Generic Framework and Methods for Integrated Risk Management in Water Safety Plans

In the 3rd edition of the Guidelines for Drinking-water Quality, the World Health Organisation emphasis the preparation of risk-based Water Safety Plans (WSPs) to manage risks to drinking water consumers. WHO, among others, emphasise that the entire supply system, from source to tap, should be considered when managing risks. The WSP framework facilitates a much needed increase in awareness and understanding of risk issues for providing safe drinking water. However, an analysis of the WSP framework indicates that there are opportunities for further development, primarily regarding risks to water quantity and methods for risk identification, risk estimation and risk evaluation.

The main objective of Work Area 4 (WA4) – *Risk Assessment and Risk Management* in TECHNEAU is: *to integrate risk assessments of the separate parts in drinking water supplies into a comprehensive decision support framework for cost-efficient risk management in safe and sustainable drinking water supply*. The framework should be regarded as a *structure and toolbox* for risk assessment and risk management in WSP. It should be applicable to both groundwater and surface water supply systems, with basic as well as more complex designs. The framework should also be applicable on both the operational and strategic levels.

A generic framework which forms the basis for further development of risk management procedures and methods in TECHNEAU is presented. The development of the framework was based on an extensive literature review and the main components are shown in the Figure below. To provide the necessary basis for integrated risk management for both basic and complex systems on the operational as well as strategic levels, the framework includes all major steps in the risk management process, as defined in established standards.

To be efficient and functional, the framework must also include a set of reliable and well-established tools, adapted to specific decisions to be made and considering type of water supply system, level of complexity, and level of decisions, i.e. operational or strategic. Principal levels of sophistication of risk assessment tools are:

- Qualitative, e.g. based on checklists and classification of risk levels, providing relative ranking of lists and identification of critical points for risk reduction.
- Quantitative, e.g. based on models for combining and structuring events and chains of events, and estimations of quantitative risk levels. This level of sophistication facilitates quantitative comparison of estimated risk levels with established risk tolerability levels.
- Quantitative including decision analysis methods, facilitating strategic analysis of risk reduction measures, e.g. estimations of the risk reduction – investment trade-offs in prioritisation of risk reduction options.

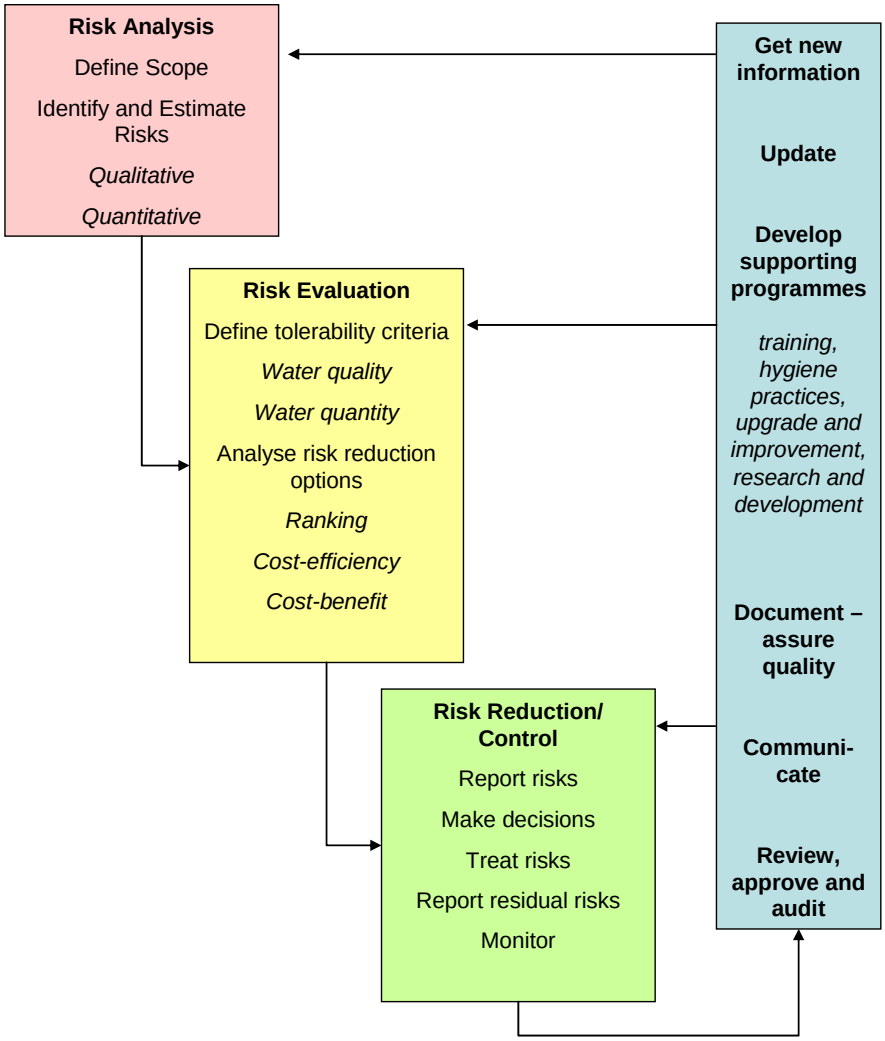

Figure. The main components of the TECHNEAU generic framework for integrated risk management in WSP.

The suggested framework cannot provide one single risk management method applicable to all types of water utilities for decisions at both strategic and operational levels. Instead, the framework when fully developed will provide:

- Principles for good risk management practice
- The relevant set of tools necessary for performing the risk assessment and management
- Description of these tools, e.g.:
    - TECHNEAU Hazard database, THDB
    - Risk analysis methods description
    - TECHNEAU Risk reduction options database, TRDB
    - Decision support tool

Clear examples of risk assessment applications and testing of these tools.

More information
The results of this work are presented in the report "*Generic Framework and Methods for Integrated Risk Management in Water Safety Plans*" (Deliverables D4.1.3, D4.2.1, D4.2.2, D4.2.3).

Authors
Lars Rosén – Chalmers University of Technology, Göteborg, Sweden
(lars.rosen@chalmers.se)

Per Hokstad – SINTEF, Trondheim, Norway
(per.hokstad@sintef.no)

Andreas Lindhe – Chalmers University of Technology, Göteborg, Sweden
(andreas.lindhe@chalmers.se)

Snorre Sklet – SINTEF
(snorre.sklet@sintef.no)

Jon Røstum – SINTEF
(jon.rostum@sintef.no)

Quality Assurance
Patrick Smeets – EAWAG
José Menaia – LNEC

TKI Categorisation

Classification											
Supply Chain		**Process Chain**		**Process Chain (cont'd)**		**Water Quality**		**Water Quantity (cont'd)**	
Source		**Raw water storage**		**Sludge treatment**		**Legislation/regulation**		- Leakage	
- Catchment		- Supply reservoir		- Settlement		- Raw water (source)		- Recycle	
- Groundwater		- Bankside storage		- Thickening		- Treated water			
- Surface water		**Pretreatment**		- Dewatering		**Chemical**		**Risk management / Consumers**	
- Spring water		- Screening		- Disposal		- Organic compounds		**Risk analysis**	
- Storm water		- Microstraining		**Chemical dosing**		- Inorganic compounds		- Hazard identification	X
- Brackish/seawater		**Primary treatment**		- pH adjustment		- Disinfection by-products		- Risk estimation	X
- Wastewater		- Sedimentation		- Coagulant		- Corrosion		**Risk evaluation**	
Raw water storage		- Rapid filtration		- Polyelectrolyte		- Scaling		- Risk tolerability decision	X
- Supply reservoir		- Slow sand filtration		- Disinfectant		- Chlorine decay		- Analysis of options	X
- Bankside storage		- Bank filtration		- Lead/plumbosolvency		**Microbiological**		**Risk reduction/control**	
Water treatment		- Dune infiltration		**Control/instrumentation**		- Viruses		- Risk reduction options	X
- Pretreatment		**Secondary treatment**		- Flow		- Parasites		- Decision making	X
- Primary treatment		- Coagulation/flocculation		- Pressure		- Bacteria		- Implementation	X
- Secondary treatment		- Sedimentation		- pH		- Fungi		- Monitoring	X
- Sludge treatment		- Filtration		- Chlorine		**Aesthetic**		**Risk Communication**	
Treated water storage		- Dissolved air flotation(DAF)		- Dosing		- Hardness / alkalinity		- Communication strategies	
- Service reservoir		- Ion exchange		- Telemetry		- pH		- Potential pitfalls	
Distribution		- Membrane treatment		**Analysis**		- Turbidity		- Proven techniques	
- Pumps		- Adsorption		- Chemical		- Colour		**Trust**	
- Supply pipe / main		- Disinfection		- Microbiological		- Taste		- In water safety/quality	
Tap (Customer)		- Dechlorination		- Physical		- Odour		- In security of supply	
- Supply (service) pipe		**Treated water storage**						- In suppliers	
- Internal plumbing		- Service reservoir				**Water Quantity**		- In regulations and regulators	

- Internal storage		**Distribution**						**Willingness-to-pay/acceptance**	
		- Disinfection				**Source**		- For safety	
		- Lead/plumbosolvency				- Source management		- For improved taste/odour	
		- Manganese control				- Alternative source(s)		- For infrastructure	
		- Biofilm control				**Management**		- For security of supply	
		Tap (Customer)				- Water balance			
		- Point-of-entry (POE)				- Demand/supply trend(s)			
		- Point-of-use (POU)				- Demand reduction			

TKI Categorisation (continued)

Contains		**Constraints**		**Meta data**					
Report		Low cost		*Author(s)*					
Database		Simple technology		*Organisation(s)*					
Spreadsheet		No/low skill requirement		*Contact name*					
Model		No/low energy requirement		*Contact email*					
Research		No/low chemical requirement		*Quality controller name*					
Literature review		No/low sludge production		*Quality controlerl organisation*					
Trend analysis		Rural location		Source					
Case study / demonstration		Developing world location		*Date prepared*					
Financial / organisational				Date submitted (TKI)					
Methodology				Date revised (TKI)					
Legislation / regulation									
Benchmarking									