Symposium Program

LEADERS & PEOPLE 2020 VIRTUAL SYMPOSIUM

Water Management in a Changing Climate

A joint symposium for The LEaders in wAter anD watERshed Sustainability (the LEADERS Program) and the Network on Persistent, Emerging, and Organic PoIIution in the Environment (the PEOPLE Network).

August 31st – September 1st, 2020 | Zoom Meetings
Welcome Message

We invite you to join us for the first LEADERS & PEOPLE Virtual Symposium: Water Management in a Changing Climate, August 31st – September 1st, 2020! This symposium is co-hosted by the LEaders in wAter anD watERshed Sustainability (the LEADERS Program, led by Queens University) and the Network on Persistent, Emerging, and Organic PoLlution in the Environment (the PEOPLE Network, led by Memorial University) for Highly Qualified Personnel (HQP) training. Both are funded by the Collaborative Research and Training Experience (CREATE) Program of the Natural Sciences and Engineering Research Council (NSERC) of Canada.

Persistent, emerging, and organic pollutants pose ecological and health risks due to their persistent, toxic, carcinogenic, and/or bio-accumulative properties and associated long-term ecological and health risks. Many are not regulated or legislated, mainly due to the lack of in-depth knowledge about their fate, transport, impact, or corresponding lack of effective management and mitigation. These emerging pollutants are found in air, surface water, groundwater, ice caps, oceans, soils, and sediments, and there is increasing evidence of their toxicity at all trophic levels, highlighting an urgent need for effective management and mitigation approaches globally. The topic becomes ever challenging in the context of climate change and important for science and policy.

This symposium will bring in a variety of keynote speeches, technical presentations, and roundtable discussions on the above topic and challenges. We welcome students, post-doctoral fellows, faculty, industrial and government partners to join us for an exciting two days of learning, sharing ideas, and virtual networking!

Regards from your symposium chairs,

Dr. Stephen Brown
Director, the LEADERS Program
Associate Professor
Department of Chemistry &
School of Environmental Studies
Queen’s University
Kingston, ON, Canada

Dr. Bing Chen
Director, the PEOPLE Network
Professor and Head
Department of Civil Engineering
Faculty of Engineering & Applied Science
Memorial University
St. John’s, NL, Canada
Dr. Stephen Brown
Director, the LEADERS Program

Dr. Stephen Brown is an Associate Professor in the School of Environmental Studies and the Department of Chemistry at Queen's University. He is the Principal investigator and Program Director for the LEaders in wAter anD watERshed Sustainability (the LEADERS CREATE Program), which brings students from a variety of schools and departments to the forefront of water research through an interdisciplinary approach to develop future leaders in water-related science and policy. Dr. Brown's research group focuses on the development of new methods of environmental analysis, with emphasis on detecting small organic compounds in aqueous samples. This requires development of instruments and chemical/biochemical assays to provide sensitive and selective measurement of a particular contaminant. Dr. Brown has an extensive track-record in the commercialization of water sensor technology and is also the principal inventor of IP and co-founder of TECTA-PDS Inc., which markets automated microbiological water quality monitoring systems. TECTA-PDS was originally formed in 2003 as a direct result of the Walkerton disaster in Ontario to revolutionize microbiological monitoring methods.
Dr. Bing Chen
Director, the PEOPLE Network

Dr. Bing Chen is a Professor and Head of the Department of Civil Engineering, and Director of the Northern Region Persistent Organic Pollution Control (NRPOP) Laboratory at Memorial University, Canada. He is also the founding Director of the global Network on Persistent, Emerging, and Organic Pollution in the Environment (PEOPLE Network). He is an elected Fellow of the Canadian Society for Civil Engineering (CSCE), Member of the Royal Society of Canada (RSC) College, and Alumnus of the Global Young Academy (GYA). He is an internationally respected leader in environmental engineering research with significant contributions in the areas of environmental emergency (e.g., oil spills) responses, persistent/emerging pollutant fate and transport, wastewater treatment, marine and coastal pollution mitigation, environmental modeling, and decision making. He has produced over 370 technical publications including over 130 refereed journal articles and 3 books, and 6 patents/disclosures. Dr. Chen has served as Senior Advisor of the United Nations Development Programme, Vice-President of the CSCE, Vice-President of the Canadian Association on Water Quality (CAWQ), Member of the Royal Society of Canada’s Expert Panel, Vice-President of Avalon Chapter of Sigma Xi, National Advisory Committee Member of Canada’s Oceans Protection Plan Multi-Partner Research Initiative, Associate Editor or Editorial Member of 5 refereed journals, and Adjunct/Visiting professor of 6 institutions worldwide. He has received over 30 prestigious awards, such as WEF A.S. Bedell Award, Terra Nova Young Innovator Award, CFI Leaders Opportunity Fund Awards, FEAS Award for Research Excellence, and various conference and journal awards.
Symposium Themes

All current/prospective students and postdoctoral fellows under the LEADERS and PEOPLE CREATE programs will present their research related to, but not limited to, the following topics:

- Persistent, emerging, and oil pollutants (PEOPs) monitoring, analysis, fate, and transport
- PEOPs prevention, treatment, and remediation
- Ecological impact, toxicological analysis, and risk management
- Community health effects and technology transfer

Student Awards

All undergraduate, masters, and Ph.D. presenters are competing for the student awards. Presentations will be evaluated by faculty, staff, and student judges. A First Prize and a Runner-up will be selected for each program. Student awards will be announced at the closing ceremony.

Program Book Design
Weiyun Lin

Technical Support
Sophie Felleiter
Jingjing Ling
Miao Yu

Student Judges
David Patch
Xing Song
Nahid Hasanshahi
Katherine Moir
Zheng Wang
Lauren Halliwell

Social Media
Maryam Rajper
Qiao Kang

Symposium Organizers

Sophie Felleiter
Coordinator
LEADERS Program
Queen's University

Dr. Weiyun Lin
Coordinator
PEOPLE Network
Memorial University
Dr. Denise Hardesty is a principal research scientist for CSIRO’s Oceans and Atmosphere. A broadly trained ecologist, her work has taken her to all seven continents, studying everything from penguins in Antarctica to hornbills in West Africa, the rainforests of central and South America, and looking at plastic waste along the coastlines in Australia, Asia, North and South America and Africa. For the last decade her work has increasingly focused on plastic pollution, looking at impacts on wildlife such as seabirds, turtles and marine mammals, and examining the sources, drivers and distribution of mis-managed waste. Denise’s team takes a risk-based approach to addressing biodiversity impacts resulting from ingestion and entanglement, combining empirical evidence with model-based approaches. Her marine debris work also focuses on gear loss from fisheries, drivers for litter losses into the environment, waste policy effectiveness, and non-point source reduction. Her team’s work addresses the impacts on communities and economies, as well as addressing policy responses and effectiveness. She advocates for the role of science in underpinning policy and decision making, and has served as a scientific expert on a number of international panels. As recognition of the plastic pollution issue grows, Denise is increasingly asked to provide expert opinion on marine debris related matters to international and domestic governments, industry, fisheries and other stakeholders including the United Nations, G7 and G20 bodies, and the Convention on Biological Diversity, with the aim of to reducing this important transboundary issue. She believes strongly in the contribution of communities, having worked with more than 8,000 citizen scientists over the last few years to help tackle the plastic pollution problem.
Dr. Schuster-Wallace is an Associate Professor in the Department of Geography and Planning at the University of Saskatchewan, a water-health researcher within Global Water Futures program, and a member of the Global Institute for Water Security and Centre for Hydrology. She also holds adjunct positions at the University of Waterloo and McMaster University. Previous positions include Senior Research Fellow (water-health) in the Water and Human Development Programme at the United Nations University Institute for Water, Environment and Health (UNU-INWEH), Research Associate in the School of Engineering at the University of Guelph (Canada), and a water-environment specialist for the Public Health Agency of Canada and was a consultant to Part 2 of the Walkerton Commission of Inquiry into the Walkerton, Canada drinking water tragedy of 2000. Her research interests include 1) Local water security for health, 2) Water, disease and climate change, and 3) Water and Sustainable Development.
Roundtable Discussions

#1 Indigenous engagement in research and training
Facilitators: Dale Booth and Jyoti Kotecha

As President and Founder of I7, and as a member of the Naotkamawing First Nation, Dale Booth brings over 20 years of experience working in the Indigenous affairs space, specializing in major infrastructure development and Public Private Partnerships (P3) procurement. Dale has honed his P3 project knowledge and significant alternative service delivery expertise to give his clients confidence that no stone will remain unturned while working with the I7 team. I7, as a registered Indigenous business, is First Nations owned and operated.

Dale has held senior positions within Indigenous and Northern Affairs Canada (INAC) and the Assembly of First Nations (AFN) and was appointed to the National Aboriginal Economic Development Board in 2008. As the AFN Chief Executive Officer, Dale demonstrated keen abilities in strategic planning, operational management and financial management. Prior to founding I7, Dale worked in the private sector and for the federal Crown corporation PPP Canada, where gained considerable experience in business development; project and business case development; fairness advisory services; community engagement processes and First Nation’s economic value propositioning. Dale’s extensive infrastructure and government institutional expertise combined with his knowledge of global procurement best practices ensure he delivers results for his clients.

Jyoti Kotecha is the Associate Director of Research and Business Development at the Beaty Water Research Centre (BWRC) where she works with research faculty, industry and community partners to support the growth of interdisciplinary research at the Centre. Ms. Kotecha develops research partnerships and supports graduate student success, through securing internships and mentoring them in research ethics, research proposal development, and knowledge translation activities. Ms. Kotecha was the former Director of the Queen’s University International Centre, and the Assistant Director of the Centre for Studies in Primary Care, at Queen’s University. Through these positions she has gained substantial experience in establishing research Centres and national research networks. Ms. Kotecha is also an adjunct in the Department of Family Medicine and her research interests include, community based care research, participatory research and water and health.
Trained in Medicine and specialized in public health (both from India), Dr. Atanu Sarkar pursued a second masters in environmental studies at Queen's University (Kingston, Canada) and received the research excellence award from the faculty of health sciences (2010). Dr. Sarkar is interested in environmental health, particularly environmental contaminants and adverse human health impacts, climate change, and Indigenous health. Dr. Sarkar has been successful in getting research grants from CIHR, NSERC, SSHRC and also several supports from provincial funding agencies. Dr. Sarkar published several research papers in leading journals such as Environment International, Global Environmental Change, Environmental Research, Eco Health, Environmental Justice, BMJ Endocrinology etc. and lead editor of a volume on climate change, food security and adaptation, published by Springer, Switzerland. In 2015, Dr. Sarkar received research excellence award from the faculty of medicine. Prior to joining MUN, Dr. Sarkar served United Nations and various international agencies in India and Africa. Dr. Sarkar is currently co-chair of Ethics and Philosophy Committee of International Society for Environmental Epidemiology.

Dr. Uta Passow is a Tier 1 Canadian Research Chair (CRC) in Biological Oceanographic Processes, at the Ocean Sciences Center, Memorial University. She has actively worked in oil spill research since the Deepwater Horizon (DwH) accident in the Gulf of Mexico in 2010, and spearheaded the discovery that marine snow is an important transport vehicle for oil, resulting in the sedimentation of oil to the deep seafloor. The fact that about 20% of the spilled DwH oil was deposited at the bottom of the sea, was unexpected to responders, decision makers and the oil spill community and not included in the oil budget calculator. Her research on the fate of oil spilled during DwH pointed to the importance of natural marine processes and particle dynamics for the fate of the spilled oil.
Dr. Louise Meunier studied mechanical engineering and worked for twenty years as an aerospace engineering officer in the Royal Canadian Air Force before completing a Ph.D. in chemical engineering specializing in environmental chemistry. Dr. Meunier’s research focuses on the toxicity of contaminants in soils and mine tailings, and on environmental and human health risks associated with exposure to contaminants in water and soil. These investigations include research on inorganic and organic pollutants, as well as novel materials (e.g., nanoparticles, graphene), and contaminant mixtures. Dr. Meunier works in collaboration with industrial and academic experts involved in various aspects of interdisciplinary environmental engineering research. Dr. Meunier is also involved in engineering education research; her interests include improving problem-solving and resilience abilities in engineering students, and incorporating innovative teaching approaches in the engineering curriculum.

Dr. Peter S. Ross is the Vice-President of Research at Ocean Wise, part of the Vancouver Aquarium family. He currently oversees eight research programs at Ocean Wise that deliver conservation science to the international community. He is Adjunct Professor at the University of Victoria. He served as a Research Scientist with the Canadian government between 1996 and 2013. He is an international authority in the area of ocean pollution, having published over 150 scientific articles, with a focus on the source, transport, fate and effects of priority pollutants. He discovered the region’s killer whales to be the most ‘contaminated marine mammals in the world’ in a groundbreaking study in the year 2000, and more recently reported on the widespread distribution of microplastics in the NE Pacific Ocean. He and his team launched PollutionTracker (http://pollutiontracker.org/) in 2017, the first ever coast-wide monitoring program for pollutants of concern in British Columbia, and Ocean Watch (https://research.ocean.org/program/ocean-watch), a coast-wide ocean health report card.
Roundtable Discussions

#4 Wastewater based epidemiology
Facilitators: Dr. Geof Hall and Dr. Ehssan Koupaie

**Dr. Geof Hall**
Associate Director of Education & Outreach, Beaty Water Research Centre (BWRC)

Dr. Geof Hall is the Associate Director of Education & Outreach, Beaty Water Research Centre and an Adjunct Professor, Department of Civil Engineering & School of Environmental Studies. Dr. Hall is a multidisciplinary researcher spanning the fields of biology, engineering and public health. He holds degrees in both Biology and Civil Engineering from Queen's University. As the Associate Director of Education and Outreach at the Beaty Water Research Centre, Dr. Hall develops and supports water-related education, research and outreach opportunities. His research interests include surface and groundwater quality, microbial biomes and their role in natural and engineered systems. In addition, his interests include holistic approaches to the assessment of environmental factors affecting human health. These include the modeling and movement of infectious, water-borne and zoonotic diseases, along with heat-related illness effects at the community level.

**Dr. Ehssan Koupaie**
Assistant Professor, Department of Chemical Engineering, Queen's University

Before joining Queen's University, Dr. Ehssan Koupaie was an NSERC Postdoctoral Fellow at the Department of Chemical Engineering and Applied Chemistry at the University of Toronto. He has also been affiliated with BioZone, The Centre for Applied Bioscience and Bioengineering Research, The Pulp and Paper Centre at the University of Toronto, and The Bioreactor Technology Group at the University of British Columbia. Dr. Koupaie received his Ph.D. in Civil and Environmental Engineering from the University of British Columbia in 2017. During his Ph.D., he collaborated with an interdisciplinary team of researchers from environmental engineering, electrical engineering, and physics disciplines; a collaboration that led to the development of a novel energy-efficient radio frequency (RF) thermal hydrolysis technology for enhanced bioenergy recovery from municipal biosolids. His research revolves around environmental BioEngineering and aims to generate sustainable, cost-effective, and energy-efficient techniques for enhanced conversion of organic waste into bioenergy, biofuels, and value-added chemicals.
## Symposium Agenda

All time marked as Eastern Time

### Day One, Monday, August 31st, 2020

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
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<tbody>
<tr>
<td>10:00 – 10:30</td>
<td>Welcome and opening remarks / Zoom Room 1</td>
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<tr>
<td></td>
<td><strong>Dr. Stephen Brown</strong> (The LEADERS Program)</td>
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<td><strong>Dr. Bing Chen</strong> (The PEOPLE Network)</td>
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<tr>
<td>10:30 – 11:30</td>
<td>Keynote speaker: <strong>Dr. Denise Hardesty</strong> / Zoom Room 1</td>
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<td>Principal Research Scientist, Oceans and Atmosphere, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia</td>
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<td></td>
<td>Title: <strong>TBD</strong></td>
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<tr>
<td>11:30 – 12:30</td>
<td>Break</td>
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<tr>
<td>12:30 – 14:00</td>
<td>Presentation Session 1</td>
<td>Presentation Session 2</td>
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<tr>
<td></td>
<td><strong>Emerging contaminants in the context of environmental engineering</strong> / Zoom Room 2</td>
<td><strong>Global and community health</strong> / Zoom Room 1</td>
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<tr>
<td></td>
<td>Co-Chairs: <strong>Dr. Baiyu (Helen) Zhang &amp; Dr. Wendy Huang</strong></td>
<td>Co-Chairs: <strong>Jyoti Kotecha &amp; Sophie Felleiter</strong></td>
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<tr>
<td>14:00 – 14:15</td>
<td>Break</td>
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<tr>
<td>14:15 – 16:00</td>
<td>Presentation Sessions 3</td>
<td>Presentation Session 4</td>
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<td></td>
<td><strong>Fate, effects and monitoring of various contaminants</strong> / Zoom Room 2</td>
<td><strong>Water and wastewater</strong> / Zoom Room 1</td>
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<td>Co-Chairs: <strong>Dr. Bas Vriens &amp; Dr. Nasima Chorfa</strong></td>
<td>Co-Chairs: <strong>Dr. Stephen Brown &amp; Dr. Zhiwen Zhu</strong></td>
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<tr>
<td>16:00 – 16:10</td>
<td>Closing Message</td>
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### Day Two, Tuesday, September 1st, 2020

<table>
<thead>
<tr>
<th>Time</th>
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<th>Location</th>
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<tbody>
<tr>
<td>10:45 – 11:45</td>
<td>Keynote speaker: <strong>Dr. Corinne Schuster-Wallace</strong> / Zoom Room 1</td>
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<td></td>
<td>Associate Professor, University of Saskatchewan, Canada</td>
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<td></td>
<td>Title: <strong>Creating Ripples</strong></td>
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<tr>
<td>11:45 – 12:15</td>
<td>Break</td>
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<tr>
<td>12:15 – 14:00</td>
<td>Presentation Session 5</td>
<td>Presentation Session 6</td>
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<tr>
<td></td>
<td><strong>Oil pollution, response and treatment</strong> / Zoom Room 2</td>
<td><strong>Ecotoxicology</strong> / Zoom Room 1</td>
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<td>Co-Chairs: <strong>Dr. Carlos Bazan &amp; Dr. Bo Liu</strong></td>
<td>Co-Chairs: <strong>Dr. Geof Hall &amp; Dr. Xiaying Xin</strong></td>
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<tr>
<td>14:00 – 14:15</td>
<td>Break</td>
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<tr>
<td>14:15 – 15:45</td>
<td>Roundtable Discussion (Facilitators)</td>
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<td></td>
<td><strong>Indigenous engagement in research and training</strong> (Dale Booth &amp; Jyoti Kotecha)</td>
<td><strong>Microplastics and other emerging contaminants in water</strong> (Dr. Louise Meunier &amp; Dr. Peter Ross)</td>
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<td><strong>Mitigation of impacts to marine oil spills</strong> (Dr. Atanu Sarkar &amp; Dr. Uta Passow)</td>
<td><strong>Wastewater: challenges and opportunities</strong> (Dr. Ehssan Koupaei &amp; Dr. Geof Hall)</td>
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<tr>
<td>15:45 – 16:00</td>
<td>Student Award Annoucement and Symposium Closing / Zoom Room 1</td>
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Meeting Location

LEADERS & PEOPLE 2020 Virtual Symposium (Zoom Room 1)
Host: the LEADERS Program

Please download and import the following iCalendar (.ics) files to your calendar system.

Daily: [https://queensu.zoom.us/meeting/tJ0sc-CrrD8uHdJdAw3JKjugYMzggPG3l6PW/ics?icsToken=98tyKuChrz8jGdaRtB6BRox5BY-gXenzpilbgqd3mD7yUAp4aBbxD89YNaNPN4v5](https://queensu.zoom.us/meeting/tJ0sc-CrrD8uHdJdAw3JKjugYMzggPG3l6PW/ics?icsToken=98tyKuChrz8jGdaRtB6BRox5BY-gXenzpilbgqd3mD7yUAp4aBbxD89YNaNPN4v5)

Join Zoom Meeting

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Dial by your location

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</table>

Index  Keynote  Roundtable  Agenda  Presentation Schedule  Abstract: Session 1/2/3/4/5/6
Meeting Location

LEADERS & PEOPLE 2020 Virtual Symposium (Zoom Room 2)
Host: the PEOPLE Network

Please download and import the following iCalendar (.ics) files to your calendar system.

Daily: https://zoom.us/meeting/tJMldu-grDkoHd1eGlH1cV2QbNVVvwFUOc4d/ics?icsToken=98tyKuCvpjosGNaXsh6ORowEGoj4M-rzpnpBgqcMmTjpK3FQVFHNMx0BKRoNu3

Join Zoom Meeting

https://zoom.us/j/97816222279?pwd=c0lyWFVRd0hrMTNMeUo1QWZ1VC9vUT09

Meeting ID: 978 1622 2279
Passcode: 039610

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Find your local number:
https://zoom.us/u/aw8A9yEkR
# Presentation Schedule

All time marked as Eastern Time

Day One, Monday, August 31st, 2020

<table>
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<tr>
<th>12:30 – 14:00</th>
<th>Session 1: <em>Emerging contaminants in the context of environmental engineering</em></th>
<th>Session 2: <em>Global and community health</em></th>
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</thead>
<tbody>
<tr>
<td>Co-Chairs</td>
<td>Dr. Baiyu (Helen) Zhang, Associate Professor, Memorial University</td>
<td>Jyoti Kotecha, Associate Director Research &amp; Business Development, Beaty Water Research Centre</td>
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<tr>
<td></td>
<td>Dr. Wendy Huang, Assistant Professor, University of Calgary</td>
<td>Sophie Felleiter, Research Coordinator, the LEADERS Program</td>
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</table>

**Student Judge**

<table>
<thead>
<tr>
<th>12:30 – 12:45</th>
<th>Fate and transport of metformin in saturated zone: A flow cell experiment and its simulation</th>
<th>Environmental governance: persistent organic pollutants and culture</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Qiao Kang, Memorial University</td>
<td>Jeffrey McLean, McMaster University</td>
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<tr>
<td>12:45 – 13:00</td>
<td>Comprehensive study of dissolved methane harvesting using omniphobic membrane contactor</td>
<td>Exploring the knowledge, attitudes and behaviours of current well water stewardship in rural Ontario communities: Implications for drinking water vulnerability and public health risks</td>
</tr>
<tr>
<td></td>
<td>Abhishek Dutta, University of British Columbia</td>
<td>Sarah Lavalée, Queen’s University</td>
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<td></td>
<td>Guihua Dong, Memorial University</td>
<td>Om Prakash Yadav, Memorial University</td>
</tr>
<tr>
<td>13:15 – 13:30</td>
<td>Investigation of the phototransformation mechanisms of benzotriazole in surface waters using compound-specific isotope analysis</td>
<td>The impact of land cover changes on land and water surface temperatures in the Cataraqui River Conservation Authority’s watershed</td>
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<td>Langping Wu, University of Toronto</td>
<td>Matthew Senyschen, Queen’s University</td>
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<tr>
<td>13:30 – 13:45</td>
<td>Enhanced gas chromatography-mass spectrometry (GC-MS) based analysis of metformin and guanylurea in water samples</td>
<td>A scoping review on potential human health effects due to exposure to microplastics and knowledge gaps</td>
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<td>Yunwen Tao, Memorial University</td>
<td>Md Arifur Rahman, Memorial University</td>
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<tr>
<td>13:45 – 14:00</td>
<td>Oxidant competition of offshore produced water substrates in a process of TiO$_2$ Nanotube Arrays, UV-LED aided photocatalytic ozonation</td>
<td>Assessing the relationship of Total Coliforms to E. coli in the context of drivers of microbial contamination of drinking water wells in Ontario</td>
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<td></td>
<td>Bo Liu, Memorial University</td>
<td>Ioan Petculescu, Queen’s University</td>
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LEADERS Program  
PEOPLE Network  
Student competition
### Day One, Monday, August 31st, 2020

**14:15 – 16:00**  
**Session 3: Fate, effects and monitoring of various contaminants**

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<td>Dr. Bas Vriens</td>
<td>Dr. Stephen Brown</td>
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<td>Assistant Professor, Queen's University</td>
<td>Associate Professor, Queen's University</td>
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<td>Dr. Nasima Chorfa</td>
<td>Dr. Zhiwen (Joy) Zhu</td>
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<td>Research Associate, University of Manitoba</td>
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**Student Judge**  
Nahid Hasanshahi  
PhD student, UNBC

### 14:15 – 16:00

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Pacific Environmental Science Centre |
|               | Synthetic biology applied to wastewater phytoremediation; primer and prospects                   |
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| 14:30 – 14:45 | Reproducing springtime Arctic tropospheric ozone depletion events in an outdoor mesocosm sea-ice facility  
Zhiyuan Gao  
University of Manitoba |
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Rama Pulicharla  
Université Laval |
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David Patch  
Royal Military College of Canada |
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Lauren Halliwell  
Queen’s University |
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Jessica Ollinik  
Pacific Environmental Science Centre |
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Cristian Ruben Garcia Sanchez  
Université Laval |
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Joseph Monaghan  
Vancouver Island University |
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Max Robinson  
Queen’s University |
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Fereshteh Shahhoseini  
Memorial University |
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Mahsa Keyvan Hosseini  
Dalhousie University |
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Parisa Keyvan Hosseini  
Dalhousie University |

All time marked as Eastern Time
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<td>Dr. Geof Hall&lt;br&gt;Associate Director, Beaty Water Research Centre&lt;br&gt;Dr. Xiaying Xin&lt;br&gt;Postdoctoral Fellow, Memorial University</td>
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<td>Lauren Halliwell&lt;br&gt;MASc, Queen’s University</td>
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<td><em>Toxic effects of ingestion of marine oil snow on blue mussels (Mytilus edulis)</em>&lt;br&gt;Verena Kalter&lt;br&gt;Memorial University</td>
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<td><em>How is the biodegradation of dispersed oil influenced by the incorporation of oil into aggregates?</em>&lt;br&gt;Jong Jin Lee&lt;br&gt;Memorial University</td>
<td><em>Assessing the sorption of the cyanotoxins microcystins to microplastics</em>&lt;br&gt;Eden Hataley&lt;br&gt;Queen’s University</td>
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 Stay Tuned and Follow us!

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Abstracts
Session 1
Emerging contaminants in the context of environmental engineering

Fate and transport of metformin in saturated zone: a flow cell experiment and its Simulation
Qiao Kang, Arpana Datta, Bing Chen*
MEMORIAL UNIVERSITY

As a widely used anti-diabetes drug as well as a suspicious endocrine disruptive substance, metformin started to raise many growing concerns in academic circles recently. Its existences in different compartments such as treatment plant effluents and sludge, surface water, and soil have been reported leading to the strong needs in understanding metformin’s fate and transport processes in groundwater system are few. To help fill the knowledge, as well as evaluate the impact of the emerging contaminant in soil and groundwater, a 2D flow cell experiment focused on metformin’s transport in the saturated zone was conducted. A numerical model of the domain was subsequently built using Visual Modflow for simulating subsurface flow and contaminants transportation. After model calibration and sensitivity analysis, significant parameters were identified. A integrated simulation approach to describe the fate and transport processes of metformin in the saturated zone was developed which will help understand the behavior and effects of metformin in the subsurface environment.
Session 1

Emerging contaminants in the context of environmental engineering

Comprehensive study of dissolved methane harvesting using omniphobic membrane contactor

Abhishek Dutta, Xuesong Li, and Jongho Lee

University of British Columbia

Recovery of dissolved methane from anaerobic effluents has long been a challenge, in particular at low temperatures, due to an increased solubility of the gas in the effluent at decreased temperatures. We propose a novel approach, solvent-based membrane contactor (SMC), for dissolved methane recovery from wastewater using an omniphobic microporous membrane that traps air in the pores when submerged in liquids. In this approach, an omniphobic membrane is placed between a methane-rich feed solution (e.g., anaerobic effluent) and an organic draw solvent that has an order of magnitude higher methane solubility than water. Driven by the solubility difference, methane is then extracted from the feed into the draw, while water transport is deterred due to the low water solubility of the draw solvent. Through this study, we successfully demonstrate over 90% recovery at three different temperatures and flow conditions, using methane-saturated deionized water. We also develop a mass transfer model to investigate the impact of temperature, flow condition, and presence of other dissolved gas species (i.e., carbon dioxide) on methane recovery. Our experimental data and predicted values from the model are in excellent agreement, showing that the energy gain from the recovered methane is higher at a lower temperature, the recovery kinetics is mainly influenced by feed flow condition, and the recovery rate is nearly unaffected by presence of other gas species. An energy analysis comparison of the SMC also shows the possibility of the process to contribute towards net energy generation, by harnessing the methane gas. We further extend the study using methane saturated AnMBR effluent, to study effects of different foulants and fouling on methane transfer in the SMC process. Our experiments showed continued high methane recoveries (>90%) with minimal fouling effects on the recovery process. We conclude that our SMC process, when combined with a low-temperature anaerobic treatment process, has great potential for harvesting of dissolved methane as a renewable energy source from anaerobic effluents even in cold climates.
Session 1

Emerging contaminants in the context of environmental engineering

An integrated MnO$_2$/uv-activated persulfate process for the removal of bisphenol a from water

Guihua Dong, Bing Chen*, Bo Liu, Stanislav R. Stoyanov*, Yiqi Cao, Baiyu Zhang, Min Yang

Memorial University

Persulfate-based advanced oxidation processes have attracted considerable attention in recent years due to their high efficiency for generating sulfate radicals (SO$_4$•-) that degrade emerging and persistent pollutants. Previous studies have demonstrated that persulfate (PS) could be activated by MnO$_2$ or ultraviolet (UV) radiation to produce SO$_4$•- and other radicals for the removal of organic contaminants. However, there are only a few research reports on the synergetic use of MnO$_2$ and UV radiation. This study presents an integrated MnO$_2$/UV-activated PS process for bisphenol A (BPA) removal from water. The parallel systems using MnO$_2$, PS, MnO$_2$/PS, and UV/PS are tested to compare the degradation efficiency of both BPA and total organic carbon. The reaction mechanisms, degradation pathways, and toxicity reduction effected by BPA removal via the MnO$_2$/UV/PS process are investigated. The results show that the MnO$_2$/UV/PS process could completely remove BPA in 30 minutes, and that 90% of total organic carbon is removed after 2 hours treatment, which is significantly higher than other processes. The reactive species (SO$_4$•-, •OH, 1O$_2$) generated in the process are the main drivers of BPA degradation. Kinetic analysis results suggest that MnO$_2$ and UV-C act synergistically to considerably accelerate the generation of the reactive species and enhance the degradation and mineralization of BPA in the PS-based advanced oxidation process. Thirteen intermediates in this process are identified by gas chromatography-mass spectrometry to support the proposed BPA degradation pathways. The acute toxicity analysis shows that the toxicity increases slightly (by 3.3%) in the first 30 minutes and then decreases four-fold over 2 hours. These findings help not only elucidate the mechanism of BPA degradation but also provide an effective PS activation strategy for the treatment of persistent and emerging organic pollutants.
Session 1
Emerging contaminants in the context of environmental engineering

Investigation of the phototransformation mechanisms of benzotriazole in surface waters using compound-specific isotope analysis
Langping Wu and Elodie Passeport

University of Toronto

Benzotriazole is part of a larger family of benzotriazoles which are widely used as antifreeze, corrosion inhibitor and UV-stabilizers in many commercial and industrial applications. It is frequently detected in urban runoff, wastewater, and receiving aquatic environments. In surface waters, benzotriazole is typically resistant to biodegradation and hydrolysis, but can be transformed via direct photolysis and photoinduced mechanisms, e.g., by reactive species formed from dissolved organic molecules. Compound-specific isotope analysis (CSIA) is a promising tool to track and quantify contaminant transformation in the environment. Due to the highly reaction-specific isotope fractionation patterns, CSIA can provide direct evidence of contaminant transformation and has the potential to provide insights into transformation mechanisms. In addition, measuring changes of isotope ratios of more than one element can help identify the relative contribution of different reaction mechanisms. Therefore, the aim of this study was to characterize the phototransformation processes of benzotriazole using multi-element CSIA. The direct photolysis of benzotriazole resulted in significant 15N fractionation, which were -3.4±0.4‰ at pH 5, -7.0±0.8‰ at pH 7 and -4.7±0.6‰ at pH 9, respectively, indicating a N-N bond fission yielding imine is the rate-limiting step. The identified transformation products of aniline, 3-aminophenol and phenazine further supported that the yield imine was rapidly stabilized via two routes: nitrogen elimination followed by hydroxylation and a dimerization process. The formation of hydroxybenzotriazole during indirect photolysis suggested an oxidative attack by OH radical on the benzene ring. The significant 13C fractionation and non-detectable 2H and 15N fractionation in the UV/H₂O₂ system revealed that the formation of O-C bond at the benzene ring was the rate-limiting step of the indirect photolysis. The results of this study highlight the great potential for multi-element CSIA application to track benzotriazole degradation in complex environments.
Session 1
Emerging contaminants in the context of environmental engineering

Enhanced gas chromatography-mass spectrometry (GC-MS) based analysis of metformin and guanylurea in water samples

Yunwen Tao, Baiyu Zhang, Yuming Zhao, Zhiwen Zhu, and Bing Chen
Memorial University

Metformin is widely used as one of the most effective first-line oral drugs for type 2 diabetes. It is difficult to be metabolized by the human body thus commonly exists in both urine and feces samples. Guanylurea is metformin’s main biotransformation product with increased concentrations in the aquatic environments. Liquid chromatography-tandem mass spectrometry (LC-MS) based methods used for measuring the two compounds have been well developed, but extremely limited studies have tracked gas chromatography-mass spectrometry (GC-MS) based analysis. To help better track the occurrence of the two non-volatile biguanide compounds in liquid samples, the improvement of existing GC-MS based methods for reliable metformin and guanylurea analysis is conducted. Derivatization of metformin and guanylurea is the key pre-treatment procedure before the associated GC-MS analysis. Four selected factors affecting for the derivatization were evaluated, and the optimal factors include temperature (90°C), reacting time (40 minutes), solvent (1,4-dioxane), and ratio (1.5:1) of reagent to target component. Buformin and N-methyl-bis(trifluoroacetamide) (MBTFA) were used as the internal standard and the derivatization reagent, respectively. Calibration curves were made based on the optimal conditions of derivatization for metformin and guanylurea with the R² values of calibration linearity achieved as 99.35% and 99.2%, respectively. The values of relative standard deviation (RSD%) of metformin and guanylurea based on seven repeated trails are 2.67% and 15.37%, respectively. The optimal conditions for enhancing the sensitization of metformin and guanylurea derivatization performance were obtained. The improved GC-MS analysis method was eventually applied for metformin and guanylurea analysis in real water samples.
Session 1
Emerging contaminants in the context of environmental engineering

Oxidant competition of offshore produced water substrates in a process of TiO$_2$ Nanotube Arrays, UV-LED aided photocatalytic ozonation

Bo Liu, Bing Chen, Baiyu Zhang, Xing Song, Ganning Zeng, and Kenneth Lee

*Memorial University*

Offshore produced water (OPW) contains various inorganic and organic substrates such as metal, halides, aliphatic and aromatic hydrocarbons, phenols, organic acids, and insoluble particles. These substrates have various effects on the kinetics and mechanisms of advanced oxidation processes at different degrees. Besides, the interaction of inorganic and organic substrate is more complicated, which has not been well studied. This study, therefore, integrated a photocatalytic ozonation system with TiO$_2$ nanotube arrays (TNA) and UV-light-emitted diode (UV-LED) irradiation for the removal of polycyclic aromatic hydrocarbons (PAHs) in OPW. The selection of PAHs was due to their chronic effects on the ecosystem. The kinetic modeling efforts were made to evaluate the degradation efficiencies of PAHs and examine the oxidant competition of the OPW composition (e.g., phenols, iodide, and bromide). The results indicated that ozone was the dominant factor in the enhancement of PAH degradation, following by TNA, while UV-A had a negative effect. In the early stage, the ozone consumption rate of PAHs was $1.10 \times 10^{-2} [O_3]$, which was $\sim 10^6$ times less than that of iodide, indicating the strong ozone competitor of iodide. An iodide-hypoiodite loop could be formed in the presence of phenols, prolonging the competitive effect. The UV-LED was strongly absorbed by the oxidation products of iodide, generating iodine radicals that further accelerated ozone deactivation. Further, the degradation of aromatics was altered by iodide and bromide at different stages. These results helped better understand the critical processes in the photocatalytic ozonation of OPW. It would further guide the operational configurations.
Humans are not separate from nature. Our health and wellbeing is dependent upon the environment. Governance is the organization of society to mobilize decision making. Intuitively, environmental governance is the organization of society to mobilize decision making for the environment. For example, persistent organic pollutants (POPs) help society in many ways by killing pests, reducing malaria burden, or increasing crop yield. However, POPs also are deleterious to the health of people and the environment.

This research works to further the connection between culture and environmental governance in two ways: (1) by considering the history of POPs and their impact on Inuit and (2) through introducing cultural trauma as a mobilizer of change. POPs accumulate in the Arctic, where Inuit live, leaving a significant impact on the health of people and nature in this region. Inuit leaders had direct involvement in POP governance, putting the human face on the consequences of their use. Through the processes of inclusive governance, we have succeeded in mobilizing change around the use of POPs, and global usage has been scaled back. Inuit culture is characterized by an intimate connection with nature and the harvest of country foods; Inuit are directly threatened by environments highly contaminated by such toxins. After considering the history of Inuit and POPs, I highlight how cultural trauma, defined as the rapid and unexpected disturbance of normative ways of being that causes radical changes to a group of people, helped mobilize environmental governance surrounding POPs. Thus, this research provides an understanding of the unique role that culture must play for improved environmental governance. For equitable gains in global health to be realized in an era of climate change, belief that humans are not separate from nature and the role of culture must be amplified.
Session 2
Global and community health

Exploring the knowledge, attitudes and behaviours of current well water stewardship in rural Ontario communities: Implications for drinking water vulnerability and public health risks

Sarah Lavallee, Paul D. Hynds, Stephen Brown, Corinne Schuster-Wallace, Sarah Dickson-Anderson, and Anna Majury

Queen's University

Background: Private well users are responsible for managing and maintaining the quality of their drinking water source. Increased risks of acquiring waterborne illness among private well users are frequently associated with the susceptibility of private well water supplies to contamination by enteric pathogens. Previous studies in Canada have reported low testing rates among well users, a cornerstone of well stewardship behaviours that can prevent the consumption of contaminated groundwater. The current study sought to identify, assess, quantify and address the gaps associated with private well water stewardship behaviour (i.e., testing, treatment, bottled water use) via development of “risk factors” from developed domains (awareness, attitudes, risk perceptions, beliefs, and experience).

Methods: A province-wide online survey was undertaken over the 4-month period May to August 2018. The survey was designed to quantify Ontario’s well owners’ awareness, perceptions and behaviours in relation to their personal source and local sources of contamination. In order to quantify and compare results, a scoring protocol for the four “risk domains” (i.e., awareness, attitudes, risk perceptions and beliefs) was developed.

Results: The survey was completed by 1030 respondents. Preliminary findings indicate that previous experiences (i.e. residential presence during well construction, previous case(s) of acute gastrointestinal illness within household) significantly influence both owner awareness (p<0.001, p=0.038, respectively) and perception of local groundwater contamination risk (p=0.017, p<0.001, respectively). Additionally, increased awareness (p=0.018) and positive attitudes (p=0.006) towards personal well water supplies were associated with an increased likelihood of water testing. Ongoing binary logistic regression modeling is being used to investigate the multivariate relationships between location, demographics, risk domains and the key factors driving protective actions among well users in Ontario.

Conclusion: Findings illustrate that previous experiences influence both respondent awareness and risk perception, with higher levels of awareness and positive attitudes increasing the incidence of protective actions. Models will illustrate the interplay between awareness, attitude, perception, experiences, and behaviour, thus enabling public health agencies to design evidence-based interventions and communication strategies for private well users.
Session 2
Global and community health

Spatial and temporal analysis of Persistent Organic Pollutants in the European Union: analysis of the NORMAN database system

Om Prakash Yadav, Arifur Rahman, Atanu Sarkar, Gopal Achari, and Jaroslav Slobodnik
Memorial University

Background: Persistent Organic Pollutants (POPs) are carbon-based organic chemical substances. POPs such as Pre and Perfluorochemicals (PFASs), Polybrominated diphenyl ethers (PBDEs), and Bisphenol A (BPA) are found in different environmental matrices. The Present study highlighted the spatial and temporal analysis of PFASs, PBDEs, and BPA from the NORMAN database. The NORMAN database is a network of reference laboratories, research centers, and related organizations to monitor the currently emerging environmental contaminants.

Objective: The project's primary objective is to explore the concentration of various congeners of PFAS, PBDE, and BPA present in various environmental matrices through data mining in the EMPODAT NORMAN database system.

Methods: The NORMAN database is hosting more than 10.5 million data on more than 3,300 chemical pollutants. In the present study, 15 PFAS and 13 PBDE congeners and BPA were included. The data is retrieved from the EMPODAT NORMAN database, a database of geo-referenced monitoring and biomonitoring data on emerging substances. The data of 28 European countries, including international water, was collected, followed by a compilation of data based on the location and environmental matrices and subjected to statistical analysis.

Results: As the study is ongoing, we are presenting the preliminary findings. We are aiming to find out temporal trends along with geographic locations. The data presents mostly from 2003 to 2019. The data from biota includes the concentration of chemicals in fish, molluscs, macrophytes. The concentration of chemicals from surface water and sediments was obtained from various rivers and river basins such as Danube, Rhine-Meuse, and Dahle. Around two-thirds of total data gathered from the surface water matrices. Only a few countries included groundwater and wastewater data.

Conclusion: Although the study is ongoing so we cannot make a definite conclusion; however, initial results show the trends of declining concentration.
The impact of land cover changes on land and water surface temperatures in the Cataraqui River Conservation Authority's watershed

Matthew Senyshen and Dongmei Chen*

*Queen's University

Land cover (LC) change in watersheds is a common altering force, which can come in various forms such as urban development, forest harvesting, agriculture expansion, natural disturbances, hydrological alterations, and wetland loss. These various LC alterations have been shown to change the surface temperature on the land of which they occur. It has been shown that LC change not only effects the area where it occurs but also the land surrounding it. However, past LC studies have not yet investigated if there is an effect on water surface temperatures from nearby LC change. The Cataraqui River Conservation Authority’s (CRCA) watershed is located in Eastern Ontario and contains various types of LC changes as well as large and small bodies of water. It is home to approximately 210,000 people and lies within the Algonquin to Adirondack conservation corridor. A common approach for tracking LC change is through remote sensing Earth observation satellites. The Landsat satellite series features the longest, continuous recorded satellite observation of the Earth offering temporal consistency at a moderate spatial resolution. LC change will be determined through the continuous change detection algorithm (CCDC) on Google Earth Engine from 1984 - 2019. This algorithm accounts for seasonal phenology changes, trend components, the effects of clouds, abrupt changes, and uses continuous instead of discrete change. The CCDC method will allow for water temperature change to be tracked with nearby LCC. All necessary atmospheric and surface emissivity data to compute surface temperature are available on Google Earth Engine. Land and water surface temperature will be overlaid onto LC classes and LC change over time to reveal any resulting impacts and trends.
Session 2

Global and community health

A scoping review on potential human health effects due to exposure to microplastics and knowledge gaps

Md Arifur Rahman, Om Prakash Yadav, Atanu Sarkar, Gopal Achari, and Jaroslav Slobodnik

Memorial University

Background: Microplastics are ubiquitous environmental contaminants leading to unavoidable human exposure. However, little is known about the potential health effects of microplastics exposure to humans. This scoping review explores the existing evidence of potential human health effects of microplastics and subsequent knowledge gaps.

Methods: An electronic search of published articles was conducted in PubMed, EMBASE, Scopus, Cochrane databases, and Google Scholar using a combination of subject heading and text word terms for microplastics and human health effects. Documents only published in English between 2004 and March 2020 were included. Exclusion criteria included letters, comments or notes, conference abstracts, and editorials. A focused search was performed in Google Scholar and the environmental organization websites to gather grey literature. A total of 17,043 citations were retrieved from the initial database and grey literature search, and 4,817 unique articles were selected for screening. After full article review and investigating their references, a total of 125 articles were identified for analysis. Throughout the screening process, every document was reviewed by at least two of the researchers.

Results: It has been reported in literature that exposure to microplastics might occur through ingestion, inhalation, and dermal contact due to its presence in food, air, water, and consumer products. Evidence shows that in all biological systems, microplastics exposure might cause particle toxicity through oxidative stress, cytotoxicity, inflammatory lesions, altering metabolism, reproductive toxicity, neurotoxicity, and carcinogenicity. Microplastics have also been found to release their constituents, pathogenic organisms, and other adsorbed contaminants.

Conclusion: Knowledge of microplastic toxicity on human health is still limited and primarily influenced by exposure level, particle size and components, adsorbed contaminants, organs involved, and individual susceptibility. Further research is needed to understand human health effects due to exposure to microplastics, which requires compelling evidence on human exposure assessment, pathogenesis, and precise quantification of its effects.
Session 2
Global and community health

Assessing the relationship of Total Coliforms to E. coli in the context of drivers of microbial contamination of drinking water wells in Ontario

Ioan Petculescu
Queen's University

Private wells are the primary drinking water source for the majority of rural Ontarians, with over 500,000 wells dedicated to domestic use, serving 2 million Ontarians (Felleiter, McDermott, Hall, Sheth, & Majury, 2019). Currently, private well water remains unregulated, with well stewardship (testing, treatment, maintenance) being solely the responsibility of the well owner. Understanding and interpreting water quality indicators is critical to adequately assessing public health risk, especially since no notable research has been done on the relationship between total coliforms (TC) and E. coli.

This study will examine the relationship between TC and E. coli, as well as the impact of various anthropogenic (ie: septic tank density, proximity to agricultural land) and environmental (ie: seasonality, subsoil type, well depth) drivers of contamination on this relationship. So far, the WWIS and WWTD datasets have been correlated and combined in order to create a single dataset. Data validation and analysis has been conducted on this combined dataset to better understand the distribution of the data, detect outliers and data entry errors, and identify associations between variables.

The objectives of this study are as follows:

1) Assess the relevance of using a particular concentration of total coliforms present in a water sample (eg: five colony-forming units (CFU) of TC per 100 mL) as a threshold that is predictive for faecal (E. coli) ingress.

2) Determine whether a TC threshold can be predictive for faecal ingress in the presence of anthropogenic and environmental drivers of contamination and whether this threshold is temporally affected.

3) Identify a mathematical relationship between TC and E. coli, then analyse the relationship to determine how it varies temporally and as a consequence of anthropogenic and environmental drivers of contamination.
Session 3
Fate, effects and monitoring of various contaminants

Tiered approach to long-term weathered lubricating oil analysis: GC/FID, GC/MS diagnostic ratios, and multivariate statistics
Candice C. Chua, Pamela Brunswick, Honoria Kwok, Jeffrey Yan, Daniel Cuthbertson, Graham van Aggelen, and Dayue Shang*

Pacific Environmental Science Centre (PESC) of Environment and Climate Change Canada (ECCC)

Frequent small-scale environmental releases of lubricating (lube) oils have deleterious effects on aquatic ecosystems. In the event of a spill, oil fingerprinting enables source attribution, informs clean-up procedures, and aids in liability assignment. Oil forensic investigations can be particularly challenging when oils are weathered over an extended period of time, as a large number of biomarkers become lost and the chemical composition changes significantly from its source. This study simulated an environmental case in which long-term weathered lube oil “spill” samples were matched to unweathered suspect “source” oils. While traditional oil fingerprinting techniques including GC/FID and GC/MS diagnostic ratios were insufficient for reliably attributing the source, a comprehensive and systematically tiered approach proved successful. The proposed methodology follows three tiers: Tier 1 GC/FID, Tier 2 GC/MS diagnostic ratios, and Tier 3 multivariate statistics. This novel approach provided environmental chemists with a powerful tool for dealing with an otherwise extremely challenging lube oil forensic investigation.
Session 3
Fate, effects and monitoring of various contaminants

Reproducing springtime Arctic tropospheric ozone depletion events in an outdoor mesocosm sea-ice facility

Zhiyuan Gao and Feiyue Wang
University of Manitoba

Every year during springtime a series of photochemical events occur episodically in the troposphere over the Arctic and Antarctic, including bromine explosion events (BEEs), ozone depletion events (ODEs), and mercury depletion events (MDEs). All these events could drastically change the fate of associated atmospheric pollutants in a short time, which are known to be triggered by photochemical activation of the sea-salt bromide to reactive bromine species involving multi-phase reactions at freezing temperatures. Extensive fieldworks have reported the occurrence of those events, yet uncertainties remain both in fundamental chemical processes (e.g., the role of snow and ice; the impact of pH, temperature, and ionic strength) and in meteorological and sea-state conditions that may affect the timing and magnitude of these events. Here, we report an outdoor mesocosm-scale study in which we successfully reproduced ODEs in winter at the Sea-ice Environmental Research Facility in Winnipeg, Canada, in an otherwise urban environment far away from polar regions. By freezing UV-blocking and UV-transmitting acrylic cylinders into bromide-enriched artificial seawater, we were able to detect significant mid-day ozone losses in the air immediately above the ice surface in a pattern that is characteristic of BEE-induced ODEs. The ability of reproducing such events at a mesocosm-scale environment in a non-polar region opens up never-before opportunities to systematically study fundamental cryo-photochemical processes leading to BEEs, ODEs, and MDEs, their implications for biogeochemical cycles in the polar regions, and how they may respond to a changing climate.


Session 3
Fate, effects and monitoring of various contaminants

Gamma Irradiation of PFAS

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This study investigates degradation of fourteen different per- and polyfluoroalkyl substances (PFASs) in water following treatment by gamma irradiation. Perfluorooctanoic acid (PFOA), perfluorooctanesul-fonic acid (PFOS), and 6:2 fluorotelomer sulfonate (6:2 FTS) were irradiated independently to investigate overall degradation, isomer-specific degradation, and transformation into shorter-chained PFAS. Independently PFOA was transformed by 80.95±4.5%, PFOS was transformed by 70.32±7.96 %, and 6:2 FTS was transformed by 44.32±6.5%. Original PFAS degradation and corresponding transformation were highest at pH 11, but transformation products were disproportionately higher, indicating a pH-dependent transformation mechanism into shorter-chained PFAS including C2, C3, and H/F ex-changed polyfluorinated alkyl substances. Thirteen different PFAS, including C4-C12 carboxylates, C4, C6, C8 sulfonates, and C8 sulfonamide were then irradiated together to investigate overall trans-formation. Carboxylate degradation did not depend on chain length or pH, with average total degradations of 97.79±3.01%. Sulfonate degradation was highly dependent on chain length, with degradation totals of 3.95±1.38% for PFBS (C4), 49.63±0.77% for PFHxS (C6) and 61.17±1.10% for PFOS (C8). Degradation of PFOSA was highly dependent on pH, with a total degradation of 98.78±1.06% at pH 7 compared to 69.75±2.6% at pH 11. Degradation rates for most PFAS were twice as high at pH 11 compared to pH 7. PFOS and PFHxS exhibited isomer-dependent degradations, with linear isomers being more resistant to degradation than their branched counterparts. These findings provide critical information for developing PFAS remediation technologies that can be applied to a wide range of PFAS including different chain lengths, functional groups, and isomers. These findings also suggest further development of existing analytical methods is possible to provide better insight into partial defluorination products.
Session 3
Fate, effects and monitoring of various contaminants

The presence of fatty acids in intertidal biofilm and its importance to migratory shorebirds

Jessica Ollinik, Mark Drever, and Dayue Shang

Pacific Environmental Science Centre

The fact that migratory shorebirds consume intertidal biofilm as an energy source has only been known to scientists for the past twenty-five years. The Western Sandpiper, a type of shorebird that migrates up the Pacific coast from Central and South America to Alaska, was among the first bird species discovered to use this unconventional food source. The migratory success of these birds has been attributed to the fatty acids in biofilm, which likely provide the birds with much-needed energy for the journey.

A type of algae known as diatoms is primarily responsible for the fatty acid content in biofilm. These photosynthetic organisms accumulate a specific ratio of saturated, mono-, and poly-unsaturated fatty acids in biofilms depending on their environmental growth conditions. Factors such as season, temperature, water chemistry, and tidal cycles all affect diatom growth and, thus, fatty acid concentration and composition within biofilm.

Research states that some biofilm growth areas are more nutritious than others. The Fraser River Estuary, located on the Pacific coast of British Columbia, is one of the most popular biofilm growth areas used as a stopover location for migratory birds. The specific fatty acid content of biofilm in this area is being investigated to understand how various environmental and external factors could affect migratory birds. Analytical techniques such as ATR-FTIR, GC-FID with derivatization, GC-MS with derivatization, LC-MS and LC-QToF all have applications in studying these important fatty acids in biofilm.
Session 3
Fate, effects and monitoring of various contaminants

Membrane introduction Mass Spectrometry: A powerful tool to directly assess the fate and distribution of naphthenic acids in water

Joseph Monaghan, Joshua K. Jai, Chris G. Gill, and Erik T. Krogh
Vancouver Island University

Naphthenic acids (NAs) are an extremely complex class of trace organic contaminants associated with the extraction and transport of bitumen from Canada’s heavy oil industry. Their presence in oil sands wastewaters as well as natural receiving waters is a concern due to their known toxicity to aquatic organisms. Analytical methods to assess their fate and distribution in engineered treatment systems and in the environment are important. Current techniques typically involve high-resolution mass spectrometry (MS) coupled with chromatography. However, these approaches are often limited to batched lab-based analysis and lengthy/expensive sample clean-up. Direct mass spectrometry techniques, such as condensed phase membrane introduction mass spectrometry (CP-MIMS), obviate sample clean-up and allow in-situ process monitoring. CP-MIMS uses a semi-permeable membrane to extract trace organic contaminants from complex heterogeneous samples while rejecting charged and particulate matrix components. Analytes are dissolved in a flowing acceptor solvent which can be continuously infused to a MS. We present recent results comparing high and low mass resolution of oil sands processed waters indicating that polydimethylsiloxane membranes selectively extract the classically defined O2-NAs that are associated with aquatic toxicity with minimal isobaric interference. In addition to enabling the rapid screening of large sample sets, the use of low resolution MS lends itself to on-site process monitoring. While phytoremediation and other treatment technologies have been shown to attenuate NAs in the aqueous phase, their fate (e.g. physical, chemical, or biological transformation) remains uncertain. We directly monitor the rate and extent of NA adsorption processes to natural and engineered sorbents. In addition, we will present a workflow and preliminary results involving the measurement of NAs sorbed to biomass samples. The online monitoring of trace organic contaminants in water has important applications in optimizing treatment strategies and ultimately the protection of both environmental and human health.
Session 3
Fate, effects and monitoring of various contaminants

Porous thin film devices for environmental water monitoring of persistent organic pollutants

Fereshteh Shahhoseini, Ali Azizi, Carlos Bazan, and Christina Bottaro

Memorial University

Monitoring for trace concentrations of persist organic pollutants (POPs) such as polycyclic aromatic hydrocarbons (PAHs) and phenols is of interest to industry (e.g., oil and gas companies), regulatory bodies and the public, particularly following damaging inputs like oil spills. These POPs can have adverse effects on human health and the environment and are prone to long-range transport, bioaccumulation and biomagnification through the trophic levels. Monitoring these pollutants provides valuable data for decision-makers to control and reduce the effects of pollution. Traditional grab-sampling is not always practical for remote marine monitoring due to high cost of transport and storage, and challenges in providing sufficient, reliable, and timely results. Typically, water samples sent to commercial labs are analyzed using extraction strategies such as solid phase extraction (SPE) and solid phase microextraction (SPME) in various configurations (e.g., fiber, thin film, and stir bar). SPME shows great potential for water analysis because of its low solvent consumption and potential for field applicability and high-throughput analysis. However, current SPME extraction phases are non-selective, and the devices can be expensive necessitating rigorous cleaning needed to overcome carryover, fouling, and inter-device variability. Recently, our research group invented a method for rapid inexpensive manufacturing of extraction devices for various classes of emerging contaminants, such as PAHs, phenols, thiophenes, and pesticides in water samples (i.e., seawater, river water and produced water). These devices are compatible with a most analytical instrumentation including common techniques such as GC-MS, HPLC-UV, and LC-MS, as well as other configurations to reduce sample handling and solvent consumption like headspace injection to GC, and direct-introduction ionization methods for bench-top or portable MS. Minimal performance variability between extraction devices makes them suitable for single-use important for intensive field sampling campaigns and in situ analysis.
Session 4
Water and wastewater

Synthetic biology applied to wastewater phytoremediation; primer and prospects

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Queen's University

Traditional chemical and biological municipal wastewater treatment strategies lead to the pollution of downstream aquatic ecosystems by pharmaceuticals and other pollutants not readily removed by these facilities. Microalgae have been investigated for their role in more sustainable wastewater treatment, but their ability to treat these emerging contaminants is primarily indirect in mechanisms of removal. Heterologous protein expression in microalgal chloroplasts may serve as a tool to directly empower microalgal bioremediation by expressing enzymes that allow the light-driven metabolism of such pollutants. While microalgal heterologous monooxygenase expression has been reported, cultures have yet to be transformed with the intent to treat emerging contaminants. Considerations regarding enzyme selection and further transformations are discussed, as are mechanisms of transformation and metabolic trade-offs that may impact industrial applications of recombinant microalgae.
Spatial and temporal variability of seven contaminants of emerging concern in water: a case study in Quebec

Rama Pulicharla, Francois Proulx, Sonja Behmel, Jean-B. Sérodes, and Manuel J. Rodriguez

Laval University

As part of continuous collection of baseline data on the occurrence of contaminants of emerging concern (CEC) in Quebec’s source and drinking waters, a robust sampling program was conducted in the main water supply system of the Quebec city region: St-Charles Lake, St-Charles River and treated waters of the treatment plant (TP). The bi-weekly program comprised 10 sampling locations and had a duration of fourteen months to consider the seasonal variations occurring in the region. All samples collected were analyzed for seven CEC selected based on various criteria: their occurrence in natural waters according to the literature, their association with products or substances widely used by population, and the cost for laboratory analysis. The selected contaminants including acetaminophen, salicylic acid, caffeine, carbamazepine, ibuprofen, sulfamethoxazole and drospirenone were analyzed using solid-phase extraction-ultra pressure liquid chromatography-mass spectrometry (SPE-UPLC-MS/MS). Site selection across lake and river focused on areas suspected to be susceptible to contamination from either human wastewater or surface runoff water (i.e. wastewater effluents discharges, septic effluent discharges, inflow of different tributaries) and a site at the intake of the TP. Thus, sites sampled in source water correspond to a variety of geohydrology locations with potential sources of CEC. For all sites in lake and river considered together, the detection of the CEC was higher than 73%, except for drospirenone, which was detected in 42% of samples during the sampling period. In the case of the TP intake (raw water), acetaminophen, salicylic acid, and caffeine were detected in more than 60% of samples; the remaining CEC were detected in less than 32% of samples. For the samples collected at the treated water, the detection frequency was as follows: salicylic acid (92%), caffeine (72%) and acetaminophen (48%); for the remaining CEC, the frequency was lower than 24% during the sampling period. The results of this investigation indicate that selected CEC are continuously present at trace levels in surface waters, which is a major concern where they are used for drinking water production. The results highlighted that the TPs have variable efficiency for the selected CEC. Such variability is mainly associated with the initial concentration of CEC (at raw water), the physical-chemical properties of CEC and the treatment processes at the TPs.
Session 4

Water and wastewater

Modelling the efficacy of Canadian wastewater stabilization ponds in the face of climate change

Lauren Halliwell, Geoffrey Hall, and Pascale Champagne

*Queen’s University*

Water treatment systems are imperative to society because of their influential role they have in safeguarding human health and the natural environment. If wastewater is not managed appropriately there can be detrimental effects to human health and the natural environment. Therefore, it is pertinent to have a sustainable wastewater treatment system option to collect, breakdown and to redistribute safe water back into the surrounding environment. An example of one sustainable water treatment system is Wastewater Stabilization Ponds (WSP) (Liu et al., 2015). WSPs are a significant and innovative system that utilize natural decomposition in treating wastewater (Liu et al., 2015). Not only are these systems substantially better for the environment but they are more economically feasible. A demand for WSP research is critical in light of the emerging climate changes in Canadian environments, that act as major stressors to water quality (Heinke et al., 1991). In collaboration with a municipal wastewater treatment facility, Loyalist Township, and the National Research Centre of Canada, research has been undergoing for a year, demonstrating the WSP adaptability to climate changing events. Specifically, this project looks at developing a 3D numerical model to monitor WSPs by coupling their hydrodynamic and water quality natural processes in order to further develop their design for future mitigations. Through the development of a water quality and hydrodynamic model, as well as a winter WSP numerical model, the prediction of treatment for WSPs will be certified. Further confidence is required in building future WSPs in Canadian communities in order to successfully safeguard human health and the environment. This research, studying the effects of Wastewater Stabilization Ponds in the face of climate change is creative, compelling and has taken a positive approach to making change that would ultimately help to create a more sustainable ecosystem in Canada.
Session 4
Water and wastewater

Monitoring drinking water quality from source to tap: a field study in northern communities of Nunavik

Cristian Garcia, Stéphanie Guilherme, Manuel J. Rodriguez

*Université Laval*

Access to optimal quality drinking water is internationally recognized as a basic principle of public health, necessary to preserve human life in a dignified, comfortable and ethical manner. In Canada, most population have access to sufficient and safe drinking water. However, such access is compromised in some communities, including some indigenous villages. In the Canadian Arctic region, some indigenous communities have limited access to drinking water in terms of quality and quantity. This research is carried out in the arctic region of the province of Quebec above the 55th parallel in the region of Nunavik. Generally speaking, communities of Nunavik have two types of water supply sources. The first one is the municipal source, which is a drinking water treated in a treatment plant and distributed to the community by tanker trucks. The use of trucks for delivering water to each household is associated with the difficulty to build a distribution network due to the presence of soil permafrost. The second type of source waters are the alternative sources, which represent natural waters with an ancestral use and widely used principally because of the rejection of chlorinated water by the population. Chlorine is used in treatment plants of these communities as a secondary disinfectant, to maintain disinfectant residuals for protection against potential microbiological contamination of water. The objective of this research is to evaluate the appropriate use of secondary disinfection in these communities. The study will develop a framework for optimal secondary disinfection, based on international regulations and in accordance with distribution and storage times of drinking water between the source and each household. Optimal chlorine dosage levels that ensure adequate residual disinfectant at the consumption tap will be estimated considering the generation of regulated disinfection by-products (trihalomethanes and haloacetic acids) and the acceptability of population to taste and odors associated with chlorinated water. The research comprises robust sampling campaigns conducted in the field at Nunavik communities and field and laboratory analysis of numerous chemical and microbiological water quality indicators.
Sediment Dynamics in a mixed primarily gravel-cobble stream
(The Salmon River, Ontario, Canada)

Max Robinson

Queen's University

Gravel-cobble streams are found throughout the world, and are common in areas that are moderately steep, as opposed to sand-bed streams with low gradients. It is becoming increasingly important to understand the flow hydrodynamics and sediment transport in these streams for their application to pressing issues such as flood hazard and mitigation, habitat restoration, and river morphology.

These gravel-cobble beds are studied in laboratories extensively, however, in contrast to the case of sand streams, only a few isolated field studies aimed at understanding their hydrodynamics and sediment transport mechanics have been carried out to date. This field study at the Kennedy Field Station, on a reach of the Salmon River, hopes to considerably increase our understanding of sediment dynamics in the stream.

The aim of this project is to create a working model of the flow and cobble transport. A 1D model in the Hydrologic Engineering Center’s River Analysis System (HEC-RAS) is being developed to determine flow depths and flow velocities in a 6 km stretch of the Salmon River, using hydrometric data from Environment and Climate Change Canada. Statistical frequency analysis is being conducted to allow for the prediction of floods flows with various return periods, using historical data, which can later be applied to the model. Future work includes field data collection, and a laboratory investigation of the initiation of cobble transport. Combining these works will allow us to investigate what flow conditions will cause cobbles to be dislodged and transported downstream.
Session 4
Water and wastewater

Study of membrane fouling reduction with mechanical cleaning technology (MCT) during the process of water separation in a newly designed hybrid membrane photobioreactor (HMPBR)

Mahsa Keyvan Hosseini and Lei Liu

Dalhousie University

Membrane filtration is one of the most current procedures in water treatment which has advantages such as a smaller footprint and high quality of permeate. Of all the advantages, membrane fouling is the bottleneck of this process. There are chemical and mechanical cleaning methods to reduce membrane fouling in membrane bioreactors during the separation process. Membrane bioreactors consist of biological interactions and physical separation with membrane support. In this study, the effect of the mechanical cleaning method (using granular particles) in different packing ratios such as 0, 0.5, 1, and 1.5% (v/v) in a hybrid membrane photobioreactor (HMPBR) was considered. In this microalgae-contained system, results showed the addition of these particles up to 1.5% reduced cake resistance by 53% in comparison with the absence of granular particles. Cake resistance was the most part of total fouling resistance. By adding 1.5% of granular particles, TMP jump decreased by about 47%. FTIR analysis from the cake layer and supernatant samples showed protein is the major foulant. To do so, the good impact of such particles in membrane fouling reduction during the process of water treatment was represented.
The study of membrane fouling mitigation using different orifice diameters in a novel hybrid membrane photobioreactor (HMPBR) with microalgae separation

Parisa Keyvan Hosseini and Lei Liu

_Dalhousie University_

The significant role of membrane bioreactors in water treatment has been proven during the years. Technology like the hybrid system combined with the membrane is a growing frontier. The origin of these hybrid systems came from the basis of membrane bioreactor (MBR). These types of bioreactors are used as an alternative to the Conventional Activated Sludge Process (CASP) in the field of water treatment due to their beneficial impacts. The bioreactor performs biological treatment and the membrane acts as a filter in the filtration process. Despite the positive points, membrane fouling is regarded as a challenge in membrane bioreactors. There are ways to lessen fouling including backwash, mechanical, and chemical cleaning. In the present study, the hybrid membrane photobioreactor (HMPBR) was replete with microalgae, and fouling was controlled with the aeration method. This system could separate water and microalgae solution. The effect of different orifice diameters on membrane fouling was considered. Therefore, three spargers with the orifice diameters of 0.5-1.5 mm were constructed to measure various resistances like cake resistance and pore blocking resistance. The results showed that by increasing the orifice diameters from 0.5 to 1.5 mm, the cake resistance decreased by 43%. Changing orifice diameters could influence total resistance which the cake resistance was dominant in comparison with other resistances. Protein was recognized as the key source of membrane fouling and the protein concentration in cake layer related to the smallest orifice diameter was the most and it was 38.08 mg·L$^{-1}$. Furthermore, the decrease in the protein concentration of cake layer could be seen in larger orifice diameters.
Session 5

Oil pollution, response and treatment

**Interactions between microplastics and spilled oil in the marine environment**

Min Yang, Xiaying Xin, Baiyu Zhang, and Bing Chen

*Memorial University*

Microplastics (MPs) and spilled oil are two great concerns in the marine environment. They may have negative impacts on the marine ecosystem and human health. Previous studies focused on the formation of oil-mineral aggregates and marine oil snow. The interactions between MPs and oil have rarely been reported. This study explored the interactions among MPs, oil, and dispersant in the marine environment. We verified the existence of MPs-oil-dispersant agglomerates through seawater column. In the presence of dispersant, MPs and oil could be covered by dispersants through their hydrophobic tails and form MPs-oil-dispersant agglomerates. The resurfacing or sinking of agglomerates led to the reduction of oil dispersion effectiveness. Results showed that the dispersion effectiveness of light oil and heavy oil decreased 38.26% and 38.25%, respectively, with MPs addition. This study promotes the understanding of the transport and fate of MPs-oil-dispersant agglomerates in the marine environment, it may influence future decision making on the selection and use of oil spill response options.
Session 5
Oil pollution, response and treatment

An enhanced simulation and optimization coupling approach for supporting marine oil spill responses

Xudong Ye, Bing Chen, Kenneth Lee, Rune Storesund, and Baiyu Zhang

Memorial University

Anthropogenic oil spill accidents have negative impacts on the complex social, economic and ecological systems. An efficient marine oil spill response management system can significantly minimize the total recovery time and cost. This study developed an enhanced simulation and optimization coupling approach to improve marine oil spill accident responses. An integrated particle swarm optimization approach with the advantages of the multi-agent system (MAS) and evolutionary population dynamics (EPD) was proposed, which eliminated the drawbacks of original PSO versions. MAS is a computerized system with multiple intelligent agents within an interacting environment, which can prevent candidates from trapping by local optima. EPD can further remove the worst individuals and improve the convergence efficiency in each iteration. The performance of the proposed optimization algorithm was evaluated via multiple benchmark functions under different variable levels, which represented the results of 97.60% to 100% lower optima than the ones from the traditional PSO. The developed simulation-optimization approach was further applied to the planning of the marine oil spill response process. The study provided an efficient decision support tool for marine oil responses with a comprehensive consideration of emergency procedures. The effects of oil weathering and characteristics (e.g., slick thickness, viscosity, remaining oil volume, evaporation, dispersion and emulsification) and tactical allocations of human resources, cleanup equipment and supplies were considered. The optimal planning declared an 80.28% overall recovery efficiency. The optimization module provided contingency plans with response selections and resource allocations with a minimal response time. The proposed method can be a powerful and useful tool to help decision-makers for oil spill response.
Session 5

Oil pollution, response and treatment

Use of cellulose-based material in the oil pollution control

Zhikun Chen and Chunjiang An
Concordia University

Increasing number of oil exploration, production, and transportation activities for decades have resulted into the higher risks in oil spill accidents all over the world. The residual oil could be transported to beaches by wind, waves, and currents. These oil that becomes stranded on beaches continues to attenuate and weather. Surface-washing agents (SWAs) are an option to enhance the removal of oil spilled or stranded on beaches, which typically consist of surfactants and solvents. As these components may be harmful, there are concerns about the potential impacts of these chemical agents on beach organisms and nearby coastal populations. To address these concerns there is a need to consider new formulations of SWAs that are more effective, economical, and environmentally friendly.

In this study, the potential use of biomass-derived nanoparticles as a SWA was investigated by examining its effectiveness and toxicity. The washing tests were conducted to quantify the washing efficiency of the nanofluid under different environmental conditions. In addition, a biotoxicity test was implemented to assess the toxicity of biomass-derived nanoparticles on green algae, and a comparison in removal efficiency between the nanofluid and surfactant was performed.

The results revealed that salinity and temperature were two factors that positively correlated to oil removal efficiency. The biotoxicity tests suggest that adding biomass-derived nanoparticles did not hinder the green algae growth but also mitigate the oil toxicity. In addition, the removal efficiency using the nanofluid was compared with that of commercial surfactants and the results showed a higher removal efficiency for the nanofluid on washing the oiled sand. Overall, the biomass-derived nanoparticles have a high potential to be applied as a SWA for beach cleanup due to the low cost, low toxicity, and high efficiency in a marine environment.
Oil spill events are some of the most infamous environmental disasters in remembered history and are both ecologically devastating and reviled by the public. Due to oil migration post-spill concurrent with time, rapid collection is paramount to ameliorate environmental harm. Recent consideration has been given to improving the ratio of water/oil that is stored in collection vessels for treatment onshore, freeing up space for more oil. Oil water separation technologies subject of improvement to increase separation rates sufficient to release decanted water in situ. This assessment aims to test the viability of gravity settling and centrifuge in their application to in situ decanting purposes with consideration for cold-weather and high-energy environments characteristic of the economically expanding Arctic. It has been found that distinct trends are indeed observed during centrifuge and settling separation using Terra Nova Crude oil at a 70/30 ratio correlating with the operational parameters subjected to it, notably that settling rate was more efficient in saline water, yielding an average of 36% free water compared with an average of 18% in distilled water after one hour, up to 66% free water in the saline and 35% in the distilled sample after 3 hours, and that when subjected to rocking motion of 100rpm for 1 hour, yielded 61.7% free water compared to 57.4% in the distilled sample. Separation rate in the centrifuge occurred at varying speeds (3000-5000 RPM) and times (10min, 15min, 20min) with both saline/distilled samples, and cold and room temperature samples in which it was again observed an increase in separation efficiency in saline samples (~65%) as opposed to distilled (~57%). It was found that temperature did not greatly influence separation rate in either separation methodology with observable significance.
Session 5
Oil pollution, response and treatment

Biomarker traced biodegradation of oil treated by a green dispersant

Xing Song, Baiyu Zhang*, Bing Chen, Bo Liu, and Kedong Zhang

Memorial University

The increasing demand for biodegradability of spilled oil promoted the development of green dispersants in recent years. Most of the new dispersants have an acceptable performance of oil dispersion. However, whether the dispersed oil has a high biodegradability is a critical question to the applicability of new dispersants for marine oil spill response. The primary aim of this study is thus to tackle the biodegradability of a medium and a heavy grade of crude oil treated by a purified green dispersant newly generated based on shrimp waste (SW). To accurately track the biodegradation process, an extrapolatable biomarker-based oil tracing method was developed. Biodegradation of the crucial components of two types of oils treated by the SW dispersant was then assessed and compared with that by a chemical dispersant. The results revealed that the green SW dispersant did not inhibit the biodegradation of alkanes. Moreover, the biodegradation rates of Alkylated PAHs were promoted compared to those in chemically dispersed and non-dispersed oil. The findings would help to support the development, improvement, and applications of green dispersants as an environmentally friendly agent for oil spill cleanup.
Mystery of the oil spill off the Brazilian coast in 2019 and remediation biotechnologies

Ricardo Borges Baltazar dos Santos Júnior, Célia Karina Maia Cardoso, Isadora Machado Marques, Antônio Fernando de Souza Queiroz, Olívia Maria Cordeiro de Oliveira, and Ícaro Thiago Andrade Moreira

Universidade Federal da Bahia (Brazil)

This presentation analyzes the application of analytical techniques for petroleum geochemistry and its interpretations in studies to identify the type and origin of oily material collected from beaches in Northeast Brazil in October 2019. Forensic geochemistry included the study of the relative distribution of hydrocarbons, stable carbon isotopes analysis and biomarker compounds that are indicative of the sedimentation environments of organic matter that originated petroleum in its geological history. Samples of the oily material collected on the beaches in the states of Bahia and Sergipe, Brazil, were analyzed, and for comparison purposes, samples of crude oils produced in Brazil, Middle East, Nigeria and Venezuela were also analyzed. The analytical results showed that the oily material that reached the beaches, has geochemical characteristics compatible with those of the Venezuelan oil sample, indicating it was severely weathered due to the time it remained in the sea, or a product made with heavy oil produced in that country. Our group has developed remediation biotechnologies for removing viscous oils in marine waters and sediments, showing removal efficiency of more than 90% with the use of photobioreactors, more than 80% with phytoremediation and high removal of oil stains in marine waters. we use biofiber barriers with high adsorptive capacity after chemical treatment with ionic liquid.
Session 5

Oil pollution, response and treatment

How is the biodegradation of dispersed oil influenced by the incorporation of oil into aggregates?

Jong Jin Lee and Uta Passow

Memorial University

During the Deepwater Horizon oil spill in the Gulf of Mexico, the importance of marine snow transporting oil to the deep seafloor was first discovered. Marine snow provides micro-habitats to microbial communities and function as hot-spots of activities. Based on this knowledge, it is hypothesized that the biodegradation rates of dispersed oil increase with the incorporation of oil into marine snow. Experiments are planned to measure the biodegradation of dispersed oil as a function of aggregation. Specifically, oil-biodegradation will be measured as a function of the concentration of aggregates. It is expected that the concentration of aggregates controls the amount of oil incorporated into aggregates as well as oil-biodegradation rates. Additionally, oil incorporated in aggregates will be analyzed separately from that in the surrounding seawater, to investigate potential differences in degradation. Experiments will be conducted in roller tanks, which mimic the continuous sinking of aggregates in the ocean without touching container walls. Various properties of aggregates and surrounding seawater will be measured to understand the biodegradation of dispersed oil, including total oil concentration, the concentration of individual oil compounds, ratios of n-alkanes to acyclic isoprenoid hydrocarbon (e.g., n-C17 : pristane, n-C18 : phytane), and bacteria concentrations. This study addresses the interaction of spilled oil with natural marine particles. It will help guide the development of and/or update existing oil spill response plans that consider regional environmental conditions.
Microbial response towards chemical dispersant application during a marine dilbit spill

Yiqi Cao, Baiyu Zhang, Charles W. Greer, and Bing Chen

*Memorial University*

The global increase in the marine transportation of dilbit (diluted bitumen) can increase the risk of spills, and a chemical dispersant may be applied as an oil spill treating agent. Previous microcosm experiments have produced controversial perspectives for the impact of dispersant application on microbial oil biodegradation, and few studies have evaluated the influence on the initial abundance of hydrocarbonoclastic bacteria. This study employed microcosms at two scales: small (250 mL) and large (1500 mL) volumes, for tracking community dynamics during dispersed dilbit biodegradation using 16S rRNA gene amplicon sequencing. Metagenomic and metatranscriptomic sequencing were further applied in the large-scale microcosms to examine the microbial response towards hydrocarbon degradation. Results showed that increasing the microcosm scale reduced the effects of stochasticity for dilbit biodegradation investigations. Dispersant (i.e., Corexit 9500) addition limited the microbial richness and diversity at the early stage (6 days) but had little effect on community composition at the late stage (50 days). In the early stage, multiple species involved in coordinated degradation of both alkanes and aromatic compounds were detected in the dilbit only microcosms. However, dispersant addition resulted in enrichment of *Alteromonas*, causing a decrease in aromatics degradation efficiency. In addition, genes in *Alteromonas* species responsible for antioxidation ability, especially glutathione metabolism, that prevents cellular damage caused by reactive oxygen species, showed high abundance and expression, implying higher toxicity caused by dispersant application. These findings could help us understand the sophisticated microbial response for marine dilbit spills and further provide critical suggestions for evaluating the potential application of chemical dispersants.
Session 6
Ecotoxicology

Insights into the Acute and Chronic Toxicity of Triclosan to Green Microalga Chlorococcum sp.: Biochemical Analyses and Roles of Environmental Factors

Xiaying Xin
Memorial University

This study investigated the acute and chronic toxicity of triclosan to the green microalga Chlorococcum sp. under multiple environmental stressors. The interactions between triclosan and environmental stressors were explored through full two-way factorial, synchrotron-based Fourier transform infrared spectromicroscopy, principal component analyses and stepwise-cluster analysis. In the 24-h test, Phosphorus concentration, pH * phosphorus concentration, and temperature * pH * NaCl concentration were the most statistically significant factors under triclosan exposure. It is interesting to find Chlorococcum sp. may become more resistant against triclosan in phosphorus-enriched environment. Two high-order interactions of temperature * pH * NaCl concentration and temperature * pH * NaCl concentration * phosphorus concentration had more contributions than others at the subcellular level, which could be attributed to the interactive complexity of biomolecular components. Due to cellular self-regulation mechanism and short exposure time, the biophysiological changes of Chlorococcum sp. were undramatic. In the 120-h test, nitrogen content became the most significant factor of the physiochemical properties. Some insignificant factors in the 48-h test became significant in the 120-h test. Temperature * nitrogen content, temperature * phosphorus content, and pH * phosphorus content were the most significant two-order interactions. More high-order interactions became significant in the 120-h test, indicating the complexity and impacts of all the factors may increase when time was extended. The chronic toxicity of triclosan presented more distinguishable variations among treatments based on biochemical alterations. These results demonstrate that the sensitivity and fragility of algae to triclosan can be amplified with time extension. Long-term exposure can be applied to better evaluate and predict the environmental toxicity behavior of triclosan. These findings can help reveal the interactive complexity among triclosan and multiple environmental stressors. It is suggested that multiple environmental stressors should be considered during ecological risk assessment and management of emerging pollutants.
Nearshore sedimentary mercury concentrations reflect legacy point sources and variable sedimentation patterns under a natural recovery strategy

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The St. Lawrence River at Cornwall, Ontario received substantial inputs of mercury from local, shoreline-based industries through much of the 20th century. Although emission controls were implemented in the late-20th century to reduce the influx of mercury and other metals entering the river, legacy contamination of riverine sediments continues to be a local concern. Monitored natural recovery was prescribed in 2005 as the preferred method to remediate contaminated sediments, but few surveys have been undertaken to examine its effectiveness on shallow, nearshore sediments in contaminated areas. Surface sediments were collected at nearshore sites in three contaminated zones and upstream reference areas to evaluate the current state of sedimentary contamination of mercury and other metals. A Getis-Ord Gi* hot spot analysis was employed to assess the spatial distribution of contaminants. Three sediment cores were additionally collected from contaminated zones and dated using radioisotopes (210Pb) to assess sedimentation patterns over time. Results indicate that surface sediments from contaminated zones remain elevated in mercury relative to reference sites, but that the spatial distribution of contaminants is highly heterogeneous. Dated sediment cores suggest that sedimentation is not occurring consistently across all contaminated zones. It is likely that variable sedimentation and resuspension patterns over small spatial scales are driving heterogeneous sedimentary contamination, holding important implications for remediation strategies in nearshore regions.
Historic pollution impacts on benthic invertebrates in the St. Lawrence River at Cornwall, ON and implications for ecosystem management

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Twentieth-century historic industrial activity in Cornwall, Ontario loaded high amounts of heavy metals and metalloids to the St. Lawrence River. Despite industrial improvements and the eventual closure of point-source polluters, sedimentary contamination in the Cornwall waterfront remains above provincial guidelines, causing concern for ecosystem management. We analysed chironomid (Order: Diptera) subfossils from modern-day surface samples as well as a sediment core from the Cornwall waterfront in order to better understand historic pollution impacts and potential recovery. Modern-day chironomid assemblages were diverse (48 genera, >70 species) and showed little evidence of trends in diversity associated with metals. Overall assemblage structure was weakly related to metal concentrations, with Procladius, Paratanytarsus, and Ablabesmyia being identified as metal-tolerant and Rheotanytarsus, Polypedilum and Paratendipes being identified as metal-sensitive. The sediment core showed peak total mercury (THg) concentrations were an order of magnitude higher than in modern-day surface sediments. In sections of the core below 10 cm in depth, THg concentrations were high (~30-50 µg/g) and chironomids were nearly absent from the record. As THg concentrations decreased in the core since c. 1980, metal-tolerant chironomid taxa return in low abundances. Subsequent intervals display an increase in diversity, biomass, and relative abundance of metal-sensitive taxa. This study provides evidence of both severe pollution impacts and successful ecological recovery in invertebrates in the Cornwall waterfront, providing information that supports remediation consistent with the area’s management strategy.
Session 6
Ecotoxicology

Endocrine disruptive effects of agricultural retention pond water in the American Toad (*Anaxyrus americanus*)


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Retention ponds are becoming more frequently implemented in the agroecosystem as a strategy to reduce the impacts of agricultural run-off entering surface waters. A potential consequence of these constructed wetlands is the attraction of wildlife. For example, wild amphibians may use these sites as breeding grounds. Consequently, offspring will develop in water with highly concentrated levels of agrochemicals. The main objective of this research project is to study the effects of water from an agricultural retention pond on native larval amphibians. Pond water quality was assessed, and chemical analyses revealed a complex and dynamic mixture of agrochemicals, including herbicides (e.g., glyphosate, S-metolachlor), insecticides (e.g., neonicotinoids), and a fungicide (azoxystrobin). Chronic exposures to this retention pond water were performed on the American toad (*Anaxyrus americanus*) from the free-feeding stage throughout metamorphosis. Endpoints related to, survival, growth, and morphology were assessed throughout the experiment. Treated toads were significantly smaller in morphometric indices compared to control animals and that rate of metamorphosis was altered by exposure. In amphibians, organismal size and rate of metamorphosis are associated with fitness and fecundity. Therefore, such disruptions may lead to adverse outcomes on an individual or population level. The molecular mechanisms underlying these effects were investigated using targeted gene expression analyses. Exposed organisms exhibited significant alterations of gene expression of the hypothalamus-pituitary-thyroid axis in liver tissue. Thus, suggesting that these agrochemical mixtures are disruptive to the endocrine system of tadpoles. This work provides ecologically relevant information of the potential effects of agricultural activities and retention ponds in a North American context.
Session 6
Ecotoxicology

Toxic effects of ingestion of marine oil snow on blue mussels
(Mytilus edulis)

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Marine snow aggregates are defined as composite particles larger than 0.5 mm consisting of organisms, organic detritus and clays. Marine snow sinks and represents the main transport pathway by which surface-derived organic matter reaches deep waters. Marine snow aggregates are a vital food source for a variety of organisms. When contaminated with oil droplets, as seen during the Deepwater Horizon oil spill in the Gulf of Mexico in 2010, marine snow is referred to as “marine oil snow.” As marine snow is a common food source, marine oil snow is expected to expose animals to crude oil via their diet. However, despite the well-known toxic effects of crude oil on organisms, the effects of ingestion of marine oil snow are largely unknown. This study aims to assess the sub-lethal effects of ingestion of marine oil snow on blue mussels (Mytilus edulis) in comparison to the uptake of free-floating oil droplets and phytoplankton. Ingestion of polycyclic aromatic hydrocarbons (toxicants present in crude oil) is expected to be higher when oil droplets are associated with food.
Assessing the sorption of the cyanotoxins microcystins to microplastics

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Microplastics are now commonly found in freshwater lakes with pervasive harmful algal blooms. Generally seen as separate environmental issues, microplastic pollution and eutrophication are almost always studied in isolation from one another. Freshwater cyanobacteria can produce a variety of toxic secondary metabolites; yet, to date, little attention has been paid to how the presence of microplastics may influence cyanotoxins. Concerns regarding microplastic pollution and its ability to accumulate large concentrations of waterborne environmental contaminants led us to assess the sorption of four frequently detected microcystin congeners (MC-RR, MC-YR, MC-LR, and MC-LA) by four types of highly produced plastics: polyethylene terephthalate (PET), low-density polyethylene (LDPE), polystyrene (PS), and polyvinyl chloride (PVC). We performed laboratory batch sorption experiments with unaged and aged microplastics as well as an in-situ sorption experiment in a eutrophic lake (Dog Lake, Ontario, Canada). We found that under laboratory conditions, microcystins sorbed poorly, or not at all, to microplastics, and there was no difference in sorption capacity between unaged and aged microplastics. Sorption capacity followed the general trend LDPE>PET>PS>PVC, and more polar microcystin congeners demonstrated a greater affinity for plastic compared to less polar microcystin congeners. However, in the field, all four types of plastic demonstrated some level of sorption capacity for microcystins. Furthermore, sorbed concentrations of microcystins did not consistently vary among plastics, but when we did observe significant differences, PET typically sorbed greater concentrations of microcystins compared to the other three plastics. Overall, we show that microplastic pollution in eutrophic lakes can influence the environmental fate of waterborne toxins produced by cyanobacteria—which in turn, can alter the exposure of humans, domestic and wild animals, and aquatic life to these potentially lethal toxins. Our study is the first to assess the sorption of multiple microcystin congeners to several plastic types and do so both in the laboratory and field.