Existing Foresight Studies:

A LITERATURE REVIEW

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Colofon

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Existing Foresight Studies: a literature review

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Executive Summary

Introduction

Workarea 1 of TECHNEAU is focusing on trends, impacts for the water sector and adaptive strategies to cope with these challenges. In this report, major existing foresight studies are summarised and discussed.

Importance

The foresight studies summarized in this report serve as a basis of comparison with the adaptive strategies developed in TECHNEAU and as supplementary information for the case studies in which adaptive strategies will be tested (work package 1.3).

Approach

The following existing foresight studies were summarized and discussed:

- AwwaRF, Update of Strategic Assessment of the Future of Water Utilities: Trend Paper (2005)
- Future Scenarios for a Sustainable Water Sector: A Case Study from Switzerland (Lienert et al., 2005)
- Global Water Outlook to 2025 - Averting an impending crisis (IFPRI + IWMI, 2002)
- Business in the world of water: WBCSD Water Scenarios to 2025 (WBCSD, 2006)
- De Kartonnen Doos: Toekomstverkenning voor de drinkwatersector (BTO, KWR, 2003)
- Sustainable Water Management; A future view (WRc plc - June 2003)

Results

The AWWARF trend paper research identified 19 broad trend areas, which are focusing mainly on the drinking water situation in the USA. The study of Lienert et al. used different scenarios to frame long-term strategies and define priorities. These scenarios included (A) Regionalization, (B) Material Flows Management, (C) Financial Crisis. The IFPRI and IWMI study addresses the future water needs regarding food production. It was concluded that the future of water and food is highly uncertain. Some of this uncertainty is due to relatively uncontrollable factors such as weather. But other critical factors can be influenced by the choices made collectively by the world's people. These factors include income and population growth, investment in water

infrastructure, allocation of water to various uses, reform in water management, and technological changes in agriculture. Policy decisions - and the actions of billions of individuals - determine these fundamental, long-term drivers of water and food supply and demand.
In the WBCSD study, three scenarios were analysed ("H2O scenarios") which deal about the role of business in relation to the growing issue of water in the world. These scenarios do not try to cover everything, but attempt to bring to life a limited number of alternative future environments that will challenge economic viability, social legitimacy, and global fitness in the marketplace. The three scenarios are specified as H (Hydro), 2 (Rivers), and O (Ocean).
In the BTO / KWR Study "De Kartonnen Doos", 28 relevant trends were gathered and different scenarios were analysed: (1) "Living is experiencing"; (2) "Sustainable Coexistence"; (3) "Diligent Efficiency"; (4) "Solitary and Sober". There are 4 main strategies for preparing for the future: (1) Robust, (2) Flexible, (3) Broad, (4) Everything or Nothing. Based on a literature study, the 'flexible' and the 'robust' strategies was concluded to be the most useful for the water sector. The robust strategy is most applicable to a situation where the water supply companies have a monopoly position.
The WRc-plc study focused on the water situation in the UK. This study approaches the future proactively from the outset, by developing one target vision (Sustainability). For this reason much attention is paid to problems with the current situation, as well as potential threats to achieving the desired changes. Identified challenges include a.o. the collective commitment to a vision and closing the gap between research and practice.

More information

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Work area 1 of TECHNEAU is focusing on trends, impacts for the water sector and adaptive strategies to cope with these challenges. In this report, major existing foresight studies are summarised and discussed. The foresight studies summarized in this report serve as a basis of comparison with the adaptive strategies developed in TECHNEAU (work package 1.2), and as supplementary information for the case studies in which adaptive strategies will be tested (work package 1.3).

1. AwwaRF, Update of Strategic Assessment of the Future of Water Utilities: Trend Paper (2005)

Water utility future trends were identified in a reassessment of the 2000 American Water Research Foundation (AwwaRF) "Strategic Assessment of the Future of Water Utilities" project. The study consisted of five elements:

- developing and conducting interviews of managers to identify key issues and trends facing the industry today
- examining available literature / experience on future trends and scenarios
- developing the trend paper
- conducting an Expert Futures Workshop that included presentations by futurists
- synthesizing the input from the workshop into "actionable" response strategies

In a workshop with experts, a range of trends were identified and studied (see list below). Participants of the workshop identified (1) to (10) as the "top-10" major trends, and (11) to (19) as the major future trends:

1) Energy
2) Employment and workforce issues
3) Political environment
4) Population and demography
5) Regulatory trends
6) Total Water management
7) Customer expectations
8) Information technology
9) Utility finances
10) IT Security
11) Automation
12) Climate change
13) Health trends
14) Medical trends
15) Regionalization
16) Treatment technology issues
17) Economic trends

18) Private Sector participation
19) Physical security issues

A more detailed description of these trends and sub-trends can be found in the extensive AWWARF report.

Discussion

Nowadays much utility attention focuses on providing customer satisfaction.
Other actual trends of concern include water utility restructuring, private sector competition, water resource constraints, infrastructure needs, financial constraints, environmental regulations, and stakeholder relations.

Several trends seem to be gaining in importance. The rising risk profile of water utilities is more apparent now. This appears to be partly driven by increased sensitivity to physical and information technology security in the wake of the 9/11 attacks.
Total water management ranks high in importance. The strategic importance of water and environmental planning on larger scales than traditionally practiced appears to be growing. Furthermore, it is concluded that cost reduction measures increasingly require crossing broader geographic and policy boundaries (e.g., water, wastewater, growth, discharge limits, watersheds, land-use planning).

Environmental activism may also increase as the population in the U.S. increases and quality-of-life issues become more important. A "sustainability ethic" for water-poor and water-rich communities may develop in which the goal is to leave the smallest "environmental footprint" through environmentally sensitive water policies. Some of this can be seen in the expansion of NGOs as advocates for local watershed protection.

Continued tightening of drinking water regulations will drive debate about the feasibility of maintaining high-quality water from centralised sophisticated treatment plants through distribution systems. Maintaining the quality of water during distribution will be a particular challenge as U.S. infrastructure ages. Water utilities have characterised this issue as one that will have a significant effect on the water industry. It is also likely that technology developments and regulatory interest will drive online monitoring of water quality in distribution systems.

Infrastructure management will continue to be a pivotal issue for water utilities. Water infrastructure needs in the U.S. will require significant investment of capital, causing large increases in consumer costs in affected communities. Improvements in pipe-replacement technology and other asset rehabilitation and replacement techniques may reduce the degree to which rates rise to support this investment. Nonetheless, many utilities will be hard-pressed to raise sufficient capital to fund their infrastructure needs and will turn to state or federal assistance. Managing infrastructure is ultimately tied closely with the ability to raise capital. Financial constraints will require innovative financing strategies (including the use of private capital). It may well drive greater regionalisation and consolidation.

Conclusions

In the report, the following conclusions were drawn:

The strategic future of water utilities rests in the confluence of many significant trends. These trends can act in a cumulative, synergistic, or an antagonistic fashion. It seems to be reasonable to draw several inferences from the array of trends. To that end, the utility of the future will likely do three things really well:

- It will be operationally efficient. The effective water utility will do this because active consumers and political interests will demand solid financial stewardship as water rate increases mount for repair, rehabilitation, and construction of water supply infrastructure. Operational efficiency will require a motivated and engaged workforce.
- It will be engaged in the community. The effective water utility will never take its customers or shareholders or stakeholders for granted. Communication systems will be geared to creating a constant "dialogue" with the community and to ensuring that there is philosophical alignment among the community, its elected leaders, and the utility's policies and actions.
- It will use total water management principles to conduct water planning in a holistic fashion. The effective utility will integrate water management, treatment, environmental sustainability, and public policy decisions in a fashion that leverages regional opportunities and relationships and economies of scale.

3. Lienert et al., Future Scenarios for a Sustainable Water Sector: A Case Study from Switzerland (2005)

Uncertainties about the long-term prospects of urban water management systems have increased substantially over the past decade due to an increasing variety of regulations, technologies, and demand structures. In Switzerland, this uncertainty is mirrored by growing difficulties of utility managers and (waste)water scientists to agree on shared strategies: Water professionals demand support for pressing management problems, while researchers fundamentally question the longer-term sustainability of the established water management system. To re-establish shared orientation, a foresight study was conducted for the Swiss (waste)water sector in 2004. Based on interviews with 29 experts from Swiss water management and research to collect 56 drivers of change, a team of 17 experts developed three scenarios: (A) regional mergers of water utilities leading to enhanced professionalism in the sector, (B) consequent material flows management leading to a radically restructured urban water management system, and (C) generalized financial crisis leading to a breakdown of centralized utility services. These scenarios helped identifying shared research priorities. It was concluded that scenario analysis is a powerful tool for framing long-term strategies, defining priorities, and integrating different interests in the multidisciplinary contexts of sustainability science, which are marked by high uncertainties and concern a wide range of stakeholder groups.

Scenario A: Regionalization.

Starting projection is the realization of many experts that fundamental problems of the Swiss water sector can only be solved with a professional approach. Financial pressure, increasing demands on operation and maintenance, and public awareness regarding micropollutants (e.g., pharmaceuticals) call for increased efficiency.

Because Switzerland remains sceptical toward privatization of the utilities, improved performance is obtained with regional mergers of the 4000 water companies, which are reduced to 250. This enables returns of scale, technical expertise, research, and specialization. Financial efficiency measures (benchmarking, flexible pricing) are broadly introduced.
The regional water companies are controlled by cantonal authorities. They exchange know-how via the syndicates and outsource some activities to private companies.
This simplifies strategy building for the whole sector.

The centralized system is continuously optimized, risk and innovation management is improved, and the concerted development of strategic niches allows for experimentation with decentralized technologies. In the longer term (> 50 years), Switzerland will integrate European laws, and international private water companies might seriously compete with Swiss firms.

Scenario B: Material Flows Management.

Scenario B is based on environmental sustainability considerations. Starting projection is the political demand for consequent material flows management (e.g., resources recycling) and reduced emissions. Main drivers are financial pressure, the demand for efficiency, and massive tightened regulations for discharging wastewater, which is driven by new evidence on environmental effects of micropollutants. Because “zero discharge” can only partially be

obtained by upgrading the centralized system, decentralized technologies and new concepts (e.g., source control) are sought for. Innovations such as on-site treatment in households, of point sources (hospitals), and eco-design of chemicals are implemented. The Swiss water policy is redirected toward innovation, adaptation, and flexibility. Regional mergers of companies and new financial measures increase efficiency.

Some duties are assigned to private companies, such as operating decentralized units. This generates a growing market for new, intelligent household appliances, which need, however, consequent maintenance, intelligent steering technology, and new disposal logistics (note: most of these technologies do not yet exist, but need to be innovated first). Climate change was not regarded as a necessary driver, even though it would be a very strong one if it did occur. Success in niches of new concepts is possible until 2030, but a widespread replacement of our current system needs > 50 years.

Scenario C: Financial Crisis.

Starting projection is a financial crisis of the water companies. The main drivers are organizational deficiencies (as scenario A), combined with a strong political demand to tighten water pollution control (as scenario B). The crisis is caused by insufficient capital provisions, deficiencies in pricing (neglecting infrastructure costs), decreasing revenues, and limited competition. However, instead of increasing efficiency and focusing on strategic planning for whole Switzerland, singular solutions are implemented. This leads to an unfavourable distribution of risks and inefficient economic structures. In this situation, the private sector boosts innovations and decentralized solutions constitute 30 % of the water sector. While environmental impacts are reduced, water consumption and the revenues also continue to decrease. Because the infrastructure is no longer used to full capacity, expensive redimensioning is necessary and it can hardly be kept to best-technology standards. The pressure to include private capital increases. To avoid privatization or the systems' breakdown, it seems inevitable that the water sector will be reorganized in the longer-term (> 50 years), e.g., as in scenario A.

4. Global Water Outlook to 2025 - Averting an impending crisis (IFPRI + IWMI, 2002)

This study addresses the future water needs regarding food production.

The future of water and food is highly uncertain. Some of this uncertainty is due to relatively uncontrollable factors such as weather. But other critical factors can be influenced by the choices made collectively by the world's people. These factors include income and population growth, investment in water infrastructure, allocation of water to various uses, reform in water management, and technological changes in agriculture. Policy decisions - and the actions of billions of individuals - determine these fundamental, long-term drivers of water and food supply and demand.

To show the very different outcomes that policy choices produce, three alternative futures for global water and food are presented in this report, followed by an assessment of specific policy options.

Business As Usual Scenario

Current trends in water and food policy, management, and investment remain as they are. International donors and national governments, complacent about agriculture and irrigation, cut their investments in these sectors. Government and water users implement institutional and management reforms in a limited and piecemeal fashion. These conditions leave the world ill-prepared to meet major challenges to the water and food sectors.

In the water sector, the management of river basin and irrigation water will become more efficient, but slowly. Governments will continue to transfer management of irrigation systems to farmer organizations and water-user associations.

Such transfers will increase water efficiency when they are built upon existing patterns of cooperation and backed by a supportive policy and legal environment. But these conditions are often lacking.

The cost of supplying water to domestic and industrial users will rise dramatically. Better delivery and more efficient home water use will lead to some increase in the proportion of households connected to piped water. Many households, however, will remain unconnected. Small price increases for industrial water, improvements in pollution control regulation and enforcement, and new industrial technologies will cut industrial water use intensity (water demand per $1,000 of gross domestic product). Yet industrial water prices will remain relatively low and pollution regulations will often be poorly enforced. Thus, significant potential gains will be lost.

Environmental and other interest groups will press to increase the amount of water allocated to preserving wetlands, diluting pollutants, maintaining riparian flora and other aquatic species, and supporting tourism and recreation. Yet because of competition for water for other uses, the share of water devoted to environmental uses is expected not to increase.

Almost all users will place heavy demands on the world's water supply. Total global withdrawals are projected to increase by 22 % till 2025 compared to 1995, 4772 km^3 (27 % in the developing countries, 11 % in the developed world). Water scarcity for irrigation, which is by far the largest user of the world's water, will intensify. Water scarcity will lead to slower growth of food production and substantial shifts in where the world's food is grown.
E.g. the global yield growth rate for all cereals is projected to decline from 1.5 % per year from 1982 to 1995 to 1.0 % per year from 1995 to 2025. Developing countries will dramatically increase their reliance on food imports from 107 million tons in 1995 to 245 million tons in 2025.

Together, consumption of water for domestic, industrial and livestock uses - that are all non-irrigation uses - will increase dramatically, rising by 62 % from 1995 to 2025. Because of rapid population growth and rising per capita water use, total domestic consumption will increase by 71 %, of which more than 90 % will be in developing countries. Conservation and technological improvements will lower per capita domestic water use in developed countries with the highest per capita water consumption. Industrial water use will grow much faster in developing countries than in developed countries. In 1995 industries in developed countries consumed much more water than industries in the developing world. By 2025, however, developing world industrial water demand is projected to increase to 121 km^3, 7 km^3 greater than in the developed world. The intensity of industrial water use will decrease worldwide, especially in developing countries (where initial intensity levels are very high), thanks to improvements in water-saving technology and demand policy. Nonetheless, the sheer size of the increase in the world's industrial production will still lead to an increase in total industrial water demand in spite of actual declines in total domestic and industrial water use in the United States and Europe.

Water Crisis Scenario

A moderate worsening of many of the current trends in water and food policy and in investment could build to a genuine water crisis. In the water crisis scenario, government budget problems worsen. Governments further cut their spending on irrigation systems and accelerate the turnover of irrigation systems to farmers and farmer groups but without the necessary reforms in water rights.

Attempts to fund operations and maintenance in the main water system, still operated by public agencies, cause water prices to irrigators to rise. Water users fight price increases, and conflict spills over to local management and cost-sharing arrangements. Spending on the operation and maintenance of secondary and tertiary systems falls dramatically, and deteriorating infrastructure and poor management lead to falling water use efficiency. Likewise, attempts to organize river basin organizations to coordinate water management fail because of inadequate funding and high levels of conflict among water stakeholders within the basin.
In search of improved incomes, people will turn to slash-and-burn agriculture, thereby deforesting the upper watersheds of many basins. Erosion and sediment loads in rivers will rise, in turn causing faster sedimentation of reservoir storage. People will increasingly encroach on wetlands for both land and water, and the integrity and health of aquatic ecosystems will be compromised. The amount of water reserved for environmental purposes will decline as unregulated and illegal withdrawals increase.

As in the business as usual scenario, the rapid increase in urban populations will quickly raise demand for domestic water. But governments will lack the funds to extend piped water and sewage disposal to newcomers. Governments will respond by privatizing urban water and sanitation services in a rushed and poorly planned fashion. The new private water and

sanitation firms will be undercapitalized and able to do little to connect additional populations to piped water. An increasing number and percentage of the urban population must rely on high-priced water from vendors or spend many hours fetching often-dirty water from standpipes and wells.

The developing world will pay the highest price for the water crisis scenario. Total worldwide water consumption in 2025 will be 261 km^3 higher than under the business as usual scenario—a 13 % increase—but much of this water will be wasted, of no benefit to anyone. Virtually all of the increase will go to irrigation, mainly because farmers will use water less efficiently and withdraw more water to compensate for water losses. The supply of irrigation water will be less reliable, except in regions where so much water is diverted from environmental uses to irrigation that it compensates for the lower water use efficiency. For most regions, per capita demand for domestic water will be significantly lower than under the business as usual scenario, in both rural and urban areas. The result is that people will not have access to the water they need for drinking and sanitation. The total domestic demand under the water crisis scenario will be 162 km^3 in developing countries, 28 % less than under business as usual; 64 km^3 in developed countries, 7 % less than under business as usual; and 226 km^3 in the world, 23 % less than under business as usual. Demand for industrial water, on the other hand, will increase, owing to failed technological improvements and economic measures. In 2025 the total industrial water demand worldwide will be 80 km^3 higher than under the business as usual scenario - a 33 % rise - without generating additional industrial production. With water diverted to make up for less efficient water use, the water crisis scenario will hit environmental uses particularly hard. Compared with business as usual, environmental flows will drop significantly by 2025, with 380 km^3 less environmental flow in the developing world, 80 km^3 less in the developed world, and 460 km^3 less globally.

Sustainable Water Scenario

A sustainable water scenario would dramatically increase the amount of water allocated to environmental uses, connect all urban households to piped water, and achieve higher per capita domestic water consumption, while maintaining food production at the levels described in the business as usual scenario. It would achieve greater social equity and environmental protection through both careful reform in the water sector and sound government action.
To stimulate water conservation and free up agricultural water for environmental, domestic, and industrial uses, the effective price of water to the agricultural sector will be gradually increased. Agricultural water price increases will be implemented through incentive programs that provide farmers income for the water that they save, such as charge-subsidy schemes that pay farmers for reducing water use, and through the establishment, purchase, and trading of water use rights. By 2025 agricultural water prices will be twice as high in developed countries and three times as high in developing countries as in the business as usual scenario. The government will simultaneously transfer water rights and the responsibility for operation and management of irrigation systems to communities and water user associations in many countries and regions. The transfer of rights and systems will be facilitated with an improved legal and institutional environment for preventing and eliminating conflict and with technical and organizational training and support. As a result, farmers will increase their on-farm investments in irrigation and water management technology, and the efficiency of irrigation systems and basin water use will improve significantly. River basin organizations will be established in many water-scarce basins to allocate mainstream water among stakeholder interests. Higher funding and reduced conflict over water, thanks to better water management, will facilitate effective stakeholder participation in these organizations.

Domestic and industrial water use will also be subject to reforms in pricing and regulation. Water prices for connected households will double, with targeted subsidies for low-income households. Revenues from price increases will be invested to reduce water losses in existing systems and to extend piped water to previously unconnected households. By 2025 all households will be connected. Industries will respond to higher prices, particularly in developing countries, by increasing in-plant recycling of water, which reduces consumption of water.

With strong societal pressure for improved environmental quality, allocations for environmental uses of water will increase. Greater investments and better water management will improve the efficiency of water use, leaving more water in stream for environmental purposes.

In the sustainable water scenario the world consumes less water but reaps greater benefits than under business as usual, especially in developing countries. In 2025 total worldwide water consumption is 408 km^3, or 20 %, lower under the sustainable scenario than under business as usual. Higher water prices and higher water use efficiency reduces consumption of irrigation water by 296 km^3 compared with business as usual. Globally, potential domestic water demand under the sustainable water scenario will decrease 9 % compared with business as usual, owing to higher water prices.

In 2025 total industrial water demand worldwide under the sustainable scenario will be 85 km^3, or 35 %, lower than under business as usual.
Compared with the business as usual scenario, the sustainable scenario will also result in an increase in the environmental flow of 850 km^3 in the developing world, 180 km^3 in the developed world, and 1,030 km^3 globally.

Consequences of Key Policy Changes

If policymakers do not make a holistic change in water policies and investments but simply change certain key factors, could this produce substantial benefits? It was examined what would happen if policymakers and water users raised water prices, shifted to sustainable groundwater use, or better exploited the potential of rain fed agriculture.

Regarding price of water could be shown, that higher water prices for industry, domestic, and agricultural sectors would result in large water savings that can be used for environmental purposes. Making water use more efficient in conjunction with higher prices is critical to maintaining or increasing the reliability of irrigation water supply and food production compared with business as usual.

A sustainable groundwater use (low-groundwater scenario) projects big drops in cereal production, at which the biggest drops are concentrated in the basins that currently experience large overdrafts, especially China and India. As a result, the developing world as a whole will increase its net imports, with major increases concentrated in China and India, and developed countries will increase their net exports. These country-level shortfalls in demand and increases in imports could be serious, but they may be a worthwhile trade-off for restoring sustainable groundwater supplies. More important, countries must combine a phase-out of groundwater overdrafting with policies to mitigate the impacts on the overdrafting regions in order to maintain income growth. Countries should increase their agricultural research investments, and, particularly in the hardest-hit river basins, make investments and implement policy reforms to increase basin

efficiency, and encourage diversification from irrigated cereals to crops that give more value per unit of water.

Appropriate investments and policy reforms will be required to enhance the contribution of rain fed agriculture. In some regions water harvesting has the potential to improve rain fed crop yields. But crop breeding for rain fed environments is crucial to future cereal yield growth. Strong progress has been made in breeding for enhanced crop yields in rain fed areas, even in the less favourable environments. The continued application of conventional breeding and the recent developments in nonconventional breeding offer considerable potential for improving cereal yield growth in rain fed environments. Progress could be hastened by extending research to farmers and by using tools derived from biotechnology to assist conventional breeding. Governments must also combine crop research targeted to rain fed areas with increased investment in rural infrastructure and policies to close the gap between potential and actual yields in rain fed areas. Important policies include higher priority for rain fed areas in agricultural extension services and access to markets, credit, and input supplies.

Implications for the future

In the report, the following implications were defined:
Water scarcity will get much worse if policy and investment commitments from national governments and international donors and development banks weaken further. The water crisis scenario—predicated on the worsening of a number of already evident trends—would lead to a breakdown in domestic water service for hundreds of millions of people, devastating loss of wetlands, serious reductions in food production, and skyrocketing food prices that would force declining per capita food consumption in much of the world. Failure to adopt water-saving technology improvements and policy reforms could make demand for nonirrigation water grow even faster than we projected, further worsening water scarcity.

The scenarios explored in this report point to three broad strategies that can address the challenge posed by water scarcity for food production:

- invest in infrastructure to increase the supply of water for irrigation, domestic, and industrial purposes;
- conserve water and improve the efficiency of water use in existing systems through reforms in water management and policy;
- improve crop productivity per unit of water and land through integrated water management and agricultural research and policy efforts, including crop breeding and water management for rain fed agriculture.

A large part of the world is facing severe water scarcity, but the impending water crisis can be averted. The precise mix of water policy and management reforms and investments, and the feasible institutional arrangements and policy instruments to be used, must be tailored to specific countries and basins. They will vary based on level of development, agroclimatic conditions, relative water scarcity, level of agricultural intensification, and degree of competition for water. But these solutions are not easy, and they take time, political commitment, and money. Fundamental reform of the water sector must start now.

5. Business in the world of water: WBCSD Water Scenarios to 2025 (WBCSD, 2006)

The H2O scenarios, developed by the World Business Council for Sustainable Development (WBCSD), offer three scenarios about the role of business in relation to the growing issue of water in the world.
These scenarios do not try to cover everything, but attempt to bring to life a limited number of alternative future environments that will challenge economic viability, social legitimacy, and global fitness in the marketplace.
While the three scenarios together – H (Hydro), 2 (Rivers), and O (Ocean) – were created in relation to each other, as part of a 'molecular set', they are intended to present mutually exclusive worlds as platforms for discussion.

Hydro is the scenario of efficiency (more value per drop and more drops for less). It highlights avoiding or unlocking legacies inherited from the past – in ways of thinking as well as in technologies, business practices, and public policies – to create new business opportunities in the world of water. The scenario focuses on the 'H' of H2O – 'Huge' economic opportunities in this new, urbanized world through innovations, especially in technology.

In Hydro, there is a strategic advantage to being the first to market with the flexible, right-choice solutions rather than being locked out. While the geographical focus of the scenario is China, Hydro raises serious questions about other parts of the world.Where else is urbanization at risk from a multitude of water challenges? Where else are governments and their societies likely to respond with market-enabled solutions?

The implicit warning in this world of increasing hydro opportunities is that current business and technical solutions cannot be continually or effectively scaled up to solve the growing water stress. In addition, WBCSD expects technical and efficiency-focused solutions not to solve the resource allocation problems.

Rivers is the scenario of security – enough water of sufficient quality for both the haves and the have-nots. In this scenario, cast in the form of a cautionary tale, business recognizes that there are many different sides to security. Some businesses increasingly risk losing the license to operate where they are competing with basic human needs or are out of touch with political realities.

The scenario focuses on the '2' of H2O – 2 sides of the water question (although sometimes there are more than two sides); 2 sides of a water dispute – often, literally, on opposite banks of a river that divides one territory from another or between upstream and downstream interests; 2 ingredients for meeting future water needs – market-driven solutions *and* far-sighted government policies; and, most importantly, the necessity of solving water problems '2-gether', in partnership with other stakeholders.How do we allocate water fairly for all users in a community, not just the highest bidders? In Rivers business cannot choose to operate only in the economic realm, which is just one side of the management challenge, if it wants water security.

Ocean is the scenario of interconnectivity – accounting for the sustainability of the whole system. It focuses on how business begins to recognize its role in a world of bigger, more complex, interconnected, and dynamic water challenges and natural systems in which economies, societies, cities, and individual human lives are embedded.

In the scenario Ocean, business realizes that it cannot help particular communities survive and prosper at the expense of causing water stress elsewhere. Ocean is a scenario that offers new opportunities to help societies and governments achieve more inclusive and integrated forms of security. Like the entirety of the ocean, the whole round 'O' of the H2O scenario set is difficult to see, much less to act in relation to.

Messages derived from the scenarios

"H" - Hydro:

- Technology is only part of the solution.
- Appropriate solutions involve participation and partnerships and do not necessarily mean 'high tech'.
- Relevant innovation is driven locally.

"2" - Rivers:

- Business cannot buy its way out of water problems.
- Business must engage and negotiate outside its fence line, within the territory of the 'other', in order to secure its activity.
- Creating trust helps to secure the license to operate.

"O" - Ocean:

- Take into account the changing water context in order to anticipate risks that stem from far outside your current business model or comfort zone.
- Connect all the components into a whole system to create opportunities to which you would otherwise remain blind.
- A new level of accountability and governance is required.

General:

- Business cannot survive in a society that thirsts.
- You don't have to be in the water business to have a water crisis.
- Business is part of the solution, and its potential is driven by its engagement.
- Growing water issues and complexity will drive up costs.

6. De Kartonnen Doos: Toekomstverkenning voor de drinkwatersector (BTO, KWR, 2003)

Introduction

In 2002 the board of clients for the joint research program of the Dutch drinking water companies requested that Kiwa Water Research develop four realistic scenarios for the drinking water sector in 2020. During 2003 the final product was published, which comprises four glossy books (1 per scenario) plus an explanatory user manual. The research team used the scenario planning method that was devised by Shell during the 1970's.

The first step involved research and identification of the trends that directly or indirectly influence the Dutch drinking water sector. Trends in each of the SEPTED (social, economic, political, technological, ecological, demographic) dimensions were considered. A long list of 70 relevant trends was prescribed by a Planning consultancy bureau (CIBIT Futures Inc.). The research team subsequently selected 28 trends that experts deemed most likely to significantly affect the Dutch drinking water sector by 2020. This timeframe was chosen as the optimum for allowing time for the water supply companies to adapt, while limiting the uncertainty to a practical range.

Once 28 relevant trends were selected, the research team determined to what extent these trends were the subject of earlier futures studies for the water sector. This step was important to avoiding repeated work. The next step involved trend analysis and the definition of possible impacts. Three areas of influence were considered:

- products and services
- production and distribution
- cooperation and organisation

The results of the trend analysis indicated that the trends were likely to influence the water sector to varying degrees. Some trends could be grouped and others omitted from the shortlist for further study. Eleven trends were eventually selected, with preference for trends with a high level of uncertainty:

1. individualisation of society;
2. increasing efficiency and effectiveness of management;
3. development of a knowledge economy;
4. the role of the government;
5. membrane technology;
6. sensors;
7. ICT and automation;
8. infrastructural technologies;
9. biotechnology;
10. sustainable society
11. climate change

A subproject was opened for each of these trends to facilitate further investigation. These trends more explicitly defined and a better understanding of the driving forces and the uncertainty was developed. The influence of each trend on the water sector was also analysed in detail. This research involved interviews, company visitations, consultation of futurologists, desk studies, internet research, discussions etc. Possible opportunities and threats were also defined. Based on this analysis, two driving forces were defined. These formed the axis for the scenario skeleton because they were fundamental consequential drivers for each of the trends: (1) the extent of technological development; (2) the style of citizenship. The extremes for the scenario axis were thus (1) technological forerunner or follower, and (2) individualistic or communal citizens (see Figure below).

	Follower	Technological forerunner
Individualistic	**Scenario 4**	**Scenario 1**
Communal citizens	**Scenario 3**	**Scenario 2**

Conditions for the first scenario, for example, are defined by the positive extremes of the driving forces i.e. the water sector is a technological forerunner with individualistic citizens. A brief overview of the four scenarios follows:

Scenario 1: Living is experiencing

This version of the future is characterised by a strongly individualistic society and critical consumers who are focussed on comfort and enjoyable experiences. Materialism dominates. There is much progress in the development of technologies, especially those associated with satisfaction of consumer demands. New technologies are rapidly implemented because the level of community trust is high. People have little worries about the possible side effects.

Scenario 2: Sustainable coexistence

Society grows to become more coherent and places value on the meaning of life, caring for the environment, sustainability, and health. Technological development progresses rapidly, especially in those fields that are focussed on increasing the sustainability of society (sustainable development). Consumers trust new technologies.

Scenario 3: Diligent efficiency

The social climate is conservative and focussed on cost reduction above everything. There is stagnation of technological development due to lack of investment. Experimental technological development is stalled by the government in response to a number of scandals that have led to public suspicion surrounding new technologies. Only proven technologies are implemented in the endeavour to realise an optimum standard of living by simple and efficient means.

Scenario 4: Solitary & sober

People are taken over by an "every man for himself" mentality. There is little finance for research and development. Existing technologies are optimised in an attempt to keep the clients satisfied while cutting costs. There is little trust in new technologies.

Implementation and Results

The four scenarios handled above are explicated in the four booklets that compose the final product (Kartonnen Doos) of this futures research. This set of books has been published and distributed within the Netherlands. Besides this, various (strategic) advice projects have been undertaken with individual water supply companies. A team of trend monitors was established to follow the progress of the trends and determine which scenario was dominating. The information produced by these researchers formed a useful basis for the TECHNEAU WA1. Various research questions were also born out of this research, which are currently being addressed in the joint research program of the Dutch drinking water companies.

Conclusions:

In the report, the following conclusions were drawn:
The four scenarios diverge significantly from each other. And while it may be tempting to choose the scenario that best suits our temperament, we cannot determine the future. Broader future conditions are mostly dependant on factors over which we have little influence. Will the economy grow or not? Will individualisation progress, or is a temporary fad? Will The Netherlands develop to become a true knowledge economy, or has that boat been missed? This type of indeterminate trend has much influence on future circumstances, and thus which scenario becomes the best model of reality. The purpose of futures studies is not, however, to perfectly project the future. This study was conducted to advise the board of clients for the joint research program of the Dutch water companies on how to handle uncertainty regarding the future with respect to the management of the research program and the individual companies.

There are various means of managing uncertainty. The various players must choose a mode that suits them considering the projected dynamics. The research team looked at various options for managing such uncertainty. The first step identified in translating the scenarios into specific situations for individual companies is the generation and testing of options. This translation step is performed by identifying the five most important opportunities and the five most important threats associated with each scenario. Subsequently a sort of system analysis is performed, to determine the key elements and how they interact. This enables judgements about the consequences of any given change to be made. The implications of a scenario for the water sector can thus be determined. For example, investments in new purification technologies turned out to be more successful in scenarios 1 and 2 than in 3 or 4. Whether an intervention successful is, or not, further depends on the type of strategy chosen.

There are 4 main strategies for preparing for the future: [Also here better with column wise order]

1) Robust

2) Flexible
3) Broad
4) Everything or Nothing

Based on a literature study, the ‘flexible’ and the ‘robust’ strategies are the most useful for the water sector. The robust strategy is most applicable to a situation where the water supply companies have a monopoly position. This approach aims at avoiding serious risks. The resulting strategy is not perfectly tailored to any one scenario, but there is no risk of being beaten by a competitor. The flexible strategy, on the other hand, requires that an action plan be designed for each scenario. Characteristic to this approach is a short reaction time between changing circumstances and adaptive strategies. Trend monitoring is thus essential, so that the business plan can be frequently adapted to suit projected circumstances. This strategy may be best suited to a competitive water sector. In the end, individual players in the water sector must choose their own strategy. The four ‘Kartonnen Doos’ scenarios are a useful tool for this process, but the outcomes are not concrete enough to provide general guidelines which are needed in WA1 of TECHNEAU. In WA1, the focus is on identification of main trends and adaptive strategies to cope with these trends, rather than scenarios.

7. Sustainable Water Management; A future view (WRc plc - June 2003)

This study was conducted by the UK Parliamentary Office of Science and Technology's Associate Foresight programme for the UK water sector. The 'Sustainable Water Management' research theme was established in recognition of the fact that water is essential for life and business and it is a non-substitutable commodity. This foresight study looks at water management with a 10-20 year scope.

Information was gathered from diverse sources using various methods, including:

- a think tank to focus the issues and create the view
- a structured workshop to establish an initial view and determine what a sustainable water industry should be
- workshops at Warwick University and at EPSRC (Engineering and Physical Sciences Research Council UK) at which an initial view of the issues surrounding sustainable water management were formulated
- from the Warwick workshop, the diagram overleaf representing a preliminary view of a sustainable water industry was developed
- from this preliminary view, a comprehensive questionnaire was formulated and circulated widely throughout the water sector both in the UK and overseas
- Focus-group workshops involving the principal sponsors to debate the issues

The research team took a proactive approach and devised an ideal 'scenario' for a sustainable future for the UK water sector, rather than waiting and reacting to change. Research concluded that the main driving force for change in the international water sector is legislation, "with increasing attention to public health, protection for the environment and liberalisation of world trade." In this report the main questions that arose from the Foresight Associate Programme are combined with information resulting from research in the water sector. This information is divided into four key issues:

1. Industry Structure and the Water Cycle
    - Structure
    - Management of the wastewater system
    - Incentivising Innovation
2. Customers and Regulation
    - The role of customers in future regulation
    a. Future self-regulation and deregulation
3. Supply / Demand Balance
    - Future metering policy
    - Leakage in water stressed areas
    - Increase of supply
    - Environmental Stewardship
4. Working in the Water Sector

- Recruitment, retention and re-training
- Creating a sustainable working environment in the sector

Since this study was devised with a clear plan for the future (sustainability), potential barriers to achieving this goal make up an important part of the study. Key barriers include:

- non-holistic and inflexible regulation
- the lack of transparent and agreed Sustainability objectives
- collective inability to make firm long-term sector-wide policy decisions
- a general lack of trust and transparency at a sector level
- funding structures are too short term
- inadequate transparency of true investment needs and acceptable returns to investors / stakeholders
- levels of funding / margins in the sector are insufficient to support innovation
- recruitment, retention and re-training of appropriately skilled people
- inadequate public understanding of the need for rational and objective debate on sustainability issues and decision procedures

Besides potential barriers to the collective 'dream' of the sector, this study recognised various challenges that need to be addressed if a sustainable future is to be achieved:

- collective commitment to a vision
- closing the gap between research and practice
- development of a 'River Basin Model' for the Framework Directive
- a major demand-led initiative (e.g. metering and leakage reduction) is needed
- research to examine the scope for deregulation and self regulation
- facilitation of auditing of self-regulated activities via data management systems
- a set of practical and meaningful output driven sustainability targets are required
- asset management research for supporting new financial / regulatory structures
- knowledge management research to explore the practicalities of creating and delivering shared knowledge across business and institutional boundaries both vertically and horizontally
- funding for technology-based innovation and technology at both the research and implementation levels

Conclusions

In the report, the following conclusions were drawn:
Unlike most of the other studies listed in this literature review, this study approaches the future proactively from the outset, by developing one target vision. For this reason much attention is paid to problems with the current situation, as well as potential threats to achieving the desired changes. This study also has a more focused spatial scope (the UK water sector). In the case of TECHNEAU, the plan is to recognise the threats and opportunities of those trends over which the global water sector has no or little influence. In using this approach, the goal is to generate input for strategies of different players in the sector, and establish prospective demands for and on technologies. For these reasons, the approach used in this study cannot be used in

TECHNEAU WA1. Goal scenarios could, however, be used by individual TECHNEAU partners at a later stage and then tested against the intractable trends that are defined in WA1.

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