Sustainable Arsenic Mitigation (SASMIT)

Community driven initiatives to target arsenic safe groundwater as sustainable mitigation strategy

Project Proposal

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KTH Land and Water Resources Engineering

NGO FORUM FOR DRINKING WATER SUPPLY & SANITATION

25 years of partnership

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Executive Summary

Access to safe drinking water is a basic human right and a component of effective policy for health protection. Chronic arsenic (As) poisoning results from drinking water with high levels of As over a long period and the consequences are dependent on the susceptibility, the dose and the time course of exposure. Health effects related to the presence of As in drinking water manifests as *arsenicosis*. Today tens of millions of people, mainly in developing countries are affected by As in drinking water exceeding WHO drinking water guideline of 10 μg/L and the global impact now makes it a top priority water quality issue, second in order to microbiological contamination. Elevated concentration of As in groundwater results both from natural and anthropogenic processes. Elevated As concentrations of natural origin in groundwater have been observed in several parts of the world and further incidences are continually being reported. The problem with high As groundwater exists in e.g. Bangladesh, India, Argentina, China, Bolivia, Pakistan, Nepal, Thailand, Cambodia and Vietnam etc.

A wide gap between the number of exposed people and the pace of mitigation programmes in rural areas of developing countries is the main problem in providing safe drinking water. The main challenge is to develop a sustainable mitigation option that rural and disadvantaged people can adopt and implement themselves to overcome possible public heath hazards.

KTH-International Groundwater Arsenic Research Group (GARG) was established at KTH, Stockholm, Sweden in 1999 and since then it has been actively engaged in research on the topic. For the past eight years, GARG is involved in research on the genesis of As in groundwater, options for safe drinking water and management in different parts of the world in collaboration with a number of universities and research organizations worldwide. Current research collaborators include: University of Dhaka, Bangladesh; University of Kalyani, Jawharlal Neheru University, Indian Institute of Technology (Bombay and Guwahati), and Physical Research Laboratory, Ahmedabad, India; Huhhott Anti Epidemic Research Station and Hangzhou University, P. R. China; CSIRO, Australia; Universidad Nacional de Santiago del Estero, Argentina; Masaryk University, Czech Republic; Universidad Mayores de San Andrés, Bolivia and Ramböll, Sweden and Denmark. Besides these institutions GARG also co-operates with other institutions world wide. During recent years GARG have extended their efforts significantly through a number of research projects/programmes.

The sensitivity to As poisoning is clearly related to the economic situation of the individual. The water handling in developing countries is generally the task of women. Women are more aware than men about the As problem and would like switching to safe wells if properly informed and motivated. However, switching to safe wells generally implies longer distances to the water source and more work for them. The As poisoning case is structured in several ways by class and gender. Only rich people can afford the higher cost involvement in installing deeper wells, that are As safe, leaving behind the poor communities more vulnerable. The worse nutritional status of poor households, and particularly the women of those households, may mean that As contamination has more severe social consequences for them. The identification of contaminated wells may lead to greater conflict over uncontaminated water and greater hardship for women fetching water. The gender impacts of As contamination of water are also becoming evident in other areas of women's lives: health and social status. Since

arsenicosis causes skin ulcers and lesions, and many other symptoms, women and girls affected with As poisoning are suffering disproportionately both in terms of lack of medical attention and in being ostracized. All these points to the serious social consequences of groundwater As poisoning for women in particular, even though arsenicosis can affect an entire family.

According to some estimation it is reasonable to think that more than 200 000 people will get arsenicosis only in Bangladesh unless the exposure is reduced on an immediate basis. Thus there is an urgent need to reduce the exposure and intake of As through drinking groundwater. The magnitude of the human tragedy will depend on the rate at which mitigation programmes can be implemented. Keeping in mind the huge number of exposed people (> 50 million) in developing countries with household based drinking water sources mostly live in rural areas and the low rate of outcomes from the mitigation programmes of the Government and various donor organisations, it is obvious that there is an urgent need for the people themselves to find practical mitigation options, if the UN Millennium Development Goal (MDG) for providing safe water is to be met by 2015.

During the recent years, it has been found that new approaches have emerged in Bangladesh, primarily from people's own initiative. The local drillers target presumed safe aquifers on the basis of colour and texture of the sediments. The practice of installation of safe tubewells with local technique has so far reached the affluent class of the rural population. We have found that local drillers prefer to install tubewells in oxidised whitish to reddish aquifer sands instead of darker black to grey aquifer sands, primarily because of low concentrations of dissolved Fe. A correlation between the colour characteristics of the sediments and the groundwater redox conditions and risk for As mobilisation has been established by GARG. The study showed that it is possible to assess the relative risk of high concentrations of As in aquifers if the colour characteristics of the sediments are known and thus, local drillers may target safe aquifers. If the mitigation approach can be validated as sustainable in Matlab Upazila and other areas of Bangladesh, as well as in other areas of the world, it would be easier to improve the safe water coverage fast. On the other hand, if the sustainability cannot be proved, the local initiative needs to be stopped immediately before a large investment is made for a non-sustainable option.

The objectives of this project are to i) increase global awareness of the problems associated with high As groundwater of geogenic origin, ii) exchange experiences regarding feasibility of mitigation options, and iii) develop a sustainable option for safe drinking water for rural and disadvantaged community through targeting safe aquifers in regions with high As groundwater of geogenic origin for installation of community hand tubewells. The concept is based on the idea that identification of safe aquifers can be made on the basis of visible geological features, their relation to groundwater chemical composition and relative risk for high As occurrences.

The project includes two major components: i) a global component for advocacy, awareness raising, capacity building, exchange of information, conceptualisation of the mitigation option and replication-trials for validation of the option for other developing countries with elevated levels of geogenic As in groundwater, and ii) a multidisciplinary action research (field trial) in Matlab Upazila, Bangladesh including hydrogeological investigations, field implementation, generation of knowledge, capacity building based on participatory approaches, monitoring,

management and establishment of water safety plan for the promoted option in collaboration with the with local government and other stakeholders.

Incidents of groundwater As contamination are far more widespread globally than thought initially. It is therefore imperative to develop a global advocacy through campaigns on raising awareness, about the possible presence of As, its heterogeneities and behaviours in natural groundwater environment and the necessities to explore for safe aquifers that can be sustainable over a wide range of countries with diverse socio-economic scenario. In order to comply with the overall objectives of the project, information and database on the groundwater resources for exploitation of safe drinking water in different parts of the As affected hotspots in various parts of the globe will be consolidated. GARG has been involved in such activities by contributing/editing a number of books, conference proceeding and special issues of journals. The latest being the special publication on 'Geogenic Arsenic in Groundwater of Latin America' to be published by Taylor and Francis. As a project component this will be strengthened through inclusion of the new areas with a compilation of the available database on the occurrences of As, estimation of the affected population, and the present mitigation approach and their sustainability as safe drinking water source. Under the current project we plan to organise a two day Asian International Arsenic Symposium in collaboration with the local stakeholders in India, Bangladesh, Vietnam, Cambodia and other external donor agencies preferably during December 2010. The project group will participate in arranging the biannual "2nd International Congress on Arsenic in the Environment: From Nature to Human" in Valencia, Spain during 2008. In order to validate the possibility to replicate the mitigation option in other developing countries we will perform replication on pilot-scale studies in other regions with high As groundwater of geogenic origin. The pilot-scale studies will be done in India, Pakistan, and Cambodia. The replication-trials will include basic hydrogeological studies for aquifer delineation with respect to groundwater chemistry and sedimentological characteristics as well as basic assessment of the possibility to target safe aquifers with local drilling techniques. Based on the findings of this project and other collaborative projects we will develop a mitigation option for replication in other areas with elevated concentrations of As in groundwater used as source of drinking water.

The project will act as a platform for discussion, exchange of ideas and sharing experiences on sustainable As mitigation world wide. An extended network of researchers and stakeholders will be established by organising international conferences. Small-scale field studies for sustainable As mitigation will be carried out in different parts of the world by way of students research projects in partnership with collaborating universities and NGOs. Global experiences will be combined for the formulation of a sustainable As mitigation strategy for application in different parts of the world. A dedicated web page will be used for dissemination of strategy documents and relevant information.

In order to identify safe aquifers in Matlab Upazila, to assess the risk for cross-contamination, and sustainability as a safe drinking water source, basic hydrogeological investigations are needed. This essentially means that mapping of the oxidised/reddish and reduced/blackish sediments and their characterisation in relation to safe groundwater must be carried out. In order to do this, a number of surface and subsurface techniques such as geophysical survey, hydrogeochemical analyses, exploratory drilling and sediment analysis has to be conducted. Through this work we will also raise the awareness in Matlab Upazila and thereby create a platform for motivating the local drillers to be educated in installing safe tubewells. Awareness

raising and community mobilisation are the two top priorities for implementing a sustainable safe water project in the village areas that will be covered under this project. Sustainability of the targeted mitigation option will be assessed by using results from the various field and laboratory investigations and by running predictive models. This would lead to the development of a Water Safety Plan and proper management of safe drinking water in Matlab Upazila. Significant preparation, attention, and focus will be given to the human resource development stage of the project implementation. Local drillers will be trained on how to handle and disseminate the invented method of installing safe tube wells. The project will increase the safe water coverage directly and indirectly. It is our belief that the practise of installation of safe tubewells will be used also on completely private basis. The practice of privately installed safe tubewells will be followed-up in the monitoring and management part of the project. At the final stage of the project, a dissemination Symposium will be organised with the various stakeholders.

On completion of the multidisciplinary action research, significant contributions will be made in improving the existing knowledge in the field of As mitigation. Installing 300 community hand tubewells in the targeted aquifers will enhance access to safe water for the poor and disadvantaged community of the area. All the project findings, data and results will be made available to public domain by the project web page. Annual progress reports would include results of all activities carried out during the reporting period. Training manuals, strategy documents, Best Practice Manuals etc. will be developed and distributed among the stakeholders for ensuring sustainable and safe exploitation of groundwater. Capacity of the local level stakeholders and end users will be improved substantially by providing training and conducting awareness campaigns. Guidelines (WSP) will also be formulated for long term monitoring and management of implemented mitigation options after completion of the project

Arsenic mitigation and management concerns needs teamwork among various disciplines. The project team consists of experts from University of Dhaka, NGO Forum in Bangladesh and collaborating partners at KTH and Ramböll. The total budget for the SASMIT project is ca. 9.45 M SEK (ca. 2.36 M SEK/year) including all costs. The whole project will be completed over period of four year.