the system. Better understanding of this regional flow system can offer clues to knowledge of flushing of contaminants and processes such as salinity intrusion.

### 3.2 Arsenic and other quality problems in groundwater

Since Bangladesh lies at the mouth of the entire drainage system of the large stretch of the sub-continent, it also receives the bulk of sediments and substances transported by surface runoff. Consequently, contaminants from upstream also find their way into the drainage system of the country and then onto the aquifers too. One major such contaminant has been arsenic. Arsenic in groundwater of Bangladesh was detected in the early 1990s when dependence on the deep groundwater for general water supply had been developed. Later, the neighbouring Indian state of West Bengal also witnessed incidences of arsenic in the southern Deltaic sediments. Further investigation over the years has revealed the large extent of arsenic in the Gangetic sediments which span from Bangladesh and West Bengal to the Indian states of Bihar and Uttar Pradesh and recently in the Terai part of Nepal. In Bangladesh, arsenic of high concentrations are found in the southern and south-eastern regions. The arsenic-affected patients show arsenic skin lesions such as melanosis, leucomelanosis, keratosis, hyperkeratosis, dorsum,

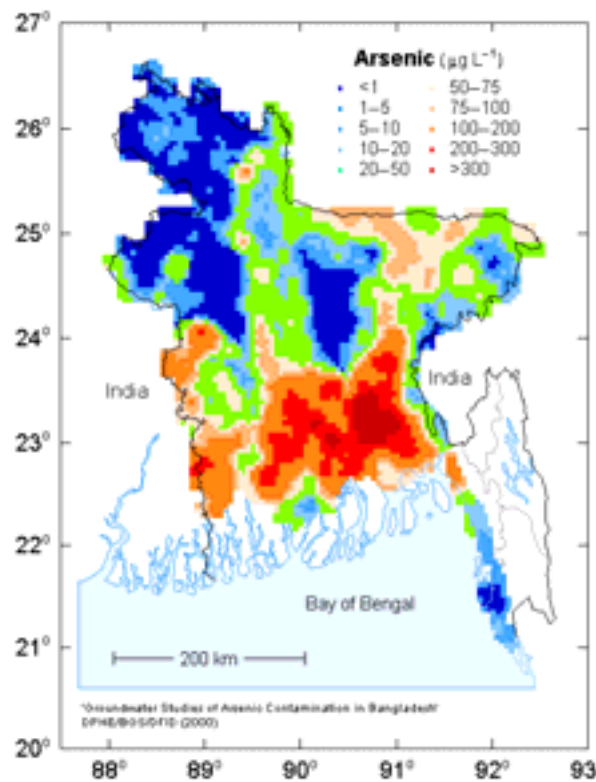


Figure 4: Distribution of arsenic in groundwater of Bangladesh

non-pitting oedema, gangrene and skin cancer. It has been observed that exposure to arsenic can affect mental health of children. The Pleistocene sediments show lesser concentrations of arsenic than the relatively recent Holocene ones. For eg. the Dhaka aquifer lying on Pleistocene sediments has been found to be free of arsenic contamination.

The process of mobilization of arsenic from the aquifers has several contesting theories, two of which have some acceptance: 1. During the lowering of water tables, arsenic present in sulphide minerals are oxidized and absorbed onto the Iron hydroxide in the soil. When there is recharge, Iron hydroxide releases arsenic into groundwater. The process of oxidation of arsenic from Sulphide minerals has contesting theories. 2. Arsenic is present as a coating of Iron hydroxide and is reduced by organic matter into groundwater. However, these theories have not stood the test of extrapolation in general, and a common understanding is yet to be realized.

Solutions to water treatment of arsenic contaminated water are Reverse Osmosis, Ion exchange, Manganese Green sand filter, Activated Alumina and Coagulation-Adsorption.

### 3.3 Coastal Salinity

Saline water intrusion into the delta part of Bangladesh and West Bengal in India is a problem to irrigation and drinking water. A combination of tidal inundation and intrusion within the aquifers has caused several parts of cities such as Khulna to be affected by high salinity. There is also evidence of saline water in rivers seeping through to

groundwater. Studies till now have been limited and much more attention is needed to understand the regional extent of the problem.

### 3.4 Impact of groundwater on irrigation and reducing poverty

Bangladesh is one of the World's poorest countries in terms of per capita GNP and also lags behind in terms of other factors of human development such as life expectancy and child mortality. However, the country has made much considerable progress in the past 25 years in terms of human development factors as compared with the overall economic progress. This is mainly attributed to the flowering of non-governmental organizations (NGOs) and community service organizations (CSOs) that have played an important role in rural development in the context of a weak state and poorly developed market institutions. The trend toward self-sufficiency in food production achieved mainly through summer/dry season cultivation of rice has been vital to this progress. This production of rice has been possible through the rapid development of groundwater resources starting in the 1980s. Productivity increase has resulted from increase in cropping intensity (from 145% in 1975 to 175% in 1999) driven by increased cultivation during the dry season using groundwater. The contribution of groundwater to total irrigated area has increased from 4% in 1971 to 70% in 1999. Current estimates of contribution of groundwater to overall irrigation water vary from 70% to as high as 90%. (Figure 5, 7). The Human Poverty Index has dropped by more than 20% during 1981 to 1997. Currently, the agriculture sector contributes 36% of GDP, of which crop sector contributes 71%. This sector generates 63.2 % of total employment of which crop sector share is 55%.

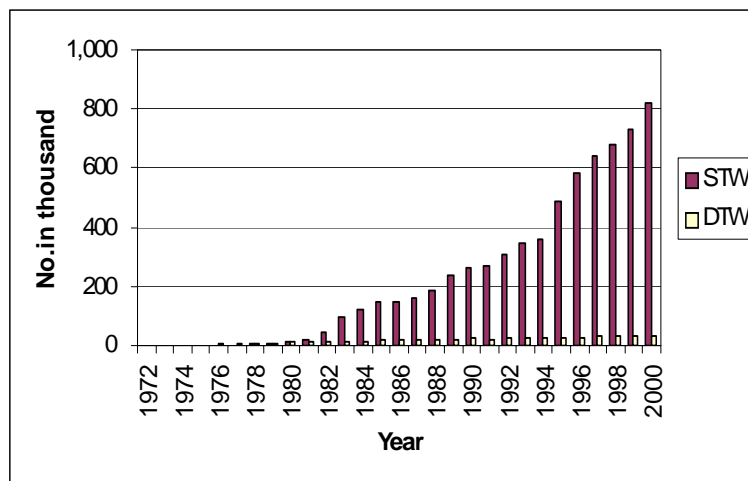


Figure 5: Growth in number of wells in Bangladesh (Mainuddin, 2002)

Therefore, the role of groundwater in agriculture and through that to the national GDP is vital. The introduction of the treadle pump has also contributed significantly to the poverty alleviation program. Groundwater irrigation has increased the employment in

agriculture since 1985 by 250%. A peep into the future can give some indications as to the requirements from this sector. The population of Bangladesh is projected to be 190 million in 2020 and 218 million in 2050. The food production has to be increased by 50% to feed the increased population even by 2010, assuming that this extra need is not imported. A large portion of this increased production is expected to be from expansion of irrigation. With the present trend, most of the required water withdrawal will come from groundwater.

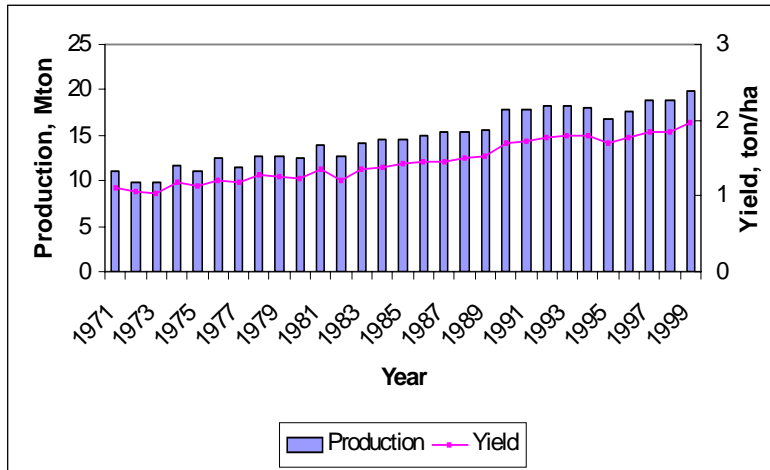


Figure 6: Rise in agricultural productivity and yield in Bangladesh (Mainuddin, 2002)

It is however debatable how growth in irrigation, primarily in rice production can further contribute to reduction in poverty. In the past 10 years, poverty has been reducing by only 1 percentage point a year and more than half of the population still lives below the poverty line. Rice production, though increasing, has due to the low purchase capacity of the population not been as remunerative. But for poor farmers for whom rice is a staple diet, this strategy has been useful for food security. The question is where would further reduction in economic poverty come from.

The Poverty Reduction and Social Development strategy of Bangladesh (give ref.) considers the development of the rural non-farm sector to be vital to the further alleviation of poverty:

“Through rapid expansion of non-farm activities, the Government’s strategy is to make the rural non-farm sector as the leading sector of Bangladesh’s rural economy. Given the characteristics of the rural labor market and the structure of farm holdings dominated by small and marginal farmers, both farm and non-farm incomes would be increased along with incentives for movement of labor from farm to non-farm sector”.

Within this possible development of the rural non-farm sector, the groundwater-based agricultural economy would need to provide the backbone that sustains the food security and rural livelihoods.

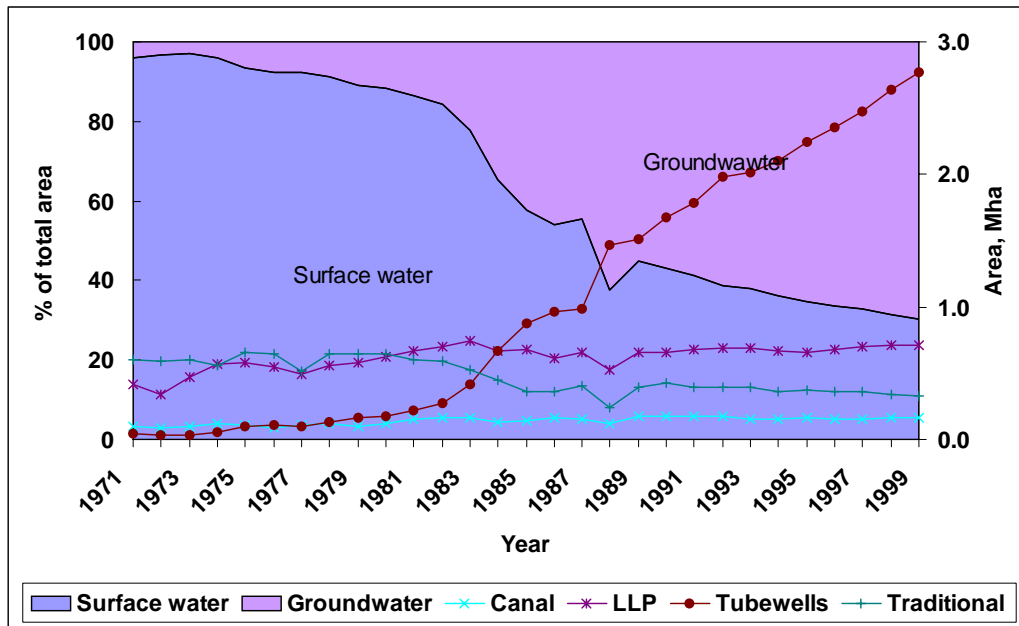


Figure 7: Relative contribution of different sources to overall water for irrigation (From Groundwater Socioecology survey, 2002)

### 3.5 Dhaka city

A city of 10 million inhabitants, Dhaka lies on top of the Miocene Dupra Tila formation that is free of arsenic contamination. The main sources of recharge to this aquifer are the Buriganga and the Balu rivers that lie on the boundaries of the aquifer. Even with an average rainfall of 1800 mm annually, there is almost no vertical recharge to the aquifer because of the thick Madhupar clay layer on top with thickness varying from 6m to 40m. With the current water requirement of 1.6 Mm<sup>3</sup>/year out of which 80% is met through groundwater, the groundwater levels have been showing a secular declining trend of 1m per year for the past 30 years (Zahid et al, 2004). The trend seems to be to shift towards surface water through proper treatment or by supplying groundwater from surrounding areas through pipelines as has been done in many other large cities of the world. But excessive pollution of surface water due to industrial effluents and sewage is a major concern and the quality of water supplied to consumers from surface water treatment plants is in general, not of acceptable quality. Therefore, efforts need to be made towards proper treatment, as well as reducing system delivery losses and also towards water saving by the consumers.

#### **4. Major institutions involved in groundwater research and management, their relative role and importance and some key issues in this respect**

Within the Government of Bangladesh, the agency directly responsible for groundwater is the Bangladesh Water Development Board which is a part of the Ministry of Water Resources. BWDC experimented with the first set of deep tubewells in Barind area during the 1960's which eventually kickstarted the country's shallow tubewell revolution. Despite the fact that Bangladesh depends so heavily on groundwater for irrigation, groundwater agency is a small part of the Ministry of Water Resources which is heavily staffed by civil engineers. This is perhaps a legacy of the past since Pakistan Water and Power Development Agency (WAPDA) which ran the water affairs of the erstwhile East Pakistan was heavily dominated by canal irrigation focus. As of now, however, BWDC plays only a marginal monitoring role in Bangladesh's groundwater economy.

Bangladesh's NGOs played a key role in ushering in its groundwater revolution. During the early 1980's, PROSHIKA installed hundreds of deep tubewells and handed them over to poor women's groups to help them make a living out of managing these tubewells and selling irrigation service to farmers. Bangladesh Rural Advancement Committee (BRAC), Grameen Bank and several other NGOs too played a key catalytic role in popularizing groundwater irrigation. International Development Enterprises (IDE) popularized the use of low cost treadle pumps during early 1990s. Their numbers increased to over a million by 2000. However, towards the end of the 1990s, the government liberalized the import and trade in small pumps. This led to massive import of cheap Chinese diesel pumps which rapidly made the older deep tubewells and new treadle pumps obsolete while shallow tubewells with diesel pumps became the new groundwater industry standard in Bangladesh.

Among research institutions, Bangladesh Agriculture University at Meimensingh and Bangladesh Institute of Development Studies at Dhaka has been important in terms of socio-economic and policy research. There is a private consultancy, Center for Environmental and Geographic Information Services that we were taken to in Dhaka which seems to be doing interesting work on GIS and RS on a commission basis. However, their orientation seemed more towards contract work for bilateral and multi-lateral donors in preparation for large infrastructure investment projects. It was not apparent that this centre had broad-based policy and institutional analysis competency or even a strong hydro-geology depth.

IWMI had a small presence in Bangladesh during mid-1980's; however, IWMI's work has remained largely peripheral. Collaborative research projects between Maimensingh (Dr MAS Mandal) and University of East Anglia (Richard Palmer-Jones) has produced some prolific and insightful research on the unfolding of Bangladesh's groundwater drama since early 1980's. IWMI-Tata Program has had some history of collaborative work in Bangladesh with one Dr K C Roy, from the Bangladesh Agriculture Research Institute (BARI) at Joyebpur, Gazipur, who co-ordinated our survey of groundwater irrigators. We found that collaboration useful; however, Dr Roy has since retired and we

found it difficult to trace him. He may be a useful point-man for our cross-cutting research.

Our sensitization visit to Bangladesh was facilitated by the Bangladesh Water Development Board who was also represented in the pre-proposal workshop we organized in Calcutta for getting inputs for the Groundwater Governance project proposal. The day-long workshop organized by BWDB was well-attended (as the following list of participants shows) and had participation from government, NGOs and media. Some key NGOs—such as PROSHIKA, BRAC, IDE, etc—however were absent; so was Bangladesh Institute for Development Studies, Dhaka.

### **5. Description of tour, referring to an itinerary, and a complete list of people and institutions visited**

List of participants:

<b>Sl.No.</b>	<b>Name and Designation</b>	<b>Organization</b>
01.	Md. Menhazur Rahman Hydrogeologist	Aqua Consultants
02.	Syed Musleh Uddin Geologist, Ground Water Hydrology	Bangladesh Water Development Board, 72, Green Road, Dhaka
03.	Mr. Lutfe Noor Geologist, Ground Water Hydrology	Bangladesh Water Development Board, 72, Green Road, Dhaka
04.	Mr. Humayun Kabir Executive Director	Protiva Sangstha, Colagache Bazarm P.O. Arua Upzila: Keshabpur , Dist Jessore Tel: 0176-833956
05.	Md. Saiful Islam Journalist	BSS News Agency <a href="mailto:shameembss@yahoo.com">shameembss@yahoo.com</a> Phone: 011-810995
06.	Md. Mominur Rahman Geologist, Ground Water Hydrology	Bangladesh Water Development Board, 72, Green Road, Dhaka
07.	Mr. Aminul Islam Engineer	Bangladesh Arsenic Mitigation Water Supply Project, Department of Public Health and Engineering, Kakrail, Dhaka
08.	Mr. Ehsan Hafiz Chowdhury	Center for Environmental and Geographic Information Services, House#6, Road#23/C, Gulshan-1, Dhaka
09.	Mr. ASM Woobaidullah, Professor	Department of Geology, University of Dhaka, Dhaka-1000.
10.	Mr. OH Shamin Sher, Consultant Hydrogeologist	C.E. Group of Professional Services

11. Mr. Muhammad Qamrul Hassan, Professor  
Department of Geology, University of Dhaka, Dhaka-1000.  
Email: [mqhassan@udhaka.net](mailto:mqhassan@udhaka.net)  
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14-15 Mitijheel C/A, Green Road, Dhaka 1000  
Off: 9550815, 9552412
13. Md. Mizanur Rahman, Chief Engineer, Hydrology  
Ispahani Building (4<sup>th</sup> floor)  
14-15 Mitijheel C/A, Green Road, Dhaka 1000  
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14. Dr. Tushaar Shah  
IWMI
15. Dr. Md. Sazzad Hossain Professor  
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17. Dr. MA Sattar Mandal Professor  
Bangladesh Agriculture University, Mymensingh
18. Mr. Gholam Mostafa Geologist, Ground Water Hydrology  
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Phone: 9005807
20. Mr. Shawkat Alam Khan Geologist, Ground Water Hydrology  
Bangladesh Water Development Board, 72, Green Road, Dhaka
21. Mr. Golam Morshed Geologist, Ground Water Hydrology  
Bangladesh Water Development Board, 72, Green Road, Dhaka
22. Md. Shahidul Alam Geologist, Ground Water Hydrology  
Bangladesh Water Development Board, 72, Green Road, Dhaka  
Geological Survey of Bangladesh, Segunbagicha, Dhaka
23. Md. Nehal Uddin Deputy Director  
Email: [nehalu@bttb.net.bd](mailto:nehalu@bttb.net.bd)  
Tel: 880-2-8314810 – 14/ ext 345
24. Mr. M.A. Karim Deputy Director, Ground Water Hydrology  
Bangladesh Water Development Board, 72, Green Road, Dhaka
25. Mr. Waliur Rahman  
Bangladesh Water Development

	Deputy Director, Ground Water Hydrology	Board, 72, Green Road, Dhaka
26.	Ahmadul Hassan	Center for Environmental and Geographic Information Services, Email: <a href="mailto:ahassan@cegisd.com">ahassan@cegisd.com</a> Tel: 8821570-2
27.	Mr. Gias Uddin Ahmed Choudhury Executive Director	Center for Environmental and Geographic Information Services, House#6, Road#23/C, Gulshan-1, Dhaka
28.	Mr. Anwar Zahid Deputy Director, Ground Water Hydrology	Bangladesh Water Development Board, 72, Green Road, Dhaka Tel: 0088-02-8121272 Email: anwarzahidb@yahoo.com

### *5.1 Speakers*

1. Ejar Uddin: Md Ejar Uddin's summarized the entire water resources situation of Bangladesh. He outlined the various efforts undertaken by BWDB in the past towards better understanding of groundwater resources. The main problem mentioned by him was the arsenic contamination in various parts of the country.

2. Tushaar Shah (groundwater governance in general): This talk gave an idea of IWMI's work on groundwater in different regions of the world. He gave indications of how management practices tried in one part of the world can be beneficial to other countries. Some examples of research done in India was described in more detail.

3. Sunderrajan Krishnan (project details): This talk was focused on the scope of the Groundwater Governance project and how the Bangladesh partners can participate.

4. Anwar Zahid (GW problems in Bangladesh and in Dhaka): In this presentation, the problems in Dhaka city on depletion of groundwater was described in detail. Also, the various causes for arsenic contamination and how progress has been made in understanding this were mentioned. Anwar Zahid also gave some topics for research within this project such as: 1. Characterization of aquifers for better understanding of groundwater flow, 2. Modeling of aquifers to be utilized in better management of groundwater. He also mentioned another concurrent project which BWDB is participating on groundwater modeling in the Bengal basin that includes the Indian part of the basin as well.

### *5.2 Other Recommendations for research*

Sattar Mandal & Richard Palmer Jones: In the ensuing discussion, there were feedbacks on the possible research from Sattar Mandal and Palmer Jones. Their recommendations were:

1. To have the Bangladesh Planning Commission report on PRDP to be a basis document for research in this project.
2. To revive past research performed 10-15 years back in Bangladesh on the extent of groundwater markets, its role in development of groundwater and how further development of groundwater is linked to this private aspect of groundwater use.

Prof. Qumrul Hassan: Prof. Hassan from Dhaka University was interested in participating in projects which deal with problems of coastal salinity and groundwater modeling of these problems.

## **6. Conclusions and recommendations**

Bangladesh is critical for CP project on Groundwater Governance. Our sensitization visit helped create a foundation for a variety of partnerships we can potentially build there. One clear issue we need to settle is to strike a balance between government and NGOs. BWDC would likely want the gate-keeper role; however, it is clear that non government agencies have always played, and are still playing a critical role in Bangladesh's groundwater drama. Moreover, our sense is that BWDC is essentially a Dhaka-based outfit with limited rural outreach which is essential for our project.

Arsenic issue is already hyped up to hyperbolic levels. There already is a good deal of scientific research and assessments of the problems going on. It is not clear what value can our project add to this work. Our sense is we need to keep out options open in terms of; [a] whether the Project should support partner research; and [b] if so, what might be the areas where our support can add value. Until we have a clearer view of the lay of the land, it might be better to provide small seed-research grants on a Terms-of-reference basis rather than commit substantial resources to a single proposal or institution.

On the other hand, there is scope –and perhaps even need—for opening more slots for the Course for Bangladesh participants. Palmer-Jones hinted at additional support that might be available to finance more participants from Bangladesh. If this becomes a reality, we should be ready to have more fieldwork sites in Bangladesh too.

For cross-cutting research, it is important to identify one or more NGOs/ research centres with a strong grassroots base to provide logistical support as well as some research oversight. Perhaps, MAS Mondal from Maimensingh can play an anchor for us in this respect although we need to keep BWDC in the loop on whatever we decide.

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