Abstract proceedings

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List of contents

Water and Environment theme, Sino-Danish Center for Education and Research (SDC), Beijing

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Abstract
Sino-Danish Center for Education and Research (SDC) is a partnership between all eight Danish universities and University of Chinese Academy of Sciences (UCAS) in Beijing. SDC provides a platform for jointly undertaken research activities and exchange of scientific staff between China and Denmark. The selection of Water and Environment themes is based on the presence of complementary strengths and significant growth potential. The overall aim of SDC is to promote and strengthen collaboration between Danish and Chinese learning environments and increase mobility of students and researchers between Denmark and China.

SDC in Beijing offers unique Master's Programmes jointly developed by Danish and Chinese research environments. As part of the development of the MSc educational programmes, SDC is involving a range of Danish companies to ensure that the students become acquainted with how these companies operate in China including existing areas of business, potential R&D activities as well as requirements/expectations of future employees. This is important as the same companies are expected to be future employers of the SDC candidates. Collaboration with the industry is a cornerstone in SDC's education and research activities.

Students can receive training through internships and thesis collaboration whereas researchers can work with company labs on commercializing results and access state-of-the-art technology. At the same time, companies can use SDC to access talents and resources at Danish universities and China's leading national institution for science, technology and innovation: Chinese Academy of Sciences (CAS).

This presentation will give an overview and status of the initiative including opportunities and challenges.

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China Europe Water Platform

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Abstract
In March 2012, the China-Europe Water Platform (CEWP) was launched at the 6th World Water Forum in Marseille, France, where a Joint Statement was signed between Mr. Chen Lei, Minister of Water Resources of the People's Republic of China and Ms. Ida Auken, Danish Minister of the Environment, representing the Presidency of the Council of the European Union.

The CEWP aims at realising good governance in managing water resources, enhancing mutual understanding on approaches in integrated water resources policy development and implementation. The CEWP will seek to promote the exchange of innovative knowledge and technologies to meet common challenges, creating opportunities for private sector and research institutes on both sides to undertake business development and joint research programs of common interest.

The CEWP is a platform for co-operation based on equality and dialogues in the areas of policy, research and business and has a five year horizon. The work was officially started by a technical session at the Yellow River Forum in Zhengzhou in September 2012 and several activities at both a political and a more practical level are ongoing.

As Denmark is co-lead on Groundwater and therefore has the initiative on this issue, the Danish Nature Agency has started a parallel activity with a programme aiming at exchanging Danish experiences and expertise with China on groundwater in business, management and research, including the rest of Europe on the long term. The presentation will give a short overview of activities and plans of the initiative at both the European and the Danish level.

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Hydrological modelling for climate change and water management impact assessment in data sparse regions

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Abstract
The cross-disciplinary research and capacity building project CLIVET addresses the assessment of climate change impacts on water resources and agriculture in the Great Ruaha River (GRR) Basin in Southern Tanzania. A prerequisite for the hydrological assessment under future climate conditions are sound hydrological modelling tools which are setup, calibrated and validated under historic climate conditions. Hydrological modelling at large scale in developing countries is however often limited by a lack of sufficient climatological and hydrological data combined with insufficient records of land surface conditions such as vegetation and irrigation.

Special focus in the project has been on the Upper Great Ruaha River (UGRR) and the seasonal Usangu wetland. The Upper great Ruaha is the hydrologically most important tributary to the GRR. Not only is the UGRR considered the bread basket of Southern Tanzania due to the large irrigation based agricultural production, but the UGRR also feeds the downstream Mtera Dam which produces 70 % of all electricity in Tanzania. In addition, the dry season flow in UGRR is vital for the animals in the Ruaha national park and game reserve. Therefore an observed decline in dry season flows in UGRR is of huge national attention and its restoration is critical.

In the presented study it is attempted to utilize the vast amounts of remote sensing data available today to generate consistent data records of both the past 10 years and to utilize the remote sensing based information to improve spatial interpolation of rain gauge data for periods before remote sensing data were available. In Tanzania, rain gauge stations have declined considerably in numbers since the 1960's, and today only a fraction of the original station network exists. The recent decline in rain gauge stations coincides with the development of satellite remote sensing for estimating rainfall maps. Although the raw satellite based rainfall maps are not of sufficient quality in the mountainous catchment to be used directly in the hydrological modelling, the spatial pattern of remotely sensed rainfall can be used to improve the spatial interpolation of the sparse rain gauge network.

In addition to the utilization of satellite based rainfall estimates time series of satellite data are used to obtain a 10 year long record of vegetation density (Leaf Area Index) from the MODIS satellite. This enables a detailed description of both the spatial and temporal pattern of vegetation cover since the satellite estimates are produced every 8 days at 1000 m resolution.

Besides the data scarcity, hydrological modelling of the UGRR is complicated further by the seasonal dynamics of the Usangu wetland which in the wet season covers roughly 700-1000 km^2 while it diminishes to only in 50 km^2 the dry season. In order to map this seasonal dynamic Satellite radar data from the European Envisat ASAR sensor are being used, enabling an observation based evaluation of the modelling of the wetland dynamics.

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Geophysical and geochemical characterisation of groundwater resources in Western Zambia

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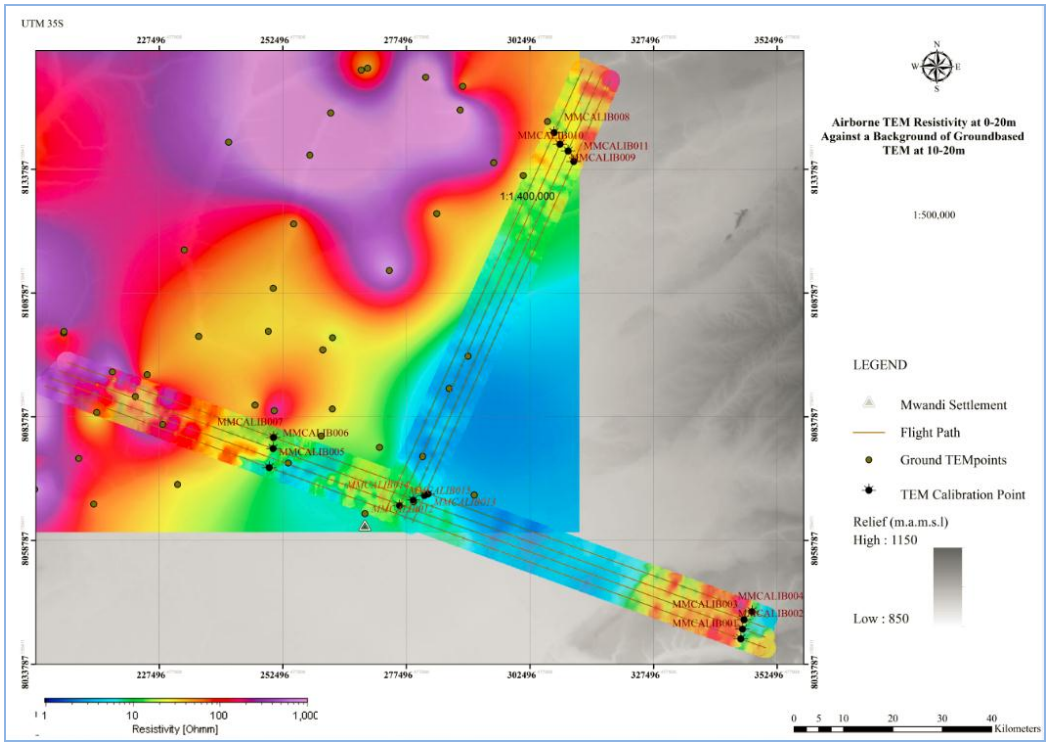
Abstract
Zambia's rural water supply system depends on groundwater resources to a large extent. However, groundwater resources are variable in both quantity and quality across the country and a national groundwater resources assessment and mapping program is presently not in place. In the Machile area in South-Western Zambia, groundwater quality problems are particularly acute. Saline groundwater occurrence is widespread and affects rural water supply, which is mainly based on shallow groundwater abstraction using hand pumps.

This study has mapped groundwater quality variations in the Machile area using both ground-based and airborne geophysical methods as well as extensive water quality sampling. The occurrence of saline groundwater follows a clear spatial pattern and appears to be related to the palaeo Lake Makgadikgadi, whose northernmost extension reached into the Machile area. Because the lake was a closed endorheic system over at least parts of its geologic history, evapo-concentration caused high lake water salinity and deposition of saline sediments. Those saline sediments are presently exposed at the land surface. Surface water – groundwater interaction as well as local recharge from precipitation has formed limited freshwater reservoirs in a generally saline area, which need to be sustainably managed.

We will present initial results from the geophysical and geochemical surveys conducted over the past few years. We will interpret these findings in terms of the geologic history of Southern Africa and link them to Lake Palaeo Makgadikgadi. Finally, we will discuss implications for sustainable groundwater resources management in the area.



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SUSA Ghana: A multi-disciplinary research project on sustainable sanitation in peri-urban Ghana

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Abstract
The University of Copenhagen in partnership with the University of Ghana, Kwame Nkrumah University of Science and Technology and the Dodowa Health Research Centre has been awarded funding from the Danish Ministry of Foreign (FFU) affairs to conduct a large sanitation research project in the Dangme West District of Ghana, with a focus on rapidly developing townships.

Close to 50% of Ghana's 23 million residents currently live in urban or peri-urban environments, however, only 27% of such residents have access to improved sanitation and only 13% are connected to sewerage facilities. The traditional approach to building sanitation facilities has not resulted in significant and sustained sanitation coverage, in particular for the peri-urban poor. Latrine uptake is low because existing technologies are poorly designed, in poor condition, unsafe and cost prohibitive. Poor sanitation is the primary cause of diarrheal disease, which accounts for 9% of all deaths in Ghana and 4.3% of all disease reported in outpatient facilities.

The Dangme West District in Ghana has been chosen as the study site for this research because over the last 10 years the proportion of urban residents in the District has risen from 20% to 40%, which has outpaced the capacity of government to handle the accompanying sanitation challenges. The toilet facilities often do not meet the standards of improved latrines and waste disposal methods are not environmentally safe or hygienic. A large proportion of households (43%) has no toilet facility and uses the bush, beach or field. Approximately 21% of households use unimproved pit latrines.

The objective for the SUSA Project is to use a multidisciplinary demand driven approach to identify existing barriers to and opportunities for improved sanitation including solutions that residents will use and maintain in poor urban settings. A total of 5 Ghanaian PhD researchers and 10 Danish and Ghanaian Master Students will conduct research on 5 key aspects of sustainable sanitation from January of 2011 to October, 2014:

- Preferences and Practices in Peri-Urban Sanitation (Social Science Research)
- Technical and Urban Planning Barriers to Improved Sanitation (Engineering Research)
- Risks and Hazards in Peri-Urban Sanitation Provision (Microbiological Research)
- Sanitation Business Systems in Peri-Urban Environments (Economics/Business Research)
- Monitoring and Evaluation in the Sanitation Sector (Survey Research)

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Growth, yield and WUE of drip and sprinkler irrigated okra grown on sandy soil under semi-arid conditions in Southeast Ghana

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Abstract

Vegetable production systems at the Keta sand spit, Southeast Ghana, are typically managed with excessive amounts of irrigation water and fertilizers on sandy soils with low inherent water and nutrient retention capacities. The shallow groundwater which is the primary irrigation water resource is prone to salinization from the Keta lagoon, the Atlantic Ocean and brackish water underneath (Kortatsi and Agyeku, 1999). To ensure the sustainability of vegetable production at the Keta spit, introduction of water saving irrigation systems and improved irrigation management schemes are important. Thus, the main aim of our study was to explore the water saving potential of drip irrigation in order to save the shallow groundwater from over exploitation.

A two season study (minor dry season, 2011 and major dry season, 2012) were carried out to determine the okra crop response to the following treatments: 1. sprinkler irrigation with spread manure; 2. sprinkler irrigation with placed manure; 3. drip irrigation with placed manure and 4. drip irrigation with fertigation. Fertigation was done only two times (two weeks after emergence and immediately after flowering) during the first experiment while weekly fertigation (8 times from two weeks after emergence) was done during the second experiment. The treatment effects on growth, yield, biomass, water use efficiency of the economical fresh pod yield (WUEy), and on the total above ground biomass (WUEtbm) were studied. The results showed that the okra crop did not respond well when fertigation was done only twice; however, the second experiment in the major dry season, the 2012 season, showed a marked improvement in the fertigated treatment compared to the others when fertigation was done weekly. In the second experiment despite the application of the same amount of nitrogen (89 kg N/ha), there were significant differences ($P \leq 0.05$) between yield obtained with sprinkler spread manure (11.2 t ha-1), sprinkler placed manure (13.7 t ha-1), and drip fertigated (17.5 t ha-1); however, the yield difference between sprinkler placed manure (13.7 t ha-1) and drip placed manure (13.9 t ha-1) was insignificant ($P \leq 0.05$) and WUEy and WUEtbm in the drip fertigated treatment was significantly ($P \leq 0.05$) higher than in other treatments. Seasonal crop water use (ETc) for drip irrigation was 236 mm compared to 339 mm for sprinkler in the 2011 season. In the 2012 season, ETc for the drip irrigated okra crop was 269 mm compared to 379 mm for sprinkler. By adopting drip irrigation to okra, the seasonal crop water use could be reduced close to 30 %. From the results it is concluded that on rough textured sandy soil drip irrigation with frequent weekly fertigation resulted in significant water savings and yield increase compared with sprinkler irrigation.

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Water and Health: Challenges in Denmark today

C. Jørgensen, DHI

Abstract
John Snow identified contaminated water from a pump on Broad Street as the route of transmission of cholera in London in 1854. He persuaded the authorities to remove the water pump handle and thereby prevented further transmission of the disease. Robert Koch proved that sand filtration of drinking water reduced the risk of cholera infections in Altona compared to Hamburg if the number of bacteria in the filtered water was below 100 CFU (colony forming units) in 1892. Snow and Koch are in many ways fathers of water management as they identified water related health risks, designed and implemented interventions and means of monitoring of the effect.

Today we know much more about hazards and health risks related to the water and legislation is in place. The drinking water and the bathing water directives seek to reduce the risks by setting water quality standards and require surveillance. The objective of the urban waste-water directive on the other hand is to protect the environment from the adverse effects of urban waste water discharges. The implementation of this legislation has been a tremendous success, to the extent that we do not in our daily life consider waste water and faecal contamination as a significant risk. Due to the success of urban water management health risks have been largely neglected and consequently our knowledge about the extent of water related illness in Denmark is inadequate. However, the increased occurrence of extreme rain events has led to an increased exposure to waste water and thereby given increased risks. Therefore an increased focus on water related health risks are warranted.

This presentation will give an overview of the links between the risk of becoming ill after exposure to water, identify gaps in our knowledge and suggest solutions.

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Iodine in Danish ground and drinking water – preliminary speciation results and design of a nationwide sampling campaign

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Abstract

In Denmark, the content of iodine in groundwater is an important factor for human thyroid functioning as drinking water is a major iodine source. Previous studies have shown that parts of the Danish population receive enough iodine from their drinking water while others do not. However, in 2000 the national health authority initiated table salt iodisation and the population probably receives enough iodine, and possible adverse effect on public health of I amendment is closely monitored. The reported Danish population based studies are for Copenhagen, Randers, Skagen and Aalborg, there might thus still be some sub-population groups receiving insufficient I as long as the distribution of drinking water I and its bioavailability are unknown for other locations.

Many geochemical aspects of iodine's natural cycling are nevertheless obscure as there are no studies of the entire hydrogeochemical cycle of iodine in Denmark. Danish paradigms for analysis of groundwater and drinking water at public and private water works do not include iodine, and therefore geographical and spatial variations are poorly described. However, iodine was included in the Danish groundwater monitoring program in 2012.

The aim of an ongoing Geocenter project is accordingly to study iodine in the hydrogeological cycle related to the implication of low iodine intakes for human health. Such improved understanding of spatial variation, amounts and speciation of iodine in natural sources could be crucial for the ongoing evaluation of the program for iodisation of table salt. For example, it was previously found that iodine is bound to bioavailable humic substances in Danish drinking water from Skagen, and it has been interfered that the epidemiology of thyroid diseases probably depends on the source of aquifer sediments as iodine in drinking water not necessarily is bioavailable.

In this presentation we'll give an overview of the first results including multivariate data analysis and iodine speciation studies, and discus the findings in a geological, hydrogeochemical and medical geology context.

During 2013 a nationwide sampling of Danish drinking water will be carried out as part of the project. The aim is to establish a fully comparable dataset for multivariate analysis of I speciation in groundwater and drinking water, including a number of major and minor parameters. In addition to iodine speciation the collected water sample could also be used for concomitant analysis of other elements and compounds which are not standard parameters. Possible spin-off projects from a combined nationwide sampling and analysis of novel parameters in a fully contemporary campaign as the iodine project will be discussed.

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E. coli contamination and health aspect associated with the use of on-site treated wastewater and canal water for irrigation of potatoes and tomatoes

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Abstract

Clean water has become one of the main limiting factors in agricultural food production in Europe and to overcome water shortages the European Water Framework Directive encourages the use of treated urban wastewater in agriculture. However, the use of low quality water in agriculture poses potential health risks. The application of wastewater through subsurface drip irrigation lines could possibly overcome public health concerns by minimizing farmer contact with wastewater but it is uncertain if the risk for consumers of waste water irrigated produce would be acceptable. During 2007 and 2008, the faecal contamination of irrigation water, soil, potatoes and tomatoes were assessed by enumeration of the faecal indicator organisms *E. coli*.

Potatoes irrigated by sprinkler, furrow and subsurface drip irrigation, using treated urban wastewater, canal water and tap water were compared at experimental sites in Serbia and Italy. The study found low levels of *E. coli* in irrigation water (mean value: Italy 1.70 cfu/ml and Serbia 11 cfu/ml). In Italy, three soil samples from 288 soil samples contained *E. coli* (mean: 1.0 cfu/g) and in Serbia, 24 soil samples out of 90 were positive for *E. coli* (mean: 1.1 cfu/g). In Italy, one potato sample out of 36 potato samples contained *E. coli* (1.0 cfu/g) and no potato samples (0/18) contained *E. coli* in Serbia. Tomatoes were irrigated by sprinkler irrigation and surface and subsurface drip irrigation with treated urban wastewater and tap water at experimental sites in Crete and Italy. The study found elevated levels of *E. coli* in irrigation water (mean: Italy 17.53 cfu/ml and Crete 4.88 cfu/ml) and low concentrations of *E. coli* in soil. Of the 348 soil samples collected in Italy, *E. coli* was detected in 31 of the soil samples (mean: Italy 95 cfu/g). *E. coli* was detected in 23 out of 104 soil samples in Crete (mean: 33 cfu/g). Only two tomato samples out of 48 samples in Crete contained *E. coli* (mean: 2700 cfu/g), while tomatoes from Italy were free of *E. coli*. During 2008, 69 *E. coli* isolates were collected from irrigation water, soil and potatoes at the potato field in Italy and characterized by Pulsed Field Gel Electrophoresis (PFGE) DNA fingerprints. Three *E. coli* isolates from the one *E. coli* positive soil sample resulted in three different DNA fingerprints with one being unique and two being identical to *E. coli* isolates from irrigation water isolated on the same day. The three *E. coli* isolates from the potato sample were identical but not similar to any of the *E. coli* isolates recovered from soil and irrigation water. PFGE DNA fingerprints of *E. coli* (Italy, n=137; Crete, n=27) collected from tomato fields during 2008 showed no identical pattern between water and soil isolates which indicates contribution from other environmental sources with *E. coli*, e.g. wildlife.

A QMRA model combined with Monte Carlo simulations was used to assess whether the different irrigation practices and associated health risks complied with guidelines set by the WHO. The risk assessment models found the use of treated wastewater and canal water to exceed the acceptable levels of risks for gastro-intestinal disease (1.0×10^{-3} disease risk per person per year (pppy)) as recommended by the WHO for the accidental ingestion of soil by farmers (Serbia: 0.22 pppy and Italy: 5.7×10^{-2} pppy). Disease risk from consumption of potatoes in Italy and in Serbia was found to be within acceptable levels. The risk assessment models found the tap water and treated wastewater used for irrigation of tomatoes to be associated with risks that exceeded acceptable limits for accidental ingestion of irrigated soil by farmers (Crete: 0.67 pppy and Italy: 1.0 pppy). The QMRA found that the consumption of tomatoes in Italy was deemed to be safe while acceptable limits were exceeded in Crete (1.0 pppy). Overall, the quality of tomatoes was safe for human consumption. It is a limitation of the WHO QMRA model that it is not based on actual pathogen numbers, but rather on numbers of *E. coli* converted to estimated pathogen numbers, since it is widely accepted that there is poor correlation between *E. coli* and viral and parasite pathogens. Our findings also stress the importance of the external environment, typically wildlife, as sources of faecal contamination.

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Bathing water: Risk, solutions, and monitoring. Case: Ironmen swimming in diluted wastewater

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Abstract
For years we have been discussing in Denmark whether swimming in coastal areas was associated with any health risks. The general acceptance was that this was not the case, and until recently evidence of the opposite has been lacking. With the European Bathing Water Directive, which is being implemented these years, this is changing, and the focus has been dedicated to protect human health: *'...The purpose of this [the Bathing Water] Directive is to preserve, protect and improve the quality of the environment and to protect human health ..(article 1, section. 2)'* and to adapt some kind of early warning if unacceptable water quality is expected to occur at the beaches.

Since 2002, DHI in cooperation with the City of Copenhagen and Copenhagen Energy (Copenhagen water utility company), has operated an early warning system for bathing water quality. To improve the predictive values of this system, we have over the last few years worked on methods and tools to quantify the risk associated with recreational waters as such, exemplified by combined sewer overflows near beaches in and around Copenhagen. The methods combine dynamic hydrodynamic- and bacterial modelling with quantitative microbial risk assessments (QMRA), and hence, provide dynamic assessments of risks associated with the use of sewage polluted recreational waters. However, the methods and tools are applicable for any water body, and eventually any kind of pathogen bacteria, vira, etc.

For this presentation the developed methods and tools will be presented and the strength of the system showcased by Copenhagen's first official triathlon event, Copenhagen Challenge 2010, where almost 1800 triathletes were exposed to bacterial levels that by far exceeded the official thresholds for safe bathing water quality.

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Flooding and health risks
What will Greater Copenhagen Water Company do?

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Abstract
The overall objective for a water company is to protect public health through:

1. Provide safe and reliable water
2. Remove and discharge wastewater to minimize contact with infectious agents
3. Manage stormwater to minimize accidents and avoid damage to vital infrastructure

Since the cholera epidemics in Copenhagen I the 1850's (mirrored elsewhere in Europe), Copenhagen has constantly improved its water supply and sewerage system to accommodate economic development, increase in urbanisation and public demand for a clean and healthy environment.

Following the extreme stormwater event 2. July 2011, Copenhagen had to address the issue of flooding in the city immediately, to reduce negative impact on humans, infrastructure and property.

This presentation will address what the Greater Copenhagen Water Company already has done and what are the main concerns and issues ahead. The main concerns related to public health are deaths due to drowning, electrocution or infectious diseases like Leptospirosis. Further, is the protection of vital infrastructure prioritised including power supply, the water and wastewater system, hospitals and evacuation roads. An English survey concluded that flooding in the high income usually does not results in outbreaks of infectious diseases, as pathogens becomes so much diluted by flood water, that the infective dose is insufficient for disease transmission.

The presentation will include initiatives taken so far and the expected effect of these. The initiatives include improved disaster preparedness and handling of flood water

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Drinking water: Risks, solutions, and monitoring. Case: Nørrebro.

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Abstract

The drinking water supply is extremely decentralized in Denmark with approximately 2600 waterworks, exclusively groundwater based and without disinfection. Ten years ago the Danish Environmental Protection Agency (EPA) and the Danish Water and Waste Water Association (DANVA) conducted questionnaires addressing the environmental centers, municipalities and waterworks to collect information on microbial drinking water contaminations. The project (Engelsborg et al., 2009) aimed at elucidating factors influencing and affecting drinking water contaminations.
The data included waterworks and distribution systems and were based on 3,123 measures of microbiological parameters. In the investigated period January 1st 2000 - December 31st 2002, at least 205 microbial incidents in 185 different water supplies, and 50 boiling orders were registered. Microbial contaminations increased during autumn, following the increase in precipitation where the larger water volumes increase the risk for intrusion of surface water into the water supply. 48% of the microbial contaminations were only detected at the waterworks and 30% only in the distribution systems. More serious contaminations (*i.e.* levels which should lead to boiling order) were detected at waterworks than in distribution networks. The frequency of microbial contaminations was relatively high at the very small water supplies (<10,000 m^3/yr), since 23% of the detected contaminations was related to these water supplies. 94% of all serious contaminations were detected in small water supplies (< 350,000 m^3/yr, ~4,560 users) which constituted 94% of the waterworks in Denmark. However, this group only abstracts approximately 36% of the total abstracted volume in Denmark, indicating a relatively larger risk for serious contamination for smaller water supplies than for larger ones. In distribution systems more microbial contaminations were detected related to larger water supplies with a more frequent control than in smaller ones, and it is assumed that the detection of contaminations in distributions systems probably is proportional to the frequency of sampling. The boiling orders lasted more than 100 days in 23% of the cases, and for 23% of the cases with boiling order, it took more than 1 month before the boiling order was issued.
Data from the Enteropathogenic Register with the address of diarrhea-patients, were related by GIS-tools to the geographical location of the contaminated water supply area. Diarrhea-frequency was higher in contaminated water supply area compared to the rest of the municipality in more than half of the 35 investigated cases – by detailed analysis in an even larger fraction. There was also a tendency for higher number of gastro-intestinal disease for consumers living in area with a low degree of urbanization (rural) than in large cities.
During the last years Embedslægerne has followed up on this work with annual reports on drinking water contaminations confirming that the frequency of contaminations is more or less unaltered.
Increased control and monitoring may be ways to prevent the microbial contaminations – and DDS (water safety plans) and increased on-line monitoring (Corfitzen & Albrechtsen, 2011) have been initiated at many water utilities, but so far the full advantages of these initiatives remain to be harvested. Unfortunately a number of major contaminations have been registered, at e.g. Køge, Tune, Aarhus, and Copenhagen and lately Kalundborg - in some cases even with substantial outbreaks. This probably reflects an increased awareness of the water quality and the monitoring data.

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Studies of UV techniques for treatment of the aqueous phase from dredging operations of tributyltin contaminated sediment

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Abstract
The extensive use of organotin pesticides as anti-fouling agent in ship paints has led to a massive pollution of the sediment and to a lesser extent the water of industrial harbours worldwide. From the beginning of the 1960's and up until it was banned in 2003 by the International Marine Organization (IMO), tributyltin (TBT) was considered the most effective active ingredient in anti-fouling paints. The prevention of biological settlement on ship hulls decreases fuel consumption, biological corrosion rates, and frequency of dry-docking, and in 2004, it was estimated that TBT-self-polishing copolymer paints covered more than 70-80% of the world's fleet. However, the cost of the success is paid by the coastal marine environment and in particular the marine species inhabiting sediment and water of ports, harbours and shipyards, where high concentrations of TBT exceeding acute and toxic levels is found.

The concentration of TBT in sea water is typically very low (on the level of nanogram per liter), but due to its strong accumulation in sediment it constitutes a challenge of concern, when sediment is dredged from ports, harbours and channels to maintain sail routes, extent dock areas etc. During sediment dredging and subsequent disposal at upland sites, sea water is used as a carrier medium, and discharge of the drained water and run off to the marine recipient is authoritatively regulated. Large shallow areas for sediment disposal with good sunlight penetration are needed for the natural TBT degradation to be sufficient to maintain discharge limits. In order to save valuable land in areas of typically high industrial activity, artificial treatment of the water drained from the upland sites can be economically beneficially.

This study presents results from photolytic and photocatalytic treatment experiments conducted in cooperation with the Port of Esbjerg where the influence of the sea water matrix, different types of high and low pressure ultraviolet (UV) lamps and different reactor design have been examined. The investigation showed that the photolytic rate of degradation in sea water was reduced by 41% compared to the degradation in dist. water. Moreover, the photocatalytic TiO_2 surface was inactivated by the relatively high salinity of the water. With the same type of lamp, the rate of removal was dependent only on the specific amount of UV energy supplied to the water regardless of the specific power used. The high energy medium pressure Hg lamp (L1) was found to be the most efficient compared to the four low pressure lamps used, and the energy consumptions were estimated to be in the 7-8 Wh L^{-1} range per log reduction. This study has demonstrated a feasible method for abatement of TBT in this specific sea water matrix.

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Relating dynamic conditions to the performance of biological rapid sand filters used to remove ammonium, iron, and manganese from drinking water

Carson O. Lee, Hans-Jørgen Albrechtsen*, Barth Smets*, Rasmus Boe-Hansen**, Søren Lind***, Philip J. Binning*, Technical University of Denmark, DTU Environment *, Kruger**, HOFOR****

Abstract
Biological rapid sand filters are used throughout the world to remove both particulates and dissolved compounds from drinking water and is a proven and effective treatment technique for providing safe and secure drinking water. However, experience has shown that some filters have problems consistently meeting regulatory guidelines for compounds like ammonium and reduced forms of iron and manganese. These compounds can cause biological instability in the distribution system and can lead to many problems including the growth of pathogens and aesthetic problems (taste, odor, and color).When problems occur in these filters, current solutions are often based on rules of thumb and guess work rather than on firm scientific principle. The goal of this research is to characterize the underlying processes that control the biological performance of biological rapid sand filters in order to link filter management to performance. This can be used to optimize operating conditions such as flow rate, loading conditions, and time between backwash cycles, to ensure that water quality guidelines are continuously met and so the filters are operated as efficiently as possible.

Pilot scale biological rapid sand filter columns were set up at Islevbro water works, a drinking water plant in west Copenhagen, to determine how operating conditions and substrate loading affect the performance of the filters. Two columns were run in parallel and fed with influent water from the water works. The sand in the pilot columns was taken from one of the full scale filters and matches the depth profile of the full scale filter.

The pilot columns were initially operated for 2 and a half months at similar operating conditions as the full scale filter to validate the performance of the pilot columns. After this, a series of short term ammonium load shift experiments were performed in one of the columns to determine the maximum nitrifying capacity of the filter. Ammonium was dosed until steady state was established (between 6 and 8 hours) and water samples were collected with depth to determine the ammonium and nitrite removal throughout the depth of the column. These experiments were also performed at two different flow rates and various times after backwashing to determine if these conditions influenced the nitrifying capacity of the filter. Water samples were also collected with depth for Iron and manganese to determine the effects of flow and increased ammonium loads on the removal of these compounds. Media samples were also collected with depth and qPCR analysis was done to determine the density and distribution of ammonium oxidizing bacteria (AOBs) in the columns.

The results showed that the columns were able to remove significantly more ammonium than under normal loading conditions and that the capacity does not change as a function of flowrate or time after backwash. The columns did see increased nitrite above regulatory limits in the effluent during the load shift experiments. Iron and manganese removal were not affected by increased ammonium loads and the density and distribution of AOBs closely follows the ammonium removal in the filter. The results show the filters are able to safely operate under increased flow rates and ammonium concentrations and that the time after backwash does not dramatically effect nitrification in the filters.

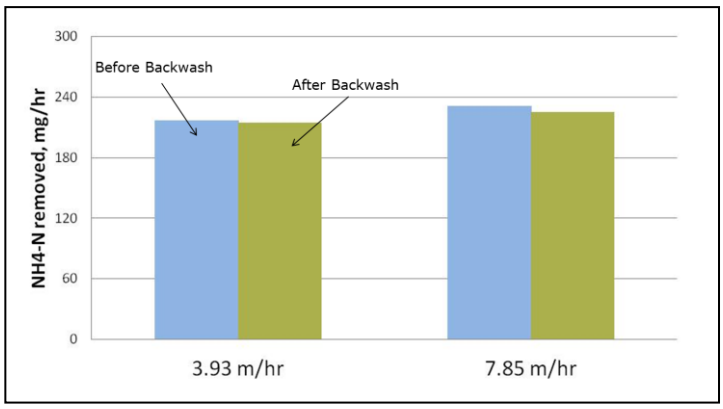

Figure 1: Ammonium removal (mg NH4-N/hr) in pilot columns at normal flow (3.93 m/hr) and double the normal flow (7.85 m/hr) both before and after backwash

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NATIOMEM
Development and testing of TiON photocatalytic membranes

G. Heinicke, DHI, O. Grønborg, Skjølstrup & Grønborg ApS***

Abstract
NATIOMEM is a collaborative research project co-funded by the European Commission under the Seventh Framework Programme (FP7). The objective of NATIOMEM is to develop novel technology for treating contaminated water, based on visible light photocatalysis on a membrane coated with nitrogen-doped titanium dioxide (TiON). In addition to DHI (project coordinator) and Skjølstrup & Grønborg (Water engineering, SME), NATIOMEM includes universities in France, Italy, the UK and Israel, and partners for pilot testing in Jordan and South Africa. The presentation reports current results from the development and testing of coated membranes.

Photocatalytic coatings based on TiON were developed by the coating laboratories, and transferred to a selection of membrane substrates, including metal filter material and several ceramic microfiltration membranes. The coated membranes were investigated using a custom-made flow-cell. The flow-cell allows for various flow conditions, including dead-end, cross-flow, as well as recirculation over the coated surface. The test objectives included the efficiency of coatings to degrade chemical substances, the effect of filtration mode (dead-end, cross-flow, or flow along the coated surface), particle retention, microbial inactivation, the effect of the cover material, interference of ions, as well as cleaning options after fouling.

Pilot plants have been designed and constructed by Skjølstrup & Grønborg, using the most promising coated membrane. Two separate concepts were developed for rural and for urban applications. In South Africa, a low-tech application for drinking water treatment will not require electrical power, chemicals or other logistical support. For urban areas, the pilot plant will be tested in two applications: Disinfection of microbial unsafe piped drinking water, and polishing of pre-treated grey wastewater for non-potable reuse.

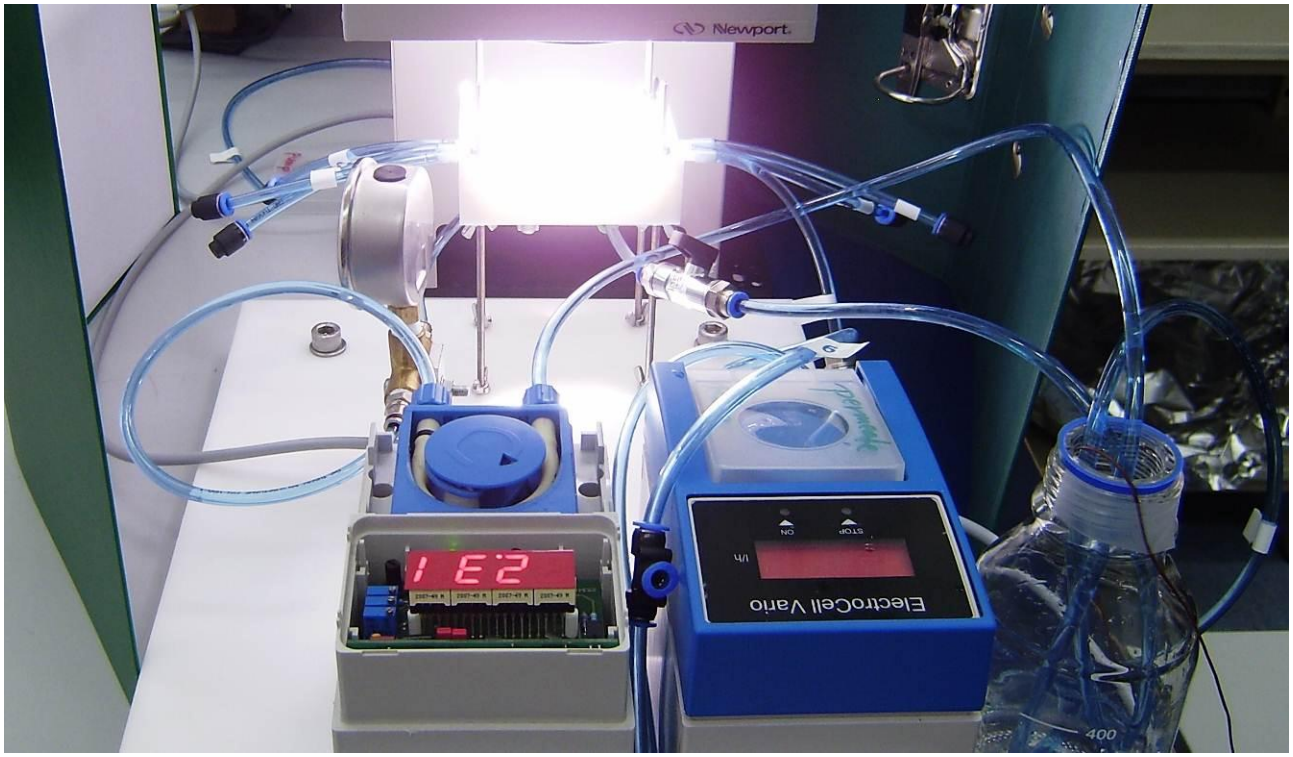

Figure: Custom-made flow cell with coated membrane, here under a solar simulator at Tel Aviv University

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Nitrification activity stratifies in a rapid sand filter for drinking water treatment - A study in two Danish waterworks

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Abstract
Rapid sand filters are widely used in groundwater treatment to remove ammonium, iron and manganese from the raw water. Typically, filter performance is evaluated based on effluent concentration leading to a "black box" approach with regard to the processes that take place in the filter. This lack of knowledge creates uncertainty about performance robustness and reasons for filter malfunctioning. Specific insight of the processes is needed to allow a detailed optimization and remedial strategy.

Ammonium is removed biologically by nitrifying microorganisms attached on the sand grain surface. Nitrification kinetics is the key parameter controlling ammonium removal in a filter and can therefore be a powerful diagnostic tool revealing potential process limitations. In this study, we used a lab scale biofilm assay to investigate nitrification activity in two Danish waterworks. The aim was to identify how nitrification activity distributes within a filter and whether this profile is consistent in filters performing differently. Plant 1 operates a single line of pre and after filters and has been well performing over the last years. Plant 2 consists of two separate lines, each one with pre and after filtration steps. Plant 2 has experienced challenges in removing ammonium below the 0.05 mg/L regulatory limit especially in one of the two lines. Sand core samples were taken from the after filter in plant 1 and each after filter line of plant 2. Core samples were divided according to depth and nitrification activity was measured with a biokinetic assay. The experimental set up consisted in small columns packed with the sand core subsamples. The columns were continuously loaded with ammonium, mimicking the respective full scale filter conditions. To investigate kinetics, the loading was increased in short time experiments and the effect on the effluent was monitored. Ammonium removal rate at full scale filter conditions and potential nitrification activity were derived for the different filter regions of the two treatment plants.

Nitrification activity was in all cases concentrated at the top 10 cm of filter depth, and maximum nitrification capacity was 7 g NH_4^+-N/ m^3 sand/h compared with 0.8-0.4 g NH_4^+-N/ m^3 sand/h in the middle and bottom layers. A water sampler was installed in the full scale filter of plant 1 to observe the ammonium profile with depth. Ammonium was removed within the upper 15 cm with a removal rate ranging of 3.6- 7.7 g NH_4^+-N/ m^3 sand/h. Full scale observations fit with the lab scale activity measurements showing that the upper layer of the filter is where nitrification mostly happens. Deeper layers that are less active, provide extra nitrifying capacity in case ammonium is not removed within the top 15 cm. This study showed that rapid sand filters are stratified in terms of biological activity. This can be an important consideration for process optimization and modeling considerations.

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Use of advanced oxidation processes for removal of micropollutants

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Abstract
One of the big challenges of modern water treatment is the handling of micropollutants. These are compounds found in very low concentrations, often at ppt or ppb level, but are still capable of having a potent effect on the environment, and possibly humans as well. One of the emerging technologies for removal of micropollutants is the use of advanced oxidation processes (AOPs). AOPs use highly reactive hydroxyl radicals to degrade the micropollutants, but the processes are very energy intensive, which may limit their applications.

To investigate the feasibility of introducing AOPs in the Danish water treatment industry, a study was set up at Vejle Waste Water Treatment Plant (WWTP). Here the WWTP had employed a UV system to disinfect treated waste water, and it was decided to investigate the effect of applying titanium dioxide (TiO_2) surfaces to the system. TiO_2 will produce hydroxyl radicals through photocatalysis when illuminated with UV light, and it may furthermore be arranged so the photocatalyst is immobilized on the UV quartz tubes by coating, which removes the need for a constant addition and subsequent removal of TiO_2 to the system. The effect of the current system, and the TiO_2 modified system was investigated by degradation of the synthetic estrogen 17α-ethinylestradiol (EE2). EE2 was used as the model compound since it is a very potent endocrine disruptor that has been found to have endocrine effects on fish at ppt levels. Also, the disinfection capability with photocatalysis was investigated to determine the effect of the modification of the UV system on its original purpose. The degradation experiments were carried out at pilot scale in the laboratory, and then compared to data collected at the WWTP.

TiO_2 was found to improve the rate of degradation of EE2 by 66 % compared to the photolytic degradation with UVC light alone. It was as such a significant improvement. However, even with TiO_2 coated surfaces, a relative large amount of energy is required to degrade EE2. By assuming the UV system in Vejle to be operating at maximum capacity, a photocatalytic system would be capable of removing between 1 and 5 % of the EE2 concentration within the measured flow regime. Coated TiO_2 surfaces were found to reduce the disinfection efficiency compared to pure UV light. This was assumed to be because of differences in the disinfection mechanisms. Where UV light directly affects the DNA of the microorganisms, photocatalysis works by oxidizing the cell membrane for microorganism adsorbed to the coated surface, which is a more inefficient process per mole UV light.

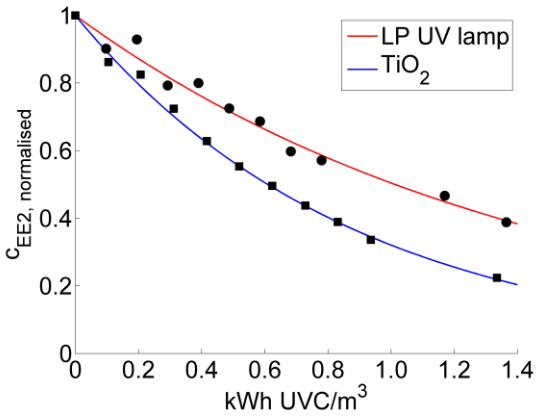

Figure 1 Degradation of EE2 by UVC light and photocatalysis as a function of deposited UVC energy

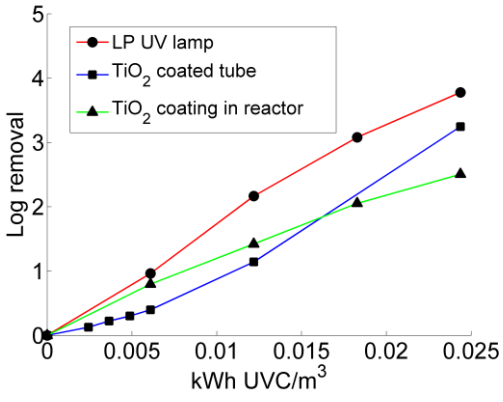

Figure 2 Removal of *E.Coli* by three methods: UVC light, TiO_2 coated tubes, and TiO_2 coated surfaces in reactor.

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The tools for designing chemical disinfection solutions of combined sewer overflows - DesiCSO

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Abstract

Combined sewer overflows (CSOs) occur when it rains heavily and the hydraulic capacity of either the wastewater treatment plant or the collection of system that transports the combined flow of rain water and raw sewage to the wastewater treatment plant exceed. The excess flows tend to be discharged into receiving bodies nearby like sea, lake and river. CSOs contains a variable mixture of raw sewage, watershed runoff pollutants consists of variable pathogenic microorganisms, suspended solids, chemicals and floatable materials which adversely impacts on the quality of receiving water bodies and cannot used for recreational activities e.g. bathing. Namely the frequent loss of bathing water quality (blue flag) has a significant economic impact.

The existing solutions to loss of bathing water quality are capital intensive solutions either to constructing retention basins, very long seawater outlet pipes or UV disinfection systems at the point of CSO release. With increasing recreational use of surface waters close to cities and increased frequencies of substantial CSO releases from intensive rain events the very capital intensive solutions are difficult to apply due to the high number of installations which are required. Alternative solution which requires a low initial investment could be chemical disinfections which are known from treatment of many other types of water. However, general design parameters for the use of disinfection chemical in CSO are not available.

In this work we determined the main parameters needed to design disinfection systems for CSO overflows for four disinfectants (peracetic acid, performic acid, chlorine dioxide, sodium hypochlorite) that may potentially be applied for CSO.

Model CSO water for experiments was created by diluting raw sewage (5, 15 and 40 %) with demineralised water based on the correlation of the ammonium concentration in the CSOs profile described on literature. Analytical methods were either adopted or developed for the chemicals used in CSO water. With the analytical methods concentration profiles (with time) of each chemical in different qualities of CSO and pH were recorded.

The efficiency of each chemical in removing the indicator organisms mentioned the EU bathing water directive were determined. Finally the risk of toxic effects from the use of the chemicals and ecotoxicity analysis of treated effluents were evaluated.

The influences of initial concentrations and contact times on the removal of indicator organisms, on residual biocide and on by-products formation were compared among four disinfectants. The disinfection effect of Performic acid (PFA) on indicator organisms was superior to rest of the disinfectants and this chemical also appeared to less toxic among other chemicals.

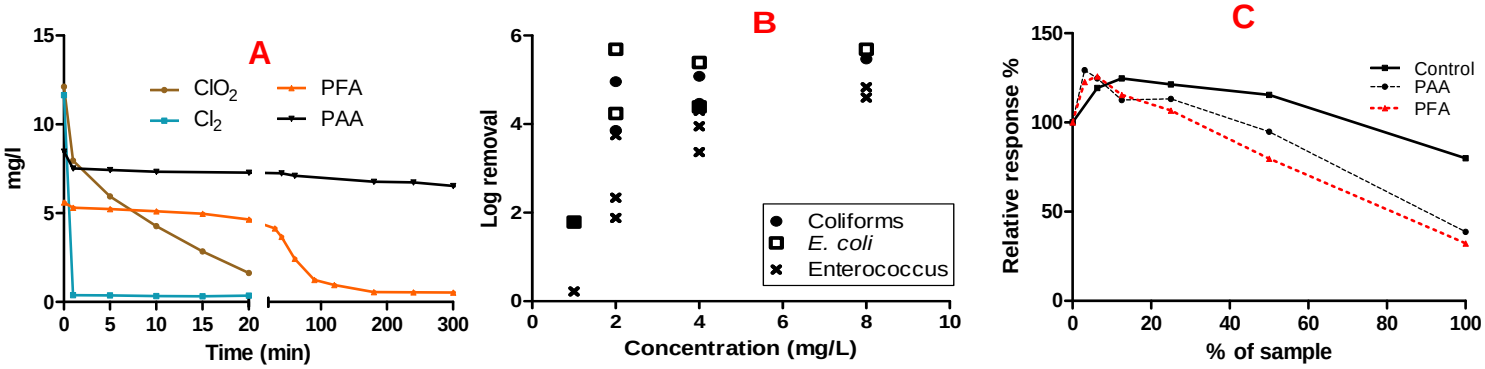

Figure 1: A) Concentration profiles (with time) effect of four chemicals in model CSO (15% raw wastewater). B) Disinfection by performic acid of indicator organisms. C) Toxicity to Vibrio fischeri after chemical treatment of model CSO (15% raw wastewater).

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An influence diagram for urban flood risk assessment through pluvial flood hazards under non-stationary conditions

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Abstract
Urban flooding introduces significant risk to society. Extreme flood events can grow into national threats if timely adaptation and protection measures are not implemented. More information is needed to understand climate change impacts and other non-stationary conditions for development of suitable adaptation strategies at a regional scale.

Infrastructures are important assets in urban environments and their continuous operation is crucial to society. Urban infrastructures have a long technical lifetime. For example the technical lifetime for drainage systems is often assumed to be 100 years. On these time scales the effects of climate change will be statistically evident; because of this, adaptation of long-lived infrastructures should be investigated well ahead of their construction.

Decision-makers need to agree on how to adapt urban areas to flooding. However, non-stationarity leads to increased uncertainty and this is shown to be difficult to include into actual decision-making. Transparent methods are needed to facilitate the decision-making process. While decision-makers can gain an understanding of future climatic changes through scenarios and projections there is still a considerable knowledge gap between different projections and actual decision-making based on these projections. The large uncertainties introduced by future projections can lead to aversion in making a decision and investing in adaptation to floods.

The primary objective of this study was to develop a risk assessment and decision support framework for pluvial urban flood risk under non-stationary conditions using an Influence diagram (ID). Non-stationarity is considered to be the influence of climate change where extreme precipitation patterns change over time. The overall risk is quantified in monetary terms expressed as expected annual damage (EAD). The network is dynamic inasmuch as it assesses risk at different points in time to evaluate the non-stationarity in the urban system. The framework provides a means for decision-makers to assess how different decisions on flood adaptation affect the risk now and in the future. For the development of the ID we used the HUGIN software. The result from the ID was extended with a cost-benefit analysis defining the net benefits for the investment plans. We tested our framework in a case study where the risk for flooding was assessed on a railway track in Risskov (Aarhus). Drainage system improvements are planned for the area and our case study presents how the developed BN illustrates the increase in risk over time and the decrease in risk due to the planned improvement.

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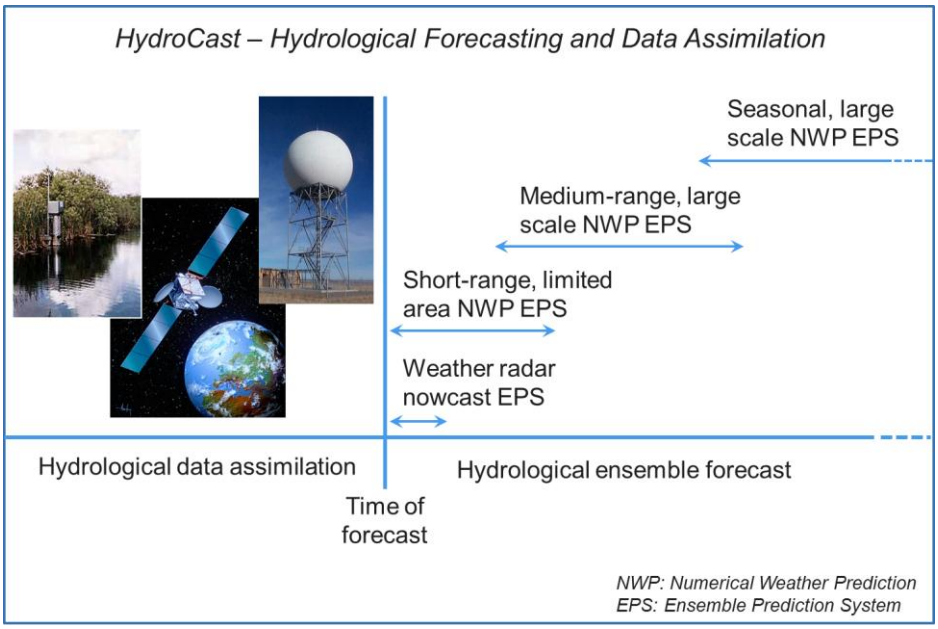
Hydrological forecasting and data assimilation – The HydroCast project

*H. Madsen, DHI**

Abstract
Hydrological forecasting is an important instrument for more effective water-related management and operation, such as warning and protection against flooding, real-time operation of infrastructure, improved water allocation and environmental management. Use of hydrological forecasting is also an attractive non-structural instrument for climate adaptation. A combination of structural measures and forecasting and early warning systems is often more cost-effective, considering the large uncertainties related to climate change projections.

HydroCast (Hydrological Forecasting and Data Assimilation) is a research project funded by the Danish Council for Strategic Research that started 1 January 2012. The objective of the HydroCast project is to establish and test a general framework for hydrological forecasting that combines different data sources with meteorological and hydrological modelling. Key scientific challenges addressed by the project include: (i) integration of on-line measurements, radar rainfall forecasts, numerical weather prediction models, and hydrological models for short-range hydrological forecasting, (ii) combination of meteorological ensemble predictions with hydrological models for provision of probabilistic hydrological forecasts, and (iii) assimilation of in-situ and remote sensing measurements of hydrological variables for real-time updating of hydrological models.

The developed framework and tools will be tested and demonstrated for three problem areas, considering short- and medium-range flood forecasting, seasonal forecasting of irrigation potential, and environmental monitoring.



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Effects of climate model interdependency and common biases on the uncertainty quantification of extreme rainfall projections

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Abstract
Climate models are the primary source of information in climate change impact studies but they are inherently uncertain. In recent years, probabilistic procedures based on multi-model ensembles have been suggested in order to estimate this uncertainty. However, there are still several challenges in the interpretation of multi-model ensembles, e.g. limited number of data, lack of agreement on what is a good model, biases in climate models, and interdependency of climate projections.

This study investigates the effects of interdependency and common biases in an ensemble of regional climate models (RCMs) on the uncertainty quantification of extreme rainfall projections in Denmark. A Bayesian approach has been developed using the procedure suggested by Tebaldi et al. (2005) in order to quantify the uncertainty. This approach takes into account both the correlation between the climate models and the common biases. The correlation matrix is estimated using the approach suggested by Pennel and Reichler (2011) to estimate the effective number of models in an ensemble. The common bias is included as a parameter in the Bayesian inference.

The results show that the climate model projections cannot be considered independent. If the models are assumed independent, the results will be overconfident. The effect of accounting for the common biases is smaller than accounting for the interdependency of the RCMs. This is possibly due to the bias being assumed constant from present to the future. Further work will investigate the assumption of constant bias. This study highlights the importance of investigating the assumptions underlying multi-model ensembles. These may have serious consequences in the design of climate change adaptation strategies.

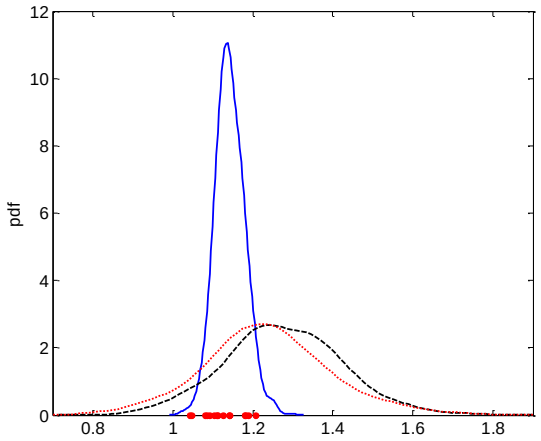

Figure 3- Probability density functions of the relative change of the 95% quantile of wet day rainfall amounts. The results from three different tests are shown: (i) the models are assumed independent and the bias is neglected (blue line), (ii) the interdependency is included in the analysis but the bias is neglected (black dashed line), (iii) both the interdependency and the bias are included in the analysis (red dotted line). The red dots are the outputs from each of the RCMs.

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Pennel, C. and Reichler, T., 2011. On the effective number of climate models. *Journal of Climate* 24, 2358-2367.

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Managing fresh water resources in coastal salinizing areas: recent examples from the Netherlands

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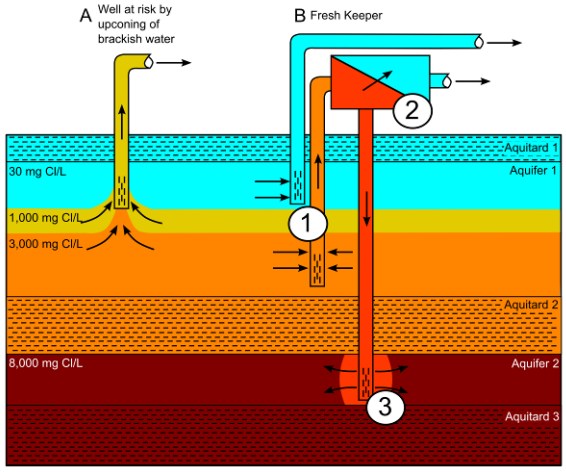
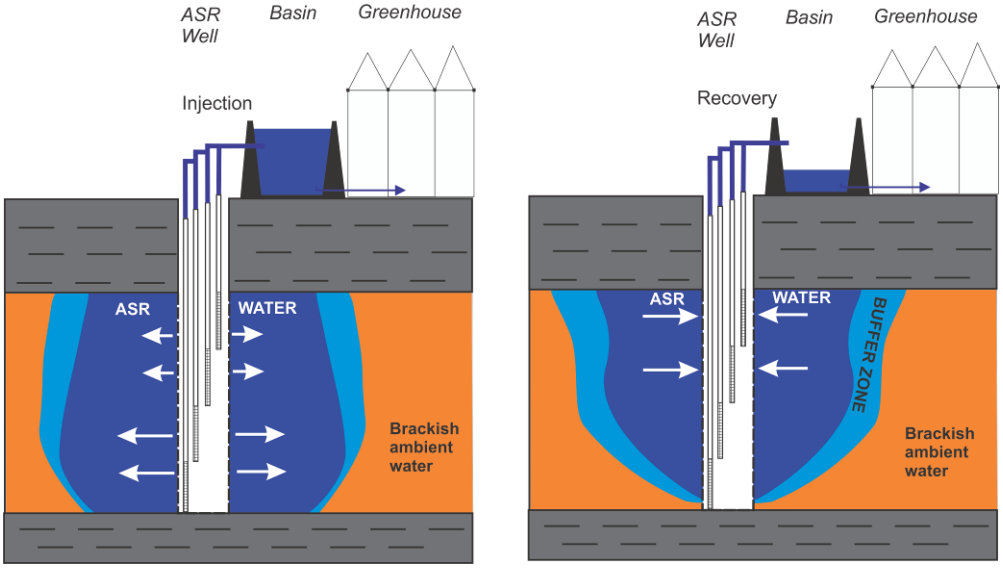
Abstract
In coastal and delta areas, fresh water resources are limited and demands are high, resulting in problems like overexploitation of fresh water aquifers, seawater intrusion and water well salinization. Seasonal shortages may hamper the supply of fresh water to the public, industries and agriculture. Subsurface technologies may provide robust solutions to these problems. We present two examples of such technologies, which were recently developed and successfully tested in the Netherlands, and which have a great potential for solving water scarcity issues in other areas worldwide.

The Fresh Keeper (Fig.1) can effectively safeguard the water supply from abstraction wells at risk of salinization. The concept follows a three-step approach: (1) intercept upconing brackish groundwater by simultaneously abstracting upper fresh and lower, intruding brackish water; (2) use the abstracted brackish water as an additional water source, by desalting it through reverse osmosis; and (3) dispose the RO membrane concentrate by deep-well injection into a confined, more saline aquifer. This 3-way approach was successfully applied in a pilot conducted by Vitens Water Supply. The new Fresh Keeper supported well sustainably supplied twice the amount of water produced by the original wells, which were abandoned 15 years ago because of salinization.



ASR-Coastal enables us to store excess rainwater in brackish and saline aquifers for fresh irrigation water supply in dry periods. Aquifer Storage and Recovery can be inefficient in these aquifers, due density-driven flow. Multiple Partially Penetrating Wells (MPPW, Fig.2) provide the answer, enabling injection at the base of the aquifer and recovery at the top. An ASR-Coastal system with MPPW was successfully applied in a Dutch coastal greenhouse (horticulture) area, rendering recovery efficiencies of 40% in the first season. This proved to be sufficient to guarantee fresh water supply to the greenhouse throughout a 2 months summer drought period.



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Stochastic runoff forecasting and real time control of urban drainage systems

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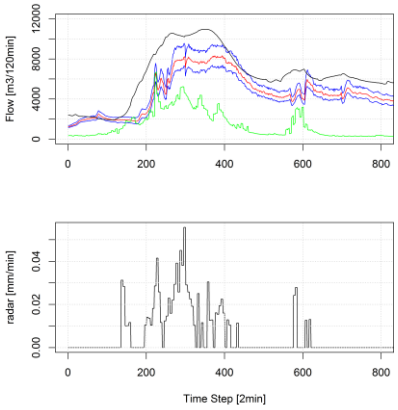
Abstract
Real time control (RTC) is an efficient means to optimise the operation of urban drainage systems and minimize combined sewer overflows. Control approaches range from rule-based strategies, based on past experience of the system, to online global optimization of storage volumes to global forecast based optimization approaches. Commonly used RTC approaches are based on the current measurements, i.e. the system is optimized based on the actual volumes stored in the drainage system.

The ability of predicting the future evolution of rainfall and the generated runoff volumes can further improve the performance of urban drainage systems: water storage in the system can in fact be optimized by both using information on the present situation and the expected evolution in the near future. However, both rainfall and runoff nowcasting models are affected by several sources of uncertainty. For example, radar-based rainfall observations and nowcasting are highly uncertain, and this subsequently affects the results of rainfall-runoff models. This high level of uncertainty has represented an important impediment towards a wide application of rainfall-runoff model in RTC systems. This obstacle can be overcome by quantifying the level of uncertainty in the runoff predictions and by using this information within the RTC strategy.

In this context, we introduce a control framework for urban drainage systems that uses probabilistic runoff predictions in conjunction with current observations to optimize urban drainage systems. The used control strategy is based on the so-called dynamic overflow risk assessment (DORA), an integrated approach which aims to reduce the overflow risk in the controlled drainage system. The overflow risk is calculated by using information on (i) the current water storage in the system, (ii) the expected runoff volume and (iii) the uncertainty of this estimation. The last two data are provided by probabilistic rainfall-runoff models.

These models are based on the so-called stochastic greybox models, which use radar rainfall nowcasts as input and provide runoff predictions (along with uncertainty bounds) for every controlled point of the system as output. A conceptual model in the form of a reservoir cascade is applied to describe the rainfall-runoff relationship in each sub catchment. Other than in the deterministic case, however, the greybox models include a stochastic term that permits the explicit modelling of uncertainties resulting from structural deficiencies, input uncertainties and observation errors. Further, the models can be updated through an extended Kalman filter, which makes them adaptive to current observations and allows accounting for deficiencies in the models' description of the actual situation.



The developed control framework was tested in the Lynetten catchment, located in the centre of Copenhagen. An integrated control of the catchment, based on DORA, is currently in the implementation phase in the system. This current implementation uses a deterministic rainfall-runoff model and it assumes a fixed level of uncertainty on runoff predictions. The performance of the current implementation (evaluated based on the overflow volume) was compared against the proposed framework, where the uncertainty in runoff predictions is dynamically estimated by grey-box models. Preliminary results, based on a small number of sample rain events, illustrate the potential of using probabilistic runoff forecasts in RTC strategies. Additional developments in the greybox model structure and adaptivity will further boost their ability in reducing the uncertainty of runoff estimation and thus improve the optimization of urban drainage systems.

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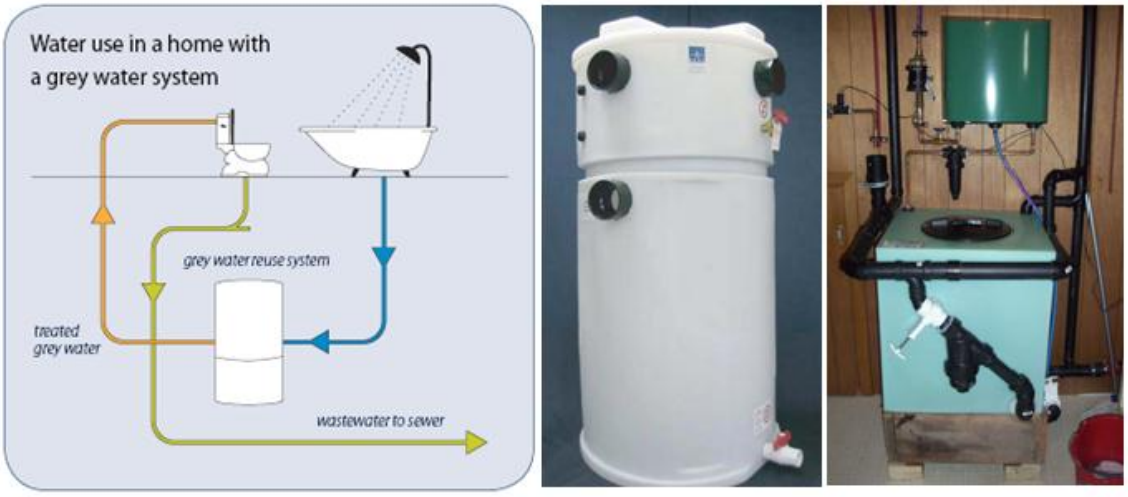
Poster abstracts

Appropriate technology and adoption of water conservation practices: Case study of greywater reuse in Guelph, Canada

M.J. De Luca, University of Guelph, Advisor: K. Farahbakhsh, University of Guelph*

Abstract

This study investigates the appropriateness of greywater reuse technologies in Canada. To design a technology to appropriately meet a user's needs the approach must conform to existing technical, cultural, economic, environmental, and social conditions. The appropriateness of two greywater reuse systems (GWRS) were investigated according to three criteria; reliability/soundness/flexibility, affordability, and sustainability. The GWRS reduced water consumption from 9-20% of total household use, and often met required fecal coliforms concentrations at several sites. However, the study revealed that neither GWRS met all the appropriate technology criteria and significant barriers preventing greywater reuse were identified. Both GWRS produced effluent that largely did not meet current regulations, were prone to mechanical failure, and did not provide any financial benefits, resulting in a varied level of acceptance among users. In addition, the systems resulted in increased green house gas emissions. The study also concluded that the regulations governing greywater quality for toilet flushing and the technology's robustness must be further refined.



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Microfluidic Amperometric Biosensor for Pesticide Detection in Water

Basil Uthuppu[1], Arto Heiskanen[1], Ida Thygesen[1], Jens Aamand[2], Claus Jørgensen[3] and Mogens Havsteen Jakobsen***[1]*

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Abstract

Access to clean and safe-drinking water is essential to health and it is a basic human right. These days, nearly a billion people of the world's population do not have access to this precious commodity. Along with many other causes, pollution of water sources by pesticides poses a real threat to the availability of clean water. Thus, the need of rapid, reliable and on-site early warning systems to monitor the quality of water becomes important. This work describes the design and development of an automated microfluidic biosensor based on immunological methods (immunosensor) to detect the presence of pesticides in ground water. A herbicide residue, 2,6- dichlorobenzamide (BAM) is chosen as a model system in this research. For this purpose, the existing BAM immunoassay is optimized to transfer it from a lab-based end-point analysis technique (ELISA) to a portable, onsite monitoring system (where regeneration of the immunosorbent is very important). This is achieved by a unique approach in which the immunosorbent is engineered by using a newly synthesised BAM hapten library. Additionally, the improvisations made to the existing BAM hapten synthesis route resulted in the isolation of haptens for the parent herbicide (dichlobenil) itself. The affinity constants of new BAM haptens are estimated and compared with the existing BAM hapten. These results are correlated with their regeneration performances. Based on this, one of the newly synthesised BAM haptens (named as hapt D) was chosen for further development of the BAM immunosensor. This immunosensor employs a cost effective, miniaturizable, amperometric detection technique.

Further, in order to incorporate the optimized BAM immunoassay and the electrochemical detection method, a microfluidic platform is designed and fabricated. A modular approach is adopted for the fabrication of the microfluidic platform to make the device simple to integrate, automate and maintain. The microfluidic platform has an in-built micro flow-injection analysis (µFIA) system as a novel characteristic of the microfluidic device prototype. The microfluidic devise is partially automated using Lego® Mindstorms® servomotors to control its micro pumps and valves.

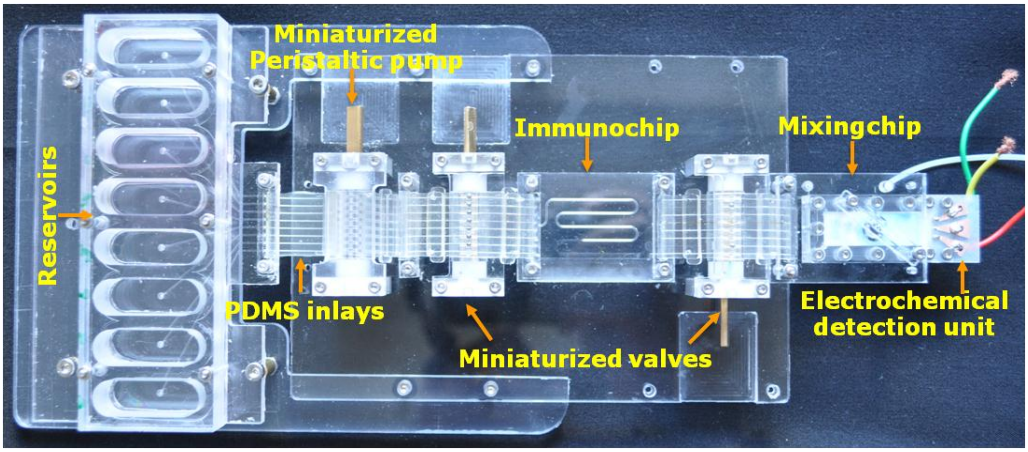

Fig 1. Amperometric immunosensor prototype

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A novel approach to managing small and medium sized water supplies

Torben Munch, Robotek Gruppen A/S and Michael Macdonald Arnskov, Danish Technological Institute***

Abstract

Efficient management of a water supply plant relies heavily on the ability to control and monitor the extraction of either groundwater or surface water and the subsequent distribution of the water to the end consumer and to do so in a manner which satisfies demand at all times. This entails a system of controllable components and units which have to interact. Traditionally this is done by tailoring and hardware configuring control panels to suit the individual needs of the specific plant. This, however, is a costly and time consuming process. Furthermore it often entails more cumbersome maintenance and costly annual software licenses.

This has, after having installed numerous control panels at Danish water supplies and waste water treatment plants, inspired Robotek to pursue new avenues by utilising experience combined with best practice from other industries where control and monitoring processes prevail and are crucial, not least the automobile industry.

By combining standard industrial components with common PLC's a system has been developed which simplifies installation and greatly enhances the final configuration of the system to adapt to the specific requirements of the supply plant, i.e. a standard control panel is software configured enabling all relevant parameters to be controlled and monitored directly or via either a tablet or a smartphone.

This enables the duty keeper to receive alerts if a malfunction occurs and intervene if required or indeed change operational conditions remotely if necessary.

Performance data is constantly sampled and evaluated. This provides management with real-time data for decision support, but also the possibility to disseminate extraction and distribution data in a wider context.

It must be expected that the quality of the extracted and distributed water on a national scale will become even more important. The concept developed enables this to be monitored and thereby enables anomalies to be detected much faster in the future as detection technology develops.

Today the system enables water supply managers to monitor daily, monthly and annual performance and thereby intercept promptly if e.g. levels of non-revenue water or malfunctions should suddenly occur.

A demonstration unit of the system has already been tested and fully verified. Indeed it has been monitored and operated successfully as remotely as from Bolivia via a tablet.

The presentation will focus on the practical aspects of adopting the concept and highlight some of the benefits it provides with regard to cost savings and enhanced performance.

The concept, termed Blue Control, has already received international interest and it is expected that it will contribute to Danish export within the water technology sector as the novel approach enables affordable replacement of outdated and inefficient technology at many smaller and medium sized water supply plants.

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medical geology

– contributions from Scandinavia

www.medicalgeology.org
Medical Geology is the science dealing with the relationships between geological factors and health

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The gold tubes ready for measurements between heaps of tailings

High concentrations of mercury in ambient air over small-scale mining communities in Tanzania

Small-scale gold miners (ssm) use mercury for extracting gold thereby releasing tons of mercury to the environment. Mercury vapour in ambient air was measured in two ssm communities in Tanzania Itumbi and Londoni.

Mercury was sampled by diffusive sampling consisting of a gold core and a surrounding diffusive cylinder. Measuring time was 26 hours.

Itumbi	0.32-0.44 µg m^{-3}
Londoni	1.35-1.87 µg m^{-3}
Global background southern hemisphere	1,2 ng/m^{-3}

The results are connected with large uncertainty as there were overload on the detector in all measurements. However, most probably the concentrations are underestimated. The mercury contents in air in the two sites are up to 1000 times higher than the global average for the southern hemisphere. The danger level of Hg in ambient air is 1µg m^{-3}.

The results show that the mercury released at ssm sites not only harms the local communities, but is spreading to other parts of Tanzania.

Acid rain kills thousands of Moose in Sweden

In the 1980s, when thousands of moose died in Sweden, close collaboration between veterinarians and geochemists started. Very low metal concentrations in organ tissues in moose, pointed to changes in the concentration of metals in the upper soil surface layer.

The culprit was acid rain spoiling forestry industry of Sweden. Spreading of lime over the forests was carried out. Unfortunately liming, mobilized molybdenum in bedrock and soils, causing a disturbed Cu/Mo ratio which is critical for the health of moose. In moose, the utilization and availability of Cu in feed is greatly influenced by interactions between Cu, Mo and S. Increased Mo concentrations in respect to Cu in the feed causes secondary copper deficiency in moose with clinical signs in close agreement with the signs reported to relate to the unknown moose disease.

A healthy Swedish moose

Farmers team up to rescue cattle from exposure to the toxic volcanic ash at a farm in Nupur, Iceland, as the volcano in southern Iceland's Eyjafjallajokull glacier sends ash into the air Saturday, April 17, 2010.

Fluoride -a health risk

Small amount of fluoride in our food and drinking water is necessary for our teeth. However, too large intake of fluoride causes dental and skeletal fluorosis damaging the mineralized tissue of teeth and bones.

Areas with active volcanism are often enriched in fluoride, potentially causing trouble for local populations. Explosive eruption in Eyjafjallajökull in Iceland in 2010 caused massive regional ash fall and flooding of the rivers draining the meltwater from the glacier. In addition to the health risk by breathing of the smallest ash particles for both humans and animals, fluoride release to the water environment, presented a contamination risk.

The first flood water had very high fluoride concentrations and rain fall on the fresh ash washed off fluoride rich surface salts. The dissolution of river suspended material, containing fresh volcanic glass, released fluoride to water Fluoride concentrations in surface water temporally exceeded the advised drinking water limit by the World Health Organisation of 1.5 mg/l and farmers had to protect their livestock from the ash covered fields and from drinking of streams, ponds and lakes.

G E U S

All substances are poisons; there is none which is not a poison. Only the dose differentiates a poison and a remedy. Paracelsus (1493-1541)

Environmental Technology Verification (ETV)

Towards mutual recognition

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Introduction

The objective of Environmental Technology Verification (ETV) is to promote innovative, environmental technologies by providing technology developers, manufacturers, and investors access to third-party verification of their technology performance. A verification body performs verification of a technology by testing against pre-defined performance claims. At the end of the verification process, a verification statement is issued. The statement contains a summary of the verification results and can be used by the vendor in marketing the technology. Furthermore, a detailed verification report, and possibly even the full set of test data, may be published. Currently, national and regional ETV programmes exist in EU, Canada, US, Japan, Philippines, Korea, and China. An international working group is currently working on having an international standard ETV procedure published by the International Standardization Organization (ISO) in order to achieve mutual recognition of verifications. In the process towards mutual recognition, an EU project - AdvanceETV - has produced verifications performed jointly between Danish/Nordic ETV programmes (DANETV[1] and NOWATECH[2], both pilot projects to the EU ETV programme), US EPA ETV, and Canadian ETV Programme. The poster describes co-operation between the national ETV programmes. Both synergies and challenges of the co-operation are presented.

Material and Methods

A verification involves steps such as indicated below with the procedure from the EU ETV pilot programme shown as an example (Figure 1).

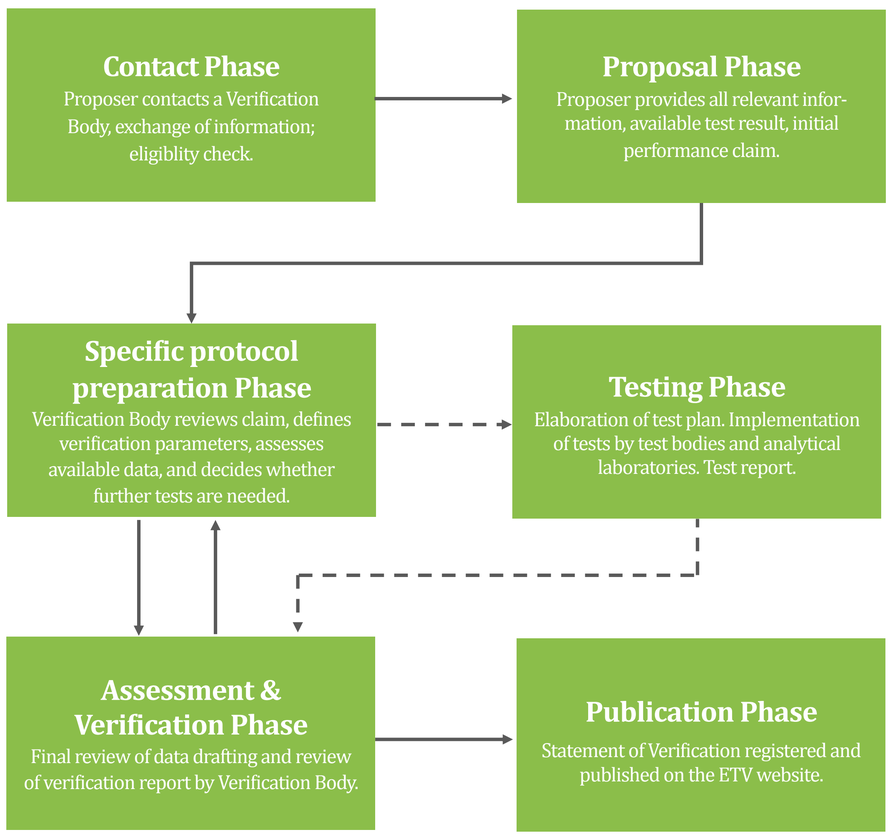

Figure 1 Steps in the EU ETV pilot programme verification procedure. (http://ec.europa.eu/environment/etv)

Table 1 lists the verifications of products for water treatment and water quality monitoring.

Vendor	Application	Involved ETV programmes
Sorbisense A/S	Measurement of volatile organic contaminants in groundwater	NOWATECH[2], US EPA ETV
HACH-LANGE	Toxicity testing of effluent wastewater	DANETV[1] , US EPA ETV, Canadian ETV Programme
Colifast AS	Automatic detection of total coliform bacteria or E. coli in drinking water	US EPA ETV, Canadian ETV Programme, DANETV[1]

Table 1 Cooperative environmental technology verifications in the area of water treatment and water quality monitoring.

Figure 2 HACH-LANGE ECLOX Handheld Luminometer.

Example 1:

HACH-LANGE had two products verified for testing of wastewater toxicity. A verification protocol and a test plan were prepared by DHI as part of DANETV, in cooperation with Battelle/US EPA ETV and Canadian ETV Programme. The testing of the equipment was performed by DHI (Figure 2). The reporting of the tests and the verification was also done in co-operation between DANETV, Battelle/US EPA ETV, and Canadian ETV Programme. Battelle and Canadian ETV Programme did intensive review of the produced data, and Battelle performed a test site audit in Denmark. Finally, one joint verification statement was signed by the three ETV programmes for each of the two tested technologies. Reports with complete test and verification details have been published (www.etv-denmark.com, www.epa.gov/etv)

Results and Discussion

The cooperation between the ETV programmes was good and the differences in the programmes were identified and actions towards general agreement were taken.
Based on the verifications performed in cooperation between the ETV programmes, two roadmaps have been developed under the AdvanceETV project. The roadmaps are designed respectively for joint verifications (where all programmes take intensive part in testing and verification as was the case for the HACH-LANGE verification) and co-verification (where one partner carry out the testing and verification and all programmes assess and accept the results). The two roadmaps are published and will harmonise joint verification and/or co-verification processes (www.eu-etv-strategy.eu).

Conclusion

For technology developers, this means that by purchasing an ETV they can now have their product validated, not only under one ETV programme, but by co-operation up front the verification statement can be valid under several of the operating ETV programmes and can give access to several national and regional markets.

1 Danish Centre for Verification of Climate and Environmental Technologies, Danish Ministry of Science, Technology and Innovation.
2 Nordic Water Technology Verification Centers, Nordic Innovation Centre.

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