Perspective

Observations and lessons learnt from more than a decade of water safety planning in South-East Asia

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Abstract

In many countries of the World Health Organization (WHO) South-East Asia Region, drinking water is not used directly from the tap and faecal contamination of water sources is prevalent. As reflected in Sustainable Development Goal 6, access to safer drinking water is one of the most successful ways of preventing disease. The WHO Water Safety Framework promotes the use of water safety plans (WSPs), which are structured tools that help identify and mitigate potential risks throughout a water-supply system, from the water source to the point of use. WSPs not only help prevent outbreaks of acute and chronic waterborne diseases but also improve water-supply management and performance. During the past 12 years, through the direct and indirect work of a water quality partnership supported by the Australian Government, more than 5000 urban and rural WSPs have been implemented in the region. An impact assessment based on pre- and post-WSP surveys suggests that WSPs have improved system operations and management, infrastructure and performance; leveraged donor funds; increased stakeholder communication and collaboration; increased testing of water quality; and increased monitoring of consumer satisfaction. These achievements, and their sustainability, are being achieved through national legislation and regulatory frameworks for water supply, including quality standards for drinking water; national training tools and extensive training of sector professionals and creation of WSP experts; model WSPs; WSP auditing systems; and the institution of long-term training and support. More than a decade of water safety planning using the WSP approach has shown that supplying safe drinking water at the tap throughout the WHO South-East Asia Region is a realistic goal.

Keywords: impact assessment, South-East Asia, water quality partnership, water safety planning

Background

Access to safe drinking water is essential to health, a basic human right and a component of effective policy for health protection. Yet an estimated 1.8 billion people worldwide use a source of drinking water that is faecally contaminated, and this contamination is most prevalent in the World Health Organization (WHO) African Region and South-East Asia Region. The delivery of safer drinking water, as well as safely managed sanitation and hygiene, are among the most successful ways of preventing disease. In line with these aims, for more than a decade, the WHO Regional Office for South-East Asia has worked in a water quality partnership (WQP) with the WHO Regional Office for the Western Pacific and WHO headquarters in Geneva, with financial support from the Australian Government. This partnership has the vision of increasing continuous access to the safest drinking water attainable. Central to this strategy has been the sustainable implementation of water safety plans (WSPs). The Australian Government supported WHO on updating the Guidelines for drinking-water quality, published as the third edition in 2004. These guidelines, for the first time, promoted WSPs as a proactive risk-based tool to help prevent outbreaks of acute and chronic waterborne diseases. WSPs are now used worldwide and are legally mandated in several countries. They are a key component of the Water Safety Framework promoted under the fourth edition of the Guidelines for drinking-water quality, which aims to set health-based targets for the quality of drinking water and monitor compliance with them through effective surveillance (see Fig. 1).

For more than a decade, WHO and the Australian Agency for International Development (AusAID, now under the Department of Foreign Affairs and Trade, DFAT) have worked together (often with the International Water Association) to help put the Water Safety Framework into practice, through normative work and technical guidance from WHO and the two regional offices, and through implementation of WSPs and support measures in countries across the two regions. This partnership has seen significant advances in the context and practice of supply of drinking water. This progress has helped to increase the awareness of water safety as a health issue and ensure that the safety of drinking water has been included as a Sustainable Development Goal (SDG) target (target 6.1 “By 2030, achieve universal and equitable access to safe and affordable drinking water for all”), with WSPs as a key measure for meeting the target. In total, 15 countries have made significant advances on water safety planning, through the direct support of the WQP. Six of these are in
the WHO South-East Asia Region (with three additional countries indirectly supported) and this paper focuses on the development of water safety planning in these countries and the lessons learnt from the process and implementation of the WSPs themselves.

**Purpose and description of water safety plans**

A WSP delivers safer water to consumers by identifying potential risks in the entire water-supply system, from the water source to the point of use, and dealing with them before they become problems. First, the ways in which hazards are introduced to the water-supply system are examined, hazardous events are identified and their risks to health are assessed. The risks are then prioritized, focusing on the hazards (microbiological, chemical and physical) and hazardous events that pose the highest risk. A plan is then developed to manage the risks, using barriers to stop contamination of water.

The process of WSP development involves bringing together professionals, technicians and stakeholders to gain a thorough understanding of the water system and work out realistic and responsible ways to make sure the system works as it should, with the lowest level of risk possible. This is achieved by preventing contamination at source; removing or reducing contamination by treatment; and/or preventing recontamination in distribution and handling in the home.

A WSP is developed through a structured process involving 10 steps:

- **Step 1**: preparation – assembly of a WSP team and definition of the scope and objectives;
- **Steps 2 to 4**: system assessment – system description, hazard identification, selection of control measures;
- **Step 5**: system improvement – development of an improvement plan;
- **Steps 6 and 7**: operational monitoring of control measures, WSP verification;
- **Steps 8 to 10**: management plans – management procedures, supporting programmes and WSP review.8

**Water safety planning versus operation and maintenance**

Traditionally, water suppliers fix problems in the system reactively when they arise, for example, if a pipe breaks and people complain about an unusual colour or smell detected in their water because of cross-contamination from sewage. However, the preventive water safety planning approach looks at potential problems that could arise and aims to fix them before they become a problem; for example, hazard analysis would detect risk areas of sewage cross-contamination in the distribution system and alert the supplier to measures to be taken. One of the reasons given initially by the Asian Development Bank for their interest in WSPs was not the improved health impacts but the improved management and performance they delivered, demonstrated by a reduction in non-revenue water – through a reduction in leakage and illegal connections.8

By providing a structure and process for developing new operating procedures or revising existing procedures for standard or emergency situations, WSPs are helping to institutionalize good practice in the operation and maintenance of water-supply systems.9 This is one of the most challenging aspects of sustainable and effective management of water supply. Once a WSP has been completed, improvements need to be made to address the risks identified; many of these may be directly operational, while others that appear to be technical may ultimately be found to be managerial, with organizational strengthening required.

A flexible approach is needed; thus, WSPs can be as simple or as complex as the systems to which they apply, so this partnership has dealt with WSPs for systems as diverse as single hand-pumps, community-managed pond systems, community-managed piped systems for 50 households, small-scale urban systems with small numbers of staff, or major water-supply systems in capital cities. Catering for this diversity of physical and management systems is complex and requires different manuals, training materials and methods, technical solutions and regulatory frameworks.

**History and current status of water safety planning in South-East Asia**

The WQP has focused on countries with government commitment to water safety planning, as well as capacity and commitment among water suppliers; with some availability of WSP education and trained trainers; with commitment of significant country donors and nongovernmental organizations (NGOs); and with a completed country WSP scale-up strategy. Both the WHO South-East Asia Region and the WHO Western Pacific Region have been part of the water safety planning. The countries of the WHO South-East Asia Region involved in the water safety planning have changed slightly over the many years of the partnership but the core countries were Bangladesh, Bhutan, Indonesia, Myanmar, Nepal and Timor-Leste, with some regional office support to India, Maldives, Sri Lanka and Thailand. The WQP evolved over three phases as follows:

- **Phase 1**, 2005–2009: focused on setting the foundations for WSPs and piloting early WSPs;
Quality and impact of water safety planning in the region

The WQP’s activities have been complex. The partnership has delivered safer water for millions of people in in the WHO South-East Asia Region, through more than 1000 WSPs implemented directly through the partnership, and more than 5000 WSPs implemented by other government agencies, projects and NGOs. In addition, the WQP has sought to achieve a change in mindset in the sector, from one of limited responses to disease outbreaks or incidents of poor water quality resulting from poorly managed water-supply systems, to one of effective proactive management based on sound risk-based approaches to water-supply management. This was reflected in a national meeting of state engineers and secretaries organized by the Ministry of Drinking Water and Sanitation in India in 2016. The joint secretary who was chairing the WSP advocacy session stated that people tend to forget the "public health" part of public health engineering departments, which are the state-level implementers, and only focus on engineering, thus neglecting water quality. This change in mindset has required a significant amount of work to ensure that:

- water safety planning is embedded within national legislation and regulatory frameworks for water supply, including quality standards for drinking water;
- training tools are locally appropriate in local languages, and extensive training of sector professionals and community representatives has resulted in good knowledge among a significant proportion of sector staff;
- model WSPs of a high standard have been created to act as field-based training centres and examples of good practice;
- key sector professionals have been trained to such a level that their understanding and confidence enables them to train and advise on WSPs and also to carry out audits of water safety planning, to identify strengths and areas for improvement;
- WSP auditing systems have been piloted to assess the WSP quality and enhance the sustainability of the water safety planning process;
- institution of long-term training and support of WSPs has ensured that the next generation of engineers and sector professionals will be immersed in water safety planning before starting service;
- the impact of WSPs on management of drinking-water supply and water quality is understood in depth, and available for advocacy purposes.

Auditing of water safety plans

One of the key measures to ensure the sustainability of individual WSPs, and of the water safety planning process as a whole, is surveillance. In its 2011 Guidelines for drinking-water quality,2 WHO defines surveillance as both the direct assessment of water quality, for compliance against national water quality standards, and the auditing of WSPs to ensure quality is maintained. In countries with advanced regulatory systems and capacity, like Australia and the United Kingdom of Great Britain and Northern Ireland (UK), WSPs are a regulatory requirement and are audited to ensure compliance. Incentives for compliance and/or penalties for non-compliance may be part of the process called "external formal" auditing. The auditing that has been carried out thus far in the WHO South-East Asia Region is called "external informal" auditing and is concerned with training potential auditors but also with identification of how good the WSPs that have been implemented are and what systemic or specific WSP improvements may be required. This is part of the process of continuous improvement promoted by WHO.

In 2014, the WHO Regional Office for South-East Asia supported two 2-week training sessions for some of the best, most available, WSP experts in the region, to develop their skills in WSP training, analysis, advice and auditing, and provide a pool of “master trainers” qualified to serve as regionally based resource persons to sustain and further develop WSPs in the region and beyond. The training was based on the urban WSP training materials subsequently published by the WHO Regional Office for South-East Asia in 2016.10 Most of these experts have continued to be actively involved in WSP work since the training, both within their own countries and internationally.

In 2016, the WHO Regional Office for South-East Asia commissioned a programme of international WSP audits led by the master trainers and observed by international experts from Australia. The international auditing work was designed to challenge the master trainers to review types of systems that are different from those seen in their own countries. They have responded well and have become valuable national and international WSP resources. Master trainers from: (i) Bhutan and Nepal carried out six WSP audits and trained future auditors in Sri Lanka; (ii) Bangladesh and Sri Lanka audited Bangkok Metropolitan Waterworks Authority’s WSP in Thailand; (iii) Bhutan and Sri Lanka audited two small schemes in Nepal; (iv) Bhutan, Nepal and Sri Lanka audited two urban model WSPs in Bangladesh; and (v) Nepal undertook audits of all pilot WSPs in Timor-Leste and completed follow-up progress visits.

Impact assessment of water safety plans

In 2016, a largely independent impact assessment was commissioned by WHO to quantify some of the key impacts that the WSPs are having on management of drinking-water supply and consequent outcomes.11 All analysis and reporting for this study was done by the NGO Aquaya, with data collection done by either government staff, NGOs or consultants, depending on the country. Given the complexities and costs associated with attributing health benefits to the improved quality of water supplied, especially in the short term, the impact assessment focused on 36 performance indicators. These indicators were based on a United States Centers for Disease Control and Prevention conceptual framework for evaluating the impacts of WSPs, which distinguishes shorter-term system-level changes (“outcomes”) from longer-term service-delivery and societal
improvements ("impacts") and provides a comprehensive evaluation tool covering institutional, operational, financial, policy, water-supply, health, and socioeconomic aspects. The study collected pre- and post-WSP data from 99 WSPs in 12 countries in the WHO South-East Asia Region and WHO Western Pacific Region: Bangladesh, Bhutan, Cambodia, Cook Islands, Lao People’s Democratic Republic, Mongolia, Nepal, Philippines, Samoa, Sri Lanka, Timor-Leste and Vanuatu.

All of the 99 WSPs included in the impact assessment were first audited for quality. While 99 sites were audited, only the urban sites (n = 59) were scored and categorized (see Fig. 2). Audits of rural sites result in a set of actions agreed to by the auditors and the WSP team. The urban audit categories (see Fig. 2) show a normal distribution around the “average” category, with four WSPs classified as “very good” and only one requiring “priority attention”. The data from eight districts in Bangladesh (see Fig. 3), suggest that there may be a relationship between WSP maturity and audit score, reflecting the principle of continuous improvement over time, although this relationship is less pronounced in other countries. Further analysis of factors affecting the quality of water safety planning is in process. The major benefits across the 12 countries have been identified as improved system operations, management, infrastructure and stakeholder communication and collaboration; leveraging of donor funds; reductions in unaccounted for water; and increased testing of water quality and monitoring of consumer satisfaction.

The impact assessment noted that challenges, including coordination of team meetings and capital for infrastructure, can limit the efficacy of WSPs. Nevertheless, positive effects were also identified. For example, there was more supplier interest in water quality, with more microbial and turbidity tests done by utilities and an average increase of 11% in the number of tests complying with microbial standards. Utilities paid increased attention to consumers, with the proportion conducting customer satisfaction surveys increasing from 14% to 38%, and recording of consumer complaints increasing from 38% to 63%. Most countries noted that new knowledge had been acquired, with changes in mindsets and more attention to water quality.

One example from Bhutan illustrates the improvements that WSPs have delivered. Bajo, a town in Wangdue Phodrang District, had such serious problems of poor water quality that the residents started to protest. Following WSP training and identification of key improvements to achieve impacts on water safety, the municipality submitted their WSP to government. They won a competition for best WSP and received financial support from the government and from the Organization of the Petroleum Exporting Countries Fund for International Development, as well as technical support from WHO; this resulted in improvements enhanced by operator capacity-building and support, and monitoring of water quality. As a result, operators were empowered and trained to collect and analyze data on water quality and make decisions on chlorination, based on the analysis. They became active WSP team members and are now trainers to other towns. More recent audits confirm that the WSP team is active and that improvements continue to be made to improve water safety. Surveillance data on water quality from the hospital in Bajo suggest that there has been increased compliance with microbiological standards and reduced contamination in non-compliant samples (see Table 1). A customer survey also shows a high level of satisfaction with the quality, although much remains to be done.

**Evolution of the water safety planning process and priorities**

In the years since publication of the third edition of WHO’s *Guidelines for drinking-water quality* and *Water safety plan manual*, the WSP agenda has evolved and expanded. New hazards and solutions are being identified and developed all the time. This is one of the successes of the process itself, as governments and organizations have seen the relevance and
importance of WSP approaches in managing not just drinking water but all facets of water, sanitation and hygiene (WASH).

The original manual and training programmes were designed mainly for urban, corporately managed systems and demand grew for training and reference materials for smaller-scale, community-managed systems; these have now been produced. Many of the examples and case-studies in the original manual were from countries like Australia and the UK, where water safety planning was already advanced. Since then, numerous examples of hazards, associated control measures and WSP management have been collected from across the globe, including many from the WHO South-East Asia Region. The manual is now being updated and will include many of these examples.

For the first seven or so years of the WQP, the training and support covered all 10 steps of the WSP, but in reality water suppliers focused on the preparation and system assessment and the early steps in operational monitoring. In more recent years, there has been much more of a demand for support on the later steps, especially on developing operating procedures for standard or emergency situations; long-term training for sector and utility staff; effective operational monitoring and treatment; and WSP verification and review, through auditing, compliance monitoring and assessment of customer satisfaction. These are encouraging signs of progress and the WHO Regional Office for South-East Asia has supported countries with training support, culminating in the publication of training manuals and materials on operational monitoring and chlorination for small urban systems, as well as on auditing.

Climate change resilience
One of the most significant emerging issues for WASH has been the impact of climate change on water sources and on WASH infrastructure, so WSPs have been modified to include risks that result from more extreme weather events such as drought, more intensive rainfall events and heat waves, and rises in sea levels, and the control measures needed to mitigate these new risks. This is having an impact on water supplies during both normal and emergency operating conditions, with new responses required to ensure water security as well as water safety. Some of the largest issues relate to spring sources in mountain areas, groundwater sources in coastal areas and cross-contamination in urban areas.

Sanitation safety planning
The same risk-based approach and WSP structure is now being applied to operationalizing WHO’s guidelines for the safe use of wastewater, excreta and greywater, as well as addressing some sanitation-management issues through the development of a manual for sanitation safety planning. These are now being piloted in the region.

Safely managed services to achieve Sustainable Development Goals
All of these developments, and the associated advocacy on water and sanitation safety, have led to the development of SDG WASH targets 6.1 and 6.2. Target 6.1 seeks to achieve, by 2030, universal and equitable access to safe and affordable drinking water for all – the indicator is the proportion of the population using safely managed drinking-water services. Target 6.2 seeks to achieve access to adequate and equitable sanitation and hygiene for all by 2030, and to end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations – the indicator is the proportion of the population using safely managed sanitation services, including a handwashing facility with soap and water.

WSPs, sanitation safety plans, the WHO Water and Sanitation for Health Facility Improvement Tool (WASHFIT) and other interventions and approaches are key tools for achievement of these targets.

Technical lessons learnt from the water quality partnership
In the WHO South-East Asia Region, while audits have shown that WSP development, and implementation of improvement plans, are performing better than ongoing activities of operationalization, monitoring and verification, the agenda is definitely moving towards the latter activities. So many WSPs are in place that the focus is now on improving existing ones before extending to new ones.

Most corporate- and community-run WSPs are much better in practice than on paper and in most cases, documentation is a real challenge. In the auditing, this was the area that brought many of the WSP audit scores down. Continuous support is needed in this area and there is a particular need to adapt community-managed WSPs to maximize the benefits for minimum effort for the communities, with more prescriptive hazard sections and checklists that require less writing.

The proactive, risk-based approach of WSPs is now being adapted for sanitation and wastewater management, and for institutions (such as WASH in health-care facilities). The approach is proving to be flexible and the WSP format is adaptable and able to accommodate extra hazards from climate change (especially water security) and to enhance equitable access through including equity lenses to WSP preparation, system assessment, operational monitoring and management planning.

At a community/system or policy/strategic level, the integral role that WSPs play in every aspect of WASH, not just water quality, is becoming clearer. Sanitation, clean environment (including management of solid waste), treatment and storage of household water, and handwashing are increasingly being understood as legitimate control measures for water safety. Linked to this, more are realizing that introducing WSPs may not require any (or very few) additional physical control measures but rather improvements in operational and maintenance practices. Therefore, WSPs can easily be introduced at any stage of WASH or environmental health activity and there is no need to start anew. However, if they are being introduced
where WASH programmes are already running, WSPs are a chance to review and consider emerging hazards.

At a utility level, the impact assessment showed that where investment is already secured, WSPs can add essential value and sustainability and that successful WSPs can attract investment. As with community-run systems, utilities introducing WSPs may not require any additional control measures but may just need to improve management of existing controls. WSPs can easily be introduced at any stage of current work and, as with WASH programmes, are an opportunity to review and consider emerging hazards.

Programmatic lessons learnt from the water quality partnership

Throughout the WHO South-East Asia Region, commitment to WSPs is high at the policy-maker level but, unlike at the operational level, they are often looked at in isolation. More focused advocacy is needed to clarify how WSPs fit in with other utility-management approaches, such as asset management, and the framework they provide for all WASH interventions. There is still a need for significant advocacy nationally and internationally, to promote WSPs in the light of the SDG target for safely managed drinking water.6 There is now much stronger evidence to support this advocacy, from the impact assessment and other work done in individual countries. In addition, the increased monitoring of water quality in the region provides a valuable data set for monitoring the SDG indicators for water quality,6 but much more work is needed to strengthen methods of data collation and quality assurance.

A post-Phase 2 comprehensive review of the programme was carried out in all three countries participating in Phase 2 (plus the three countries from the WHO Western Pacific Region, Lao People’s Democratic Republic, Philippines and Viet Nam) and this was fundamental to the redesign of Phase 3, where development of model WSPs and WSP master trainers and longer-term support to WSP implementers was introduced. Longer-term support to water suppliers is needed to complete all aspects of water safety planning; further, to fully understand the continuous process promoted within WSPs and ensure sustainability requires a deeper knowledge and resource base, with more systematic national and regional training that is supported locally in the longer run. To this end, the WQP has worked with the International Water Association to create a website for global collation and sharing of key WSP resources developed; this can be found at www.wsportal.org.21

Conclusion

In many countries of the WHO South-East Asia Region, it is very common to see people either treating water at home with household filters or using bottled water, with the majority not drinking water directly from the tap. The reason for this is either that people are not confident of the safety of water supplied or that the water supplier does not have adequate measures in place to provide safe water. Water-supply systems in many cities and towns have ageing infrastructure with huge leakages, have illegal connections, often crisscrossing sewer lines, or have intermittent supplies. In addition, a reactive approach to managing the system, and lack of regulatory frameworks for water quality, compound the problem. Supplying safe water at the tap, which is the aim of SDG target 6.1,6 is not impossible. The WSP approach helps to address these issues in a comprehensive continuous incremental process. If WSPs are implemented adequately and audited independently on a regular basis, the dream of safe water at the tap can become a reality.

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