

## Guest Editorial

### Drinking Water Treatment and Supply in Developed Countries in 2050—Where Will We Be?

*Peter Huck*

An adequate supply of clean, safe drinking water is essential for life as we know it in developed countries. Municipal water systems have evolved significantly over the last hundred or so years, and will continue to do so. As we plan for the future it is important to understand how they may change over the coming decades. What can we expect to see in the next 30 to 40 years?

In order to look forward, it helps to look back. In doing so, we quickly realize that it is very difficult to predict individual developments. For example, a certain portable device that was capable of playing tapes and that was revolutionary in the early 1980s seems totally archaic now. (Some readers may ask: What's a tape?!) Even attempting to identify and understand broad trends can be tricky – for example no one could have foreseen 30 years ago the role that the internet now plays in our lives and in society. Barring a global catastrophe, we can expect that technological developments will continue and accelerate.

It helps if we can define a paradigm that is much less likely to change. For

drinking water, a useful paradigm considers the 5 elements that are necessary to ensure a safe and adequate supply: use the best possible source, design and operate adequate treatment, provide secure distribution, conduct appropriate monitoring, and respond appropriately and in a timely fashion to an adverse monitoring result. Each of these elements has three aspects: physical, institutional and human (i.e. the person making potentially significant immediate operational decisions), creating in effect a 5 by 3 matrix. Developments will occur in individual cells of the matrix, however the overall paradigm is likely to remain a useful construct in the coming decades.

*The level of contamination in source water is largely related to land use, and making changes in this regard is a long and potentially costly process.*

The concept of robustness (i.e. the ability of a system to continue to perform satisfactorily when the inputs change, sometimes drastically) is extremely important. The overall robustness of a drinking water system results from the contributions of the individual cells in the matrix. Although

*(Continued on page 2)*

#### Inside:

- Environment on Drugs?
- Scholarship Recipients
- Water Institute Workshops
- Looking Back: Tharakal Unny

## Guest Editorial (cont.)

*(Continued from page 1)*

some minimum level of robustness is required in each, a given overall level of robustness can be achieved by different contributions from individual cells.

The increased emphasis in Ontario in recent years on the first of the five elements, source protection, is one outcome of the tragic microbial contamination incident that occurred in the water supply of Walkerton in May 2000. This greater attention is entirely appropriate, however its limitations must also be understood. The level of contamination in source water is largely related to land use, and making changes in this regard is a long and potentially costly process. Since the money for all aspects of the water treatment and supply system ultimately comes from the same source (the taxpayers/users), the allocation of resources among the five elements must be guided by overall risk assessment, to lead to maximum public health protection for a given level of expenditure.

The objective of treatment of course is to eliminate the gap between the existing raw water quality and the required finished or treated water quality. For surface water sources, treatment processes must be capable of responding to potentially extreme changes in incoming (raw) water quality – it is no longer sufficient to design for average conditions. The link to source protection is that unless source protection measures are ultimately able to guarantee a reduction in adverse raw water quality associated with extreme events, their impact on reducing treatment requirements is likely to be minimal. Arguably (and this is of course coming from a treatment process engineer!), greater public health protection can be achieved in the short term by making treatment more robust than by investing the equivalent amount of money in source protection.

The distribution system is probably the ele-

ment of the overall system that will present the greatest challenges in the coming decades. It has been said, tongue-in-cheek, that the distribution system is a large, complex and poorly-understood reactor, whose sole purpose is to degrade water quality. While this is of course an exaggeration, it does underline the problems that are faced. Distribution systems were historically designed simply based on hydraulic (flow) conditions, and only more recently has water quality also been considered. In allowing water operators to respond more quickly to adverse events in distribution systems, advances in completely different areas (e.g. sensors and wireless communication) will play an important role.

Unrelated changes in society in general will also have important impacts on water supply. For example, the public's greater access to information and heightened expectation of involvement in decision-making will impact how water supply systems conduct their activities.

The provision of high-quality drinking water in industrialized countries will remain an exciting and important challenge in the coming decades.

**Peter Huck** holds the NSERC Chair in Water Treatment and is a Professor in the Department of Civil and Environmental Engineering.

Peter Huck: <http://www.civil.uwaterloo.ca/watertreatment/>



## Water Researchers in the News

### Janusz Pawliszyn Announced as 2013 CIC Environmental Division R&D Award Recipient

Dr. Janusz Pawliszyn, a Water Institute member in the Department of Chemistry, will be the 2013 recipient of the Chemical Institute of Canada's Environmental Division Research and Development Award. This award is given for distinguished contributions to research and /or development in the fields of environmental chemistry or environmental chemical engineering, while working in Canada.

Dr. Pawliszyn is being recognized for his development of 'green' sample preparation technologies. The award will be presented at the Annual Canadian Chemical Conference & Exhibition in May 2013.

### Bryan Tolson and Students are Successful in the "Battle of Water Networks"

Dr. Bryan Tolson, Associate Professor, Department of Civil and Environmental Engineering, and his students Ayman Khedr (co-op) and Masoud Asadzadeh (PhD) recently competed

in a Water Distribution Network design optimization challenge at the Water Distribution Systems Analysis (WDSA) conference in Adelaide, Australia (<http://wdsa2012.com/btn.html>).

The design problem was multi-objective and involved minimizing design costs, greenhouse gas emissions and a measure of overall water age for a large water distribution system. Their team submitted a solution that was judged to be second place (out of 14 submissions). The team evaluated 20,000 solutions on a desktop PC using their multi-objective PA-DDS algorithm to help pick a design while the other two teams in the top three evaluated 60 million and 8 million solution evaluations across a supercomputing system.

The resulting paper, entitled "The Battle of The Water Networks (BWN-II): PADDs Based Solution Approach", was awarded with the Best Paper Presentation Award at the conference. Congratulations to Bryan and his students.

## Save the Date: May 2, 2013

The Water Institute's Inaugural

## Water Research Symposium

A showcase for Waterloo research, providing an opportunity for partner-researcher-student interaction and dialogue.

Highlights include:

Technical Symposia

WI Distinguished Lecturer: Dr. Asit Biswas

Student Poster Session and Scholarships Award Ceremony

Networking Reception

## Technology and Innovation

### The Environment on Drugs?

One fish or two fish? A boy fish or a girl fish? Studies by Dr. Mark Servos (Department of Biology), his students and colleagues, have demonstrated the widespread occurrence of a diversity of emerging chemicals of concern, such as pharmaceuticals and endocrine disruptors, in watersheds across Canada and globally. These trace contaminants, commonly detected in wastewater effluents, are altering how genes are expressed in fish, affecting their reproduction and changing ecosystems.

In the Grand River watershed, Ontario, there are thirty municipal wastewater treatment plants that were not designed to remove these types of chemicals, discharging into the river system. Recent surveys in the Grand River by Mark's group have shown that a wide variety of drugs, personal care products and industrial chemicals are released into the river. They have shown in the laboratory that many of these chemicals alter reproductive function and performance in fish. Field studies have also shown numerous impacts on wild fish, including alterations in their ability to deal with stress, store energy, maintain normal physiology (e.g. regulate sex steroids), achieve reproductive outcomes and normal community structure. In the urbanized areas of the watershed, fish such as the Rainbow Darter, show a dramatic increase in the occurrence of primary oocytes (eggs) in male reproductive tissue (testes). This site is one of the most dramatic examples of feminization of fish observed anywhere in the world. But what are the causes and what are the solutions?



Student Maricor Arlos at an effluent discharge location in Waterloo.



Rainbow Darter with evidence of intersex organs.

Exploring the mechanisms and extent of the responses in fish exposed to wastewater is currently the focus of several graduate students in the Servos research group. Experiments are attempting to link specific chemicals or mixtures with the biological responses so that remedial actions can be effectively designed, implemented and monitored. Many of the municipalities in the watershed have invested heavily in wastewater treatment (e.g. City of Guelph) and the Region of Waterloo is currently investing >\$700M in treatment upgrades. The Grand River is a unique site to study the potential responses in wild fish to these massive public investments. Mark and his group are working within broad collaborations and partnerships to better define the risks and develop real solutions that can be applied not only locally but elsewhere to address this emerging global issue.



Electrofishing in the Grand River watershed, 2012

Mark was a Research Scientist with Environment Canada before joining uWaterloo as the Canada Research Chair in Water Quality Protection in 2003. His research team is exploring the risks associated with a variety of trace contaminants found in the environment originating from industrial, agricultural and municipal sources globally. They also collaborate on a variety of projects developing and testing innovative remedial technologies to reduce or eliminate the presence of these compounds in drinking water, wastewater and the environment. Working with diverse partners, they are developing frameworks for predicting the cumulative effects of human activities within the context of natural variability at the watershed scale. These studies aim to empower water managers, at all levels, to make sound decisions that will promote a sustainable future.

Mark Servos: <http://uwaterloo.ca/biology/people-profiles/mark-r-servos>

## Water Institute News

### Water Institute Graduate Scholarships

The Water Institute is pleased to announce the winners of the ARCADIS Graduate Scholarship and Golder Associates Graduate Scholarships. Nearly 25 applications were received from across four faculties. Each scholarship is valued at \$5,000.

The 2013 **Golder Associates** Graduate Scholarships in Water recipients are:

Ms. Lillian Knopf, MSc candidate, Biology: *Short-term changes in phosphorus delivery to lakes: Implications for phytoplankton*;

Ms. Nancy Sootiens, PhD candidate, Applied Mathematics: *Flow over topography*.

The 2013 **ARCADIS** Graduate Scholarships in Water recipient is:

Ms. Laura Sauder, PhD candidate, Biology: *Ecology of ammonia-oxidizing microorganisms in municipal wastewater treatment plants*.

The scholarships will be formally awarded at the Water Institute's Research Symposium on May 2, 2013.

### Water Institute Workshops

The purpose of the Water Institute's workshop program is to enhance interdisciplinary knowledge, facilitate the formation of multidisciplinary research and teaching teams, and support the development of new university-external partner relationships. Seven applications were made to the workshop program this year. The Water Institute is pleased to fund three of the proposals. Funds for the third workshop will be directed from our education budget as it complements the proposed Integrated Water Management Program. The three proposals selected for funding are:

*"Water for Wellbeing in Marginalized Communities"* submitted by Susan Elliott, Public Health and Health Systems, Corinne Wallace, Institute for Water, Environment & Health (United Nations University), Susan Watt, Social Work

(McMaster University), and Vic Neufeld, Clinical Epidemiology and Biostatistics (McMaster University).

*"Healthy Climates: Governance in the Water, Energy, Food and Climate Security Nexus"* submitted by Larry Swatuk, Environment, Enterprise and Development, Simon Dalby, Geography and Environmental Studies (Wilfrid Laurier University), James Orbinski, International Policy and Governance (Centre for International Governance Innovation), and Jespal Panesar, PhD candidate, Environment and Resource Studies.

*"Thinking about Water: What, why and how we teach to engage the next generation of interdisciplinary water leaders"* submitted by Sarah Wolfe, Environment and Resource Studies.

### Water Institute General Meeting

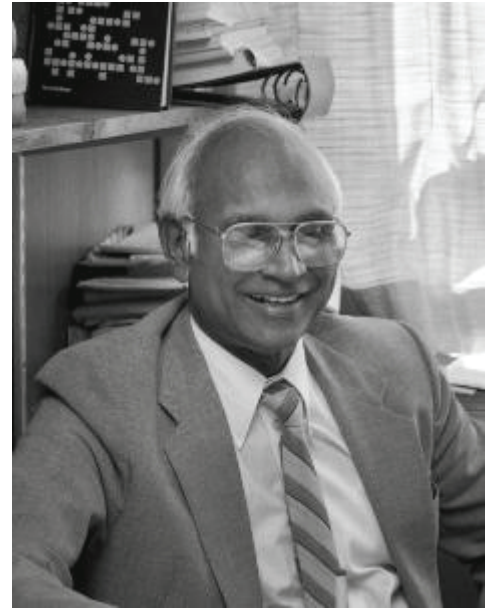
The Water Institute held its inaugural General Meeting on December 14, 2012. The meeting and mixer that followed were well-attended. Attendees were updated with some of the current Water Institute initiatives in addition to activities being undertaken by SWIGS and the Southern Ontario Water Consortium (SOWC) and were introduced to the Smart Region Initiative.



## Looking Back: Tharakkal E. Unny

Dr. Tharakkal E. Unny was born in Kerala, India in 1928 and worked for several years as a practicing engineer before earning his PhD in hydraulic engineering from the University of Dresden. In 1965, Dr. Unny emigrated to Canada to join the University of Waterloo's Department of Civil Engineering, and he later became a member of the Department of Systems Design Engineering.

Dr. Unny made remarkable contributions in water resources and environmental engineering over his career, including the areas of reservoir theory, finite elements, pattern recognition and water resource management. He was perhaps best known for his leading contributions in the areas of stochastic hydraulics and stochastic hydrology. Indeed, in 1987, Dr. Unny co-founded what quickly became the leading international journal in the field, "*Stochastic Hydrology and Hydraulics*". Dr. Unny passed away in 1991, prior to his retirement.



(This article borrows heavily from an obituary prepared by Keith Hipel, Department of Systems Design Engineering, and published in "*Stochastic Hydrology and Hydraulics*" in 1992.)

## World Water Day 2013 — March 22

We invite you to join us at the fourth annual World Water Day **Graduate Research Fair and Water Celebration** on Friday, March 22nd. This day-long celebration highlights university water research and raises awareness of local and global water issues. It is co-

hosted by the Water Institute, SWIGS, the Laurier Institute for Water Science, and the Cold Regions Research Centre (WLU).

This year the celebration will be held at the Paul Martin Centre, Wilfrid Laurier University.

The day will include two guest lectures plus an afternoon of graduate student poster presentations.

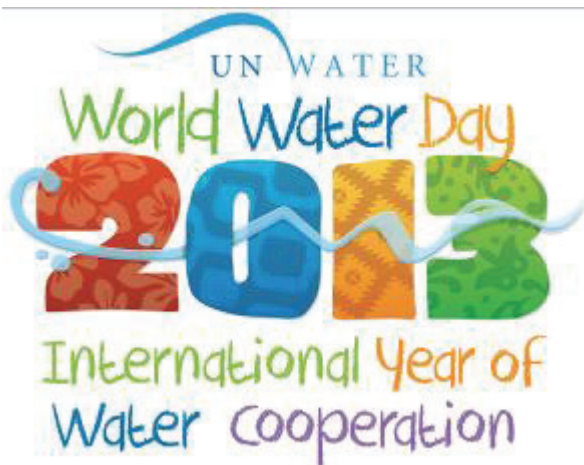
### Keynote Speakers:

Dr. Gail Krantzberg, McMaster University, "*Great Lakes, Great Responsibilities*"

Dr. Bruce Pardy, Queen's University, "*Drowning in Confusion: The Debate over Water Rights*"

Feature Documentary: "*People of a Feather*"

[www.wlu.ca/WWD\\_2013](http://www.wlu.ca/WWD_2013)



## Students of the Water Institute, Graduate Section

### End of Term Festivities

SWIGS ended the Fall 2012 term with excellent events to cap off a highly successful year. On the academic side, Scott Ketcheson and Corey Wells from Geography and Environmental Management wrapped up the 2012 **Student Lecture Series** with presentations of their wetlands related research. Their talks generated excellent discussion with the attentive audience and helped expose the graduate community to the importance of wetlands research. SWIGS **Journal Club** also ended 2012 with a discussion of disinformation in hydrologic research, exposing those in attendance to the importance of potential uncertainty in their own work.

SWIGS' social committee ROCKed the end of term with a very successful **Rock Climbing** event at Grand River Rocks. The majority of those in attendance were new to SWIGS' events, an excellent ending to very well attended social events throughout 2012. November and December saw the last **Blue Drinks** events of 2012 at the Grad House. Both were very well attended and led to increased interest in SWIGS students from members of water related industries. Look for more opportunities to network with industry representatives in 2013!

Overall, fall 2012 completed a fantastic year for SWIGS on a very high note! Tremendous thanks must be given to all members of the organizing committees for their ideas and dedication to the success of their events, and of course to everyone who attended! We hope to see you again throughout the New Year!

*Kim Mitchell (left) and Ryan Brooks (right) enjoy a climb during SWIGS' rock climbing event in November 2012. Watch for future rock climbing events in 2013!*



### 2013 Beginnings

After the Christmas break SWIGS kicked off the New Year in celebration with a **Blue Drinks** event on January 16. SWIGS' outreach committee also started the year off quickly with **Bottled Water Free Day** held in conjunction with the **UW Ban the Bottle Coalition**. Designed to encourage students to cease their use of bottled water, this event will hopefully encourage the entire university community to stop the wasteful use of bottled water. Look for more information about the Ban the Bottle Campaign on Facebook and in future issues of *Splash Pad!*

In addition to these early events, SWIGS has many other activities planned for Winter 2013:

**World Water Day Graduate Research Fair and Water Celebration** - Friday March 22<sup>nd</sup>, All Day, Paul Martin Centre, Wilfrid Laurier University.

**Student Lecture Series** - Throughout Term, Dates and Topics TBD, free pizza  
**Feb 13**, 12:30-1:30 pm, EV3-3412

Jason Olsthoorn—Modelling sediment resuspension and the effects of topography.

Jared Penney—Numerical simulation of pressure driven flow in waste rock piles

**Blue Drinks** - Feb 13 and Throughout Term.

**Rock Climbing** - March, Date TBD.

**SWIGS Annual General Meeting** - March or April, Date TBD.

Watch the SWIGS website and Facebook page for more events occurring this winter!

**Remember, the success of SWIGS depends on the people involved!** If you are a faculty member who participates in water related research, please encourage your students to get involved with SWIGS. There are many ways to learn more about the world of water through SWIGS, from volunteering on committees to leading event planning as an executive! To get involved let us know at [water.grad@uwaterloo.ca](mailto:water.grad@uwaterloo.ca).





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## Feedback

The Water Institute invites your letters on water-related subjects, including, but not limited to, those discussed in *Splash Pad*.

Please submit letters to Mary Anne Hardy ([mahardy@uwaterloo.ca](mailto:mahardy@uwaterloo.ca)). Letters should be brief; preferably 100 words or less.

Other areas where we welcome contributions include:

- Suggestions for engaging guest speakers for our seminar series;
- Offers to provide a technology / innovation profile article for *Splash Pad*;
- Expressions of opinion about water issues through a guest editorial in *Splash Pad*;
- Submission of photos for our collection of water research images.

“There is nothing in the world more beautiful than the forest clothed to its very hollows in snow. It is the still ecstasy of nature, wherein every spray, every blade of grass, every spire of reed, every intricacy of twig, is clad with radiance.”

William Sharp



Richard Kelly