A strategic approach for Water Safety Plans implementation in Portugal

Jose M. P. Vieira

ABSTRACT

Effective risk assessment and risk management approaches in public drinking water systems can benefit from a systematic process for hazards identification and effective management control based on the Water Safety Plan (WSP) concept. Good results from WSP development and implementation in a small number of Portuguese water utilities have shown that a more ambitious nationwide strategic approach to disseminate this methodology is needed. However, the establishment of strategic frameworks for systematic and organic scaling-up of WSP implementation at a national level requires major constraints to be overcome: lack of legislation and policies and the need for appropriate monitoring tools. This study presents a framework to inform future policy making by understanding the key constraints and needs related to institutional, organizational and research issues for WSP development and implementation in Portugal. This methodological contribution for WSP implementation can be replicated at a global scale. National health authorities and the Regulator may promote changes in legislation and policies. Independent global monitoring and benchmarking are adequate tools for measuring the progress over time and for comparing the performance of water utilities. Water utilities self-assessment must include performance improvement, operational monitoring and verification. Research and education and resources dissemination ensure knowledge acquisition and transfer.

Key words | drinking water quality, risk management, strategic planning, Water Safety Plan

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INTRODUCTION

Based on estimates for 2006 (WHO/UNICEF 2008), 87% of the world's population uses drinking water from improved sources: 54% with piped household water connection located inside the user's dwelling, plot or yard; and 33% using other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs and rainwater collection). This translates into 5.7 billion people worldwide who are now using drinking water from an improved source, an increase of 1.6 billion since 1990. About 3.6 billion people use a piped connection that provides running water in or near their homes. Table 1 shows the global distribution of improved drinking water sources coverage. The population using unimproved drinking water sources (unprotected dug well, unprotected spring, cart with small tank/drum, tanker truck and surface water) is below one billion (currently 884 million). This means that real progress is being made worldwide in regards to meeting the Millennium Development Goals drinking water target (MDG 2000). Current trends suggest that more than 90% of the global population will use improved drinking water sources by 2015.

With this increase in the proportion of the global population having access to drinking water via piped supplies, additional challenges in risk assessment and risk management methodologies for water quality control will arise. Many of these water supply systems regularly or sporadically do not meet the required drinking water standards (quality, quantity, pressure, continuity of supply), consequently supplying unsafe drinking water.

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Table 1 | Improved drinking water sources coverage in 2006 and percentage-point change 1990–2006 (adapted from WHO/UNICEF 2008)

	1990			2006			
MGD region	**Piped water**	**Other improved**	**Total improved**	**Piped water**	**Other improved**	**Total improved**	Δ
Commonwealth of Independent States	71	22	93	73	21	94	+1
Latin America & Caribbean	67	17	84	80	12	92	+8
Northern Africa	58	30	88	78	14	92	+4
Western Asia	69	17	86	80	10	90	+4
Eastern Asia	51	17	68	73	15	88	+20
Southern Asia	20	54	74	22	65	87	+13
South-eastern Asia	16	57	73	32	54	86	+13
Sub-Saharan Africa	16	33	49	16	42	58	+9
Oceania*						50	−1
Developing regions	36	35	71	46	38	84	+13
Developed regions	91	7	98	93	6	99	+1
World	48	29	77	54	33	87	+10

*Information not included due to lack of complete data.

Providing good and safe drinking water is of paramount importance for public health protection, and must be the primary objective of public water supply systems. In the late nineteenth century, many countries in Europe and America started with new approaches of drinking water quality control, especially in highly populated urban public systems, relying mainly on disinfection by chlorine for pathogen microorganisms inactivation. The quality of drinking water produced and distributed is being monitored by so-called end-product testing, which consists of spot-sampling of the water on a weekly, monthly or yearly basis, where the frequency depends on the amount of water produced.

Several shortcomings and limitations of the end-product testing methodology have been identified: (i) results of spot sampling become available once the water has already been delivered and often already been consumed; (ii) there is a multitude of waterborne pathogens that cannot be detected or they can be detected insecurely with the classical indicators (*E. coli*, *coliforms*, *Clostridium perfringens*), particularly viruses and protozoa; (iii) the water quality between two sampling exercises can deteriorate considerably but might go unnoticed for a long time; especially where in small supplies the sampling frequency is low due to manpower constraints; (iv) end-product testing can hardly be considered a sound method for representative water quality status: a very small fraction of the total volume of water produced and delivered is subject to microbiological and chemical analysis.

Recognizing these limitations, there is a strong tendency to move away from management based on end-product testing alone towards a risk assessment and risk management approach for drinking water quality control. Following this objective, the World Health Organization Guidelines for Drinking-Water Quality (WHO 2004) propose the new concept of Water Safety Plan (WSP) for hazards identification and effective management procedures for their control, comprising all steps in water protection, from catchments to consumer's tap (Bartram *et al.* 2001). In addition to this operational quality control, a final verification by independent audits is required. Based on the same concept, the International Water Association launched a corresponding framework, the 'Bonn Charter for Safe Drinking Water', which has the goal of ensuring 'good safe drinking water that has the trust of the consumers' (IWA 2004). This framework provides water suppliers and public health and regulatory authorities with the institutional, managerial and operational mechanisms for the effective provision of safe drinking water.

The concept of WSP is broadly and relatively well understood as a powerful risk assessment and risk management tool for drinking water quality control (NHMRC 2004;

NZMH 2005; WHO 2005). Although WSP implementation can be found as a day-to-day practice in many developed countries, following the first Australian experiences, progress in developing countries has been slower. The establishment of international networks (e.g. the Bonn Network (IWA 2009), the Latin America and Caribbean WSP Network (LAC-WSP-Net 2009), the African WSP Network and the Asian WSP Network) goes some way towards providing a platform and mechanisms for water professionals in the world to share knowledge and experiences in implementing WSP. Moreover, the development of specific resources (Bartram *et al.* 2009), awareness raising through international and regional forums and educational and training programmes can be seen as decisive means for wide dissemination of the WSP concept.

Several case studies describing successful implementation of this risk assessment and risk management approach, in both industrialized and developing countries, have been reported (Kato *et al.* 2006; Staben *et al.* 2008; WHO 2009).

Widespread WSP application through the scaling-up of these success stories is a difficult task due to a number of factors related to different methodological approaches from agencies and utilities and lack of political commitment amongst others. Although support agencies urge water suppliers to gain experience through pilot projects on WSP and to share this expertise, lack of legislation and policies and the need for appropriate monitoring tools constitute serious constraints for this scaling-up. Those difficulties and the feedback from current global experience in developing and implementing WSP point towards the need for a more structured approach to establishing strategic frameworks for a systematic and organic scaling-up of WSP on a national or regional basis. This will provide a sound basis for governments, utilities and water professionals in planning and implementing activities with long-term impact on improving water supplies and health.

The aim of this study is to establish a comprehensive methodology to inform future policy making by understanding the key constraints and needs in relation to institutional, organizational and research issues that can be crucial for a strategic approach for WSP implementation on a national basis. The Portuguese case study presented in this work illustrates how the proposed framework provides a methodological contribution for WSP implementation which can be replicated at a wider global scale.

METHODS

Progresses on WSP implementation in Portugal

Since 2003, when a pioneer experience started in Águas do Cávado Water Company (Vieira 2007), WSP methodology has been smoothly spread through other water companies supplying bulk water, subsidiaries of AdP-Águas de Portugal S.A. (a holding company whose subsidiaries deliver drinking water to 7.5 million people, nearly 75% of the Portuguese population). Table 2 shows the present situation of WSP implementation in AdP group (Vieira *et al.* 2008).

In addition, research work has been done in order to make available practical approaches for implementing this concept in Portugal through the publication of a WSP manual and supporting documentation for training courses (Vieira & Morais 2005).

Following these successful experiences, the Portuguese Regulator (ERSAR-Regulator Authority for Water and Waste Services) recommended a systematic risk management approach in water supplies and launched a pilot project (2008–2010) monitoring the WSP implementation in ten water utilities with different sizes and organizational structures (Alexandre 2008). The objective of this project is to promote and give technical support (through training activities and the development of tools) in implementing WSP methodology through public drinking water utilities of different sizes and complexities, geographically distributed along the country, taking into consideration major local conditions and limitations, namely: size of utilities (water quantity supplied and number of inhabitants); raw water source characteristics; water treatment processes applied; and human, technical and organizational resources available at the water supplier.

These planning and implementation activities will create the necessary conditions for momentum in WSP dissemination. The challenge now is to provide consistent and coherent support to promoting a national framework with this objective.

Water supplies in Portugal

In most countries drinking water is supplied by small and medium-sized water suppliers. A vast majority of the water supplies in Europe are small (serving fewer than 5000 persons) to very small (serving fewer than 50 persons).

Table 2 | WSP implementation in water companies (subsidiaries of AdP)

Water company	Municipalities supplied (n°)	Population served (10^3 inh.)	Water mains length (km)	Certifications awarded	Year of WSP implementation
Águas do Cávado, S.A.	8	600	278	ISO 9001; ISO 14001; ISO 17025; OHSAS 18001	2003
Águas do Douro e Paiva, S.A.	19	1500	417	ISO 9001; ISO 14001; OHSAS 18001	2006
EPAL, S.A.	25	2600	700	ISO 9001; ISO 14001	2009
Águas do Algarve, S.A.	16	400	400	ISO 9001; ISO 14001; OHSAS 18001; ISO 22000:2005	2006

Monitoring and controlling the water quality of these small systems is a major issue throughout Europe and WSP implementation can be seen as a promising way forward for the whole drinking water production and distribution process as well as for reducing the risk to public health. Today, 92% of the Portuguese population uses piped drinking water supplied from public systems. Small water supplies constitute the large majority of these systems (93%) although they represent only 19% of the total population served (Figure 1).

Drinking water supply is the constitutional responsibility of the 278 Portuguese municipalities. Pluri-municipal integrated solutions have been established to deal with specific subsystems (abstraction, treatment and storage) leading to two different organizational schemes: multi-municipal systems (managed by AdP subsidiaries public companies, with capital shared by the state and municipalities) and integrated municipal systems (which are solely the responsibility of the municipalities). To date, 183 municipalities (7.2 million inhabitants) have formed multi-municipal systems, and 95 municipalities (2.7 million inhabitants) have formed integrated municipal systems. Distribution systems are the direct responsibility of the local municipality. The institutional models applied for infrastructural asset management are: (i) 251 municipal authorities, as a separate entity, an internal technical services department, or municipally owned companies (7.7 million inhabitants); 27 municipalities with concession management contracts, public or private companies (2.0 million inhabitants). The environmental institutions, River Basin District Authorities (*ARH-Administração de Região Hidrográfica*), have the responsibility for raw water sources quality monitoring. Drinking water quality surveillance is committed to ERSAR, which has in practice a national performance indicator system for drinking water supply utilities.

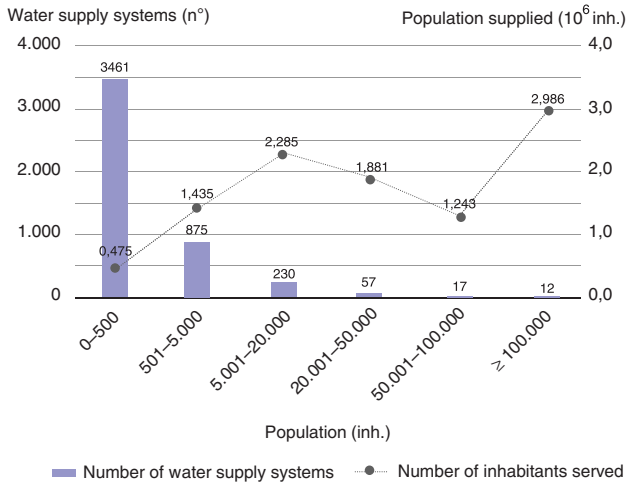

Figure 1 | Dimension of public drinking water supplies in Portugal.

Setting a national framework for WSP implementation

Lessons learned from individual suppliers' experiences can promote a broader national perspective for a pragmatic scaling-up WSP implementation. A coherent, structured and

comprehensive national framework must have the active contribution of policy makers, health and environmental authorities and water stakeholders. Figure 2 presents a schematic outline of this proposed framework based on three major components: institutional settings, practical implementation and supporting mechanisms.

Institutional settings. Public health protection must be emphasized as the focus for such a framework. Institutions, namely health authorities and the national regulator, may promote the changes needed in legislation and regulation giving support for WSP scaling-up.

Practical implementation. Success in practical implementation of the framework depends on a sound understanding of national barriers and levers. For this purpose, it is essential that the following issues are considered: (i) at national level – problem definition, needs and methodology; and (ii) at water utility level – setting up the system, operational monitoring and self-assessment.

Supporting mechanisms. The proposed methodological approach is supported by research and education programmes as well as a structured knowledge transfer policy. Monitoring of WSP implementation and benchmarking are adequate tools for the surveillance process, and must be done by independent auditing at both levels: national and water utility.

RESULTS AND DISCUSSION

The framework proposed in this study provides a national strategic approach for implementing WSP in Portugal. Replication of this framework in other countries requires flexibility to be adopted, taking into consideration the conditions and constraints related to that specific country national drinking water supply situation.

Procedures at water utility level

At first, the WSP concept must be adopted and implemented by water utilities. This process implies their commitment to follow the WSP step-by-step standard procedure in drinking water supply system surveillance in order to meet the health-based targets: (i) system assessment, which involves assessing the capability of the drinking-water supply chain (from water source to the point of consumption) to deliver water of a quality that meets the identified targets and assessing design criteria for new systems; (ii) operational monitoring, which includes the identification of control measures that will collectively control identified risks and ensure that health-based targets are met; and (iii) management plans, which describe actions to be taken during normal operation or extreme and incident conditions, and document system assessment (including upgrade and improvement), monitoring, communication plans and supporting programmes.

Monitoring the WSP implementation process at water utility level includes self-assessment, improvements in utility performance and the establishment of networks of expertise. Assessment of operational and verification results (hazards and risks, control measures, operational monitoring, management procedures) can assist water utilities in identifying weaknesses, in providing good information on WSP adequacy and in creating networks of expertise.

Feedback from this monitoring process enables benchmarking and monitoring at a national level and can provide water utilities with the confidence that their WSP process is sound and appropriate.

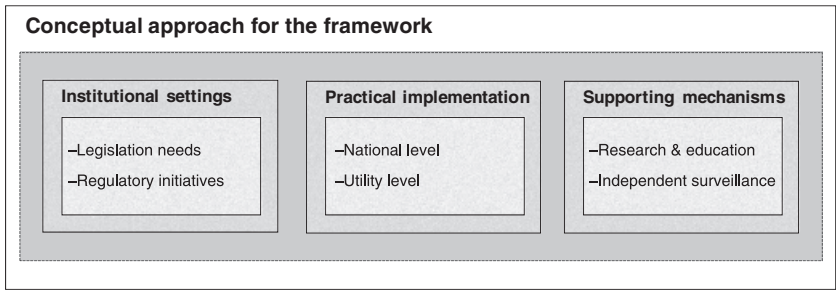

Figure 2 | Components of the national framework.

Actions at national level

WSP implementation strategy in a broader national scale must consider the following main aspects: the problem definition, the inventory of needs and a pragmatic approach.

Problem definition. The establishment of a successful nationwide WSP implementation needs a well-defined problem where most of limitations and difficulties must be understood and anticipated: (i) lack of awareness of benefits of WSP that must be compensated by clear quantification and justification of progress in drinking water quality and continuous improvement in utilities performance; (ii) limited knowledge and capacities in the country due to deficits in established education/training programmes and considering the limited number of water utilities with practical experience; (iii) non-compulsory legislation for supporting WSP although advocacy has been made in the last years; (iv) limited financial resources to adapt procedures and methodologies, especially in small water supplies.

Inventory of needs. A practical analysis of national capacities and knowledge gaps in both processes and organizations leads to an inventory of needs. The most important identified limitations and difficulties are related to: (i) WSP explicit in regulation and in drinking water quality official policy commitment; (ii) availability of skilled research and training centres needed for knowledge transfer in the areas of data collection and analysis, risk assessment, control and emergency procedures; (iii) simple and flexible practical tools for wide dissemination of the WSP concept and implementation; (iv) WSP independent auditing, by means of objective mechanisms to facilitate continuous improvement and to assess progress in WSP implementation.

Pragmatic approach. Good results can be obtained if a comprehensive methodological process is adopted for the global framework implementation. Well-established management tools can be used for developing a series of documents: (i) knowledge acquisition of lessons learned from both national experiences and international case studies; (ii) strategic plan on how to define objectives, measures and deliverables; (iii) operational plan of work detailing priorities and milestones; (iv) public authorities commitment, including key government agencies, expressing support for the WSP approach.

Driving forces

Strong leadership by ERSAR is a condition of paramount importance for the success of framework implementation. Driving forces in a national perspective include a set of initiatives in the fields of legislation, global monitoring and global benchmarking. For this, an advisory committee composed by national experts and water stakeholder representatives is recommended.

Legislation. Currently drinking water quality in Portugal must comply with standards established by the European Drinking Water Directive 98/83/EC (DWD) (EC 1998), transposed to national legislation by Decree-Law 243/2001. Article 11 of DWD states that: 'at least every 5 years, the European Commission shall review and adapt the annexes in the light of scientific and technical progress'. The DWD revision process has already been initiated and one of the identified main lines for the revision includes: 'adopting a Water Safety Plans approach as the way to go'. ERSAR, acting as the competent national authority for drinking water quality surveillance, should step forward in demonstrating a proactive interest in WSP implementation, giving guidance on how to develop the concept and proposing practical methodologies within a wider national holistic context. This means that stakeholders' responsibilities through all the production/distribution chain of drinking water systems, from the catchment to the consumer's tap, must be clarified: environmental authorities (ARH) implementing Water Framework Directive policy measures for natural waters management (EC 2000); water suppliers and plumbers applying risk management methodologies in water abstraction, treatment, storage, distribution and pipe networks in buildings.

Global monitoring. A working plan to assess the progress in WSP development and implementation and global drinking water quality monitoring must be established. This plan will act as a mechanism to facilitate the measurement of progress over time, giving an overall picture at a national scale. An on-line web-based platform will keep stakeholders informed about achievements and difficulties.

Global benchmarking. The use of specific tools for water utilities self-assessment and for overall WSP implementation process, e.g. performance indicators, are seen as adequate and powerful means that will support all water suppliers in

WSP development and implementation strategies. These tools should identify the gaps in a specific WSP and should provide feedback to each water utility in order for it to be possible to learn from others, comparing performance and facilitating continuous improvement.

Independent auditing. WSP auditing should be independent and put in place by ERSAR. Audits are needed at a water utility level (independent surveillance to assist utilities in identifying weaknesses and strengths to continuously improve the WSP) and at a national level (global monitoring and global benchmarking, allowing a national broader picture). ERSAR has to decide the best practices in establishing: (i) frequency of the audits; (ii) organization of the audits; and (iii) reporting on audits.

Supporting activities

Supporting mechanisms such as peer group networks, tools and resources are complementary activities that should constitute additional factors for the success of the global framework. Research and education as well as resources dissemination can act as decisive levers for scaling-up WSP implementation.

Research and education. Knowledge creation and transfer is seen as one of the most effective means for practical implementation of these new methodologies. This means that universities and research funding agencies must be involved, from the beginning, in the strategic work. Different types of activities can be organized at a national level: (i) research

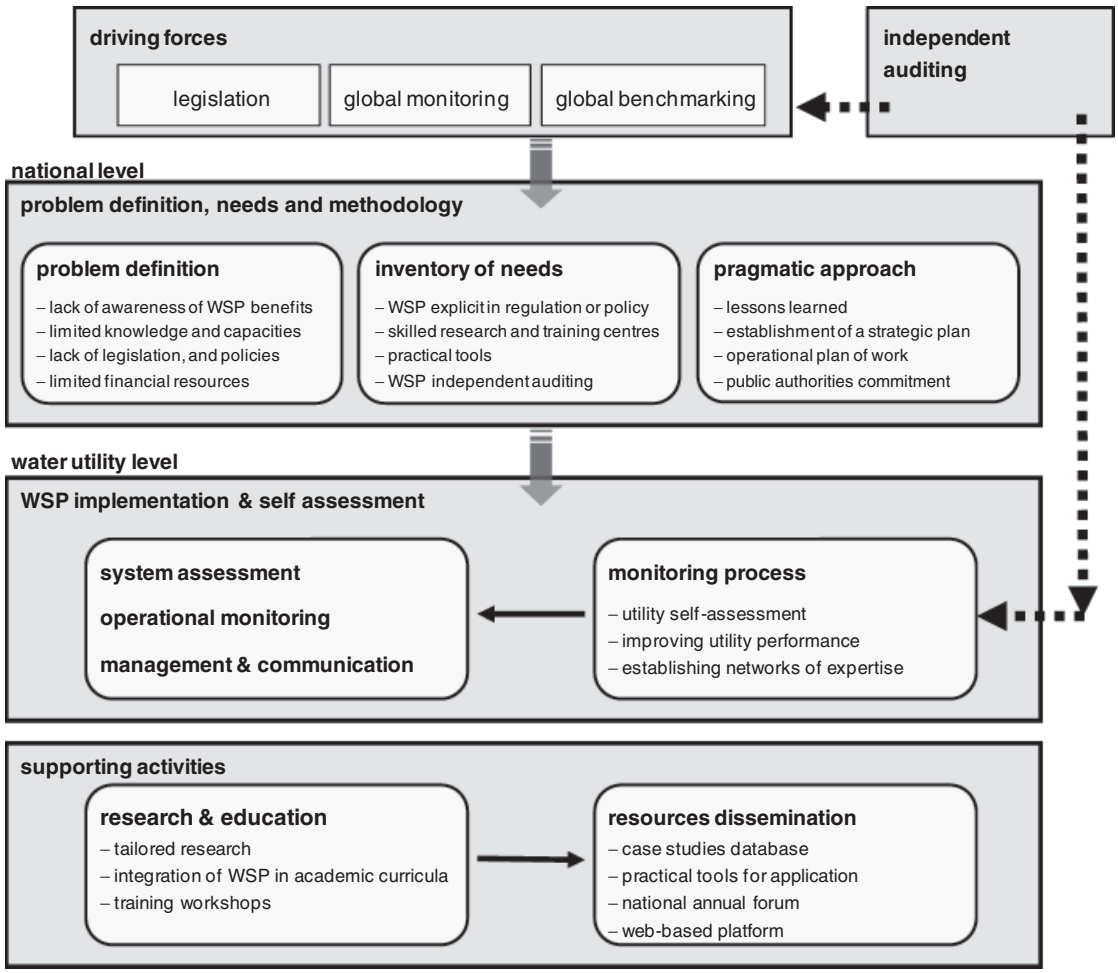

Figure 3 | Strategic approaches for WSP implementation scaling-up in Portugal.

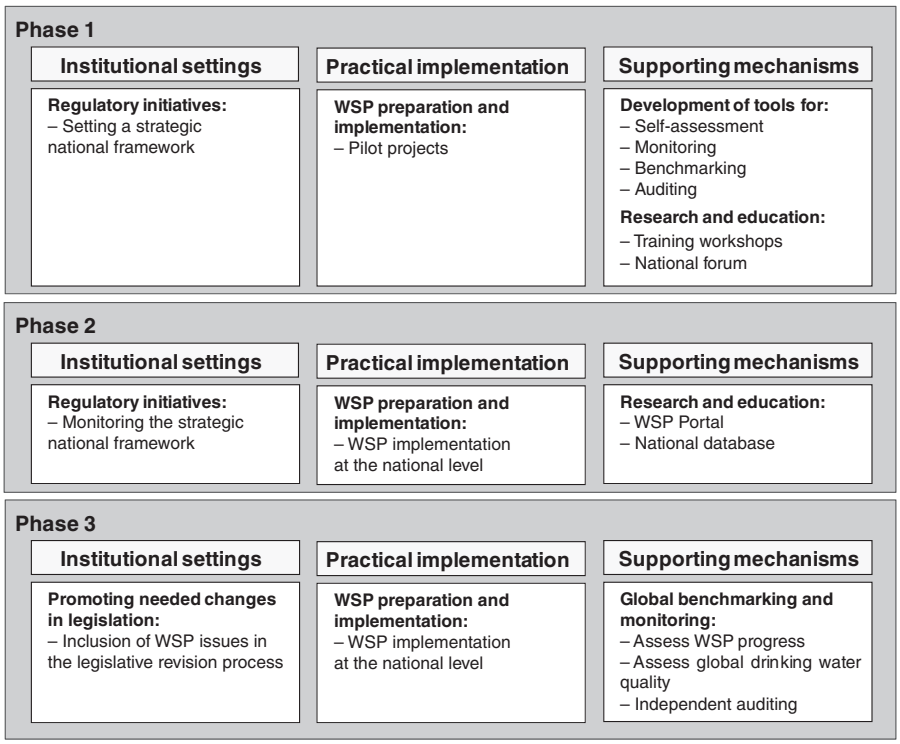

Figure 4 | Prioritization of strategic plan components.

agenda tailored to the needs of water utilities; (ii) integration of WSP concept and implementation into academic curricula; and (iii) WSP training workshops.

Resources dissemination. Exemplifying with successes and failures is a very effective pedagogical support for wide dissemination of concepts and practices. WSP implementation can greatly benefit from the following activities: (i) construction of a structured database collecting national and international case studies; (ii) development and/or enhancement of existing tools for practical application; (iii) organization of a national forum for a periodical (yearly) state-of-the-art presentation and conceptual brainstorming; (iv) establishment of a web-based platform (in English and Portuguese languages) where updated tools and case studies are made available.

Global framework

The main issues of the strategic approach for WSP implementation in Portugal have been described in the preceding paragraphs. A diagrammatic modular scheme representation for the global framework is depicted in Figure 3.

Operational programme

Challenges of WSP implementation on a nationwide scale recommend that core components of the strategic plan should be prioritized, taking into consideration a variety of institutional, technical and economic circumstances. An overall 6–7-year period is considered to be the necessary time to set up this target even though due to obvious external constraints the rate of progress is hard to anticipate. Therefore, key stakeholders must be included from the very beginning of the process in order to guarantee a smooth applicability. Figure 4 provides an overview of a three-phased process for an operational programme. Initial tasks to be worked out in Phase 1 include: (i) the establishment of the strategic national framework; (ii) launching WSP pilot projects prior to scaling-up at a national level; and (iii) the development of tools for self-assessment, monitoring, benchmarking and auditing, as well as the organization of events for WSP knowledge dissemination (a national forum and training courses). Phase 2 implies the follow-up of initiated activities with special focus on monitoring WSP implementation at the national level. In Phase 3, global achievements supported by

quantitative assessment can be extrapolated into the legislative revision process promoting WSP implementation.

CONCLUSIONS

Successful individual experiences in Portugal suggest a more systematic and organic scaling-up of WSP implementation on a national basis. Lack of legislation and policies and the need for appropriate monitoring tools are seen as major issues of concern for this objective.

Institutional commitments, organizational methodologies and supporting mechanisms are of paramount importance for a strategic approach in a national context. Furthermore, establishing a coherent and pragmatic framework is of extreme value for monitoring a WSP implementation standardized process where prioritizing core components and setting stakeholders' responsibilities are key factors for success.

Results from this study showed that: (i) independent auditing is a key issue in the operational plan of work at the national level (global monitoring programme, global benchmarking) as well as at the water utility level (water system assessment and operational monitoring); (ii) ERSAR, as the Portuguese competent authority for drinking water quality, must play a major role in the coordination of the framework; (iii) environmental protection authorities (ARH) and drinking water suppliers must get involved from the very beginning of the process; (iv) the work of research institutions is fundamental in both setting research and education programmes and resources dissemination.

A strategic approach for WSP implementation at a national scale will enable legislators and policy makers to better apply a step-by-step phased process for effective risk assessment and risk management in water supply systems, and what this implies for the achievement of sound mechanisms in protecting public health.

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