ADAPTIVE STRATEGIES

INTEGRATED APPROACH AND FLEXIBILITY UNDER RECOGNITION OF LOCAL CONDITIONS

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Summary

This report deals with adaptive strategies to cope with future challenges in the water sector. In a previous phase of Techneau Workarea 1, trends relevant for drinking water have been collected for different representative regions. Based on this inventory, a list of main trends has been made, including climate change, urbanisation, emerging pollutants, energy costs, ageing infrastructure, bottled water use and community involvement. An additional challenge is imposed by the Millennium Development Goals (MDG's).
The impacts of the main trends were investigated as well as the actions required to cope with these impacts. It was concluded that the required actions are strongly dependent on the local setting, but also more general guiding principles could be defined. These guiding principles are integration and flexibility. In this report, the guiding principles are specified and exemplified.

Contents

1 Introduction

Work area 1 of the Techneau project, titled "rethink the system" is aiming to provide a future perspective of the drinking water sector. As a first step, performed in work package 1.1, current trends were identified which are relevant for drinking water in different representative regions. Based on this inventory, a list of main trends has been made, including climate change, urbanisation, emerging pollutants, energy costs, ageing infrastructure, bottled water use and community involvement. An additional challenge is imposed by the Millennium Development Goals (MDG's).

The present report aims to provide conclusions and guiding principles from these trends on a more general basis. This is done by identifying impacts of the main trends, challenges and finally, deriving adaptive strategies. These adaptive strategies serve as guiding principles for water utilities and authorities to deal with drinking water related decisions now and in future.

2 Global trends affecting the water cycle

Before the present report was compiled, data were gathered on current and future trends in different regions represented in the Techneau project (2-12) and on basis of these reports, the following main trends were identified (1):

- Climate change
- Urbanisation
- Globalisation
- Emerging pollutants
- Increasing energy demand and costs
- Ageing infrastructure
- Community involvement & consumer intelligence
- Emerging technologies
- Increase bottled water use
- The efficiency driven water sector

In addition, a major challenge exists in reaching the Millennium Development Goals (MDG): to halve the proportion of the population without access to safe drinking water. This can not so much be regarded as a trend, but is a major aspect which has to be recognized in developing strategies for the future decades in the developing as well as in the industrialized countries.

Some of the trends can be considered to be a threat for the drinking water sector and an anticipation is required (e.g. micropollutants). Other trends can be considered to be an opportunity (e.g. emerging technologies). Consumer involvement can be regarded as a threat as well as an opportunity; for example, increased transparency improves ownership and on the other hand, too large openness may serve to erode consumer trust. In the table below, the trends are classified accordingly:

Threat; Action required	**Opportunity**
Climate change	Globalisation
Urbanisation	Emerging technologies
Emerging pollutants	Efficiency driven water sector
Energy costs	
Ageing infrastructure	
Increased bottled water use	
Community involvement & consumer intelligence	

Trends which are an opportunity can help in providing solutions for the future (see also chapter 4). Adaptive strategies should be developed for trends where an action is required. These trends have been described in a previous report (1). Their main impacts are summarized below. A summary of the trends is described in the appendix.

2.1 Climate change

Climate change impacts:

- More frequent droughts and/or floods
- Water availability reduction
- Water quality deterioration
- Increased demand for water

2.2 Urbanisation

Impacts and consequences of urbanisation

- Distribution systems do not match demand
- Urban water resources are depleted
- Shanty towns in developing and transition countries without appropriate water infrastructure
- Increased sealed surfaces, less soil infiltration

2.3 Emerging pollutants

Impacts & challenges related to the presence of micropollutants

- Disturbance of water resources and ecosystems
- High degree of uncertainty (about environmental concentrations, about effects and risks)
- Demand for ecological human toxicity assessment
- Adoption of regulatory framework (limit value)
- Development of new and refined analytical tools and monitoring methods
- Reduced acceptance of drinking water

2.4 Increasing energy demands and costs

Impacts and consequences of increased energy demand

- Higher energy prices
- Increased operational cost
- Increase of water prices
- Intensified search for alternative and renewable energy sources

2.5 Ageing infrastructure

Impacts and consequences of ageing infrastructure

- Especially severe in regions with unstable economy
- Leakages in distribution system:

water losses

intrusion (water quality compromised)

- Corrosion affects water quality
- Crusting results in increased energy demand for distribution
- Problems aggravated in areas of depopulation (overcapacity)

2.6 Increased bottled water use

Impacts and consequences of increased bottled water use:

- Influence on tap water consumption is relatively low (max. 10%)
- Bottled water can be up to 1000 times more expensive than tap water; Increase in bottled water consumption can indicate that perceived quality or taste is more important for the consumer than price
- In some cases, water quality or reliability is the main argument for buying bottled water. In this case, bottled water consumption can be considered as an indicator for public perception of water quality.

2.7 Community involvement & consumer intelligence

Consumer intelligence can be considered to be an opportunity in order to build better consumer relations, and on the other hand it can be considered a challenge for water authorities because consumers tend to get more demanding and critical. Both aspects are considered in the overview below.

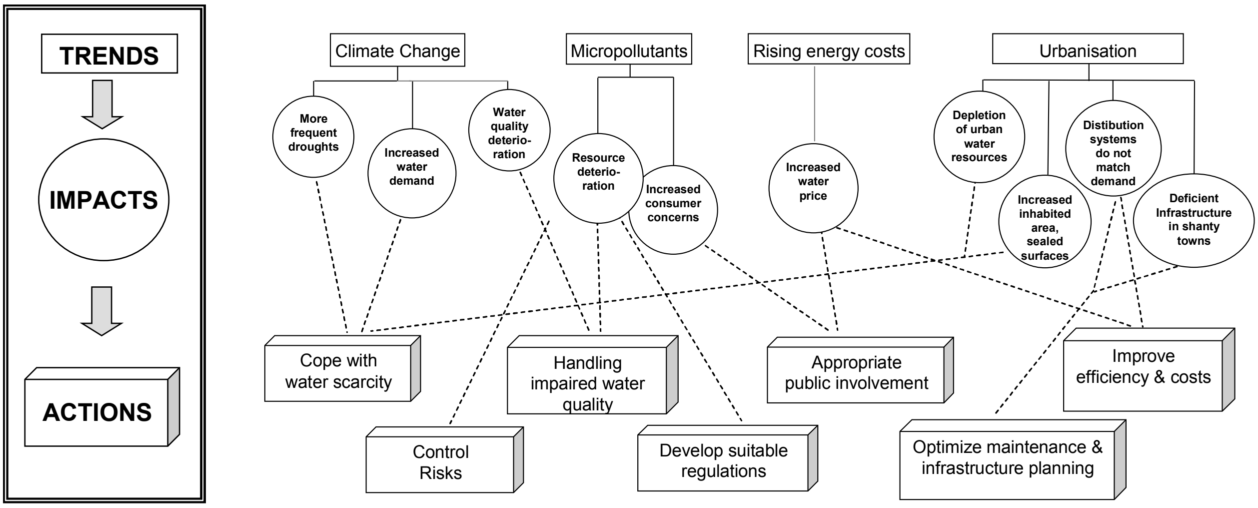
In general, consumers are becoming more demanding as regards service levels. This also applies for the drinking water sector
There is a growing need to for transparency; building mutual trust is vital
Greater openness and transparency is a double-edged sword:
It increases ownership and thus increases trust and acceptance of decisions
Too great openness may serve to erode consumer trust (e.g. revealing scientific uncertainty regarding possible health impacts of emerging pollutants)

2.8 Globalisation; Emerging Technologies; Efficiency driven water sector

In contrary to the trends discussed above, globalisation, emerging technologies and the efficiency driven water sector are not considered threats, but mainly opportunities: Globalisation enables improved exchange of knowledge and dissemination of new technologies. This is an opportunity to cope with trends and challenges as described above.
Also Emerging Technologies can provide answers to the challenges faced in future: It can lead to reduction in energy consumption, abatement of micropollutants and provide more efficient infrastructure solutions. For example, low-fouling nanostructured pipe materials for distribution systems could provide longer life times and lower maintenance requirement. Another example is water treatment by flocculation + UF to replace complex conventional treatment trains.

2.9 Trends – Impacts – Challenges

The main trends, their impacts and challenges as discussed in Section 2.1 - 2.8 have been summarized in Figure 1.



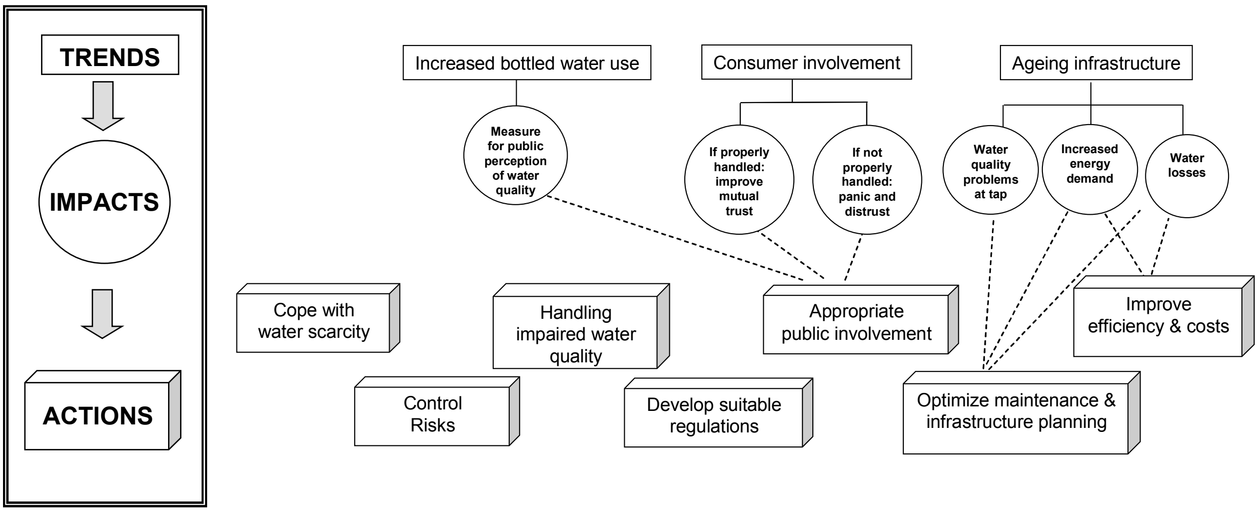


Figure 1: Main trends, their impacts and required actions.

Based on combined set of actions, general guiding principles were derived, as discussed in the following chapter.

3 Guiding principles for adaptive strategies

As demonstrated in Chapter 2, certain trends have very specific (local) impacts. Furthermore, boundary conditions may differ strongly depending on the location (e.g. financing, social conditions). This leads to the conclusions that no "silver bullet" solutions exist which are valid for all situations but that solutions must be optimized according to the local situation.
However, also some common principles can be derived from the set of actions. These common principles include Integration and Flexibility. thus, it can be concluded that appropriate long-term strategic planning is characterised by "Integration and Flexibility und consideration of local conditions". These guiding principles are exemplified below:

The *Integrated approach* refers to the following aspects:
- Integration of the whole water cycle
- Integration of all stakeholders, including NGOs and the consumers
- Integrated approach of water and energy
- Integration of all water users: Households, Industry and Agriculture

Flexibility will be required with regard to:
- Water resources
- Treatment technologies
- Financial and management structures
- Capacity (e.g. by combining centralized and decentralized treatment)

Local conditions
- Preference for avoidance or remediation (adaptation vs mitigation)
- Focus on demand or supply management
- Pressure on water resources (use related)
- Topographical conditions (possibility for reservoirs, carstic underground)
- Natural background concentration of certain substances in raw water

Drawing up adaptive strategies will have to take into account that challenges occur at different levels of the water (supply) sector and therefore have to be equally diverse in their responses. We suggest distinguishing between the following levels of investigation
- Technology and operation
- Organization, operation, management and finance
- Policy, economic measures and legislation

Generally speaking, on these levels interventions can be made for different purposes:
Adaptation: change behaviour to fit to new circumstances
Mitigation: counteract the trend by lessening its driving forces
Resistance: protect conventional practices and technologies

The concepts of Integrated Approach and Flexibility will be discussed in more detail below:

3.1 Integrated Approach

An integrated approach is required to come to the optimum solutions especially as there is an increasing interaction between the different water functions and water compartments.
The need for integrated approach is illustrated by several examples (more examples are found in Chapter 4).
The first example concerns water stress. Water stress is expected to increase due to:

- climate change
- urbanization
- population growth (especially in Sub-Saharan Africa and Asia)

Solutions towards water stress include sea water desalination, water recycling and regulation of use. The latter can be based on pricing systems (e.g. progressive tariffs), regulations on industrial and agricultural activities, regulation of domestic use (e.g. water hose bans), etc. The range of solutions is broad and the implications are difficult to oversee. In order to come to optimum solutions for each specific case, the problem must be assessed in an integral way, including resources, energy aspects, ecosystems and also financial aspects.
Another aspect of integration concerns water and energy. It requires energy to produce drinking water, but it also requires water to produce energy. For the production of bio-based energy resources (e.g. bio-ethanol) huge water amounts are required. For nuclear and fossil fuel fired power plants, large amounts of cooling water are required, which results in a substantial temperature increase of receiving waters, which can result in water quality problems and in impairment of ecological parameters. On the other hand, also drinking water production and distribution requires energy. Due to water scarcity, sea water is increasingly being used for drinking water production in coastal regions, and sea water desalination is demanding relatively high amounts of energy compared to conventional drinking water treatment.

3.2 Flexibility

Flexibility is required because the extent and effect of many of the trends in the water sector are uncertain. For example, climate change is a fact, but the effect on local precipitation patterns remains unclear and still is not satisfactorily predictable. Thus, in many countries (e.g. The Netherlands) future water systems should be able to deal with periods of high and low water availability, and moreover with large changes in the water quality associated with these events.

Another example concerns water quality aspects. On one side, the effects of improved waste water treatment result in improved surface water quality, especially concerning the macropollutants. On the other hand, an increased number of chemicals is in use and non-biodegradable micropollutants accumulate in the environment. Also, climate change can result in unexpected changes in water quality (e.g. NOM content, algal toxins..). The net effect on pollutant concentration is difficult to predict, and therefore, it is important that treatment technologies are being installed with a relatively high degree of flexibility (e.g. adjustable dosing of oxidants).

Financial / organizational flexibility is required to enable optimized structures depending on local and temporal developments which are currently unsure: For example, a general depopulation of rural areas is observed. If this trend proceeds in the next decades, the financial and technical sustainability of rural drinking water systems is endangered and suitable solutions should be become available. Examples of such solutions include decentralized treatment and distribution systems, or financing models integrating costs from rural and urbanized areas.

More examples on flexibility can be found in Chapter 4.

3.3 Local Conditions

Some trends, e.g. urbanization, are by definition local. Other trends may occur on a global scale, but their impact locally is variable. For example for the global trend of climate change, some regions are facing increasing precipitation while other regions receive decreasing amounts.

The most severe problems are imposed by the strong population growth in developing countries. If this coincides with deficient infrastructure and poor economic conditions, the challenges to provide sustainable solutions are tremendous.

Considering the huge diversity of local conditions, it will not be possible to discuss all potential adaptive strategies in the framework of this report, but some approaches and examples in regard of the focus areas of the TECHNEAU project will be discussed below.

4 Adaptive strategies to cope with challenges affecting the water sector

4.1 Coping with reduced water availability

Driving forces:
Climate change impacts
Increased demand due to population or economic growth
More stringent abstraction restrictions

Having regard to the expected impact of climate change the water sector needs to be prepared to cope with conditions of flood as well as with water scarcity and drought. Although the extent of the repercussion of this trend on the water sector are currently still difficult to predict, mere crisis intervention is no longer appropriate – risk management is on the forefront of the adaptive strategies. **Variability** in quantity and quality will become a more prominent issue. To realise such a climate proof water supply requires a high degree of flexibility and integration.

4.1.1 Matching demand and supply

In light of expected climate change effects, many areas are expected to suffer from limited water availability at least temporarily. Better matching demand to supply will therefore be an essential task for the water sector. The set of measures can comprise different tools, representing different degrees of integration and planning horizon.

Short-term and emergency measures

- water supply interruption (to different users – households, farmers, industry)
- water use restrictions (to interdict particular uses - car washing, hose piping, etc.)

Those interventions cannot be regarded as sustainable solutions. Consequently, more advanced methods to approach water scarcity and drought management will have to include incentives for a more rationale use of water:

- Raise awareness and concern of the public for the problem (water saving campaigns and plans – examples from Spain, Cyprus, France). Those measures require a more intense involvement of policy decision and should be combined with economic incentives and differentiated water pricing systems, such as differential metering coupled with progressive pricing

4.1.2 *Reduce network losses*

Measures to reduce networks losses are important, not only to increase the efficiency of resource utilisation, but also in order to improve the economics of treatment plants which have to deal with higher capacities in case of losses (see section 3.x) In the first place, appropriate maintenance and monitoring of potential leaks in the distribution system should be in place to prevent and detect leakages. Furthermore, approaches to better manage the network increasingly rely on interactive tools involving the customer, who can report detected leakage, observed by increased metered used volumes (13).

4.1.3 *Developing new and alternative resources*

Diversification of water resources utilisation

In combination with water demand management measures, increased **flexibility** with respect to exploitable resources can contribute to overcome water shortages.

Relevant alternative resources are rainwater, greywater, wastewater, brackish water and seawater. To which option priority is given is highly dependent on regional and **local circumstances,** such as the availability of these non-conventional resources in a region.

4.1.3.1 *Rainwater harvesting and management*

In regions with low precipitation, the potential for rainwater harvesting is naturally low. Nonetheless it is beneficial to capture this resource during rainy seasons, infiltrate it and store it in aquifers for periods of water shortage. Depending of the amount of rainfall per event either decentralised solutions – at the users site – or more centralised approaches that capture and store rainwater (to prevent damage and surface water pollution)

Figure Different urban water focus with regard to rainwater (from Norton et al., 2007)

	low average rainfall	high
rainfalllpeak high	II. Capture & Storage	III. Flood Control
low	I. Water reuse	IV. Stormwater Management

Infiltration of rainwater - instead of draining it to the next surface water (via a wastewater treatment plant or not) more and more constitutes an element in integrated water management.
Also the direct use of rainwater is increasingly popular among the population. For Flanders the use of rainwater by households has increased by 34% since 1995 (MIRA-T 2005). Innovative water management concepts for new settlement regularly include rain water in their programme of measures.

4.1.3.2 Water reclamation and reuse

Water reclamation and reuse is becoming an ever more established practice in water stressed regions and during periods of droughts. It helps to conserve water resources for priority use such as drinking water production or to maintain environmental flows.

- Provision of reclaimed water to large users (farmers, industry) to reduce groundwater abstraction for irrigation purposes and process water.
- Mandatory reuse rates for high rise buildings in densely built-up areas (e.g. Tokyo; London -planned)

In rare cases reclaimed water is also use to augment drinking water so called indirect potable reuse.

4.1.3.3 Desalination

Coastal regions may consider seawater desalination to augment their water supply. The technology of e.g. reverse osmosis is also suitable to restore deteriorated groundwater resources and to utilise brackish waters.

4.1.3.4 Managing different resources

- a grid distribution system enabling to connect different resources to end users in different regions
- For improved management of water resources, GIS, sensors and advanced weather forecasts could be used
- Increase of fresh water storage capacity: e.g. aquifer storage, reservoirs to absorb captured rainwater or reclaimed effluents

Overview of different elements of adaptive strategies to cope with water quantity issues

	Technological	Organizational	Economic	Legal	Political
Flexibility					
Alternative raw water sources	x				
Modular treatment processes	x	x			

(capacity, level of treatment)					
Integration					
IWRM					
water saving campaigns					
Raw water sources protection		x			x
Local conditions					
Water use restrictions				x	x
Drought management plans		x			x

4.2 Coping with deteriorated / poor / insufficient water quality

Driving forces:
Climate change impacts
Increased demand
population growth

Resource **water quality** is supposed to deteriorate under climate change impacts. Surface water resources may suffer from reduced run-off and low flow conditions which may lead to increased pollutant concentrations, as wastewater discharges become less diluted.

Adaptive strategies will take into account

- the reason for deteriorated quality (source of pollution: diffuse or point source, rise of sea level, reduced flow, increased run-off)
- the type of quality impairment (salinisation, TSS, NOM, micro-pollutants, inorganic contamination, algal blooms)
- the vulnerability of the used water source (present state, protective status)

Possible adaptive strategies to deal with these problems include:

- Flexibility in wastewater treatment: application of advanced treatment methods in periods of drought (e.g. effluent oxidation, wetlands, SAT). Flexibility is also required for temperature induced changing algal populations resulting in the occurrence of "new" algal toxins.
- Ban on combined sewer overflows (CSO's) of rainfall events directly after periods of drought or during peak flush events. Use of constructed wetlands can be a low cost option to collect, buffer and treat CSO (Flanders)
- Flexibility in resources to cope with highly polluted sources during storm events or during periods of drought (see above)

Also climate change related **temperature increase** affects the water situation in several ways:

- Water temperature increase in the network: Long-term adaptive strategies include lowering the level of distribution systems in the subsoil. For existing systems however this is not an economically viable option and other measures come into place. For example, in order to cope with bacterial growth, bacterial control methods of the distributed water should be adapted (e.g. disinfection, biological stabilization of water, etc.).
- Water quality changes are caused by increasing humic release (e.g. Scandinavia), thawing permafrost, and increase of landslide events. This will need adaptation of drinking water treatment plants (e.g. flocculation / coagulation, membrane technology).

On a higher level of integration, it can be concluded that an integrated approach is essential, including safeguarding resources, distribution system, waste water, consumer, industrial water.
Furthermore, considering the fact that water resources are not limited by borders, international / intergovernmental collaboration is needed (e.g. on river basin management).

4.3 Addressing the issue of micropollutants

A particular aspect of water quality is the presence of micropollutants in raw water sources and their save removal during water treatment processes.
The unknown effects of micropollutants are also considered the main barrier to the introduction of direct water recycling. Mitigation of discharges and appropriate treatment concepts are the most promising strategies to reduce risks caused by micropollutants.

4.3.1 Substitutes for toxic materials or chemicals

Legislation is enforcing the substitution, phasing out and reduced discharge of a number of hazardous substances. If no substitutes are available treatment of point-sources is to be preferred to end-of-pipe solutions.
In the case of diffuse pollution (e.g. agriculture, traffic), emission pathways should be evaluated and measures should be found to minimize these emissions.
The financial interests of industry producing and consuming chemicals can counteract such measures, especially in countries with unstable or manipulable political systems. On the other hand, industry can contribute to finding sustainable solutions, for example by "Product Stewardship" as adapted by the CEFIC (European Chemical Industry Council).

4.3.2 Multi-barrier concept

The detection of pollutants in all aquatic compartments and even drinking water forces reactions of water supply. Scandals of environmental pollution reveal that conventional treatment technology is often not sufficient. Membranes, ozonation, UV light and activated carbon and combination of those are options to achieve disinfection, degradation and adsorption of a wide range of contaminants.

The selection of a treatment train should aim at better balancing the risks and benefits of established or proposed new water treatment technologies with regard to energy intensity, residue management, formation of degradation by-products and alike .

4.3.3 Definition of threshold values

In view of the range and variety of chemical substances produced and in use, and taking into account the improved analytical capacities, the number of "newly" detected compounds in water resources will increase.

Policy will have to define admissible or tolerable threshold values for these substances - and mainly act according to the **precautionary principle**. On the long run, a more sound **risk assessment** will be needed to avoid undue costs related to advanced treatment.

4.3.4 Catchment monitoring and integration of water cycle

From the discussion above, it can be concluded that an **integrated approach** is essential to provide solutions for problems associated with micropollutants. This includes a more holistic approach to manage the water cycle as a whole and not only to focus on drinking water treatment.

Consequently, solutions should comprise:

- identification of relevant sources
- control of these sources (hospitals, industry, household, animal husbandry)
- practice of waste disposal of pharmaceutical (compliance)
- waste water management /treatment, (urine separation)
- regulations to favour alternative products and industrial responsibilities (product stewardship) are important elements in finding sustainable solutions.

4.3.5 Communicating with the public – involving consumers and stakeholders

An important aspect of the presence of micropollutants in water is the way the water sector addresses the topic. Unbiased information about the risk associated to measured concentrations of substances is desirable and should be made available.

A clear communication of the strategies followed to reduce and eliminate compounds may be helpful, too.

Overview of different elements of adaptive strategies to cope with water quality issues – especially micro-pollutants

	Technological	Organizational	Economic	Legal	Political
Flexibility					
Treatment technology upgrade	x				
Integration					
Catchment monitoring	x				x
Local conditions					
Emission register					x
Natural background concentrations					

4.4 Bearing the costs - The efficiency driven water sector

4.4.1 Energy cost

High level energy prices will impact on operational cost at all levels of water supply: abstraction, treatment and distribution. Pumping of groundwater, conveying surface water as well as distributing drinking water will become more expensive.

Driving forces:
Increasing energy prices due to world-wide soaring demand for fossil fuels
Application of more advanced treatment processes (more steps, more engineered

The energy actually required for water services highly depends on

- local topography
- need for elevation / lifting
- volumes transported
- type of treatment train

The cost of treatment will also rise, especially when energy intensive processes such as reverse osmosis, other membrane processes or ozonation are applied.

4.4.1.1 Optimised distribution networks

By preventing leakages during water distribution for example, pressure losses are prevented and because less water has to be treated also the energy consumption of the water treatment is diminished. Self cleaning pipes can prevent clogging of distribution system and thus reduce energy costs for distribution.

4.4.1.2 Energy efficient treatment processes

Energy saving is particularly important for processes such as sea water desalination which are known to consume relatively large quantities of energy. Initiatives exist to combine solar or wind energy with treatment process such as evaporation and reverse osmosis. By process optimization, the energy consumption also can be strongly decreased. By a large range of technical measures for example the energy consumption of conventional reverse osmosis has decreased from about 10 to approx. 2 kWh/m^3. Also innovative processes are being developed to decrease the energy consumption of sea water desalination. The most important of these include forward osmosis and membrane distillation ("MEMSTILL"). Both processes are still in the stage of development, but in a final form are claimed to have an energy consumption rate well below 1 kWh/m^3.

The search for least energy consuming **technologies** and **operational modes** will be intensified. To avoid high impacts of price increases, favourable prices for use of electricity during off-peak hours have to be negotiated with the energy supplier.

There is also a link with energy consumption and **developing / transition countries**. Especially in Asia, a large growth in the population is associated with a growth of the economy leading to a multiplication of the energy consumption. As discussed elsewhere, the water supply is deficient in many regions within Asia, and the required innovations should ideally be implemented using the most energy efficient solutions. Especially in these cases, the combination of solar / wind energy with drinking water systems are especially attractive from the viewpoint of environmental and economical sustainability.

Finally, it is important to note that **energy, climate change and water** are interlinked. For example, the melting glaciers result in larger flow variation of rivers, impacting on available water resources for generation of hydropower and drinking water. Rising sea levels result in salinisation of aquifers that then require energy-intensive desalination processes for treatment of ground water.
Water and energy are closely related: Energy is needed to produce drinking water, but conversely, water is also needed to produce energy. Even the production of alternative, "green" energy sources like bio-fuels, is associated with huge water consumption for irrigating crops.

However, possibilities exist to **integrate water and energy** in a profitable manner. e.g.:

- Use of water reservoirs and aquifers for cooling / heating
- Integrate hydropower and drinking water production, e.g. direct use of hydropower for water treatment processes

Also, examples are known of tidal energy being used for drinking water production (desalination processes) and of the generation of "blue energy" from mixing sea water and river water by the process of reverse electrodialysis (RED). Finally, in case of suitable geography, hydrostatic pressure can be used to drive drinking water treatment processes (e.g. membrane filtration processes).

4.4.2 Investment needs

Rehabilitation and maintenance of distribution networks as well as upgrade of treatment technology often requires considerable invest which public water supplier may not afford. This is particularly true for transition countries and the new member states of the European Union

4.4.2.1 Raising capital – public private partnership

The decision for involvement of private sector investment is mostly driven by financial considerations. The lack of public funding capacity to finance necessary investment in infrastructure and technology is often decisive for private party participation. The BOOT (build, own, operate, transfer) constellation is a common model. In this way also know-how regarding operation and technological aspect, often not available on a municipal level, can be tapped.

Overview of different elements of adaptive strategies to cope with rising energy demand and cost implications

	Technological	Organizational	Economic	Legal	Political
Flexibility					
Modular treatment processes (flexible capacities, level of treatment)	x	x			
Energy intensive processes (pumping to fill reservoirs) in off peak hours		x	x		
Integration					
Local conditions					

4.5 Consumer involvement

In general, consumers are not very well informed about their drinking water, especially concerning water resources, treatment technologies and organisation. However, as consumers get better educated and more demanding as time goes on this situation will call for more sophisticated communication strategies and new ways of involving consumers.
With regard to consumer involvement different dimensions have to be considered:

a) Either individual citizens or consumer organisations can be involved: Consumer organisation involvement is less direct, but can be advantageous because individual consumers might not have enough background understanding of the supply system to provide useful input and consumer organisations are capable of distributing information and feedback to a broad public.

b) With regard to the level of influence, involvement can range from non-binding discussion through to full partnership in decision taking, for example with regard to investments or organisational structures and responsibilities.

c) The goal of participation can range from generating support (marketing of ideas) through to a genuine decision-making partnership. The risk of the marketing approach is that in the long term, consumers could feel manipulated and may oppose the decisions made. More important is that the communication is aiming at building mutual confidence and trust.

Another way of improving communication with consumers is by asking for **feedback**, combined with rapid response to consumer questions or remarks. For example, Veolia has gathered positive experiences with call-centres for consumer complaints. In practice, most questions are related to water bills, which emphasises the importance of accurate accounting and transparent charging.

In general, it can be stated that **increased transparency** and improved communication promote or at least help sustain confidence and trust. It is indispensable to e.g. engage customers in water saving campaigns. However, in order to prevent negative associations, consumers should be informed steadily and communication should not only take place in the case of problems or incidents.

Furthermore, building up open and positive relationships with the media can help promote more objective and reliable reporting of supply issues in the media. This particular measure is at presently being implemented in Southern-California.

4.6 Millennium Development Goals

Global assessments by WHO and UNICEF show that a large proportion of the World's population does not have access to improved or microbiologically safe sources of water for drinking and other essential purposes: at the beginning of 2000 one-sixth (1.1 billion people) of the world's population was without access to improved water supplies. Insufficient water supply, sanitation, and hygiene contribute to 3.7% of globally quantified DALYs ("Disability Adjusted Life Years", an indicator for overall burden of disease) (WHO 2002). One of the millennium development goals (MDG nr. 7) states that by 2015, the proportion of people without sustainable access to safe drinking water and sanitation should be halved in comparison to 1990 (UN, 2006). The rapidly increasing population in Sub-Saharan countries, the enormous urbanisation ratio and the increasing number of immuno-compromised people in these regions add even more challenges in complying with these goals.

In trying to find solutions, it has appeared that the application of technologies developed in the West often do not function in developing countries because of socio/cultural or political reasons. Keys to successful implementation are involvement of local stakeholders (also local companies) and the local development of technologies. Furthermore, solutions which people can implement themselves (e.g. Point-of-Use treatment) in many cases should be preferred to centrally managed solutions, which often suffer from deterioration and poor maintenance. Thus, help from industrialized countries

should rather be focused on creating the local capacity to create solutions instead of introducing ready-to-use equipment.
Considering the major changes required to improve the situation, transition management is an important step. For example, POU treatment (Point-of-Use) could serve as a temporary solution until central systems function in a reliable manner. Also for the developing countries, solutions should not necessarily be "low-tech". Modern technology is often more efficient and more reliable and therefore actually can be more suitable. In order to decide on drinking water investments, not only cost criteria should be handled, but the whole sustainability and feasibility of solutions should be considered (technical as well as economical and political). In order to prevent a situation where only the rich part of the population profits from improved water supply, commonalities in interest between poorest and other parts of population should be created. This could lead to justification of new concepts, e.g. the concept of free water for the poor.
In developing and transition countries, the operation of centralized systems in some cases is less reliable than in the industrialized countries and the resources are often less well managed. Therefore, monitoring of water quality parameters is essential, both in water sources, in the treatment as well as in the treated water. In order to enable this, cost-effective on-line monitoring technologies for a range of water parameters should become available.
In transition countries, high economic growth rates are associated with increasing use of water for different purposes: agriculture, industry, energy, drinking etc.. In many areas, these developments lead to an increase in water shortage. As discussed before for the trend of Water Stress, flexibility and integration are needed to cope with these problems.

4.7 Privatisation/Globalisation

While drinking water services used to be publicly owned in the past, a trend towards private participation can be observed in many areas. Although it is not completely clear whether this trend will continue in the future, it is important to consider the consequences this trend may have. On the other hand, globalisation seems to be a development which cannot be stopped and will further be strengthened in future.
The opportunities of globalisation include the facilitated transfer of technology and know-how, which can lead to the implementation of most efficient water solutions and more rapid dissemination of innovations. Furthermore, worldwide operating water technology and infrastructure companies get easier access to markets and can profit from an improved synergy between similar projects on different sites. The effect of this growing market is that more and more large companies are getting active in the water market. This leads to more competition and lower prices, from which the consumers may profit, but if not managed well it could result in cartel formation and exploitation.
Another positive effect of globalisation is the improved acceptance of standards, such as those proposed by WHO, EU or EPA. Finally, the progress

in Research and Development is dependent on international collaboration and thus also is linked to globalisation.
There is a discussion about the classification of water itself as a trading good. Life-cycle assessments can attribute to each possible product an amount of consumed water, the concept of "virtual water". Use of this concept can lead to water related optimization, e.g. agriculture in places of sufficient water resources instead of places with water stress.
Although it is expected that globalisation will continue in future, in principle also the countertrend in could occur. The countertrend (nationalism, regionalism) can be caused by religious polarization and even water conflicts could possibly contribute to this countertrend (e.g. Turkish dam conflict).

Adaptive strategies: As discussed above, companies can seek out synergies between projects in different locations/countries and thereby increase their efficiency as well as market volume. Research organizations particularly will profit from generating worldwide networks in order to combine expertise and attain faster progress, e.g. with respect to water treatment technologies and water quality parameters.
In case of privatization full coverage of the service area can be a critical aspect. The more densely populated areas tend to be more profitable than rural areas and examples exist where only the urban areas are under contract of privatization (e.g. Bucharest). In principle, it is the responsibility of the regulator to prevent this situation, e.g. by creating cross-financing constructions.
In order to optimize water usage, a water label could be introduced for all products, either managed by the authority or by NGO (comparable to fair trade labels). Water labels can be based on LCA-like evaluations (Life Cycle Assessment) and can possibly be combined with other environmental or ethical labels.
In order to optimize the water usage on a national level or on the level of a catchment, water charges could be introduced for all water deductions (not only water from tap but also surface or groundwater).

4.8 Risks-oriented society

In general a trend of risk-oriented society can be observed: people want to have "full" control over the risks they are facing.
With respect to drinking water systems (and other utilities as well) the society has in fact delegated responsibilities to the service providers. People want 100% secure and sure services all the time, although theoretically and practically risks never can be excluded completely. Drinking water production and distribution is a highly vulnerable system, which makes it a potential target for terrorist activity and organised crime.
However, in order to provide the maximum possible security, a number of measures can be considered. In Work-area 4, the framework of risk assessment and measures are discussed in a more detailed way and in relation to Water Safety Plans. In this chapter, risks and measures are

discussed on a more general level and with a longer time perspective (20-50 years).
In the long term, it can be expected that **on-line analytical techniques** and on-line sensors can become available for the most important water quality parameters. Especially on-line sensors offer the possibility to control water quality on several points in the treatment system and within the distribution network (e.g. UV based sensor technology).
With respect to source water related health risks, the precautionary principle is often applied. In order to provide protection against as yet unknown factors, the multi-barrier approach is already applied broadly and for the future this should be continued or even expanded. In general, the multi-barrier approach requires high levels of investment which influence the costs and prices. In order to come to acceptable costs in the future, processes should be applied with relatively low variable costs (especially energy consumption), as discussed before.
With respect to on-line (and fast) analytics, a special challenge exists to find more advanced toxicological tests to assess the risks of unknown chemicals, mixtures of chemicals and chronic effects of the exposure of low levels (e.g. micropollutants). Epidemiological studies to assess risks are often complex and need refinement in order to establish more evident relations between water quality and human health.
Also climate change can be a considered as a risk, because the extent and effects of climate change are still largely unknown. As discussed under the chapter of Climate Change, a large flexibility is required in order to cope with future challenges of climate change.
As identified before, there is a discrepancy between the public perception of risk (expecting 100% security of supply) and the reality. In fact, 100% security can never be provided and the costs will increase exponentially if the security has to be increased. In order to prevent false expectations, it is important that water utilities communicate with their consumers about this issue. The Internet is one important medium for this because information can be presented on many different levels, and people can access the level of information they wish. Basically, the consumers should be able to have influence on, or even determine, the level of safety and security of the water service, as this is directly related to the price of the water and willingness to pay is ultimately determined by consumers and voters.

4.9 Population growth and urbanisation

A global trend towards urbanisation can be observed, mainly due to the fact that economic centres of gravity are more and more situated in urban areas and because agricultural activities are getting less labour-intensive. In many cases urbanisation is associated with a depopulation of the rural areas.
In dry areas, urbanisation leads to increased water shortages. In areas with high rainfall, the increase of impervious surface associated with urbanisation leads to increased flood incidents, sewer system failures and increased contamination by building and construction materials (e.g. heavy metals).

In the EU project SWITCH the specific problems and solutions of urban developments are dealt with. Therefore, adaptive strategies will be developed in collaboration with the SWITCH project.

Urbanisation / population growth

increased demand
increased population density
possibly seasonal peaks
increased inhabited area, sealed surfaces

5 References

1. "Global Trends affecting the Water Cycle" A. Segrave, W. Pronk, T. Ramaker, S. Zuleeg, Techneau Report, D 1.1.7 (September 2007)

2. "Reports on Trends in South Africa / Sub Saharan Africa", C.D. Swartz, G. Offringa, Techneau Report, D. 1.1.1 (November 2006)

3. "Report on Trends in Water Stressed Regions" R. Hochstrat, Techneau Report, D. 1.1.2 (November 2006)

4. "Report on Trends in Eastern European Countries - Example of the Baltic States", T. Juhna, Techneau Report, D. 1.1.3, (November 2006)

5. "Report on Trends in Southern European Countries (case of Portugal)" H. Alegre, Techneau Report, D. 1.1.4 (November 2006)

6. "Report on trends in Central Europe (Germany / Switzerland)" S. Zuleeg, Techneau Report, D 1.1.5b (November 2006)

7. "Spain, a Techneau Case Study - phase I; Climate Change" GJ. Zwolsman, W. van Ellen, Techneau Report, D 1.1.6a (March 2007),

8. "Spain, a Techneau Case Study - phase II; Climate Change" GJ. Zwolsman, W. van Ellen, Techneau Report, D 1.1.6b (March 2007)

9. "Long Term Effects of Climate Change on Europe's Water Resources - Case Study Romania" A. Domnisoru, Techneau Report, D 1.1.6c (March 2007)

10. "Organisation and Financing Models of the Drinking Water Sector - Review of Available Information on Trends and Changes" Y. Moreau-Le Golvan, P. Bréant, Techneau Report, D 1.1.11 (April 2007)

11. "Report on Consumer Trends - Cross-cutting Issues across Europe" T. Kelay, J. Chenoweth, C. Fife-Shaw, Techneau Report, D 1.1.12 (December 2006)

12. "Report on Trends in The Netherlands" A.J. Segrave, Techneau Report, D 1.1.14 (November 2006)

13. Lyonnaise des Eaux, Presentation on ASTEE Conference, June 2007