



Study is first to map Earth's hidden groundwater

—By Suzanne Ahearn



Tom Gleeson at Mystic Vale, part of the Hobbs Creek watershed

Photo: UWic Photo Services

Groundwater: it's one of the planet's most exploited, most precious natural resources. It ranges in age from months to millions of years old. Around the world, there's increasing demand to know how much we have and how long before it's tapped out.

For the first time since a back-of-the-envelope calculation of the global volume of groundwater was attempted in the 1970s, an international group of hydrologists has produced the first data-driven estimate of the Earth's total supply of groundwater. The study, led by Dr. Tom Gleeson of the University of Victoria with co-authors at the University of Texas at Austin, the University of Calgary and the University of Göttingen, was recently published in *Nature Geoscience*.

The bigger part of the study is the "modern" groundwater story. The report shows that less than six per cent of groundwater in the upper two kilometres of the Earth's landmass is renewable within a human lifetime.

"This has never been known before," says Gleeson. "We already know that water levels in lots of aquifers are dropping. We're using our groundwater resources too fast—faster than they're being renewed."

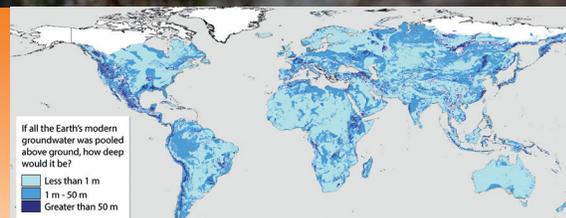
Using multiple datasets (including data from close to a million watersheds), and more than 40,000 groundwater models, the study estimates a total volume of nearly 23 million cubic kilometres of total groundwater of which 0.35 million cubic kilometres is younger than 50 years old.

Why is it important to differentiate old from modern groundwater? Young and old groundwater are fundamentally different in how they interact with the rest of the water and climate cycles. Old groundwater is found deeper and is often used as a water resource for agriculture and industry. Sometimes it contains arsenic or uranium and is often more salty than ocean water. In some areas, the briny water is so old, isolated and stagnant it should be thought of as non-renewable, says Gleeson.

The volume of modern groundwater dwarfs all other components of the active water cycle and is a more renewable resource but, because it's closer to surface water and is faster-moving than old groundwater, it's also more vulnerable to climate change and contamination by human activities.

"Intuitively, we expect drier areas to have less modern groundwater and more humid areas to have more, but before this study, all we had was intuition. Now, we have a quantitative estimate that we compared to geochemical observations," says Dr. Kevin Befus, who conducted the groundwater simulations as part of his doctoral research at the University of Texas and is now a post-doctoral fellow at the United States Geological Survey.

The next step in painting a full picture of how quickly we're depleting both old and modern groundwater is to analyze volumes of groundwater in relation to how much is being used and depleted.



Map of Earth's modern groundwater. Tom Gleeson, Kevin M. Befus, Scott Jasechko, Elco Luijendijk and M. Bayani Cardenas (2015). *Nature Geoscience*, DOI:10.1038/NGEO2590.

In a previous study that ultimately led to the investigation of modern groundwater, Gleeson's 2012 groundwater footprint report in *Nature* mapped global hot spots of groundwater stress, charting rates of precipitation compared to the rates of use through pumping, mostly for agriculture. Some of these hot spots are northern India and Pakistan, northern China, Iran, Saudi Arabia, and parts of the US and Mexico.

"Since we now know how much groundwater is being depleted and how much there is, we will be able to estimate how long until we run out," says Gleeson. To do this, he will be leading a further study using a global scale model.

Funding for this study came from Natural Sciences and Research Council, Canadian Institute for Advanced Research, US National Science Foundation and the American Geophysical Union.

MESSAGE FROM THE DEAN



It is my pleasure to share with you the accomplishments of our Faculty members, students and alumni for the Spring edition of this newsletter.

This year we welcomed Chris Kennedy as the new chair of the department of Civil Engineering. Chris comes to us from the University of Toronto. His expertise in the areas of sustainable cities and industrial ecology is well aligned with our goal to create the greenest Civil Engineering program in Canada.

We honour the accomplishments of our alumni at Alumni Week every February by nominating an outstanding Engineering alum. This year's award recipient, Jacques van Campen, BEng '88, is an executive at Schneider Electric and a wonderful role model for our students. You can read about his accomplishments on page 4.

Congratulations are due to faculty members, Alex Thomo, Rishi Gupta and Reuven Gordon. Thomo (Computer Science) and Gupta (Mechanical) are the latest recipients of UVic's annual teaching award in the faculty of Engineering. Gordon (Electrical) was recently elected as a Fellow of the Optical Society.

The faculty continues to experience strong student demand due to our distinctive programming and the strong international reputation of the University of Victoria. There is also a growing appreciation across the country of the value of an engineering and computer science education, and the ability of the graduates of our programs to make a positive difference in society.

I hope you enjoy reading this newsletter and thank you for your support.

Tom Tiedje, Ph.D., FRSC, P.Eng.

ENGINEERING HONOURS

Reuven Gordon, Professor of Electrical and Computer Engineering was elected as a Fellow Member of The Optical Society (OSA), the leading global professional association in optics and photonics. Fellow membership in OSA is reserved for members who have served with distinction in the advancement of optics. Gordon is being honoured specifically for developing the field of enhanced optical interactions using nanoapertures in metal films, with applications to sensing, spectroscopy and manipulation of individual nanoparticles and proteins.

Ian Barrodale, UVic alumnus and adjunct professor gained some well-deserved public recognition as VIATEC (Victoria Innovation, Advanced Technology and Entrepreneurship Council) Tectorian of the Week. Barrodale was a founding Chair of the Computer Science Department at UVic in 1980 and has had a career as both professor and entrepreneur, starting the successful Barrodale Computing Services Ltd., which has completed more than 450 projects. He attributes much of this success to the bright talent coming out of UVic. VIATEC has been promoting Victoria's technology sector since 1989.

Jacques van Campen (BEng Electrical '88) was honoured as this year's Distinguished Alumni Award recipient. The celebration, held at the Royal BC Museum, highlighted the achievements of twelve notable alumni from across faculties. As Vice-President at Schneider Electric, van Campen leads the global power metering business with a team of 200 engineers and marketing professionals located across five countries. The company is a global leader in sales and



Photo: UVic Photo Services

Jacques van Campen accepting the Distinguished Alumni Award in front of a full house at the Royal BC Museum at UVic's annual Alumni Week celebrations.

innovation. He remains a champion of UVic students, with Schneider Electric hiring almost 300 co-op students.

Sarah Douglas (4th year Biomedical Engineering student) is one of five recipients of the 2015 CEMF (Canadian Engineering Memorial Foundation) Undergraduate Women in Engineering Scholarship. The scholarship is awarded annually by CEMF to recognize the most promising women in an accredited undergraduate engineering program in Canada.



Dr. Subhasis Nandi

In Memoriam of Dr. Subhasis Nandi

— By Department of Electrical and Computer Engineering

Our colleague Subhasis Nandi passed away this January after a courageous battle with cancer. He leaves behind his wife Runa and daughter Brishti.

Subhasis was born in India in 1963. He received his Bachelors, Masters, and Doctoral degrees, all in Electrical Engineering, in 1985, 1988, and 2000, respectively. Between 1988 and 1996, he pursued an illustrious career in industry at the Central Power Research Institute of India. He joined the Department of Electrical and Computer Engineering in 2000. Dr. Nandi carried out research in power electronics and electric machines, and made significant contributions to his profession. He was awarded the IEEE Power Engineering Society Prize in 2007.

Professor Nandi was involved in the organization of several professional conferences and served as an Associate Editor of the IEEE Transactions on Industry Applications. He was a Senior Member of the IEEE and an active member of the IEEE Victoria Section serving as the Student Branch counselor for the past 16 years.

Subhasis was promoted to the position of Full Professor in 2015 and continued to devote time and energy to his students and family throughout his illness.

We will miss his humour, politeness, smile, and laughter.

Behavioral Biometric Identification Software protects against today's advanced cyber threats

— Edited by Brian Case

How does a person or company defend against the threat of cyber attacks and hackers? Dr. Issa Traore, UVic professor of Electrical Engineering and then graduate student Dr. Ahmed Awad, set out to address this problem. They designed a “biometric authentication software” as a line of defense against cyber threats. The results of their research inspired them to form a new company, Plurilock Security Solutions Inc., with a mission of creating a new paradigm for network security. It's called behavioural biometrics. Here is how it works.

Traditionally, biometric signatures used for security identification have focused on physical traits—fingerprints and retinal scans, for example—which require expensive hardware to protect against security breaches.

But there is another way to identify the person on the keyboard, without the need for expensive hardware. Everyone has their own unique way of using computers or mobile devices. The speed and rhythm of typing and even

the way the mouse is manoeuvred, reveal patterns that can be identified and remembered. It creates a security signature based on the way a person uses the device—in other words, behavioural biometrics.

Plurilock Security Solutions is an innovator in providing continuous authentication, significantly reducing the chances of a security breach. So instead of reacting to a breach once it has already taken place, Plurilock prevents the breach from happening in the first place.

In 2013, Plurilock was awarded a quarter million dollar contract as part of the Federal Build in Canada Innovation Program. This funding, along with a private investment boost

last year, enabled the company to build a team right here in Victoria. Its headquarters, located downtown on Wharf Street, has eight employees.



ALUMNI SPOTLIGHT: Social media mapping creates new way of seeing the world around us

Look around you on a busy downtown street and you'll likely see at least a few passersby hunched over their mobile devices, posting on Facebook, Twitter or Instagram, where they are and what they're experiencing on the ground. Now aggregate that data and you get a sense of what's going on around you on a larger scale. The ability to have hundreds of 'reporters' on the ground can radically shape the way we see events as opposed to how they are (or aren't) portrayed in traditional media. It can also expose how little privacy there is, when you can see into areas that are presumably impenetrable like military bases or North Korea.

UVic Geography alumnus Karl Swannie, had a client ask him to identify areas where people congregate. Karl used Twitter geotags to find aggregated data and visualize large groups of people. After witnessing the vast amount of interesting data that can be collected, Karl started investigating whether it would be valuable to other businesses and organizations. He began Echosec as a side project.

Through support from the Alacrity Foundation and UVic professors, Karl was eventually introduced to three engineering

alumni, all currently enrolled in the Entrepreneurial Engineering Masters Degree at UVic—Mike Anderson, computer engineering alumnus, Nick Turner, computer software alumnus and Jason Jubinville, electrical engineering alumnus.

Echosec has gained a lot of traction globally from security, intelligence, law enforcement, and journalism organizations. Their continuous growth has led Echosec to open a new office in the UK; quickly expanding from 4 to 13 employees, two of whom are based in the UK office.

Real-time media map showing activity in Lattakia, Syria. This map collects social media posts from individuals—military and civilian—to provide a mosaic of what's happening on the ground.

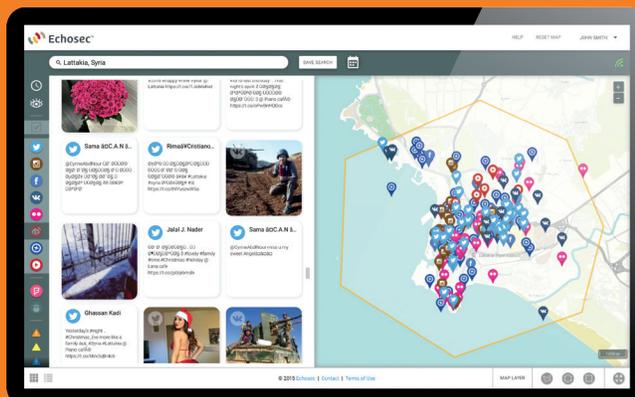


Photo: Sarah Shepherd

Engineering student Sarah Shepherd sits on BMO's Millennial Advisory Council

— Edited by Brian Case

Sarah Shepherd is one of 30 female business and engineering students from across the country invited to join BMO's Millennial Advisory Council. Its mandate is to address issues of how companies hire, move forward with diversity in the workplace, and deal with young customers.

As a third-year female engineering student and a millennial, Sarah has a lot to say about how companies need to approach the upcoming generation of professional workers and young customers to meet changing standards of conduct and an increasingly diverse workplace.

Sarah says that, even in 2016, there is still a gender imbalance across STEM fields, not just in engineering. While many factors are at play, providing a voice for female students helps all students move the needle.

A transformational gift for civil engineering

— By Sarah Tarnopolsky

Sometimes they gathered at the Grad House to watch Star Trek, or in L-Hut for late night pizza, but most often the close-knit, international community of engineering students found themselves at Bez and Carolyn's house being treated to warm hospitality and family dinners. For Marinos Stylianou, these memories, and particularly the influence of Dr. Bez Tabarrok, cemented a life-long connection with UVic.

Marinos first studied under Dr. Tabarrok at the University of Toronto, and, after a stint working in industry, followed him to UVic to pursue a PhD. Dr. Tabarrok was a leading researcher in Canada in computational mechanics and finite element analysis. He was also, Marinos says, "a great teacher and a very special individual."

After completing his PhD, Marinos developed finite element analysis software for a Vancouver based company, S-Frame, before moving to the US where he worked for almost fifteen years at MARC Analysis Research Corporation and MSC Software. He's now the CEO of S-Frame, which he's helped become a global leader in structural engineering software.

l-r; Carolyn Tabarrok; Marinos Stylianou; Bez Tabarrok



Marinos maintained his connections with the Tabarrok family, so when Bez passed away in 1999, he donated to a scholarship fund in his memory. This year Marinos took his support much further, through a substantial donation of S-Frame product licenses and tech support worth half a million dollars. It's a transformational gift for UVic's fledgling civil engineering program that will have a direct and lasting effect on students.

"Typically only large multi-national companies can afford this software," Marinos explains. "Becoming proficient with these tools during their undergraduate degree puts UVic students at a competitive advantage for securing co-op placements and jobs."

For Marinos, this latest gift is another way to honour the strong legacy of Dr. Tabarrok. Collectively remembered as a prominent scholar, and the founding chair of mechanical engineering at UVic, Dr. Tabarrok was also a significant teacher and mentor to students like Marinos. "Everything I used in my career, I learned from him," he says.



Francis Charbonneau, Co-op student of the year

Co-op student of the year

— By Co-operative Education Program and Career Services

Francis Charbonneau has a passion for making the world a better place. The fourth-year electrical engineering student has made a point of completing six co-op work terms with organizations committed to sustainability and renewable energy. He has also demonstrated a commitment to community through his volunteering and extracurricular activities. His most recent two work terms were with SgurrEnergy as a Renewable Energy Consultant. In addition to managing projects assessing wind resource and power performance of wind turbine generators, Francis provided technical reviews of wind farm cabling, compiled risk matrix reports for various projects and was involved with assessing wind resources at proposed and operational wind farm sites. He did such a good job that he was offered a full-time position with SgurrEnergy after graduation.

An exemplary student, Francis has also been active outside the classroom. He has been a member of the men's novice varsity rowing team, and is currently a co-director of sports with the Engineering Student Society. He volunteers as a Big Brother and encourages fellow co-op students to embrace job shadowing opportunities to learn the most about their possible career paths.

Giving Back

Our alumni make a difference by volunteering at events, speaking to classes, hiring co-op students or supporting scholarships. To help change the lives of our current students, you can make a donation today at uvic.ca/givingtouvic or by contacting the Development Coordinator, at 250-472-4210 or devtcoor@uvic.ca.

Planning a reunion?

The UVic Alumni Association can help by promoting your event to classmates, arranging speakers or providing door prizes. Network and keep involved by exploring the list of groups and upcoming events to find something that's right for you. alumni.uvic.ca/events/reunions.php

Alumni Newsletter

EngineeRing is published twice yearly by the Faculty of Engineering to communicate the faculty's goals, strategic direction and activities in order to connect alumni with each other and the university. Send your story ideas and feedback to Chrystal Phan at cmphan@uvic.ca.



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