TECHNEAU NEWSLETTER

July 2008

Welcome to the fifth issue of the TECHNEAU Newsletter. The newsletter is designed to disseminate news, scientific results and developments to stakeholders. Newsletters are issued every six months, with Newsletter 6 scheduled for December 2008.

TECHNEAU challenges the ability of traditional drinking water supply systems to cope with present and future global threats and opportunities. TECHNEAU will rethink options for water supply and - through innovation, research and development – will provide and demonstrate new and improved technologies for the whole water supply chain.

Newsletter 5 highlights recent activities and outputs from TECHNEAU. The Newsletter can be downloaded from the TECHNEAU website (www.techneau.eu / www.techneau.org) where comments on the Newsletter or on any project-related issue are welcome.

TECHNEAU publications are issued on the TECHNEAU website and can be downloaded free-of-charge. A list of available publications is shown on Page 7.

RTP: Technology for Safe Drinking Water in Central and Eastern Europe

Regional Technology Platforms (RTPs) are the main vehicle for consultation and dissemination in TECHNEAU. RTPs are held twice per year to promote face-to-face consultation and knowledge transfer between local stakeholders and the TECHNEAU consortium.

The fourth RTP took place in Tábor, Czech Republic, on 5-6 June 2008, hosted by the Czech National Institute of Public Health and SOVAK CR, the Water Supply and Sewerage Association of the Czech Republic. The event provided an invaluable insight into drinking water supply in Central and Eastern Europe and facilitated a lively exchange of views and information. Problems and opportunities were discussed and links established between regional stakeholders and the TECHNEAU consortium that will ensure closer cooperation in the future.

The RTP was linked to the "Pitna Voda" Conference - a regional biennial symposium of Czech and Slovak drinking water experts

Frantisek Kozisek (SZU) addresses the fourth RTP at Tábor

- and focussed on "Technology for Safe Drinking Water in Central and Eastern Europe". The RTP included presentations from a wide range of national and international water experts and highlighted specific aspects of drinking water supply in the region and relevant research results from TECHNEAU.

Water supply in Central and Eastern Europe relies almost equally on groundwater and surface water sources. Water availability varies widely in the region, ranging from 2000 m^3/cap/year in the Czech Republic to greater than 22,000 m^3/cap/year in Bulgaria. In prolonged dry periods, supply is affected by lack of water and drought, with frequent poor water quality due to pollution. For example, in Bulgaria raw water from dams may be polluted by sewage due to inadequate operation and maintenance of protection zones, while groundwaters may be affected by nitrates

(Continued on Page 2)

An Integrated Project Funded by the European Commission under the Sustainable Development, Global Change and Ecosystems Thematic Priority Area.

Contract Number: 018320
Project Coordinator: Dr. Theo van den Hoven KIWA Water Research
Project Duration: 1st January 2006 to 31st December 2010

In Issue No.5:

and pesticides. Pollution control and improvement of water quality remain key challenges for future water management.

Another major challenge for water supply in the region arises from deficiencies in the operation and maintenance of the distribution systems. For example, operational and financial problems are caused by water loss:

- physical loss caused by leakage from the distribution system and overflows at utilities' storage tanks;
- commercial loss resulting from consumer meter under-registration, data handling errors and theft; and
- unbilled authorised consumption of water used by the utilities for operational purposes, fire fighting, etc.

The cost of this water loss, which can amount for up to 50% of the total water supply, is enormous and regional water experts are searching for solutions to this problem. For example, in Bucharest measures identified to reduce water loss include network pressure management, active leakage control, improvement of the speed and the quality of repairs, introduction of district metered areas (DMAs) and improved management practices.

Water supply in Central and Eastern Europe may also be affected by decreases in population and the state of equipment. In Bulgaria for example, the population has fallen from 9 million in 1986 to 7.7 million in 2006, resulting in a significant decrease in water consumption and plant and distribution systems sometimes operating at as low as 40% of design capacity. Despite some large investments, worn and outdated equipment and treatment technologies are a major barrier to the efficient production and supply of high quality water. Water scarcity due to summer droughts also poses risks to the public water supply.

Since the early 1990s, countries of Central and Eastern Europe have undergone substantial political, economic and institutional change in the transition to market economies. Changes such as decentralisation of state administration, the introduction of new legislation and privatisation of state-owned enterprises have heavily influenced the drinking water sector. With increasing privatisation of the water sector in some countries, especially in major urban areas such as Prague and Bucharest, a greater awareness of consumer issues has been observed. Information is gathered via the internet and call centres, and regular consumer surveys are conducted. A large majority of consumers perceive the service of the water companies and the quality of water supplied as good. Less than 1% of consumers regard the water quality as being unsuitable for consumption.

Using the Czech Republic as an example, it was illustrated that 99.7% of monitored water samples complied with the standards of the drinking water directive, showing that despite the problems and challenges discussed above, water quality is relatively good. Water quality will continue to improve as a result of improved technologies and procedures, and the implementation of Water Safety Plans (WSPs).

The first risk study in the Czech Republic employing the WSP approach was conducted for the small town of Březnice as part of the TECHNEAU project. The Březnice study demonstrated the value of the risk assessment / risk management methodology, identifying microbial and chemical contamination of the groundwater sources as major hazards. The final report on the risk study was published in April 2008 and can be downloaded from the TECHNEAU website (www.techneau.eu).

In summary, the RTP provided an invaluable insight into the challenges and opportunities facing the drinking water sector in Central and Eastern Europe. A lively exchange between regional water experts and the TECHNEAU team identified areas where the link between the region and TECHNEAU should be strengthened. It was agreed to intensify cooperation between the regional experts and the TECHNEAU consortium, and to promote common research in future topics.

For further information, contact Ronald Wielinga, WA8 Leader, or visit the TECHNEAU website (www.techneau.eu).

Work Area Highlights

Treat Membrane Concentrates to Protect Water Resources (WA2)

Nanofiltration (NF) has been used for drinking water production for decades, most commonly for desalination. In recent years, NF has undergone significant advances and is becoming a common method for treatment of surface water due to its efficiency in removing natural organic matter (NOM) and micropollutants. However, 15 to 20% of the feed water is rejected by the membrane as a concentrate containing NOM typically 5 to 6 times more concentrated than in the feed. Its actual composition may vary with the industrial and agricultural activities of the region, with the weather conditions, etc.

Often the concentrate is discharged back to the source water where high dilution levels avoid any negative impacts on the environment. However, this is not always possible and TECHNEAU is investigating treatment of membrane concentrate to protect existing drinking water resources.

Treatment aims to achieve 75 to 85% elimination of NOM and micropollutants removed during nanofiltration. The investigation included onventional water treatment techniques - adsorption, coagulation, ozonation - and a combination of ozonation and adsorption. Eight pesticides detected most commonly in French surface waters were used as model micropollutants: atrazine, sulcotrione, bentazone, isoproturon, diuron, glyphosate, amitrole and acetochlore.

Tests were carried out on membrane concentrates obtained from different regions of France with the following properties:

Parameter	Value
pH (at 22°C)	7.5-7.9
Conductivity	1590-2000 µS/cm
THCa	100-400 mg/L
THMg	30-70 mg/L
TOC	8-18 mg/L
COD	13-39 mg/L

Concentrate samples were spiked with 10 µg/L of each of the pesticides to simulate seasonal concentrations and to enable quantitative analysis. Pesticide analysis was carried out by Centre d'Analyses Environnementales using chromatographic methods and NOM concentration was determined by TOC and COD analysis. The OZOTEST method was used for the ozonation tests with ozone concentration varied between 0.1-0.9 mgO_3/mgCOD. Powdered activated carbon (PAC, PICASORB16) was used as the main adsorbent at concentrations between 30-1500 mg/L. Contact times were varied between 0.5-30 min. PAC was introduced in the OZOTEST unit to carry out the combined ozonation/adsorption tests.

The results of the trials for pesticide treatment are shown in Figure 1. Between 95 and 100% pesticide removal/degradation was achieved by the combined ozonation/adsorption process.

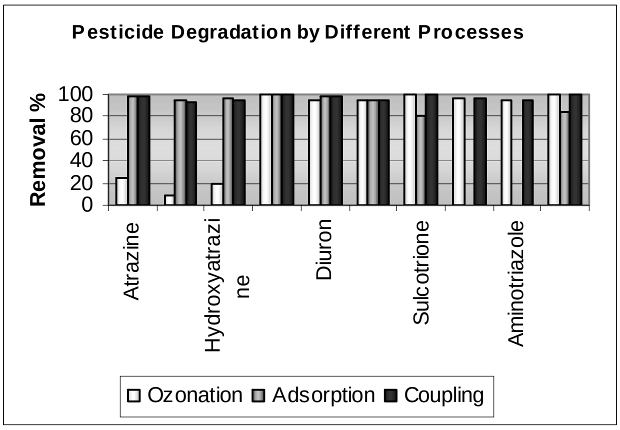

Figure 1 Pesticide removal from membrane concentrates by ozonation, adsorption and combined processes (TOC= 16.11 mg/L, COD= 33.3 mg/L CPAC= 30 mg/L, CO_3= 3 mg/L, tc= 10 min)

The operational parameters of the system were then re-optimised for removal of NOM. Results obtained with higher doses of PAC (30-1500 mg/L) and ozone (0.9 mgO_3/mgCOD) are shown in Figure 2.

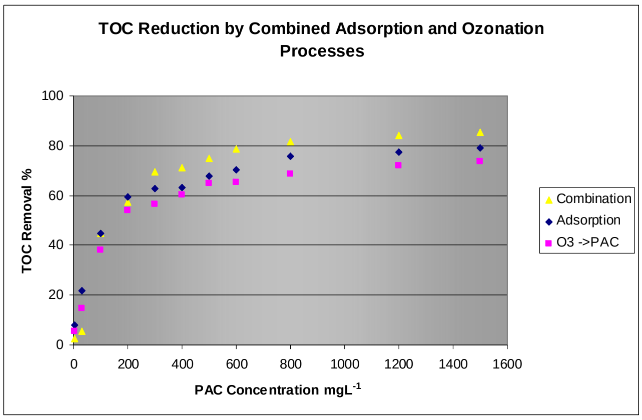

Figure 2 NOM Removal from membrane concentrates (CPAC= 5-1500 mg/L, CO_3= 30 mg/L, tc= 10 min)

From Figure 2, it can be seen that at PAC doses greater than about 300 mg/L, the NOM removal of the combined process was greater than the sequential application of the two processes.

The kinetics for removal of NOM by adsorption and the combined process are shown in Figure 3. The combined process achieved about 75-80% removal of NOM at contact times between 2-10 min. PAC adsorption alone achieved 45-75% removal.

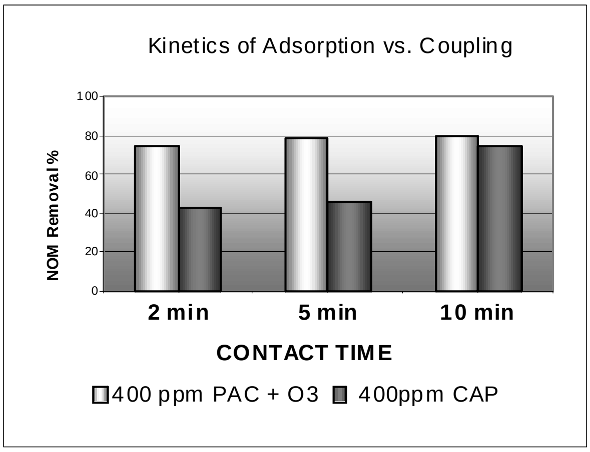

Figure 3 Kinetics of NOM removal by adsorption and combined processes

Combined ozonation and PAC adsorption proved to be an efficient method for the elimination of the polar and ozone resistant pesticides at low carbon and ozone concentrations. NOM removal can also be achieved with this system and its efficiency is greater than the efficiency of PAC adsorption (at PAC doses greater than about 300 mg/L).

The major fraction of the NOM is removed by adsorption. The difference between the NOM removal performances of adsorption and the combined process may be attributed to the catalytic effect of the PAC. It is known that basic activated carbon can initiate a radical-type chain reaction in the aqueous phase that accelerates the transformation of ozone into OH° radicals (Jans and Hoigné, 1998). NOM degradation is faster, most probably due to the OH° radicals created. NOM may also be acting as an ozone decomposition initiator. Although one would expect a decreased adsorption performance due to the increased polarity of the components, adsorption is faster due to the smaller molecules formed by the reaction between OH° radicals and NOM.

Research continues with the NOM removal studies, with investigation of continuous ozone/PAC and ozone/hydrogen peroxide systems, and the impact of ozone on PAC.

Reference

Jans, U. and Hoigné, J. (1998). Activated carbon and carbon black catalyzed transformation of aqueous ozone into OH-radicals. Ozone: Science & Engineering, 20, 67-80.

For further information, contact Marie-Renee De Roubin, WA2 Leader, or visit the TECHNEAU website (www.techneau.eu).

Bioassays Detect New Classes of EDCs in Water (WA3)

Endocrine disruption by compounds mimicking endogenous hormones is an area of intense interest. In particular, compounds mimicking estrogens (the female hormones) can cause fertility problems in wildlife (and possibly humans). Estrogens in the aquatic environment have been linked to disruption of the reproduction function of male fish. Concentrations of these endocrine disrupting compounds (EDCs) are low, measured at nanogram to microgram per liter levels. However, because of the extreme sensitivity of hormonal systems, even these low concentrations can cause problems, even more so because of the possible synergistic effect of multiple micropollutants. EDCs are chemically very heterogenic and it is possible that some may pass through water treatment and end up in the drinking water.

Bioassays have been used extensively in endocrine disruption research and monitoring programs. These have been particularly useful since they enable the measurement of the combined endocrine activity of compounds, even when present in a complex environmental mixture and the identity of the compound(s) of interest is unknown. This has enabled identification of pollution hotspots, efficacy of treatment procedures, and - in combination with advanced chemical analysis - identification of culprit chemicals. One of the assays that has been used is the ER CALUX® reporter gene assay that allows sensitive and specific detection of estrogenic activity in samples. The principle of this assay is illustrated in Figure 1.

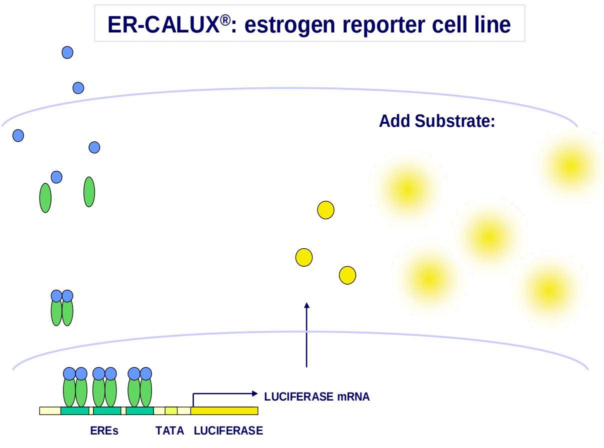

Figure 1 Principle of a reporter gene assay: The ER CALUX assay Upon estrogen (blue circles) binding, the estrogen receptor (ER - green) becomes activated and binds to recognition sequences in promoter regions of target genes, the so-called estrogen responsive elements (EREs). Three of these EREs have been linked to a minimal promoter element (the TATA box) and the gene of an easily measurable protein (in this case luciferase). The thus obtained reporter gene was stably introduced into cells. In this way, the ligand-activated receptor will activate luciferase transcription and the transcribed luciferase protein will emit light when a substrate is added. The signal will dose-dependently increase as a result of increasing concentrations of compound.

So far, most of the attention in endocrine disruption has been paid towards male and female sex steroid hormones, the androgens and estrogens. It has been found that the receptors of these steroid hormones can be easily activated or inactivated by a variety of synthetic chemicals like drugs and industrial chemicals. While other steroid hormones, like progestins and glucocorticoids are also of major importance in regulating normal physiological functions, these have received surprisingly little attention in the context of endocrine disruption. One reason for this is the lack of good biological detection systems for compounds interfering with these hormonal systems.

TECHNEAU Partner BDS (BioDetection Systems) expanded its existing panel of CALUX® bioassays to include assays responding to other classes of hormones, including glucocorticoids, progestins and thyroid hormones. The bioassays were applied to detect multiple types of hormone-like activity in a range of water samples, including surface water, drinking water and several types of waste water (see Figure 2).

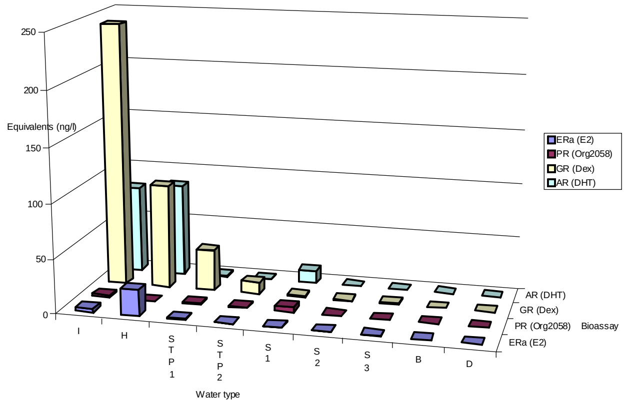

Figure 2 Bioassay results Estrogen- (ERα), progestin- (PR), glucocorticoid- (GR) and androgen- (AR) like activity in water samples, expressed as nanogram of reference compound equivalents per litre. Water samples tested are: effluents from industry (I), hospital (H) and municipal sewage treatment plants (STP1 and STP2), surface water samples from a small brook (S1) and river (S2 and S3), and drinking water (D).

Results show that the concentrations of estrogens are in the normal range for Dutch surface waters and effluents, but also that other types of hormonal activity can be detected in the effluent and surface water samples. In particular, the surprisingly high concentrations of glucocorticoids found compared to the other types of activity are of importance. These hormones are essential in regulating major functions in all vertebrates, including many metabolic (i.e. glucose metabolism) and homeostatic functions. They also regulate inflammatory responses and immune functions. Particularly in the latter context, they are an important group of drugs, used in a wide range of conditions involving inflammatory responses (e.g. asthma, rheumatism, eczema, allergic reactions, dermatologic disorders, rejection of organ transplants, hemopoietic disorders, etc). Prolonged exposure can lead to resistance; hence finding these hormonal activities in source waters is reason for concern. Fortunately, no hormone-like activity was detected in the drinking water samples.

Although the presence of compounds has been shown for a limited number of samples, more information is needed regarding the identities and concentrations of these compounds to be able to assess their risk with to human health and the environment. Future research will focus on determining concentrations in surface water and removal as a result of different types of treatment. By combining bioassay results with chemical analysis, the identity of the active compounds will be determined.

For further information contact Frank Sacher, WA 3 Leader, or visit the TECHNEAU website (www.techneau.eu).

Pathogen Growth Measured at Low Carbon Concentrations (WA3)

From a microbiological perspective, the main goal of drinking water treatment is the removal of pathogens and the prevention of pathogen growth in the distribution system. Whilst bacteria are common in water treatment and distribution - where they can grow on low concentrations of organic carbon - it is generally believed that enteric pathogens are not able to grow at the low nutrient concentrations present in natural freshwater and drinking water. TECHNEAU partner Eawag is developing flow cytometry based tools for cultivation-independent quantification of bacteria and for the assessment of biological stability and regrowth potential in drinking water (Hammes *et al*, 2007).

As a continuation of this line of research, the growth potential of pathogenic bacteria in freshwater, relative to the concentration of assimilable organic carbon (AOC), was investigated. Currently, it is thought that these bacteria are strictly copiotrophic (i.e. that they require high nutrient concentrations for growth) and that they die off quickly when released into the environment.

Using batch microcosms coupled with flow cytometric analysis, Eawag has demonstrated the growth of *V. cholerae* O1 (Vital *et al*, 2007) and *E. coli* O157 (Vital *et al*, 2008) in natural freshwaters at low organic carbon concentrations. A correlation between AOC, temperature and growth of these enteric pathogens was established (Figure 1).

The results show the potential of pathogens to grow during water treatment and distribution. However, this does not necessarily mean that the presence of AOC equates to the presence of pathogens in water. The research indicated that nutrient thresholds, temperature and competition with the natural flora all play determining roles in whether pathogen growth can occur.

These observations do, however, underpin the importance of monitoring nutrient (AOC) fluxes during drinking water treatment and distribution. It emphasizes the value of a holistic approach where the growth potential of bacteria in general, and pathogens in particular, are considered during risk assessment, process design and system monitoring.

References

Hammes, F., Berney, M., Wang, Y., Vital, M., Koster, O. & Egli, T. (2007). Flow-cytometric total bacterial cell counts as a descriptive microbiological parameter for drinking water treatment processes. *Water Res,* 42, 269-77.
Vital, M., Fuchslin, H. P., Hammes, F. & Egli, T. (2007). Growth of *Vibrio cholerae* O1 Ogawa Eltor in freshwater. *Microbiol SGM UK*, 153, 1993-2001.
Vital, M., Hammes, F. & Egli, T. (2008). *E. coli* O157 can grow in natural freshwater at low carbon concentrations. *Env Microbiol, (in press)*.

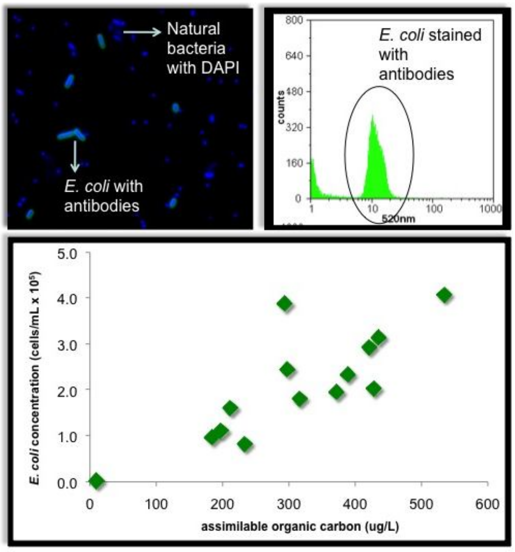

Figure 1 Pathogen results (A) Example of E. coli O157 stained with surface antibodies against a background of natural bacteria. (B) Stained E. coli cells detected with flow cytometry. (C) The relation between the growth (final cell concentration) of E. coli in batch cultures and the concentration of assimilable organic carbon in natural freshwater (data adapted from Vital et al., 2008)

For further information, contact Frank Sacher, WA3 Leader, or visit the TECHNEAU website (www.techneau.eu).

Integrated Risk Assessment and Water Safety Plans Training Seminars (WA4)

Integrated risk assessment, from source to tap, is the key to producing safe drinking water. WA4 has produced a Generic Framework for Integrated Risk Management in Water Safety Plans (WSPs) and a series of guides to advise water utilities on risk assessment and risk management (RA/RM) practice. In addition to this guidance, a range of 'tools' is being developed for use by water utilities, including the TECHNEAU Hazard Database (THDB), the TECHNEAU Risk Reduction Option Database (TRRDB) and the TECHNEAU Decision Support Tool (TDST) (see Figure 1).

As part of the TECHNEAU RA/RM Toolbox, a series of training seminars on RA/RM is planned for Southern Europe, Northern Europe and Southern Africa. Training seminars on RA will be carried out during 2008 and on RM during 2010. These seminars are designed as two-day workshops and include presentations and practical training. The seminars are aimed principally at water utility personnel but will also be of interest to others, including researchers, regulators and technology suppliers.

The first training seminar was held at LNEC in Lisbon on 15-16 May 2008. The seminar run by TECHNEAU Partners Chalmers University (Lars Rosén and Thomas Pettersson) and LNEC (José Menaia) with support from the Associação Portuguesa de Engenharia Sanitária e Ambiental (APESB), the Instituto Regulador de Águas e Resíduos (IRAR), EPAL S.A and Águas do Algarve S.A. The seminar highlighted the water situation and risks in Southern Europe and was attended by around 30 persons from Portuguese and Spanish water utilities and regulators.

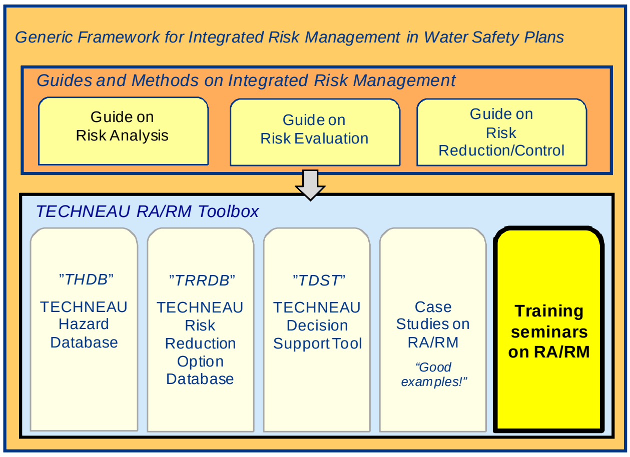

Figure 1 A conceptual schematic of the generic framework, guides and tools being developed in WA4

On the first day, presentations were given on RA and the tools developed in WA4 followed by a visit to EPAL to study the water distribution control system (see Figure 2).

On Day Two, participants worked in groups identifying potential hazards in the Lisbon water supply system using the WSP manual, the RA tools developed in WA4 and background information describing risk assessments carried out for case studies in WA4. The groups ranked potential hazards in the water supply system, presenting results in the form of risk matrices which identified the probability and consequence of each of the hazards.

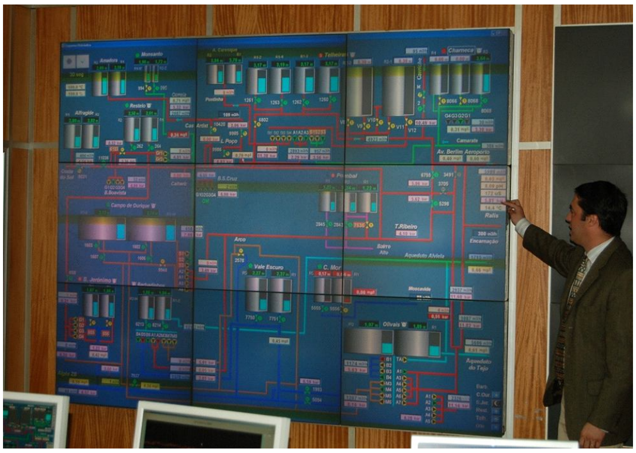

Figure 2 Visit to EPAL's water distribution control system

The training seminar was well received by the participants and the organisers are looking forward to the two remaining risk assessment seminars to be held during September 2008 in Oslo, Norway and Pretoria, South Africa.

For further information contact Thomas Pettersson, WA4 Leader, or visit the TECHNEAU website (www.techneau.eu).

Small-Scale Systems (3S) Workshop - Monitoring and Risk Assessment (WA2)

The second workshop of the TECHNEAU 3S Task Force was held in Tábor, Czech Republic, on 5 June 2008. Around 25 scientists and professionals from Europe attended the workshop to discuss monitoring and risk assessment with regard to decentralised water supply (Figure 1).

Figure 1 Participants at the second 3S workshop

The first session of the workshop was opened by Boris Lesjean (KWB) who briefly reviewed the mission and objectives of the 3S Task Force. Wouter Pronk (Eawag) identified key trends in water supply and discussed the capability of existing small-scale systems to cope with these future challenges. Where appropriate, adaptive strategies should be developed following guiding principles with regard to integration, flexibility and local conditions. Significant emerging technologies decscribed included new membrane types and UV-LED disinfection. Oliver Schmoll (UBA) and Maryna Peter (Eawag) described the structures, missions and actions of two WHO networks – 'Small Community Water Supply' (SCWS) and 'Household Water Treatment and Safe Storage' (HWTS) – that share common concerns with the 3S Task Force. The SCWS network (www.who.int/water_sanitation_health/dwq/smallcommunity/en/index.html) was formed to promote the achievement of substantive and sustainable improvements to the safety of small community water supplies, particularly in rural areas. The HWTS network (www.who.int/household_water/network/en/index.html) aims to reduce waterborne disease, especially among vulnerable populations, by promoting household water treatment and safe storage. The first session concluded with Eddo Hoekstra (EC-JRC) providing an overview of the revision of the drinking water directive highlighting the changes expected in the European regulations for decentralised supplies, including sampling points, protocols and frequencies for compliance monitoring.

The second session focussed on monitoring and risk assessment. Thomas Pettersson (Chalmers University) promoted the development of WHO Water Safety Plans with the integration of risk assessment and risk management (RA/RM) tools. Chris Swartz (Chris Swartz Water Utilization Engineers) and Frantisek Kozisek (SZU) presented case studies demonstrating risk assessments performed at small water supplies in South Africa and the Czech Republic, respectively. The risk assessment of the Upper Mnyameni water supply in South Africa identified contamination due to animals leaning on stand pipes and poor water storage practice as major risks. The main hazards identified in the Czech Republic case study were linked to the operation and maintenance of the water supply infrastructure. Ronald Wielinga (Kiwa WR) provided an overview of the activities related to monitoring undertaken by TECHNEAU. This included the evaluation of existing techniques as well as development. With respect to monitoring for 3S schemes, inexpensive and relatively simple instrumentation for group parameters was recommended. With current 3S schemes there is often a lack of monitoring data. Bistra Mihaylova (WECF) reported on-going projects in the rural areas of 12 countries of EECCA (Eastern Europe, Caucasus and Central Asia) to investigate nitrate pollution of drinking water. In rural EECCA, there is generally a low level of interest from local/national authorities and a lack of public awareness. The WECF projects will raise awareness and the need for the implementation of an adequate water policy.

For further information on the 3S Task Force contact Eric Hoa (eric.hoa@kompetenz-wasser.de). The 3rd workshop of the Task Force on "Operation, Maintenance and Customer Acceptance for Decentralised Water Supply" will be held in 2009.

For further information contact Marie-renee de Roubin, WA2 Leader, or visit the TECHNEAU website (www.techneau.eu).

Forthcoming Events

- **2-4 September 2008**

4th IWA Specialist Conference: NOM2008 - Natural Organic Matter Research from Source to Tap
Organiser: Centre for Water Science, Cranfield University
Host: Hilton Bath City, Bath, UK
Further information: Professor Simon Parsons (s.a.parsons@cranfield.ac.uk) or see NOM2008 website (www.cranfield.ac.uk/sas/water/conferences/nom2008)

- **7-12 September 2008**

IWA World Water Congress and Exhibition
Organiser: IAWD
Host: Austria Center Vienna (ACV), Vienna, Austria
Further information: See website (www.iwa-vienna2008.org)

- **15 September 2008**

Cryptosporidium Control in Drinking Water with UV Disinfection
Organiser: IUVA, WRc
Host: Imperial College, London, UK
Further information: Dr Tom Hall (tom.hall@wrcplc.co.uk) or see website (www.wrcplc.co.uk/pdf/IUVA.pdf)

- **29-31 October 2008**

METEAU: Metals and Related Substances in Drinking Water (COST Action 637)
Organiser: EPAL, IRAR, ARC
Host: Villa Rica Hotel, Lisbon, Portugal
Further information: See website (www.meteau.org)

TECHNEAU Delivered!

The TECHNEAU project has been running for 30 months. Publications are issued on the TECHNEAU website (www.techneau.eu) and can be downloaded free-of-charge. Publications available up to June 2008 are listed below.

Report Number	Title
	WA1 Rethink the System
D1.1.1	Report on Trends in South / Sub-Sahara Africa
D1.1.2	Report on Trends in Water Stressed Regions
D1.1.3	Report on Trends in Eastern European Countries (Baltic States)
D1.1.4	Report on Trends in Southern European Countries (Portugal)
D1.1.5b	Report on Trends in Central Europe (Germany / Switzerland)
D1.1.6a/b	Spain - A TECHNEAU Case Study: Phases I & II - Climate Change
D1.1.6c	Long Term Effects of Climate Change on Europe's Water Resources (Romania)
D1.1.7	Global Trends Affecting the Water Cycle: Winds of Change in the Water World
D1.1.9	Report on Trends Regarding Future Risks
D1.1.11	Organisation and Financing Models of the Drinking Water Sector: Review of Available Information on Trends and Changes
D1.1.12	Report on Consumer Trends: Cross-cutting Issues Across Europe
D1.1.14	Trend Report: The Netherlands
D1.2.1	Adaptive Strategies: Integrated Approach and Flexibility under recognition of Local Conditions
	WA2 Treatment Technologies
D2.1.2	State-of-the-Art Report on Reverse Osmosis Desalination
D2.1.2b	New Prototype Pre-Filter for Seawater Reverse Osmosis: Protocol for Bench-Scale Testing
D2.3.1.1	Organic Micropollutants with Nanofiltration
D2.3.1.2	A Nanofiltration Retention Model for Trace Contaminants in Drinking Water Sources
D2.3.1.3	Influence of Electrostatic Interactions on the Rejection with NF and Assessment of Removal Efficiency during NF/GAC Treatment of Pharmaceutically Active Compounds from Surface Water
D2.3.2	Coagulation Pre-treatment for Microfiltration with Ceramic Membranes
D2.3.3.5a	Case-Related Protocol for Optimal Operational Conditions to Treat Filter Backwash Water
D2.3.3.5b	Ceramic Membrane Applications for Spent Filter Backwash Water Treatment
D2.4.1.1	UV Disinfection and UV/H_2O_2 Oxidation: By-product Formation and Control
D2.4.2.6	Modelling of Micropollutant Removal by Ozonation and Chlorination in Potable Water Treatment
D2.5.3	International Market Survey on Membrane-based Products for Decentralised Water Supply: Bibliographic Report

D2.5.4	Decentralised Water Supply and Membrane Processes: Workshop
WA3 Monitoring and Control Technologies	
D3.1.1/2	Monitoring and control of Drinking Water Quality: Selection of Key Parameters
D3.2.1	UV-Vis Monitoring Station for Calculating ‘Integrated Parameters’
D3.2.4	A Method for the Concentration of Microbes in Large Volumes of Water
D3.2.5	Interim SOP for HPLC-based Analysis of New Algal Toxins (Dissolved State) in Natural Waters
D3.3.1	A Flow Cytometric Method for AOC Determination
D3.3.2	Feasibility Report of a Quantitative Method for Rapid Assessment of Microbial Population Composition in Drinking Water using Flow Cytometry combined with FISH
D3.3.4	Development of a Toolbox for Identifying and Quantifying Membrane Biofouling in Drinking Water Treatment
D3.3.5	Assessing the Feasibility of Total Virus Detection with Flow Cytometry in Drinking Water
D3.3.7	A Protocol for the Determination of Total Cell Concentration of Natural Microbial Communities in Drinking Water with FCM
D3.3.8	Cultivation-independent Assessment of Viability with Flow Cytometry
D3.3.12	Development of a Toolbox for Identifying and Quantifying Membrane Biofouling in Drinking Water Treatment
D3.4.6	Odour and Flavour Tests: Human Panel and Electronic Testing Compared
D3.4.10	Monitoring and Control of Drinking Water Quality by the ToxProtect Fish Monitor
D3.4.11	Comprising Report on ‘State-of-the Art’ Available Technologies for Automated Evaluation Systems
D3.5.1	Development of FISH Methods for Detection of Pathogens in Biofilm
WA4 Risk Assessment and Risk Management	
D4.1.1/2	Identification and Description of Hazards for Water Supply Systems: A Catalogue of Today’s Hazards and Possible Future Hazards
D4.1.3/ D4.2.1/2/ 3	Generic Framework and Methods for Integrated Risk Management in Water Safety Plans
WA5 Operation and Maintenance	
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D5.3.1b	Ozonation and Biofiltration in Water Treatment: Operational Status and Optimization Issues
D5.3.2	Water Treatment by Enhanced Coagulation and Ozonation-Biofiltration: Intermediate Report on Operation Optimisation Procedures and Trials
D5.3.4a	Ultrafiltration with Pre-Coagulation in Drinking Water Production: Literature Review
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D5.3.8	Impact of Chlorination on the Formation of Odour Compounds and their Precursors in Treatment of Drinking Water
D5.3.10	Backwash Characteristics of Granular Activated Carbon (GAC) from Asia
D5.4.1	Models for Drinking Water Treatment: Review of State-of-the-Art
D5.4.1a	International Workshop on Treatment Simulators: Review
D5.4.2	Models for Drinking Water Treatment: Methodology for Integration
D5.4.3	Conceptual Design of Modelling Framework
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D5.5.3	Database on the Formation of Sediment in Drinking Water Distribution Systems
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D5.5.5	Review and Selection of Monitoring Parameters and Methods
D5.5.9	Modelling Planktonic and Biofilm Growth of a Monoculture (*P. fluorescens*) in Drinking Water
D5.6.1 / D5.6.2	Report on Operational Methods and Maintenance Schemes: Applied in Praxis and Compared to Best Practice
WA6 Consumer Acceptance and Trust	
D6.1.1	Assessing Consumer Trust and Confidence: Methods Appropriate for the Water Utilities
D6.1.2	Consumer Trust and Confidence: An Overview
D6.1.5	Stakeholder Interviews
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D6.2.2	Assessing Consumer Preferences for Drinking Water Services: Methods Appropriate for Water Utilities
D6.2.5	Stakeholder Interviews
WA7 Integrate, Validate and Demonstrate	
D7.4.3	Case Study 2: Report of the End-user Workshop with EPAL
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WA8 Dissemination and Training	
D8.1.1	Scan of Promising Technologies in the SME Network

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