Developing a water-safety framework in Bangladesh

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The first step in developing a water-safety framework in Bangladesh has been to develop models to predict the risk of disease associated with particular pathogens. Water-safety plans could then be developed to counter these risks for the range of technologies used in rural areas.

Bangladesh is actively developing programmes that will implement the new WHO *Guidelines for Drinking Water Quality* (*GDWQ*). The programmes include quantitative risk assessment, water-safety plans (WSPs) and surveillance. The approach, summarized in Figure 1, demonstrates how the implementation of the different activities are linked together, with the final components being focused on how to translate the professional understanding of water safety into tools that communities and regulators can use.

Quantitative risk assessment

A key aspect of the work in Bangladesh is the development of a quantitative health-risk assessment (QHRA) model that provides an estimated disease burden. This is expressed in terms of disability-adjusted life years (DALYs) per 1000 population. DALYs include both years of life lost due to premature death and years lived with disability, which is a measure of the impairment of health due to disease (see the article by Howard and Bartram in this edition for a brief explanation of DALYs). Although only an estimate, the model does allow for a comparison of the potential disease burden between different technologies. The model follows the recommendations in the *GDWQ*[1] and uses a suite of three reference pathogens: a generic enterohaemorrhagic *E.coli*, *Cryptosporidium parvum* and rotavirus. It also considers arsenic.

For each pathogen, a range of health outcomes was considered for their relevance in Bangladesh. Only death and illness from diarrhoea were included in the final model because there is little evidence of further complications (such as haemolytic uraemic syndrome) in Bangladesh. Health data for the risk model were drawn from a variety of sources, including local data, local expert opinion and papers from the peer-reviewed literature. Further refinement will take place as new information emerges.

A number of health outcomes for arsenic were included within the model,

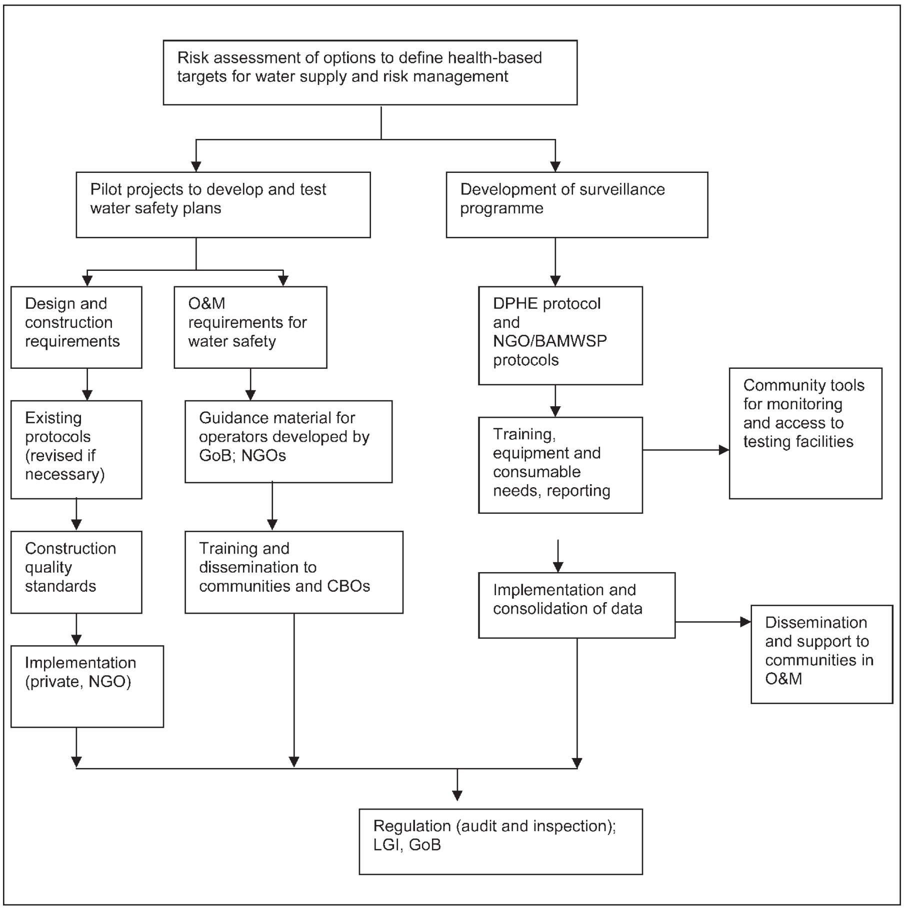

Figure 1 Developing a water-safety framework in Bangladesh

Box 1. Health outcomes for arsenic included in the quantitative health-risk assessment model

Arsenicosis (late-stage keratosis and hyperpigmentation)
Skin cancer
Lung cancer
Bladder cancer
Liver cancer

as shown in Box 1. Risks for these end-points were determined from previously published models developed for south-western Taiwanese and western Bengali populations.[2]

The model uses point-risk estimates to make assessments of potential disease levels, which provide a single value in DALYs to represent the disease burden. In many cases, probabilistic models based on distributions of risk would be preferable to reflect more accurately the range of disease outcomes that can be derived from different contaminants. Such approaches provide a clear indication of the range of results that could be obtained, showing upper, lower and median figures for disease burden estimates. While the point-risk estimate approach has yielded acceptable and usable first-stage results so far, the second stage of the project is currently underway. This second stage will involve:

- a refinement of the model on a probabilistic basis
- comparison of the outcomes of the probabilistic model with the original point-risk estimates; and
- a rigorous validation of the model with health and water quality data to verify the results.

The outputs of the model are in disability-adjusted life years, which allows both the incapacity and death resulting from unsafe water to be captured within one model. As briefly described by Howard and Bartram in this edition of *Waterlines*, DALYs are a useful tool to understand the overall health burden from water rather than specific health outcomes. The QHRA model also provides a means of validating the performance of different technologies and in the selection of technologies and specific design, operation and maintenance requirements.[3]

The data from an initial risk assessment of arsenic mitigation options have been used to evaluate the model, and this has already proved valuable in assisting in technology selection and improvements in operation and maintenance. It is planned to produce a range of planning tools, some of which will include sanitary inspection outputs, which will allow decisions to be made in relation to water-quality requirements of different technologies.

The risk assessment model is an important first stage in defining health-based targets. Without a clear understanding of the current risk and the range of potential disease burden associated with water supplies, particularly in relation to other sources of contaminants, it is difficult to state what level of target is required. This approach needs to take into account not only the risk associated with individual substances but also the overall water quality. As the development of any health-based target may have significant investment implications, it is important to understand what level of current threat exists in order to determine short- and medium-term goals for health improvements.

Water safety plans

The development of water-safety plans for a range of water supplies was initiated in Bangladesh during 2004 and builds on many existing programmes of water-quality surveillance and management. The adoption of water-safety plans is included in the new Bangladesh Water Supply Programme Project, which aims to provide piped water supplies to at least 200 rural and small-town communities.

A key issue in rural water supply is the sheer number of supplies to be considered. There are approximately 10 million shallow tubewells in the country and alternative water sources are being developed all the time. In this situation, developing individual WSPs for each supply is unrealistic and a more general technology-based approach is required.

Rural and urban non-piped water supplies

For rural and urban non-piped water supplies, the approach adopted has been to develop WSPs for a range of technologies (see Box 2) that can be used as the basis for working with communities.

The first stage in this process was to bring together a number of organizations – the Department for Public Health Engineering, NGOs and development partners – to develop outline water-safety plans at a three-day workshop in November 2004. The workshop participants were asked to go through a series of steps for each technology in a structured manner in working groups, using materials to guide the process:

- Setting objectives. The technology is described and analysed and the types of usage for the water are assessed (important in determining the risk potential of the water).
- Hazard identification and risk assessment. This is done by identifying a range of microbial and chemical hazards, analysing how those hazards may enter the water supply and estimating how 'risky' each event might be in terms of impacting on water safety and quality.
- Control measures, control points and critical limits.
- Monitoring and corrective actions.
- Verification and surveillance.
- Community tools for water-safety monitoring and management.

For each technology, a comprehensive set of information was detailed for each step. As the steps were sequential, working groups were able to use the information they had recorded in the previous step. The final stage of the workshop was to identify the types of materials required to support community monitoring and management, building as far as possible on existing materials used by agencies to support communities in operation and management.

Box 2. Rural and urban small water-supply technologies considered

Dug wells
Shallow and deep handpumps
Pond sand filters
Communal rainwater systems; and,
Community-managed piped water systems (spring, river and tubewell sources)

The materials developed within the workshop were then consolidated into draft WSPs and participating organizations were asked to review these in the light of their own experience. They were also asked to visit a sample of water supplies to provide a reality check on the draft WSPs. Pilot projects will be launched to implement the WSPs in Bangladesh. Linked to the pilot projects will be validation of the method through analysis of data relating to changes in the disease burden as a result of applying WSPs in the communities. The process will be fully documented with training materials drawing on field experience for professionals in the sector.

A roll-out of WSPs is planned across rural and urban non-piped water supplies throughout the country, using the materials developed during the pilot activities. This process is expected to support monitoring that is relevant to national conditions and that is achievable in the context of available resources.

WSPs for urban piped-water supplies

A similar process is being followed, starting with a workshop which has been held with a number of key city corporations and utilities serving urban populations to introduce the concepts of WSPs and to ensure that there is familiarity with the tools and methods. A total of three pilot projects with urban water suppliers is planned to allow guidance to be developed based on the realities of water supply within Bangladesh and addressing issues of equity and poverty. A key element of this will be to try and apply approaches for mapping risks within the piped-water supply to prioritize areas for action, including approaches previously used in Uganda and India (see articles by Tibatemwa et al. and Prem Chand et al. in this edition).

Surveillance

Many different agencies have well-established water-quality surveillance programmes, but to date they have not been brought under a single

Water stored in disintegrating water towers like this pose a serious health risk to those using it. Credit: 2004 Abdur Rahman, courtesy of Photoshare

programme. Furthermore, although projects often have the capacity to test water, most of these require resources beyond the scope of what can be implemented on a large scale by the government under the revenue budget.

In order to consolidate the surveillance programme, a national protocol for surveillance of rural water supplies is being developed. This will be implemented by the Department of Public Health Engineering (DPHE) with all other programmes being encouraged to undertake wider testing and send findings to DPHE to support ongoing development of the protocol. The national protocol attempts to be realistic in terms of what can be regularly tested, and paid for from the regular DPHE budget which is allocated from government revenue. The core parameters include thermotolerant coliforms, turbidity, sanitary inspection and analysis of arsenic, iron and manganese.

The ongoing development of surveillance will require further support in terms of capacity-building of staff and provision of equipment at local, regional and national levels. A number of initiatives by programmes are addressing these, including programmes implemented by DPHE and UNICEF, Japanese International Cooperation Agency, the Bangladesh Arsenic Mitigation Water Supply Project (BAMWSP) and NGOs such as WaterAid. It is interesting to note that some city corporations have already committed funds to build and equip their own laboratories and have employed surveillance staff.

Conclusion

Bangladesh is already making significant progress in developing a water-safety framework for the country based on local conditions and utilizing local resources. It is planned to document and disseminate experiences in 2005. Much of the material will also be available on the APSU website (www.apsu-bd.org).

About the authors

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