TECHNEAU - Safe drinking water from source to tap

State of the Art & Perspectives

We present you with a summarized overview of the proceedings of the TECHNEAU conference, held in Maastricht, the Netherlands, on June 17, 18 and 19 in 2009. For more detailed information please turn to the TECHNEAU-website (www.techneau.org). There you will soon find the official proceedings, as published by IWA, individual presentations and the TECHNEAU film, promoting results from the TECHNEAU case studies. Under "Publications" this website also lists the circa 100 TECHNEAU deliverables obtained so far, most of these are available as freely downloadable research reports and state-of-the-art overviews.

Our gratitude goes out to the dedicated people at RWTH Aachen University for organising a pleasant and fruitful conference, to the International Water Association IWA for publishing the accompanying book with the papers that were presented and to the conference sponsors Limburg Water Company WML, ENWOR and NORIT.

Theo van den Hoven, TECHNEAU coordinator

Wednesday June 17

Opening session

Ria Doedel, CEO of the Dutch Limburg Water Company WML and host of the TECHNEAU conference, was very clear in her request to the scientists and experts gathered in Maastricht: "We – WML and other water companies – need to invest in innovation to meet the challenges of the future, especially in sustainability. So I am asking you: inspire us to use knowledge to improve our sustainability." The over 130 participants in TECHNEAU's "final conference" took her words to heart and shared their knowledge freely, scientists and end-users alike. With still 18 months to go – the EU Integrated Project TECHNEAU ends in 2011 – it might seem early for a "final" conference, but as TECHNEAU coordinator Theo van den Hoven (KWR) remarked: "there are already a lot of results to share. Holding this general meeting now, promotes dissemination and use of TECHNEAU results".

Meeting the needs of a growing population – Paul Reiter

IWA CEO Paul Reiter captured the audience with his harrowing story of the challenges the global drinking water sector is faced with. A fast growing population, booming since the industrial revolution, is shaping the world we live in. More and more people are moving into ever larger cities. We are 6,5 billion now – and in 2050 there could very well be 9 billion of us. To level off population growth, people should have fewer children. That only happens when their income grows, but either way: people will keep using up more and more of their natural resources. On top of this all, we have to cope with climate change. In effect we need a few *more* planets to sustain *this* world's population. As these extra planets are not available, we have to be smart. We need to find other ways to produce our water and reuse it in the most effective ways. And we need to innovate at high speed: membrane technology took over 30 years to "get out of the box" – we cannot afford to take things that slow anymore: "Inaction is not an option". All the more reason to work on dissemination of TECHNEAU results at full speed.

What science and society can and should do – Wim van Vierssen

Wim van Vierssen, CEO of KWR Watercycle Research Institute and lecturer in science systems assessment at TU Delft, discussed the role of science in meeting the challenges mentioned above. Society today is changing rapidly. In recent years TECHNEAU has identified several of these ongoing changes or trends that influence the water sector, like urbanisation. More and more science finds itself confronted with problems involving high stakes and high uncertainties: problems that can only be solved through scenario development and constructing "possibility spaces". Government and civil society not only have to answer the question "what *can* we do", but also the normative question: "what *should* we do?” Science should assist government and civil society in answering these questions by acting as an honest broker of policy alternatives. Collaborative frameworks such as TECHNEAU are a valuable way to achieve this.

TECHNEAU – a collective effort towards safe water supply - Christian Kazner
Christian Kazner from RWTH Aachen University, leader of TECHNEAU Work Area 1, gave an introduction to the TECHNEAU project with some focus on the challenges the water sector is facing and how the project addresses these challenges. Among these challenges are climate change, continued population growth and urbanisation, emerging contaminants, aging infrastructure, an increasing shortage of good quality and readily treatable resources and more demanding regulators and consumers.

TECHNEAU is an EU-funded FP6 Integrated Project that brings together 30 leading research institutions and technology developers across Europe and beyond – and in doing so more than a 150 scientists. They work together with dedicated water professionals from some 25 end users – like water companies – in 15 countries. TECHNEAU’s task is to develop adaptive strategies, novel technologies and operational practices for safe water supplies – and thereby effectively addressing the challenges mentioned above. The project started in 2006 and ends in 2011. Its 19 M€ budget is mainly funded by the EU.

TECHNEAU’s main focus is the technology required for treatment, monitoring and control. It aims at making future systems more flexible and resilient, incorporating consumer issues and optimising the capital intensive existing infrastructure. Its aim is to validate and demonstrate the scientific results from its eight Work Areas through case studies with end-users. Wide-spread communication and dissemination of the acquired knowledge is the final goal, so close collaboration with end-users has been a major part of TECHNEAU from the start.

TECHNEAU Work Area 1, *Rethink the system*, concentrates on answering the question: how would we best organise our drinking water supply if we could start all over again? This work area has concentrated on identifying the trends that influence the drinking water sector, like urbanisation, climate change and aging infrastructure. The research has led to three important guiding principles for effective adaptation to such trends, which are always surrounded by uncertainty:

- Use an integral approach, involving the whole water cycle
- aim for flexibility and
- always optimise for local circumstances.

From these guiding principles several adaptive strategies were derived. This proved to be effective in TECHNEAU case studies in Cyprus, the Netherlands, Riga and South-Africa.

EU research on water, an overview – Andrea Tilche
The EU invests a great deal in water research, mainly to support environment related policies and the competitiveness of the European industry. There is a wide range of EU activities in water technology, besides TECHNEAU. EU representative Andrea Tilche (DG Research) introduced a number, from municipal and industrial wastewater treatment to artificial aquifer recharge with reclaimed water and safe sewage sludge treatment and disposal. His presentation gave an extensive overview of current EU research activities. Throughout the conference results from several of these research programs were presented, for instance:

- SWITCH: water management in the city of the future (Kala Vairavamoorthy, UNESCO-IHE)
- RECLAIM WATER: managed aquifer recharge for safe indirect potable use (Thomas Wintgens, FHNW, former RWTH)
- ACQWA: water resources in mountain regions sensitive to climatic change (Douglas Cripe, University of Geneva)

- HiWATE: focused on drinking water used in food production (Radu Rautiu, Imperial College Consultants)

The TECHNEAU case studies
The first day of the conference ended with an overview of TECHNEAU case studies and results, presented by Theo van den Hoven (KWR) , a video about the TECHNEAU case studies and the involved water utilities in Bergen, Lisbon, Amsterdam and Riga, and a presentation by Talis Juhna (RTU, Riga case study). The TECHNEAU video can be accessed via the TECHNEAU website.

Thursday June 18

Parallel sessions from the TECHNEAU Work Areas

Treatment (WA2) – ceramic membranes, oxidation and disinfection byproducts
New water treatment technologies are needed to cope with new sources for drinking water, for instance waste water and seawater, and with (micro-)pollution of conventional sources (*Jean-Christophe Schrotter, Anjou-Recherche*). Membrane and oxidative technologies are a major part of the technological progress achieved in water treatment. These technologies come together in the oxidation-biofiltration-membrane (OBM) process, a robust and flexible method to produce high quality drinking water from coloured and polluted water that contains NOM or emerging substances (*Kamal Azrague, NTNU*). Because new ceramic membranes are much more robust than polymers, membrane filtration can now be employed for direct drinking water production. Ceramic membranes are 2 to 3 times more expensive than polymeric membranes, but they can function at a much higher stable flux than polymeric membranes. (*Emile Cornelissen, KWR*). Progress has been made in treatment of backwash from sand filters and the concentrates produced during nanofiltration or reverse osmosis. A combination of ozonation, adsorption, GAC filtration and biological treatment proved to be efficient in removing NOM and micro-pollutants from nanofiltration concentrates (*Catherine Daines, Anjou Recherche*).
There is more insight in the behaviour of emerging substances during water treatment and their influence on the formation of disinfection by-products, for instance from application of quantitative structure-activity relationships (QSAR's) (*Victor Yangali, Unesco IHE*). Aquifer recharge and bank filtration were shown to have a good removal efficiency for substances that are relevant to newly-industrialized or developing countries, even though further post-treatment may be necessary (*Gesche Grützmacher, KWB*).

Small scale systems – 3S Task Force
Much progress has been made in small scale systems, for decentralized drinking water supply. Low pressure membrane-based systems for decentralized production could be very useful in developed and developing countries and assist in reaching the Millennium Development Goals (*Boris Lesjean, KWB*). Fouling of these systems can be stabilized without membrane flushing or cleaning. (*Wouter Pronk, EAWAG*). A gravity-driven ultrafiltration unit has been producing 5 m^3 of drinking water daily from Marne river water for five (winter) months straight with minimal cleaning. This robustness is largely due to biological activity on the membranes and on the sand filter that is employed as pre-treatment (*Eric Hoa, KWB*).

Monitoring & control (WA3) – bioassays, DNA, UV, fish and FISH
This work area concentrates on new systems to measure water quality from source to tap. These systems produce valuable steering information for water treatment and serve to maintain consumer trust and confidence in drinking water. Trends are increasing automation, more – and often coupled – high end technologies, online and real-time measurements (*Frank Sacher, TZW*). Several biological detection systems for pollutants are being developed, based on measuring their effects, like bioassays, DNA-arrays, a real-time fishmonitor for drinking water quality and an electronic nose/tongue. They have the advantage of detecting all

harmful compounds because of their effect, and not just know compounds. They offer the possibility to develop water quality limits based on acceptable daily intake (ADI) of related compounds (*Minne Heringa, KWR*). A range of UV/Vis spectrometric methods (measuring at multiple wavelengths) can measure a wide range of parameters, such as turbidity, nitrate and organics, simultaneously and real-time (*Joep van den Broeke, S::can*)
In addition to liquid chromatography and mass spectrometry comprehensive gas chromatography (GC x GC) is a valuable tool for assessing emerging contaminants (*Auguste Bruchet, Suez*). Physicochemical detection, a sometimes neglected topic, has boomed. Heterotrophic plate counting detects less than 1% of bacteria in drinking water, but new flow cytometry methods (total cell count) prove to be very useful tools, for instance in establishing an alternative assimilable organic carbon (AOC) assay that works fast and for many samples at the same time. It can also be used to assess pathogen growth potential (*Frederik Hammes, EAWAG*). Quantification of indicator bacteria and pathogens is made possible by using fluorescent FISH-technology. A complete flow cytometry toolkit, based on measuring absorption at several wavelengths and ATP, can be used to determine total numbers of bacteria and numbers of live bacteria.

Toolkit for water safety plans (WA4) – risks and Water Safety Plans
TECHNEAU work area 4 is all about *Risk assessment & Risk management*. The research concentrates on controlling the process from source to tap, preferably through implementing *Water Safety Plans* WSP as proposed by IWA and the World Health Organisation WHO. These WSP's are being tested in a number of countries. An international overview of WSP tools and standards was presented (*Thomas Pettersson, Chalmers University*). WSP implementation needs to be scaled up through capacity building (*Tom Williams, IWA*).
In the afternoon, during the workshop "Connecting policy and research", it was concluded that water safety plans should preferably become part of major regulations as the Drinking Water Directive, and applicable to all types of water supplies, including small scale systems.

Hazard identification and reduction databases
Structured and thorough analysis of risk-reduction options can facilitate transparency and long-term planning of drinking water systems (*Lars Rosén, Chalmers University*). A TECHNEAU hazard database THDB has been developed to identify hazards. It has been tried, tested and updated with water companies. For selection of the most appropriate risk reduction options a TECHNEAU Risk Reduction Database is being prepared and will soon be published (*Ralph Beuken, KWR*).
Two case studies concerning risks were presented during the TECHNEAU conference. Risk assessment in Březnice in the Czech Republic has identified and classified over forty hazards and related undesired events. The Coarse Risk Assessment method used there was a suitable tool for this small water supply (*Frantisek Kozisek, SZU*). In Upper Mnyameni South Africa risk assessment was performed using South African Risk Evaluation Guidelines and the TECHNEAU Hazard Database (*Chris Swartz, Swartz Engineers*).

Optimizing operation and maintenance in water treatment and distribution (WA5)
Operation & Maintenance are the subjects of TECHNEAU work area 5. This important work area has to deal with the fact that large parts of Europe's drinking water system and infrastructure are aging: systems have been in place for many decennia and have to be kept "running". Optimizing their performance is an important focal point for research, useful optimization criteria are: a) compliance with quality standards and regulations, b) treatment and disinfection efficiency, c) minimal use of resources and chemicals and d) cost-efficiency(*Bjørnar Eikebrokk, SINTEF*). Case studies in Riga and Trondheim were done to optimise the water treatment steps coagulation and ozonation-biofiltration. The *European Water Treatment Simulator* is taking form: this mathematical model integrates several simulation methods that were being used in Europe. Simulation modules are available for softening, sand filtration, pH-adjustment, coagulation, aeration, chlorine treatment, activated carbon filtration, biological filtration and ozonation (*Petra Ross/Luuk Rietveld, TU Delft*). A model was validated for biodegradation of NOM in biological granular activated carbon

filters (René van der Aa, TU Delft) and for NOM removal by coagulation (*Bjørnar Eikebrokk, SINTEF*).

Discoloured water is one of the most frequent customer complaints, resulting in taste and odor problems, for instance through halophenols that can be formed during waste water treatment (*David Benanou, Anjou*). Resuspended particles are the most frequent cause. In many cases suspended particles in water leaving the treatment plant are the cause. This adds particle content as criterion e) to the list concerning optimizing water treatment. A conceptual model for particle related processes in a drinking water network has been developed and the Resuspension Potential Method RPM (*Jan Vreeburg, KWR*), that has been implemented and tested in Lisbon. For networks with unprotected iron pipes corrosion models have been developed *(Stein Østerhus, SINTEF).* To clean networks flushing concepts have been optimised (*Sebastian Richardt, TZW*). A hydraulic water quality modelling framework is being developed as well (Helena Alegra, LNEC).

Thursday afternoon was dedicated to three parallel workshops
1) **Future in water treatment research**: Shaping the WssTP (EU Water supply and sanitation Technology Platform) research agenda on (drinking) water treatment. The presence of a host of international experts from water companies, regulators, technology providers and researchers was the perfect opportunity to brainstorm about future water research in Europe. This workshop was organised at the request of the European Water Supply and Sanitation Technology Platform WSSTP, which has a strong influence on the EC Research Agenda, and contributed to shaping a European Research Area on water(cycle) research.
2) **Connecting policy and research:** Scaling Water Safety Plans from the mega-cities' water system down to the village water supply (for results see under Water Safety Plans WA 4, above).
3) **Knowledge transfer of research outcomes – a matter of communication**! In this workshop several methods were discussed to ensure effective transfer of technology to end-users. A personal approach, people to people, is always the preferred method. Involving end-users from early stages on, as TECHNEAU does, is a good basis for knowledge transfer: working WITH the customers. Other ways were suggested: exchange personnel between end-users and research institutions, facilitate communication between end-users and researchers by preparing "elevator pitches" for results (and research questions) and organising speed-dating sessions. And of course: tailor research results to fit the end-users daily practice.

Friday June 19

The future of water supply: climate change, consumer issues, nanotechnology and alternative sources

Friday morning started with an overview of adaptive strategies employed in The Netherlands for drinking water production in a changing climate (*Gertjan Zwolsman, KWR*). A study was made of consumer reactions to a recent waterborne outbreak in Sweden provided insight in consumer trust and confidence: essential in the relationship between water consumer and water company (*Chris Fife-Schaw, University of Surrey*). New possibilities and threats from nanotechnology were presented – from nanocides to nanowaste (*Eugene Cloete, University of Stellenbosch*).

The subject of alternative sources was approached by speakers from Australia and South-Africa. In Australia sea water desalination and planned indirect potable reuse (IPR) have been developed. Political developments have kept IPR from actually being used, even though investments have been made in necessary structures (*Stuart Khan, University of New South Wales*).
In Windhoek, Namibia, direct potable reuse can be a practical, responsible way of augmenting potable water supplies in arid regions. This requires comprehensive planning, training and on-going commitment for continued success. (*Jurgen Menge, City of Windhoek*)


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Global Water Challenges
and Opportunities:
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