Techneau, 07.
FEBRUARY 2007

TREND REPORT

REPORT ON TRENDS REGARDING FUTURE RISKS

TECHNEAU

TREND REPORT – REPORT ON TRENDS REGARDING FUTURE RISKS

TECHNEAU is an Integrated Project Funded by the European Commission under the Sixth Framework Programme, Sustainable Development, Global Change and Ecosystems Thematic Priority Area (contractnumber 018320).

Colofon

Title
Trend report – Report on trends regarding future risks

Authors
Lars Rosén and Andreas Lindhe – Chalmers University of Technology

Quality Assurance
Wouter Pronk – EAWAG
Toine Ramaker and Andrew Segrave – KIWA

Deliverable number
D 1.1.9

This report is:
PU = Public

Summary

The development of strategies for adapting risk management to suit future water supply systems requires prediction of emerging risks. Identification of existing risks and risk that are likely to be important in the future is a key issue to the TECHNEAU project (TECHNEAU, 2005). This information is essential to the development of adaptive strategies in work area 1 (WA1) "Rethink the system", and will form the basis for developing risk management tools and strategies in WA4 "Risk Assessment and Risk Management".

The purpose of this document is to report foreseen trends regarding risk factors identified in the SEPTEDOR (Socio-cultural, Economical, Political, Technical, Ecological, Demographic, Organizatorial and Risk) analysis conducted in WA1. The description of possible future risks was based on a literature review, interviews, evaluation work carried out at Chalmers University of Technology, and contributions from WA1 TECHNEAU partners in the SEPTEDOR analysis of their different countries.

The following major risk categories were identified as likely to be significantly more important to water supply management in the future:

- Sabotage and terrorist attacks
- Conflicts
- New chemicals
- Emerging pathogens
- Public concern
- Climate Change
- Aging distribution systems

In addition to the identification of major risks categories, future risk management is discussed. Managing risks to drinking water systems is likely to be increasingly important in the future. The major reasons for this being increased awareness of risks, e.g. through the implementations of Water Safety Plans (WHO, 2004) in many countries, and a more diversified palette of risks. As a result, it is considered as likely that risk assessments, risk communication, and prioritization of risk reduction efforts will be more commonly performed in the future. It is also likely that performance and quality assurance of risk management practices will be more critically analysed. Since resources for risk reduction are limited, economic optimisation of risk reduction options is likely to be an important task in the future.

Each identified future risk category is described in the report with reference to the literature and/or interviewed persons. In a summary of the future trends regarding risk, each category is presented together with a major hazardous event, type of hazard, and potential of consequences.

The report was prepared by: Lars Rosén, Chalmers University of Technology, Göteborg, Sweden (e-mail: lars.rosen@chalmers.se) and Andreas Lindhe, Chalmers University of Technology, Göteborg, Sweden (e-mail: andreas.lindhe@chalmers.se).

Contents

1 General description

1.1 Background

The development of strategies for adapting risk management to suit future water supply systems requires prediction of emerging risks. In recent years various trends related to water safety and risks have developed; for example the increased occurrence and awareness of microbial pollutants and the emergence of membrane filtration. Identification of existing risks and risks that are likely to be important in the future is a key issue to the TECHNEAU project (TECHNEAU, 2005). This information is essential to the development of adaptive strategies in work area 1 (WA1) "Rethink the system", and will form the basis for developing risk management tools and strategies in WA4 "Risk Assessment and Risk Management".

1.2 Purpose of this document

The purpose of this document is to report foreseen trends regarding risk factors identified in the SEPTEDOR (Socio-cultural, Economical, Political, Technical, Ecological, Demographic, Organizatorial and Risk) analysis performed in TECHNEAU work area 1 (WA1). The SEPTEDOR analysis forms the basis for the description of possible future trends in WA1. The description given here of possible future risks in drinking water supply, is based on a literature review, interviews, evaluation work carried out at Chalmers University of Technology, and contributions from WA1 TECHNEAU partners in the SEPTEDOR analysis of their different countries. The complete results from the SEPTEDOR analysis are presented in separate reports.

2 Results of the analysis

To be able to manage risks in an efficient manner it is important to identify existing risks as well as possible future risks. Once future risks are identified it might be possible to take measures to eliminate or reduce the risks in an early stage. Future risks may arise as a consequence of different types of changes that have direct or indirect effects on the drinking water system (e.g. climate changes and human activities in the catchment area). Pollard (2004) describes privatization, sector globalisation, increased competition, emerging technologies, increasingly stringent regulation and the trend towards financial self-sufficiency as factors serving to transform the water sector. These factors may pose new risks as well as opportunities for drinking water systems.

The “Guidelines for Safe Drinking-water” from the World Health Organisation (WHO, 2004) and the “Australian Drinking Water Guidelines” (NHMRC, 2004) emphasize the importance of learning as much as possible from incidents to improve preparedness and planning for future events. These guidelines point out the importance of working proactively, even though learning from incidents does not specifically imply that future risks are identified. In the Australian guidelines, however, comprehensive catchment management plans are recommended to be used to mitigate existing and future risks (NHMRC, 2004). In their comprehensive book on global groundwater, and its susceptibility to degradation, Morris et al. (2003) point out that some prescriptions for improved approaches are needed if we are to manage groundwater for the future and not just for the present.

The following major future risk categories were identified in the literature, from interviews, from evaluation work carried out at Chalmers University of Technology, and from contributions of other participants in the SEPTEDOR analysis:

- Sabotage and terrorist attacks
- Conflicts
- New chemicals
- Emerging pathogens
- Public concern
- Climate Change
- Aging distribution systems

Each identified future risk category is described below.

2.1 Sabotage and terrorist attacks

Drinking water systems are often vulnerable and difficult to protect against deliberately harmful actions. It is hard to protect the distribution of treated drinking water from contamination for example, because of the many points where contamination could be introduced into the system (Linville and Thompson, 2006). Terrorist attacks and sabotage have received extra attention in some parts of the world during the last couple of years. As a result of the September 11, 2001, attacks on World Trade Center in New York, United States, a deliberate contamination intrusion to a water distribution system is now considered one of the most serious threats to public health in the United States (Ostfeld and Salomons, 2005). It may not be correct to call terrorism and sabotage future risks since these risks already exist, but the number and severity of attacks might increase. Also, the reasons for the attacks and in what way they are performed might change.

Gleick (2006) defines terrorism to water supply systems as when "water resources, or water systems, are either targets or tools of violence or coercion by non-state actors". Mays (2004) states that the probability for terrorist attacks to water supply systems is very low, but the consequences for the effected population could be severe. Many water supply systems are vulnerable to sabotage and terrorism. For example, systems with high source water quality are vulnerable to attacks, since limited treatment is needed which may imply that no, or very limited, barriers against sabotage or terror events exist. The distribution system offers, according to Mays (2004), the greatest opportunity of terrorism because it has an extensive character, and is relatively unprotected and accessible.

Mays (2004) lists cyber threats, physical threats, chemical threats and biological threats as potential ways of harming the water supply. Physical destruction of system's assets is described as more likely than contamination, one reason being that it requires fewer resources.

An important aspect of terrorist attacks was recently described by Gigerenzer (2006), who highlighted *indirect damage* due to the human behaviour after terrorist attacks. After the September 11 attacks, 2001, it was found that travel habits changed, so that highway travel increased as air travel decreased. The study showed that within one-year of the attacks an additional 1500 people were killed in highway traffic in the attempt to avoid the fate of the passengers who were killed in the four fatal flights on September 11. Similar psychological effects leading to changed behaviour and indirect damages can also be expected in the case of major terrorist attacks on water supply systems.

In Sweden and other Nordic countries, the increased awareness of terrorist and sabotage incidents has resulted in more strict security control and restricted accessibility to water production systems (Bergstedt, 2006). An issue that must be carefully considered is the trade-off between control/restrictions and operation of the production systems. Information regarding source water, treatment and distribution systems must be available for operational purposes and very strong restrictions might introduce new operational risks to the systems.

The risk of terrorist attacks is mentioned as a factor affecting most of the regions considered in the SEPTEDOR analysis. In Portugal the risk of terrorist attacks is considered very low compared with technological and climate risks. In the Netherlands it is stated that the risk of terrorist attacks has increased in recent time. However, the threat of terrorist attacks scarcely plays a role in the minds of the Dutch population and they seem to consider that all necessary measures are already taken.

2.2 Conflicts

Conflicts regarding drinking water are a major risk to water supply in many parts of the world. In politically stable areas, such as Europe, this risk is less pronounced today. Conflicts do not have to be related to terrorism, but even though water supply systems are protected by protocols additional to the Geneva Conventions (ICRC, 2006), they may be used as political or military goals in the attempt to gain control over another nation's water resources (Gleick, 2006). For example, in 2000 Uzbekistan and Kyrgyzstan cut off the water to Kazakhstan as a result of non-payment of debt and because coal had not been delivered (Gleick, 2006).

The United Nations Environmental Programme states that every conflict generates risks to human health and to the environment (UNEP, 2003). The post-conflict situation in Iraq, after 2003, comprises a range of chronic environmental issues, and presents immediate challenges in the fields of humanitarian assistance, reconstruction and administration. It has been estimated that 5 million people (19% of the total population) are at risk from lack of access to safe water and sanitation. The supply of potable water in southern and central Iraq is dependent on the continuing operation of water treatment plants in urban areas and compact units in rural areas – all of which require electricity from the main power distribution grids. Any disruption of electrical power stemming from the current conflict would therefore exacerbate an already serious situation (UNEP, 2003). This is valid also for future conflicts.

Conflicts regarding water seem more likely in areas where water is a limited resource or more then one nation or group of consumers share the same resource. In 2004 there was a conflict regarding pastoral land and water wells in Somalia, and at least 50 people were killed and many injured as a result of the fighting (Gleick, 2006). Conflicts regarding water resources and water systems arise because water is essential to economical and social development, and of course a fundamental requirement for life.

In addition to political and military conflicts, competing land-uses may result in severe conflicts regarding water resources. For example, research clearly shows that the extensive agricultural activities in Europe and North America have led to increased nitrate concentrations in many groundwater aquifers, due to increased fertilizer use. According to Morris et al. (2003) the largest increase in fertilizer use is in developing countries. This situation has resulted in growing concern in many developing countries for which agriculture is a prime part of the economy, and where the benefits to farmers' livelihoods are great (Morris et al., 2003).

According to the SEPTEDOR analysis conflicts regarding water resources are likely to arise in Africa, unless preventive measures are jointly taken in the region. To avoid conflicts, each country's water resource management strategies need to be aligned with that of its neighbours. Conflicting demand between water use and energy requirements is another factor of concern in Africa. It is stated that conflicts regarding drinking water highly unlikely to evolve into wars.

2.3 New chemicals

New chemicals that are currently being introduced in society may be a risk to the drinking water system if they contaminate the source water for example, as a result of accidents or continuous discharging. If new chemicals are more harmful or difficult to remove from water, they pose a greater risk than chemicals already in use. In addition, when chemicals are used in new ways and for new applications, they may also pose greater risks than through previous uses. When new materials are used, e.g. new piping material, it is possible that new chemicals may be emitted to the water. Another important type of source water contaminants that may cause severe problems in the future are medical pollutants.

When assessing a drinking water system, future activities in the catchment area are of interest (WHO, 2004). Chemicals and other contaminations in the source water may origin from activities in the catchment area. This makes it important to communicate with stakeholders in the area and thereby acquire knowledge about existing and planned activities.

In the SEPTEDOR analysis, new chemicals are emphasized as important aspects in most regions. In Israel governmental monitoring exists on pesticides and disinfection by-product. In the Netherlands the water companies using river water are united within RIWA (the Association of River Water Companies) to deal with poor river water quality. The companies screen the raw water for new and emerging chemical substances. Besides this, individual water supply companies also screen the raw water sources for new and emerging chemical substances. The total water quality is analysed by means of chromatographs and mass-spectrograms. Every two years new chemicals that have been found to exceed a threshold concentration are further investigated. The toxicity of these substances is studied to help decide if they should be included in the monitoring programme.

2.4 Emerging pathogens

A future risk associated with micro-organisms is newly discovered or emerging pathogens, and also the fact that infection patterns change over time (Dufour et al., 2003). Emerging and re-emerging infections have been defined as new, recurring, or drug-resistant infections whose incidence in humans has increased in the last two decades or whose incidence threatens to increase in the near future (NIM, 1998). Factors that affect the emergence or re-emergence of pathogens are intensive agriculture, increased growth and migration of human population and climate changes (Dufour et al., 2003).

One problem with emerging pathogens is how to detect them at an early stage, before they cause any harm. Effective and well functioning detection methods are consequently of great importance in protecting the drinking water. Today, the possibilities for getting fast enough results from laboratory analyses of virus contamination to prohibit infections after a pollution incident is almost non-existent (Bergstedt, 2006). A recent example of this is a virus infection event in Göteborg during 2005, where it took six months of laboratory work after the incident to identify and verify the virus that caused the outbreak.

Pathogens may pose a severe risk to human health if they can overcome the microbial barriers of a water supply system. It might be necessary to introduce new treatment steps or improve existing ones when emerging pathogens are detected; especially if the source water already containes low concentrations of micro-organisms. Durour et al. (2003) describes the emerging pathogens as a significant hazard in countries at all levels of industrialisation/economic development.

According to the SEPTEDOR analysis the microbiological quality of water is a major concern in Israel, and in Estonia chlorine is added to the distribution net for protection in case of possible microbiological terrorist attacks, which deteriorates water quality.

2.5 Public concern

Public awareness and involvement is important in determining what is considered as tolerable risk levels. It is, however, not only the risks from a natural scientific perspective that influence public concern about different substances in drinking water. Also the type of pollutants or how the pollutants are exposed to the consumers affects peoples' risk tolerability. For example, the tolerability among the public for pesticides or medical pollutants is very low (Bergstedt, 2006), no matter the risk level from a natural scientific perspective. Thus, public concern about several substances in drinking water is to a large extent driven by perceptions and not by rational views on risks. Consideration of peoples' risk perceptions – that brings concern and anxiety – is a necessary part of all successful risk management (see e.g. SRSA, 2003).

Concern about drinking water quality has increased and is likely to continue to increase as new substances are detected in drinking water. New and improved lab analysis techniques that can measure ever lower concentrations will make it possible to detect more and more substances, that were earlier only considered as undetectable and therefore "not existing" in the source and/or drinking water. Public concern regarding these substances must be managed by communication and information regarding health risks, but it can be expected that the efforts to manage this type of risk will continue to increase. According to Berg (2006) water producers have to inform consumers about medical pollutants in the drinking water and other risks in a pedagogic manner, not to cause any unnecessary anxiety.

The SEPTEDOR analysis shows that people are concerned about drinking water safety. According to a survey in England and Wales, one third of the participants think there is a danger to health from substances in their tap water. Chemicals and bacteria were indicated to be the main concern. The SEPTEDOR analysis also shows that people in Israel are concerned about health aspects of their drinking water.

2.6 Climate change

As described by IPCC (2007) observations of the Earth's climate shows that warming of the climate system is unequivocal. These changes occur as a result of both natural and human factors. Although natural factors, such as changes in solar radiation or volcanic activity, may affect the global climatic system, the term 'climate change' has popularly come to mean additional changes in the global climate due to human activities, particularly the emissions of greenhouse gases and aerosols (IPCC, 2001a).

Rising concentrations of greenhouse gases in the Earth's atmosphere cause climate change by enhancing the natural climate variability. The three gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) together contribute to over 90% of man-made global warming (EEA, 1996). Carbon dioxide is by far the largest component and has the biggest impact on our environment (Europa, 2003). Although there are many uncertainties about the scale and impacts of climate change, IPCC (2007) states that it is very likely (probability is more then 90%) that most of the observed increase in globally average temperatures since the mid-20th century is due to human emission of greenhouse gases.

The predicted changes in temperature and sea levels are larger than any climate change experienced over the last 10 000 years, and are based on current greenhouse gas emissions trends. Some possible risks to water resources and drinking water due to climate changes were outlined by Morris et al. (2003) based on information from IPCC (2001b):

Water resources

- changes in availability (or water quantity) due to new precipitation and evaporation patterns
- changes in demand due to new water supply requirements and possible increased competition for water
- changes in supply due to water quality effects

Health

- changes in weather-related mortality due to, for example, drought
- changes in the distribution of infectious diseases

Costs to society

- direct and indirect effects on economic activities, land use and human settlements from changed weather and increased frequency of extreme events

If water availability and quality changes as a result of climate changes, this may lead to new challenges and difficulties for the water producers (Berg, 2006). For the Nordic countries, the already high contents of humus in source waters are expected to increase due to climate changes (Bergstedt, 2006).

According to the SEPTEDOR analysis the climate changes have had severe consequences on water resources in Spain and Portugal. A global problem, also reported in the SEPTEDOR analysis, is that climate changes are expected to cause sea level rise and amplification of extreme hydrological conditions These hydrological conditions are expected to cause various consequences for the quality and quantity of water in many parts of the world.

2.7 Aging distribution systems

Many water distribution systems have been operating for a long time, and need increased maintenance to operate safe. All technical systems are aging and during their lifespan the likelihood of failure changes (see e.g. Freeze, 2000). The typical safety development over time can, for a technical system, be described by the so called “bathtub curve”, see Figure 1. In initial stages the probability of failure is higher due to e.g. installation procedures. After installation the system safety is generally increased (i.e. decreased probability of failure) and the safety level stabilizes. However, over time the probability of failure finally increases again, due to aging processes.

In water supply this results in increased probability of more frequent interruptions to water distribution and in some cases also increased probability of poor water quality. The situation of increased frequency of failures in distribution systems have been reported in many countries, see e.g. Lindberg and Lindqvist (2005).

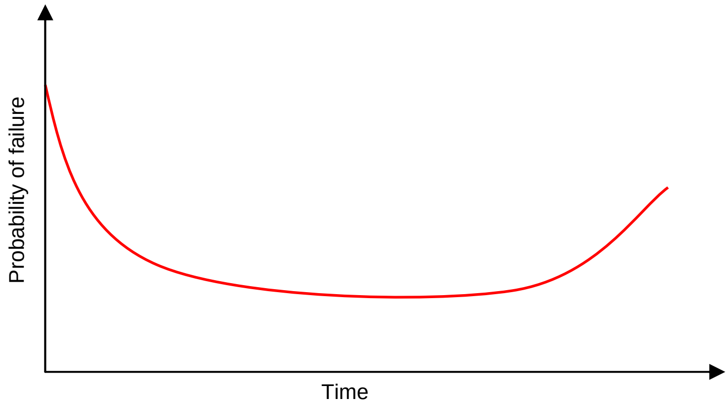

Figure 1. *Typical temporal development of the probability of failure for technical systems such as e.g. water distribution systems.*

According to the SEPTEDOR analysis few of the transportation pipelines and water mains are replaced annually. In Latvia 1-2% of the distribution networks are renovated every year and in the Netherlands 0.55% of the distribution network was replaced annually (on average) from 1993-1995. It would take 182 years to replace the entire system in the Netherlands if the same replacement rate was maintained. This replacement rate may well be too slow to maintain today's level of security. Another aspect of aging distribution systems is oversized systems in cases of decreasing water demand. For example in Estonia and Latvia water consumption is decreasing and this poses a risk of water quality deterioration from microbial pollutants due to increased retention times.

2.8 Risk Management and risk optimisation

Managing risks to drinking water systems is likely to be increasingly important in the future. The major reasons for this being increased awareness of risks, e.g. through the implementations of Water Safety Plans (WHO, 2004) in many countries, and a more diversified palette of risks. As a result, it is likely that risk assessments, risk communication, and prioritization of risk reduction efforts will be more commonly performed in the future. It is also likely that performance and quality assurance of risk management practices will be more critically analysed.

Since resources for risk reduction are limited, optimisation of risk reduction options is likely to be an important task in the future. Risk optimisation based on economic valuation of risk reduction against investment costs can be expected to be an important management tool for prioritizing resources in drinking water supply. However, the use of risk optimisation and valuations of risk and risk reduction in economic or other terms are currently limited in the drinking water sector. Risk assessment and risk management is made primarily through qualitative risk classifications for ranking of risks or through quantitative risk analyses of specific parts or risks of the systems, e.g. failure analysis of distribution networks or microbial health risk assessments, such as Quantitative Microbial Risk Assessments (QMRA).

One area of the drinking water sector where risk optimisation through the use of economic risk valuation is currently being implemented is asset management; see e.g. Yorkshire Water (Smith, 2005). In TECHNEAU (2005) economical optimisation of risks is an important part of the risk management framework being developed for use in preparations of Water Safety Plans. The purpose is to develop an approach for integrated risk management where major parts of the drinking water system (i.e. source water, treatment, and distribution networks and plumbing) are included and where risk optimisation is based on economic valuation of reduced risk costs against investment costs for achieving risk reductions, see Figure 2.

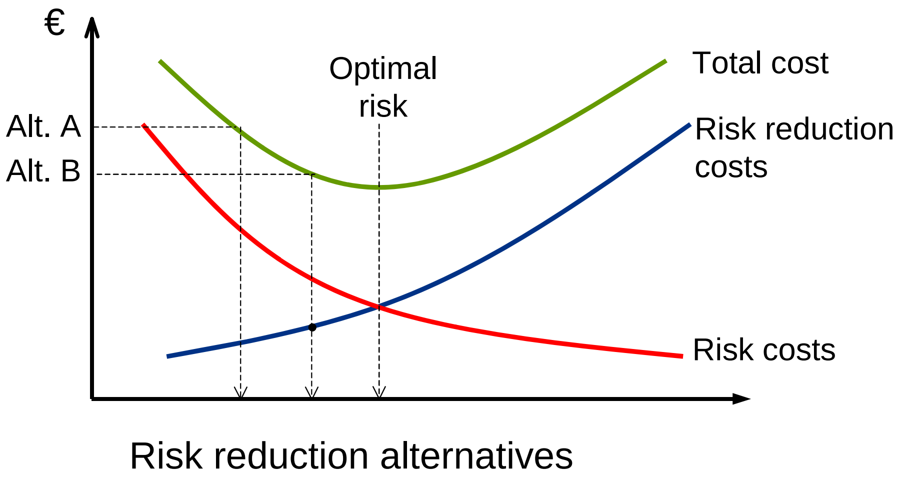

Figure 2. *Risk optimisation with respect to reduced risk costs and investment costs for reducing risks.*

3 Summary of risks

In Table 1 a compilation is presented of future risk categories identified in the trend analysis. For each risk the hazard, hazardous event, type of hazard, and potential consequence are listed. The identified future risks are included in the TECHNEAU Hazard Database, see Beuken et al. (2007).

Table 1. *Major future risks.*

Hazard	Hazardous event	Type of hazard	Potential consequences
Sabotage and terrorist attacks	Physical damage (e.g. bombing attack)	Physical	Water shortage and technical damage
	Intentional chemical contamination	Chemical	Health effects, water shortage and remediation of supply system
	Intentional microbial contamination	Microbial	Health effects, water shortage and remediation of supply system
	Cyber attack (e.g. manipulation of operational steps)	Cyber attack	Health effects and water shortage
	Non accessible information. To prevent sabotage and terrorist attacks information regarding source water, treatment and distribution are classified. Due to this all necessary information might not be available to the personal and people in general.	Non accessible information	If the personal operating the system does not have all necessary information actions might be taken that introduce new risks to the system. Also people in general might, because of lack of information, act in a way that pose new risks to the system. Water shortage and health effects are possible.
	Changed human behaviour after terrorist attacks leading to avoidance of tap water	Anxiety, human behaviour	Indirect damage. Because of lack of trust in tap water people use water from other sources and if this water is of poor quality it might cause negative health effects.
Conflicts	Military conflicts	Military	Technical damage, water shortage and health effects
	Political conflicts	Political	Political actions leading to water shortage
	Competing land use	Competing interests	Water shortage, contaminated source water and health effects

(Table 1 continues on next page)

(Table 1 continued from previous page)

Hazard	Hazardous event	Type of hazard	Potential consequences
New chemicals and changed chemical pathways	Discharge of new chemicals to source waters due to e.g. accidents or continuous leakage	Chemical	Health effects, water shortage and remediation of supply system
	Discharge of chemicals due to new applications	Chemical	Because known chemicals are put into new pathways they may cause poor water quality leading to water shortage, negative health effect and remediation of supply systems.
Emerging pathogens	Discharge to source waters	Microbial	Health effects, water shortage and remediation of supply system
	Changed infection patterns (increased susceptibility to infections among the population)	Microbial	Health effects and water shortage
Public concern	Reports on detection of chemicals or pathogens of very low tolerability	Anxiety (microbial and/or chemical)	Anxiety and decreased trust in water supply
Climate change	New precipitation and evaporation patterns	Water availability	Water shortage
	The climate changes' effects on water quality (changed surface runoff and material transport effecting water quality)	Chemical and/or microbial	Water shortage and possible health effects due to poor water quality
Aging distribution systems	Damaged distribution system and possible intrusion of contaminants	Physical, chemical and microbial	Water shortage, health effects and technical damage
	Increased retention times due to oversized systems	Microbial	Health effects

4 Comments

The trends and risks identified in this report are of different types and originate from different sources. Common for all risks are that they require a proactive strategy to be properly managed. This is explicitly described in e.g. the WHO Water Safety Plans (WHO, 2004) and the awareness of risks and risk management in the drinking water sector is currently increasing. To develop adaptive strategies for safe future water supply risk management will play an important role. Major challenges will be how to perform reliable and useful assessments, how to communicate the risks and how to value the risks in order to provide prioritization of risk reduction options that utilizes existing available resources in an efficient and sustainable manner.

5 References

Berg, C. (2006). Stockholm Vatten, Personal communication, 2006-05-10.

Bergstedt, O. (2006). Göteborg Water and Wastewater Works, Personal communication, 2006-05-10.

Beuken, R., S. Sturm, J. Kiefer, M. Bondelind, J. Åström, A. Lindhe, I. Machenbach, E. Melin, T. Thorsen, B. Eikebrokk, C. Niewersch, D. Kirchner, F. Kozisek, D. Weyessa Gari, and C. Swartz (2007). Identification and description of hazards for water supply systems – A catalogue of today's hazards and possible future hazards, TECHNEAU.

Dufour, A., M. Snozzi, W. Koster, J. Bartram, E. Ronchi, and L. Fewtrell (Eds.) (2003). Assessing microbial safety of drinking water: improving approaches and methods, IWA Publishing, London.

EEA (1999). Environment in the European Union at the turn of the century. State of Environment report No 1/1999, Chapter 3.1, European Environment Agency (EEA). ISBN: 92-9157-202-0.

Europa (2003). Kyoto Protocol on climate change. SCADPlus database, http://europa.eu.int/scadplus/leg/en/lvb/l28060.htm, 2003-05-10.

Freeze, R.A. (2000). The Environmental Pendulum- A Quest for the Truth About Toxic Chemicals, Human Health, and Environmental Protection. University of California Press, pp. 323.

Gigerenzer, G. (2006). Out of the Frying Pan into the Fire: Behavioral Reactions to Terrorist Attacks, Risk Analysis, 26, 347-351.

Gleick, P. H. (2006). Water Conflict Chronology, available at: http://www.worldwater.org/conflictchronology.html, 2006-05-08.

ICRC (2006). Protocol Additional to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts (Protocol I), 8 June 1977. The International Committee of the Red Cross - the ICRC, http://www.icrc.org/eng.

IPCC (2001a). Climate Change 2001. The Scientific Basis. Summary for Policy Makers. A report of Working Group I of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

IPCC (2001b). Climate Change 2001. Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Mc Carthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J., and White, K. S. (Eds.). Cambridge University Press, Cambridge.

IPCC (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel of Climate Change. Summary for Policymakers. IPCC. Geneva.

Lindberg, T., and Lindqvist, R. (2005). Risk profile – Drinking Water and Microbial Risks (In Swedish). Report 28-2005. Swedish Food and Health Administration.

Linville, T. J., and K. A. Thompson (2006). Protecting the Security of our Nation´s Water Systems: Challenges and Successes, Journal / American Water Works Association, 98, 234-241.

Mays, L. W. (2004). Water Supply System Security, McGraw-Hill, New York.

Morris, B. L., A. R. L. Lawrence, P. J. C. Chilton, B. Adams, R. C. Calow and B. A. Klinck, (2003). Groundwater and its Susceptibility to Degradation: A Global Assessment of the Problem and Options for Management. Early Warning and Assessment Report Series, RS. 03-3. United Nations Environment Programme, Nairobi, Kenya.

National Institute of Medicine (NIM) (1998). Recommendations for Changes in the Organization of Federal Food Safety Responsibilities, 1949-1997. National Academy Press, Washington, DC.

NHMRC/NRMMC (National Health and Medical Research Council/Natural Resource Management Ministerial Council) (2004). Australian Drinking Water Guidelines.

Ostfeld, A., and E. Salomons (2005). Securing Water Distribution Systems Using Online Contamination Monitoring, Journal of Water Resources Planning and Management, 131, 402-405.

Pollard, S. J. T., et al. (2004). Risk Analysis and Management in the Water Utility Sector: A Review Of Drivers, Tools And Techniques. Process Safety and Environmental Protection, 82, 453-462.

Smith, A. (2005). Capital Maintenance: A Good Practice Guide. Leading Edge Asset Decisions Assessment (LEADA). Water Asset Management International 1. 1 - March 2005, No. 16.

SRSA (Swedish Rescue Services Agency) (2003). Handbook for Risk Analysis. (In Swedish). Karlstad, Sweden.

TECHNEAU (2005). Technology Enabled Universal Access to Safe Water (TECHNEAU). Annex I: Description of work. Proposal/Contract no.: 018320-02. EU Sixth Framework programme.

UNEP (2003). Desk Study on the Environment in Iraq. United Nations Environment Programme, ISBN 92-1-158628-3, http://www.unep.org/pdf/iraq_ds_lowres.pdf.

WHO (2004). Guidelines for Drinking-water Quality. Third Edition. Volume 1 Recommendations. World Health Organization, Geneva, Switzerland.