Integrated Programme
Preliminary Application September 2008

[redacted]

Registration

1. *Programme*

a. Theme

A [ ] Open

	B. Thematic Frame:
2	1. Poverty and Hunger
	2. Global Health and Health Systems
1	3. Sustainable Environment
	4. Global Relationships

Motivation: Word count: 135
(*Max. 150 words, add word count)*

Elevated arsenic concentrations found in shallow groundwater resources in Bangladesh has placed millions of people under serious health threats. Replacing contaminated shallow tube-wells with uncontaminated deep tube wells is one of the recent and most propagated remediation strategies. This approach however brings up a number of risks. Our main motivation is that an interdisciplinary and adaptive approach is required to assess the sustainability of this approach. This is urgently needed before considering another major shift in the drinking water sector.

For researchers it is motivating to engage in scientific studies that bear a direct relevance to such serious development issues. We propose a framework where everyone involved can learn and while doing so can link up to village-level developments and strengthen an organisation that will continue its work after completion of this proposed research.

b. Number of sub-projects

Ph.D.: 2 Post-doc: 1

b. Duration of the programme: 48 months

c. Country(ies) where the research will be carried out: Bangladesh, Netherlands (with support from Australia, see collaborators)

2. *Title*
Technical and Social Feasibility of Deep Tube Wells for Arsenic Free Drinking Water in Bangladesh

3. *Composition of the research team*

a. Applicants

Main applicant (NL):		Co-applicant (DC):	
Family name:	Bruining	Family name:	Ahmed
First name(s):	Hans	First name(s):	Kazi Matin
Title(s):	Prof. Dr.	Title(s):	Prof. dr.
University / Institute:	Delft University of Technology / Technical Geosciences	University / Institute:	University of Dhaka / Geology department
Discipline (s):	Reactive transport in porous media, Colloid-Chemistry	Discipline (s):	Hydrogeology, Hydrogeochemistry, Environmental Impacts of Water Developments
E-mail:	j.bruining@tudelft.nl	E-mail:	kmahmed@univdhaka.edu
Address:	Stevinweg 1 2628 CN Delft The Netherlands	Address:	Curzon Hall Campus
Tel.:	31-15-2786032	Tel.:	+880-2-9661900-

[redacted]

			59/4897, 6015
Fax:	31-15-2783328	Fax:	+880-2-8615583
Male/Female (F/M):	M	Male/Female (F/M):	M
Time to be spent on the programme (f.t.e.):	0.2	Time to be spent on the programme (f.t.e.):	0.2

b. Collaborators' details

Family name:	Boes	Family name	Visser
First name(s):	Jan	First name (s)	Leontine E.
Male/Female (F/M):	M	Male/Female (F/M):	F
Title(s):	Drs.	Title(s):	Prof. Dr.
University / Institute:	Delft University of Technology	University / Institute	Wageningen University / Rural development sociology group
Discipline (s):	Physics and development economics	Disciplines	Anthropology, natural sciences
Role in the programme:	Social and risk research	Role in programme	Sociology and interaction between social and natural sciences
Time to be spent on the programme (f.t.e.):	0.2	Time to be spent on the programme (f.t.e.):	0.05
Family name:	Kroonenberg	Family name:	Masud
First name(s):	Salomon B.	First name(s):	Zahed Md.
Male/Female (F/M):	M	Male/Female (F/M):	M
Title(s):	Prof. Dr.	Title(s):	A/Prof. Dr.
University / Institute:	Delft University of Technology / Applied Geology	University / Institute:	Arsenic Mitigation and Research Foundation. Institute of Health, Population and Development.
Discipline (s):	Geological modelling	Discipline (s):	Public health and development
Role in the programme:	Technical research	Role in the programme:	Coordination in Bangladesh
Time to be spent on the programme (f.t.e.):	0.05	Time to be spent on the programme (f.t.e.):	0.2
Family name:	Storms	Family name:	Islam
First name(s):	Joep E. A.	First name(s):	Fariba
Male/Female (F/M):	M	Male/Female (F/M):	F
Title(s):	Dr.	Title(s):	Dr.
University / Institute:	Delft University of Technology / Applied Geology	University / Institute:	Arsenic Mitigation and Research Foundation
Discipline (s):	Fluvial sedimentology, geological modelling	Discipline (s):	Health and development
Role in the programme:	Technical research	Role in the programme:	Coordination in Bangladesh
Time to be spent on the programme (f.t.e.):	0.1	Time to be spent on the programme (f.t.e.):	0.2
Family name:	Shafie	Family name:	Begum
First name(s):	Hasan	First name(s):	Fauzia
Male/Female (F/M):	M	Male/Female (F/M):	F
Title(s):	Assist. Prof.	Title(s):	Assist. Prof. Dr.
University / Institute:	University of Dhaka / Anthropology department	University / Institute:	Institute of Health, Population and Development. Arsenic Mitigation and

[redacted]

			Research Foundation.
Discipline (s):	Anthropology, disaster relief.	Discipline (s):	Public health and development
Role in the programme:	Social and risk research	Role in the programme:	Technical research
Time to be spent on the programme (f.t.e.):	0.1	Time to be spent on the programme (f.t.e.):	0.1
Family name:	Merson	Family name:	Picioreanu
First name(s):	John A.	First name(s):	Christian
Male/Female (F/M):	M	Male/Female (F/M):	M
Title(s):	A/Prof. Dr.	Title(s):	Dr.
University / Institute:	University of New South Wales / Institute of Environmental Studies	University / Institute:	Delft University of Technology / Environmental Biotechnology
Discipline (s):	Social sciences, environmental policy and management, economics	Discipline (s):	Modelling microbial processes
Role in the programme:	Social and risk research	Role in the programme:	Technical research
Time to be spent on the programme (f.t.e.):	0.05	Time to be spent on the programme (f.t.e.):	0.05
Family name	Schotting		
First name(s):	Ruud J.		
Male/Female (F/M):	M		
Title(s):	Prof. Dr. Ir.		
University / Institute:	University of Utrecht / Faculty of Geosciences / Environmental Hydrogeology Group		
Discipline (s):	Quantitative Water Management, mathematical modeling		
Role in the programme:	Modeling transport processes, upsclaing		
Time to be spent on the programme (f.t.e.):	0.05		

c. <u>Researchers' details</u>

Family name:	Rammelt	Family name:	To be selected
First name(s):	Crelis F.	First name(s):	
Title(s):	Ir. (Dr. expected in 08-2009)	Title(s):	
University / Institute:	University of New South Wales / Institute of Environmental Studies	University / Institute:	
Discipline (s):	Engineering, social sciences, environmental policy and management	Discipline (s):	
Male/Female (F/M):	M	Male/Female (F/M):	F/M
Time to be spent on the programme (f.t.e.):	1.0	Time to be spent on the programme (f.t.e.):	2.0

[redacted]

Research proposal

4. *Summary of the research proposal* (*Max. 150 words, add word count)*

Word count: 146

Shallow tube-wells are the primary source of drinking water in Bangladesh. Over a decade ago it was discovered that two-thirds are severely contaminated with arsenic. The Arsenic Mitigation & Research Foundation (AMRF) started a programme initially focussing on the installation of deep tube-wells and on the formation of community-based organisations responsible for operation and maintenance. Early experiences show that communities are participating and that this approach seems successful.

The main research questions are: Does it provide a viable basis for sustainable solutions? And what are the risk factors involved? The complexity of the issue calls for an interdisciplinary and adaptive approach. AMRF provides practical support to undertake research in direct dialogue with local participants. In accordance with local priorities, researchers will bring valuable technical or social insights back into the projects, thus stimulating AMRF as a learning organisation that will take the results further into practice.

5. *Description of the programme* (*Max. 2500 words, add word count)*

Word count: 2497

a. Programme background and rationale (i), outline (ii) and innovative aspects (iii)

(i) Background and rationale

Problem statement

To provide a reliable alternative to irregular and infected surface water resources, over the last four decades more than 97% of the rural population have been provided access to drinking water through shallow tube wells (STWs) [Ahmed 2005]. Two-thirds of these wells turn out to extract groundwater with arsenic concentrations above the permissible levels set by the WHO. Arsenic is chronically toxic after prolonged low-level exposure and can lead to cancers and neurological disorders [WHO 2000]. Some have estimated 400,000 casualties in the near future and possibly much more when taking into account the intake of arsenic in food crops irrigated with contaminated water [Ahmed 2002, Huq & Naidu 2005].

Minerals containing arsenic adsorbed to iron III were deposited some millions of years ago during the formation of the delta that is now Bangladesh. As long as the arsenic remains adsorbed this situation is harmless. However, at low levels of dissolved oxygen microbes convert iron III to iron II and the latter cannot retain arsenic. This mechanism is recognised to be responsible for the release of arsenic into the water pumped up by STWs [BGS/DPHE 2001, Smedley & Kinniburgh 2002, Ahmed et al. 2005].

With low levels of income and limited access to services the rural poor are most exposed. Moreover, given their poor nutrition and low health status, their susceptibility to arsenicosis diseases is highest [Smith & Smith 2004, Atkins et al. 2007]. In Bangladeshi society, women tend to eat last and least in their households and are the most likely family members to be malnourished. This seems to imply that arsenic contamination has more severe physiological consequences for them [Crow & Sultana 2002, Hanchett 2006].

Interventions and research efforts

Many organisations are involved but unfortunately results have been meagre. The arsenic mitigation policy has been widely criticised for its low impact and the technical choices proposed [Caldwell et al. 2003, Ahmed et al. 2006]. International efforts frequently reflect narrow technical and economic views and generally fail to engage communities in decision-making [Atkins et al. 2007]. Among the few projects that

are being implemented even fewer have managed to develop suitable operation and maintenance arrangements; to bypass existing power relations; and to extend services to the very-poor [Crow & Sultana 2002, Hanchett 2006, Rammelt & Boes 2008].

Geological, geochemical, medical, social and technical research has gone far to clarify different facets of the arsenic problem. Integration of the findings of these disciplines is however far from complete. Even less attention has been given to comprehensive and pragmatic research fed by experiences from actual implementation of solutions in affected areas. It is now clear that focussing purely on research does not respond to the urgency of the situation.

The dilemma of the current situation therefore presents two operational alternatives: Should the emphasis be placed on improving our understanding of this complex issue in order to come up with the best possible solution, or should priority be given to mitigate the contamination now in order to save lives? Obviously both should be done; which brings us to our main development challenge. Contrary to technical installations that can be completed rather quickly, the underlying processes of building the supporting institutions take much more time. In sum, the challenge is to streamline short- and long-term priorities and to integrate social and technical processes.

With this in mind, the Arsenic Mitigation and Research Foundation (AMRF) was established in 2001 as a partnership between Dutch and Bangladeshi scientists and development professionals. The partner NGOs[1] started implementation in two arsenic-affected districts. We feel that where the central administration struggles with inadequate financial and institutional capacity, local NGOs could provide direct linkages to the poor. It goes without saying that AMRF has mainly engaged women due to the aforementioned gender considerations; and because they are the main managers of domestic water.

Deep tube-wells and their risks

Among the different technical options, AMRF found an overwhelming popular preference for Deep Tube-Wells (DTWs). These serve as quick mitigation; in other words an end in itself. DTWs are also a means upon which people have started building the Community-Based Organisations (CBOs) necessary for operation and maintenance. These activities have been the main starting points for AMRF and have brought about a dialogue with local communities. A number of long-term risks however come up.

While most DTWs seem safe at present, two mechanisms could lead to their contamination: the first is in situ release and the second is transferred arsenic from elsewhere. It has been suggested that massive water extraction might elicit these reactions. As organisations and policies are pushing forward with DTWs, an assessment of the risks is urgently needed. Social risks also come up: village elites sometimes dominate the CBOs; the poor's economic position may hamper DTW maintenance; gender aspects sometimes restrict the mobility of women in the village; etc.

In sum, two broad interrelated classes of risks are distinguished; one is technical and the other is social. The scientific objective is to integrate relevant academic and popular knowledge regarding these risks, which will help us assess the overall feasibility of the approach. From a developmental perspective, the objective is to integrate this knowledge with practical implementation for a number of poor and arsenic-affected communities. We believe that a synergy between efforts of partner NGOs and the experience of research organisations on a scientific level will be successful [AMRF 2005].

(ii) Outline

[1] AMRF is currently working with two partner NGOs; PRIDE and AITAM in the districts of Jessore and Munshiganj respectively.

[redacted]

Methodological considerations

Rural communities will be assisted in developing adaptive coping strategies to manage their drinking water resources. At the same time, the project will provide an opportunity for all participants to learn as new problems and risks emerge during the implementation process. This endeavour only makes sense if researchers are closely involved in field activities. As discoveries in one facet of the problem may have impacts on others, the approach must also be interdisciplinary. Finally, it must be flexible in light of surprises and scientific uncertainties.

Moreover, if people's participation is to be taken seriously, the research tools must be chosen during the process and not before. As outsiders we can predict neither the exact development process, nor the specific instruments required to properly assess it. Such views have been proposed under the umbrella of 'Adaptive Management and Governance' [Brunner 2005, Stankey et al. 2005, Gunderson & Light 2006], which draws from a wide range of methodologies and lets theory emerge from praxis.

While we believe that the exact methods must be elaborated during execution in collaboration with local stakeholders; a few things will now be said about the process of 'designing' the methodology. A number of inquiry approaches will help structure the dialogue between researchers, practitioners and local communities, especially the poor and women: 'Participatory Action Research', 'Participatory Learning and Action', etc [Altrichter et al. 2002, Scheyvens & Storey 2003, Jain & Polman 2004, Hay 2005, Vernooy 2005]. These provide potentially useful toolsets of cyclic, participative and qualitative methodologies[2].

Implementation

AMRF then functions both as a facilitating and a learning organisation:

1. It provides practical support to researchers for sampling, data collection, translation, etc. AMRF provides a favourable environment for all stakeholders to learn about implementation processes.
2. In turn, researchers will bring valuable technical or social insights back into the projects and help build up the expertise of AMRF that will take results further into practice. For example, water and microbial sampling within the technical research will be used to set up a local water quality monitoring system. Similarly, a socio-economic study will help AMRF identify and target the poor in a village community.

It is important that these research inputs – as well as the activities initiated by AMRF – bear relevance to local priorities. This 'reality check' will be provided by a Participatory Monitoring and Evaluation (PME) system. Based on people's valuation of the implementation process, qualitative and quantitative criteria will be chosen and activities will be monitored [AMRF 2005]. The aim is to phase out external inputs, gradually replacing them with community inputs [Chambers 1997, Neggers 1998]. In our view, project activities will become more appropriate as the institutional strength of the CBOs grows (Fig. 1).

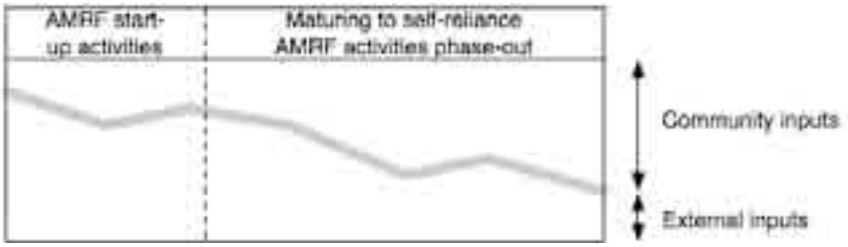

Figure 1: AMRF programme life cycle

[2] For clarity purposes, a few (semi-)quantitative methods have already been applied in the AMRF working areas; including mapping, wealth ranking, network analyses, historical surveys, in-depth interviews, etc.

For the working areas, we ultimately aim for the following results:

- Operational safe water options and functioning CBOs.
- Local procedure for operation and maintenance of the DTWs.
- Strengthened participation of the local communities in the working areas.
- Recommendations for a PME system.
- Increased links between local communities and government institutions.

Our initial experiences show that institutional strengthening at the local level has already led to a number of spin-offs. Some CBOs succeeded in accessing government Water Supply and Sanitation services that usually fail to reach the very-poor. Beyond direct impacts in the working areas, we are looking to share our experiences in larger scientific and policy-making platforms[3] through publications, seminars and conferences. We have chosen working areas with geo-morphological and social variation to help formulate recommendations relevant for other arsenic-affected districts. Considering the weaknesses of existing policies and interventions, it is necessary to suggest viable long-term strategies and discourage damaging development programmes [Atkins et al. 2007b].

(iii) Innovative aspects

We believe that the current lack of integration of scientific with local popular knowledge has been an epistemological problem since the beginning of the discovery of the contamination. This has been detrimental for development practice and policy. In this respect, this project plays a key role by bringing together stakeholders. Extensive work can be found on participation and action research but the long-term impact of these approaches is difficult to predict. There can be a large difference between a typical evaluation system based on predefined criteria and one that finds its quality in the internal dynamics of the development process based on local priorities.

While ‘Adaptive Management’ concepts are promising, their potential in the context of a developing country has not been explored much. Conceived initially by ecologists, these approaches aim to provide a structured and iterative process of optimal decision-making in the face of uncertainty via system monitoring. As opposed to the monitoring of water quality for example, the assessment of social change is quite different because decision-making tends to be highly dispersed and because of the strong intangible and long-term character of the processes. Practical and theoretical consolidation of these ideas is needed.

From a technical perspective, the innovative aspect is the combination of geological modelling [Storms 2005] and upscaling of the flow processes involving geo-chemistry [Ahmed 2005, Bruining & Darwish 2006, Bruining et al. 2008, Sutton et al. 2008].

[3] World Bank, UNICEF, FAO, Arsenic Crisis Information Centre, International Society of Groundwater Resources for Sustainable Development, Safe Water Implementation Group, etc. The partners have further links with Australian, Swedish, American, UK, Japanese groups.

b. Summary of sub-projects

(i) Post-doc Risk research

This sub-project is concerned with an integrated understanding of all risk factors involved in the Deep Tube-Well (DTW) approach. Firstly, the connections between the technical and social sub-projects will need clarification. For example, from AMRF's initial experiences we found that finding land suitable for the installation of a community DTW is difficult from a socio-cultural, economic as well as geological point of view. Another possible link comes up while handing over operation and maintenance of water supplies to local communities. This must include social organisation and technical schemes for monitoring the water quality. More such links are expected to come up during the execution of the programme.

Secondly, we must consider risks beyond the social and technical sub-projects; in the realm of governance for instance. Organisations are encouraging the implementation of piped water supplies drawing from the deep aquifers, which could induce the contamination of DTWs. As centralised approaches fail to reach the poor, many hope that NGOs will fill the gap. However, with increasingly competitive funding procedures, NGOs focus more on quantity and less on taking time to build local institutional capacity [Rammelt & Boes 2008]. Finally, different health risks have to be considered, such as the intake of arsenic through the food chain or the risk of shifting back to surface water. These are some of the risks to be studies in this sub-project.

(ii) PhD Social research

Problem statement

Existing power relations, cultural traditions, etc. might hamper participation of women and more generally the very poor [Chambers 1997 and others]. Although they need it most, these groups do not have access to safe drinking water, services, diagnosis and treatment. Another possible obstacle is that they do not relate to the problem. Firstly, they cannot identify the symptoms nor differentiate arsenicosis from other diseases. Secondly, arsenic might not be a priority when there are other more urgent sufferings. Thirdly, even if people do feel the need, they may still not culturally accept the solutions. Community-based DTWs might not compete with the proximity of private STWs for example. On the other hand, risks can be shared when a community water supply is in need of repair; but this might not be easy to set up in areas where social capital has eroded [Attwater & Merson 2007].

Methodology

As explained, AMRF's vision is to see CBOs develop as a force in the community; an aim that surely extends beyond the time frame of this research project. While it might not be possible to fully estimate the sustainability of the CBOs; it should be possible to come up with an assessment of the risks. This research will gather and analyse social, health, nutrition, gender, economic and institutional data and risk factors [Hay 2005].

(iii) PhD Technical research

Problem statement

Two mechanisms may lead to contamination of DTWs. The first mechanism is in situ release and the second is transferred contamination from elsewhere (Fig. 2). Despite important contributions, it is clear that a lack of geological knowledge is still one of the bottlenecks in understanding the patchy nature of arsenic contamination [Shah 2007].

There is limited data for the deep aquifers. Existing geological data combined with new local geological data from the AMRF working areas will be used to construct a detailed geological model. Arsenic naturally occurs in sediments, i.e., adsorbed to the minerals that for instance include iron III. It is a generally accepted that in anaerobic situations bacteria will, in the process of digesting organic compounds, convert iron III to iron II, which will release the adsorbed arsenic.

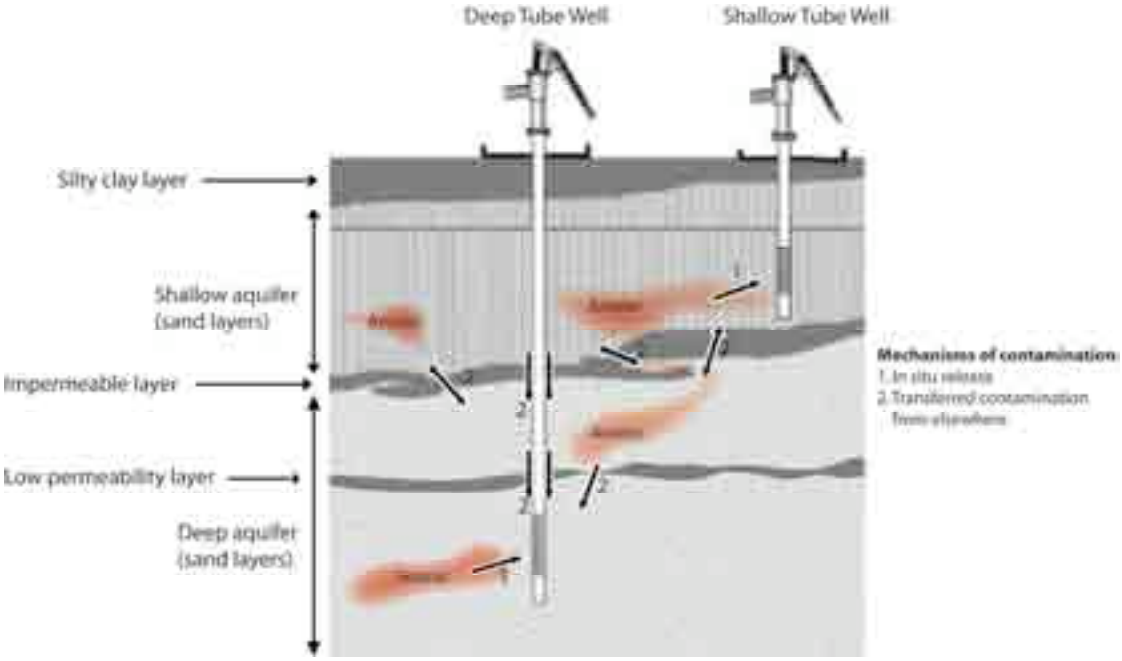

Figure 2: Possible mechanisms of contamination of DTWs.

Methodology

Groundwater samples will be taken and analysed to observe changes in redox conditions or other (bio)chemical indicators. Recent work involving DNA extraction and analysis has shown differences between the micro-organism population in samples from deep and shallow tube wells in the AMRF working areas [Sutton 2008]. A comparison between sites will show whether our data is specific or generic. Data-analysis in combination with flow modelling will provide potential mechanisms for in situ release.

We will also assess the risk of the transfer of contamination from the shallow to the deep layer. In this the low permeable layer that separates the deep from the shallow aquifer plays an essential role [Zheng et al. 2005]. Fieldwork will include measurements of sediment grain size distributions. Flow modelling can be used to determine the risk of contamination through the low permeable layer.

[redacted]

Relevant (recent) publications of the research group(s)
(max. 1 page)

Ahmed, K.M., 2005, Management of the groundwater arsenic disaster in Bangladesh. In: Natural Arsenic in Groundwater: Occurrence, Remediation and Management. London: Balkema publisher, member of Taylor & Francis Group

Ahmed, K.M., P. Bhattacharya, et al, 2005, Arsenic contamination in groundwater of alluvial aquifers in Bangladesh: An overview. Applied Geochemistry, 19(3): 181-200

Ahmed, K.M., S.M.I. Huq and R. Naidu, 2006, Extent and severity of arsenic poisoning in Bangladesh. In: Managing Arsenic in the Environment: From Soil to Human Health. R. Naidu, E. Smith, G. Owens, P. Bhattacharya and P. Nadebaum. CSIRO Publishing, Melbourne, Australia. pp. 525-540.

Arsenic Mitigation and Research Foundation, 2005, Arsenic Contamination and Community Participation Programme. Delft, Dhaka, p. 12.

Attwater, R and J. Merson eds., 2007, Sustaining Our Social and Natural Capital, ISCE Pub, Mansfiels, MA. USA.

Biswas, W. and J. Merson, 2005, The Socio-technical Challenges of Safe Water Supply in Rural Bangladesh ICFAI Journal of Environmental Economics, Vol 111, No 4 November.

Bruining J., M.I.M. Darwish, 2008. Homogenizeation for Fe2+ deposition near drink water tube wells during arsenic remediation, European Conference on the Mathematics of Oil Recovery X, Amsterdam, P003, Sept. 2006. To be submitted to Transport in Porous media

Darwish, M.I.M., V. van Beek, J. Bruining, 2005, In situ Arsenic removal using redox condition alteration: Visualization experiments, Journal of Geochemical Exploration.

Islam, Z. and H. Shafie, 2006, Anthropology on the Move: Contextualizing Culture Studies in Bangladesh. Department of Anthropology, University of Dhaka, Bangladesh. ISBN: 984-32-2436-0

Kraan, G. van der, H. Salimi, J. Bruining, Micromidels for visualization of microbial transport, J. of Scientific Instruments, in preparation.

Kroonenberg, S.B., E.N. Badyukova, J.E.A. Storms, E.I. Ignatov, N.S. Kasimov, 2000, A full sea-level cycle in 65 years: barrier dynamics along Caspian shores. Sedimentray Geology, 134, 257-274.

Potts, T., J. Merson and M. Katcka, 2007, Lawson: a case study in Fostering Sustainability. In Nelson, A ed. Steering Sustainability: policy, practice and performance in a Urbanised World, Ashgate, UK.

Rammelt, C. F. and J. Boes, 2008. The Autonomy of Local Drinking Water Institutions in Rural Bangladesh. Groundwater for Sustainable Development - Problems, Perspectives and Challenges. P. Bhattacharya, A. Ramanathan, A. B. Mukherjeeet al. London, CRC Press Balkema - Taylor & Francis: 399-409.

Rammelt, C.F. and J. Boes, 2004: Arsenic Mitigation and Social Mobilisation in Bangladesh, International Journal of Sustainability in Higher Education, 5 (3), 308-319, Emerald Group Publishing Limited Faculty of Applied Earth Sciences, Delft University of Technology

Rammelt, C.F., J. Boes, 2005: Implementation of Safe Drinking Water Supplies in Bangladesh. In: Bundschuh et al (eds.). Natural Arsenic in Groundwater: Occurrence, Remediation and Management. London: Balkema, member of Taylor & Francis Group

Ravenscroft, P., W. G. Burgess, K. M. Ahmed, et al, 2004, Arsenic Contamination of Groundwater in the Bengal Basin, Bangladesh: Distribution, Field Relations, Origins and Mitigation, Hydrogeology Journal.

Shafie, H., 2000, Health Seeking Behavior of the Arsenic Contaminated People of Rural Bangladesh. Social Science Review: A Multi-Disciplinary Journal of Social Sciences, Volume 17, Number 01, Pp. 140–147

Storms, J.E.A., R.M. Hoogendoorn, R.A.C. Dam, A.J.F. Hoitink, S.B. Kroonenberg, 2005, Late-Holocene evolution of the Mahakam delta, east Kalimantan, Indonesia. Sedimentary Geology, 180, 149-166.

Storms, J.E.A., S.B. Kroonenberg, 2007, The impact of rapid sea level changes on recent Azerbaijan beach ridges. Journal of Coastal Research, 23, 521-527.

Sutton, N.B., G.M. van der Kraan, M.C.M. van Loosdrecht, G. Muyzer, J. Bruining, and R.J. Schotting, 2008, Geochemical and biological characterization of deep and shallow tube wells in Bangladesh. To be submitted to water resources.

Thuss, B., Visualization of bacterial transport mechanisms with transparent micro-models, Master's thesis TU Delft, jointly supervised by Geo-environmental Engineering and Environmental Biotechnology, nominated for best thesis award in Dept. Applied Geoscience.

[redacted]

6. *Literature references*
(max. 1 page)

Ahmed, F., 2002, Alternative Water Supply Options for Arsenic Affected Areas of Bangladesh. In: International Workshop on Arsenic Mitigation in Bangladesh Dhaka: ITN-Bangladesh, BUET.

Ahmed, M.F., et al., 2006, Epidemiology: Ensuring Safe Drinking Water in Bangladesh. Science 314, 1687-1688.

Altrichter, H., S. Kemmis, et al., 2002, The concept of action research. The Learning Organization: An International Journal 9: 125-131.

Atkins, P., M. Hassan, et al., 2007, Poisons, pragmatic governance and deliberative democracy: The arsenic crisis in Bangladesh. Geoforum 38(1): 155-170.

British Geological Survey & Department of Public Health and Engineering, 2001, Arsenic Contamination of Groundwater in Bangladesh. D. G. Kinniburgh and P. L. Smedley. Dhaka, BGS/DPHE.

Brunner, R. D., 2005, Adaptive governance: integrating science, policy, and decision making. New York, Columbia University Press.

Chambers, R., 1997, Whose reality counts? : putting the first last. London, ITDG.

Caldwell, B. K., J. C. Caldwell, et al., 2003, Tubewells and arsenic in Bangladesh: challenging a public health success story. International Journal of Population Geography 9(1): 23-38.

Crow, B. and F. Sultana, 2002, Gender, Class, and Access to Water: Three Cases in a Poor and Crowded Delta. Society and Natural Resources 15: 709-724.

Goodbred, S. L., et al., 2003, Controls on facies distribution and stratigraphic preservation in the Ganges-Brahmaputra delta sequence. Sedimentary Geology, 155, 301-316

Gunderson, L. and S. S. Light, 2006, Adaptive management and adaptive governance in the everglades ecosystem. Policy Sciences 39(4): 323-334.

Hanchett, S., 2006, Social aspects of the arsenic contamination of drinking water: a review of knowledge and practice in Bangladesh and West Bengal. Dhaka, Arsenic Policy Support Unit: 1-51.

Huq, S.M. I., R. Naidu, 2005, Arsenic in groundwater and contamination of food chain: Bangladesh scenario. In: Bundschuh et al (eds.). Natural Arsenic in Groundwater: Occurrence, Remediation and Management. London: Balkema publisher, member of Taylor & Francis Group

Jain, S. P. and W. Polman, 2004, A handbook for trainers on participatory local development, The Panchayati Raj model in India. RAP Publication. Bangkok, FAO Regional Office for Asia and the Pacific: 68.

Hay, I., 2005, Qualitative research methods in human geography. South Melbourne, Vic., Oxford University Press.

Neggers, J.C., 1998, Programming, Monitoring and Evaluation System (PMES), a background paper. In: Black Sea NGO Forum Workshop Varna, Bulgaria.

Scheyvens, R. and Storey, D., 2003, Development fieldwork, a practical guide.

Shah, B.A., 2007, Role of Quaternary stratigraphy on Arsenic-contaminated groundwater from parts of the Middle Ganga Plain, UP-Bihar, India. Environmental Geology.

Smedley, P. L. and Kinniburgh, D. G., 2002, A review of the source, behaviour and distribution of arsenic in natural waters, Applied Geochemistry 17(5), 517-568

Smith, A. H. and M. M. H. Smith, 2004, Arsenic drinking water regulations in developing countries with extensive exposure. Toxicology 198(1-3): 39-44.

Stankey, G. H., R. N. Clark, et al., 2005, Adaptive management of natural resources: theory, concepts, and management institutions. Portland, OR, Pacific Northwest Research Station.

Vernooy, R., 2005, Participatory monitoring and evaluation, Readings and Resources. Ottawa, Rural Poverty and Environment program initiative, IDRC 30.

World Health Organisation, 2000, Towards an assessment of the socioeconomic impact of arsenic poisoning in Bangladesh. Water Sanitation and Health. Geneva, World Health Organisation: 42.

Zheng, Y. et al., 2005, Geochemical and hydrogeological contrasts between shallow and deeper aquifers in two villages of Araihazar, Bangladesh. Geochimica et Cosmochimica Acta, 69, 5203-5218.

[redacted]

7. *Summary plan for compulsory workshop*

a. Listing of participants

Academic participation (universities and research institutes, please add country):

- Delft University of Technology / Technical Geosciences, Netherlands
- Delft University of Technology / Applied Geology, Netherlands
- Delft University of Technology / Environmental Biotechnology, Netherlands
- Wageningen University / Rural development sociology group, Netherlands
- University of Dhaka / Geology department, Bangladesh
- University of Dhaka / Anthropology department, Bangladesh
- Institute of Health, Population and Development, Bangladesh
- University of New South Whales / Institute of Environmental Studies, Australia

Stakeholder participation (please provide an overview of the categories concerned, no personal names)

Workshop stakeholders IP			y/n	Please specify (name organisation, country)
1	Practitioners		☒	AMRF staff, central and field officers.
2	User group		☒	Water user groups from the AMRF working areas, Bangladesh, Village volunteers from the AMRF working areas, Bangladesh
3	Extension organisation		☒	Community Based Organisation from the AMRF working areas.
4	Civil society organisation	Local	☒	NGO sector (See 7)
5		National	☒	Geological Society of Bangladesh, Bangladesh Soil Science Society, Bangladesh Association for the Advancement of Sciences
6		International	☒	International Society of Groundwater for Sustainable Development (ISGSD)
7	NGO	Local	☒	PRIDE and AITAM (AMRF's partner NGOs), Bangladesh
8		National	☒	AMRF Bangladesh country office and AMRF Netherlands, NGO Forum, BRAC, Proshika, Grameen, DCH
9		International	☒	Water Aid, AAN, ICDDRB, OXFAM
10	Private sector entity		☐	
11	Public institute, agency or committee		☒	Bangladesh-Australia Centre for Environmental Research, Institute of Health, Population and Development.
12	Government institution	Local	☒	Union Councils (smallest administrative unit)
13		State/province	☒	Upazilla Nirbahi Officer (UNO, sub-district executive officer)
14		National	☒	Department of Public Heath and Engineering, Director General Health, Local Government Engineering Department.
15	Inter-governmental organisation		☐	
16	Other, namely….		☒	UNICEF, WHO, JICA

b. Description

Word count: 389

(*Max. 400 words, add word count)*

The project involves the collaboration between three main groups: University of Dhaka (UoD), Delft University of Technology (TUD) and the Arsenic Mitigation and Research Foundation (AMRF) (including its partner NGOs AITAM and PRIDE). The primary interest of TUD/UoD (Anthropology department) is on the institutional infrastructure at the village level,. The interest of TUD/UoD (Geology department) is in the development of models with which the technical risk factors can be assessed. AMRF is interested in facilitating the collaboration between researchers and local communities.

Over the last 9 years the collaboration between the partners has grown and resulted in several joint activities. This forms an excellent basis for ensuring the active involvement of all participants in the proposal development.

The workshop will consist of two main parts. For the partners, visits to the AMRF working area, discussions will local staff, CBO members and water users will be organised by the partner NGOs. The second part will be held centrally and will include a number of other stakeholders.

Time schedule	December				January			
Visit the field areas, discussions with the local field staff, community gatherings organised through AMRF and its partner NGOs.		X						
Visit of Dhaka University and some relevant international and governmental organisations. Discussions with them will clarify their role and their future plans.			X					
Workshop with the prime participants. AMRF, community representatives and the research team will clarify their priorities and expectations which should result in a better mutual understanding of the underlying priorities and in the definition of a common work plan.		X	X					
A literature surveys on each of the aspects	X			X	X			
Formulation of the various sub-projects		X	X	X	X			
Final write-up						X	X	X

During the final write-up close contact will be kept with the stakeholders to ensure that all will agree. The results of these activities will be reflected in the final proposal for both the individual as well as in the collaborative contributions in such a way that they jointly constitute a coherent approach. The proposed approach will be evaluated and refined during the programme. The set-up provided by AMRF as a vehicle for interdisciplinary research activities allows the embedding in larger research initiatives scientific platforms and networks. A successful project will result in a clarification of the social and technical risk factors involved when using solutions based on deep tube wells.

[redacted]

8. Keyword summary
(max 3 pages)

I. Scientific quality

Overall objective: To integrate relevant scientific and practical knowledge regarding the feasibility of DTWs as a strategy for safe drinking water supplies.			
Objectives	Expected results	Activities/methods	Target groups
1. To assess the sustainability of the DTW approach for safe drinking water by the technical and social/institutional risk factors involved (risk research).	1. Risk assessments of different forms and scales of drinking water supplies. 2. Guidelines regarding the implementation of short- and long-term safe water supplies.	1. Compile risk factors from the social and the technical research projects. 2. Assess the links with other risks (arsenic in the food chain, policy, management, etc). 3. Compile findings from Participatory Monitoring and Evaluation of AMRF projects. 4. Review of policies and third party DTW projects (e.g. BRAC, NGO Forum, DPHE, BWSP, World Bank, UNICEF plans).	1. University partners 2. Water users and CBOs 3. AMRF and partner NGOs 4. Scientific community 5. Arsenic network 6. Governmental bodies
2. To investigate social and institutional processes of implementation of safe water options (social research).	1. Insight in the local socio-economic structure. 2. Methods for successful local institutional building and insight in their determining risk factors.	1. Action and dialogue at the village level. 2. Mapping historical, cultural and socio-economic data in the working areas. 3. Try-out different institutional arrangements (in dialogue with local communities). 4. Observe, analyse and evaluate these activities in the working areas.	1. University partners 2. Water users and CBOs 3. AMRF and partner NGOs 4. Governmental bodies
3. To assess the technical risk of in-situ release and transferred contamination on the basis of the geological and (bio)-chemical processes of arsenic contamination in groundwater (technical research).	1. A comprehensive geological model to assess the risk of using DTWs. 2. A geologically based measurement/sampling programme on location to detail occurrence of microbial activity involved in arsenic release. 3. An integrated model to quantify risk of in-situ or transferred contamination based on extraction policy	1. Use geophysics to delineate the subsurface in the villages. 2. Compare with areas that do or do not exhibit arsenic contamination 3. In situ monitoring, collecting new data and lab testing for geological, biological and hydrological model. 4. Dialogue between technical and socio/institutional research activities.	1. AMRF and partner NGOs. 2. Scientific community and University partners

II Relevance for development

Overall objective: To integrate scientific knowledge with practical implementation through action research for mitigation of the arsenic contamination.			
Objectives	Expected results	Activities/methods	Target groups
1. To support AMRF as a learning organisation that translates scientific findings into practical recommendations for the community.	1. Operational safe water options and functioning local institutions that can deal with possible (social and technical) risks. 2. Local procedure for operation and maintenance of the water supplies.	1. Trigger social mobilisation and dialogue in the working areas through social and technical action research. 2. Awareness raising, discussions with water users, CBO meetings, installation of short-term technological solutions, etc. 3. Assistance in AMRF staff training and training materials by researchers and collaborators.	1. University partners 2. AMRF and partner NGOs 3. Water users and CBOs
2. To facilitate and improve the conditions under which the community can participate	1. Strengthened participation of the local communities in the working areas. 2. Recommendations for a Participatory Monitoring and Evaluation (PME) system. 3. Increased links between local communities and government institutions.	1. Participatory Action Research, qualitative interviews, historical surveys, community meetings and joint project monitoring and evaluation activities. 2. Identification of criteria and priorities of local communities especially the poor and woman. 3. Involvement of the local community in staff meetings.	1. University partners 2. AMRF and partner NGOs 3. Water users and CBOs 4. Local government
3. To facilitate interdisciplinary (social, technical and risk) action research relevant to peoples' priorities.	1. Overall understanding of the linkages between interdisciplinary research and practical implementation.	1. Opening and yearly progress meetings 2. Mediation between researchers, CBOs and water users facilitated by AMRF through community meetings 3. Conferences (Dhaka and Delft).	1. University partners 2. AMRF and partner NGOs 3. Water users and CBOs

III. International multi-stakeholder collaboration

Overall objective: To share knowledge and expertise between university partners and (non-)governmental development organisations.			
Objectives	Expected results	Activities/methods	Target groups
1. To set up a communication structure to share experiences and information.	1. Improved collaboration between UoD and the TUD for technical and social aspects. 2. Involvement in national/international networks and projects in this field.	1. Organise staff exchange between university partners. 2. Define and organise internships for Dutch and Bengali students through AMRF's existing facilities. 3. Expanding a demonstration site in which activities expertise are explained. 4. Support AMRF's seminar facilities, daily management and reporting system.	1. University partners 2. Water users and CBOs 3. AMRF and partner NGOs 4. Scientific community 5. Arsenic network 6. Governmental bodies

[redacted]

Funds required

10. *Funds requested from WOTRO*

a. Total budget: (b, c d and e): € 656, 945

b. Partnership grant for joint proposal development

Budget item	Estimated costs (€)	Details (incl. calculations)
International travel	6,000	4 return flights (1500,-/flight)
Local travel	1,000	Various transport
Accommodation/ Living costs	1,800	AMRF based living costs (30 euro/day/person)
Other cost items:	1,000	Meetings with future participants and others
TOTAL budget	9,800	

c. Estimated personnel costs: € 475,945

PhD:	Man year	Amount (€)
NL/DC/other country: temporal employee (at NL institution) (4 y)	2*	96,185
DC: Net grant (living allowance) (4 y)	4	74.000
Post-doc:		
NL/DC/other country: temporal employee (at NL institution) (4 y)	4	245.806
DC: Net grant (living allowance)		

* One half Ph-D position will be funded by the Delft Earth programme

Senior researchers:	Number	Amount (€)
Replacement costs at Dutch institution (4 y)	0.4	43.154
Allowance and/or replacement in DC	1.0	16.800

d. Estimated research costs: € 131,000

e. Estimated communication costs: € 50,000

f. Amount and source of additional funding to be sought:

€ _____ from:

[redacted]

Signature

Main applicant

Name: J. Bruining _____ Signature: _____

Co-applicant

Name: K.M. Ahmed _____ Signature: _____

Submit the application to WOTRO in twofold in:

1. an electronic form (pdf-format is required) using the IRIS system, which can be accessed by the NWO website (www.nwo.nl/wotro/grants).
   The electronic form must be submitted: before 17 September 2008, 16.00 p.m..

2. a signed hardcopy to be sent to:
   WOTRO, P.O. Box 93120, 2509 AC The Hague, The Netherlands
   or to be delivered at:
   Laan van Nieuw Oost Indië 300 2593 CE The Hague
   The hardcopy must be received by WOTRO: before 24 September, 16.00 p.m..