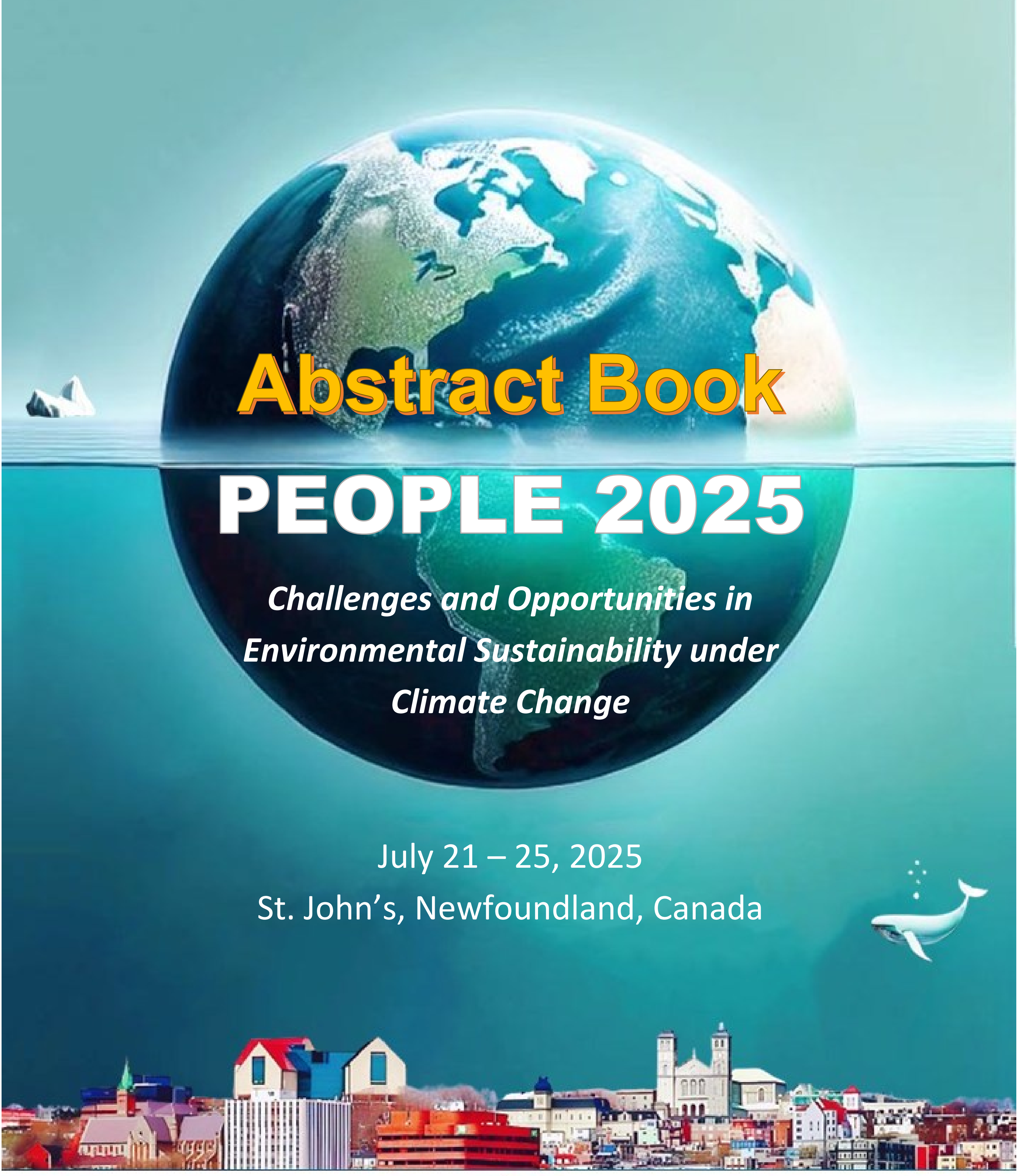

Abstract Book

PEOPLE 2025

Challenges and Opportunities in Environmental Sustainability under Climate Change

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Session 1 - Emerging Contaminants (1)

/Keynote Speaker/ Dr. Katrin Vorkamp

PFAS as a Global Problem - Findings from the Arctic and from Europe

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Per- and polyfluoroalkyl substances (PFAS) are a complex group of several thousand chemicals defined by the presence of a -CF2- or -CF3 moiety in the molecule. Due to the strong C-F bond, PFAS are extremely persistent in the environment. Three PFAS, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS), have been classified as Persistent Organic Pollutants (POPs) according to the United Nations Stockholm Convention, based on their persistence, bioaccumulation, toxicity and long-range transport. The group of C9-C21 perfluorocarboxylic acids (PFCAs) is currently under review for the Stockholm Convention. Additional national and regional regulations exist or are being considered, including a restriction proposal of all PFAS in Europe.

Their persistence and long-range transport have made PFAS a global problem, including their presence in the Arctic, as documented by the Arctic Monitoring and Assessment Programme (AMAP). Volatile precursors are commonly measured in atmospheric monitoring programmes in the Arctic, indicating atmospheric transport of neutral PFAS that can be oxidized to PFCAs and other highly persistent PFAS. Ionic PFAS can be transported with ocean currents and rivers. In addition, local sources of PFAS have been identified in the Arctic, for example from their use at airport fire training sites. Their bioaccumulation and biomagnification properties lead to high concentrations in Arctic animals, in particular at the top of the food chain. This is of concern because Arctic populations rely on fish and wildlife in their diet.

PFAS are omnipresent in the European environment, including hot spots at sites of production or intense use, contaminated sites, resulting from e.g. landfill leachates or use in firefighting, and diffuse pollution. Environmental monitoring has been established in basically all European countries, in addition to some human biomonitoring programmes and many research initiatives. The Horizon Europe Partnership for the Assessment of Risks from Chemicals (PARC) has prioritized PFAS and runs a project on a European PFAS baseline as well as 18 case studies focussing on the role of precursors in PFAS distribution. In Denmark, a national PFAS Research Centre was established in January 2025 to support government actions with scientific knowledge on environmental, food and human health aspects related to PFAS.

The complexity of PFAS is a challenge in assessing the extent, development and consequences of PFAS pollution and exposure. New analytical methods have been introduced to complement traditional target analysis by liquid chromatography-tandem mass spectrometry (LC-MS/MS). These include Extractable Organic Fluorine (EOF) determined by combustion-ion chromatography (CIC) and providing a measure of "PFAS Total". Total Oxidisable Precursor (TOP) assays determine concentrations of perfluoroalkyl acids before and after oxidation, reflective of the amount of precursors in a sample. Non-target and suspect screening techniques based on high

resolution mass spectrometry (HRMS) are increasingly used to identify unknown PFAS in a sample. Even though more comprehensive regulations are in the pipeline, efficient methods will still be needed to monitor PFAS in the environment and in humans.

Keywords

Arctic, Pollution, PFAS, POPs, Long-range transport, Monitoring

Incorporation and Distribution of Polycyclic Aromatic Hydrocarbons in Sea-Ice: An Outdoor Microcosm Study

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The loadings of polycyclic aromatic hydrocarbons (PAHs) are projected to increase in the Arctic due to enhanced marine shipping traffic and other industrial activities, potentially leading to oil spills in the Arctic Ocean. PAHs are among the most toxic substances in petroleum oil; however, much remains unknown about their partitioning and distribution behaviour in the cold ocean in the presence of sea ice.

This microcosm-based study investigates the distribution behaviour of four PAHs (naphthalene, phenanthrene, pyrene and benzo[a]pyrene) across the seawater-ice-atmosphere interface in the presence of particulate humic acid as a surrogate for particulate organic carbon (POC) present in natural seawater. Moreover, the interphase partitioning of the four PAHs between the aqueous and particulate phases in seawater and sea ice is examined along with the determination of the PAH partition coefficients (Kd). Lastly, the effect of below water-freezing temperature and elevated salinity on the Kd values is discussed.

The outdoor sea ice microcosm experiment was carried out from February 24th to March 16th, 2020, at the Sea-ice Environmental Research Facility, at the University of Manitoba, in Winnipeg, Canada. It involved six microcosms (240 L each) filled with artificial seawater and spiked with particulate humic acid. A mixed solution of naphthalene, phenanthrene, pyrene and benzo(a)pyrene was injected under the sea ice cover when it had grown to ~8 cm in thickness.

The results reveal that the higher the molecular weight of the PAH, the lower its loss to the atmosphere and the higher its content in sea ice and the POC phase. Thermodynamic data fitting shows that the Kd values for all four PAHs in seawater are reasonably well explained ($R2 > 0.54$) by temperature (270.4 - 271.6 K) and salinity (33.1 - 46.4), whereas in the ice, only phenanthrene and pyrene were well described ($R2 > 0.57$) by temperature (268.2 - 272.5 K) and bulk sea-ice salinity (4.2 - 12.8). Due to the dynamic nature of sea ice and seawater, the combined effect of freezing temperature and enhanced salinity on the Kd values is nonunidirectional and more complex than the one at above-water-freezing conditions. Therefore, these results imply that it is not appropriate to use traditional equilibrium-based approaches adapted for open-water environments when explaining the behaviour of PAHs in ice-covered waters.

Keywords

PAHs, Sea-ice, Particulate organic carbon, Partition coefficient, Arctic

Inhibitory mechanism of microplastics on carbon fixation in microalgae in lake environment

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The impact of microplastics in lake environments on carbon fixation by microalgae and the role of microalgae in promoting the sedimentation of microplastics have attracted global attention. This study proposed mitigation strategies to address the problem of microplastics in lake environments, hindering microalgae's carbon fixation and microplastic sedimentation capabilities, and constructed a synergistic promotion mechanism that is conducive to the sedimentation of microplastics and microalgae's carbon fixation in lake water environments. The molecular dynamics simulation, efficacy function coupling fuzzy Borda method, CiteSpace visualization analysis and other methods were used, and two environmentally friendly decabromodiphenyl ether substitute molecules beneficial to microalgae carbon fixation and microplastic sedimentation were successfully designed. Results showed that the plastic additive ratio scheme corresponding to the largest absolute value of the comprehensive effect value significantly improved after the designed decabromodiphenyl ether substitute molecule was used. Finally, the hotspot amino acid identification and molecular dynamics methods were used to analyze the mechanism of the effects of decabromodiphenyl ether substitute molecules on microalgae carbon fixation and microplastic sedimentation ability. It was found that microplastics using decabromodiphenyl ether substitute molecules as flame retardants were more likely to stimulate the adsorption and binding ability of surrounding hotspot amino acids to CO2 and ribulose-5-phosphate. This study successfully alleviates the impact of microplastics in lake environments on the carbon fixation of microalgae from the source, and has limitedly improved the ability of microalgae to co-sediment microplastics, which will help in the future ecological assessment of lake water environments and the interpretation of toxic effect mitigation mechanisms.

Keywords

Microplastics, Carbon fixation, Microalgae, Sedimentation, Molecular dynamics Simulation, Flame retardant substitutes

Atmospheric Deposition of PFAS in Lyon Soil: Mapping the Influence of Industrial Activities and Background Contamination

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As the environmental impact of per- and polyfluoroalkyl substances (PFAS) increases, understanding their deposition to soils near chemical industries is vital to mitigate health and ecological risks. Lyon (France) is a hub of chemical production and faces concerns about PFAS releases into the environment. This study assessed the extent of PFAS deposition from chemical industries located in central Lyon to different parts of Lyon. Through a target analysis using UHPLC-MS, we investigated the concentration of 80 PFAS in 215 Lyon soil samples collected around a fluoropolymer industrial complex. PFAS contamination of eggs in Lyon has been reported by local public health; hence, we evaluated PFAS in soils from a few selected chicken-feeding areas and free-range chicken eggs. High PFAS concentrations (3.8 - 175 µg/kg) were observed in soils near fluorochemical industries, with levels declining as distance from the industrial site increased. Long-chain PFCAs (C ≥ 8) and PFSAs (C ≥ 6) showed high detection rates (78 - 100 %), with PFUnDA (0.05 - 106 µg/kg), PFTrDA (0.03 - 47.6 µg/kg), PFOS (0.1 - 32.6 µg/kg), PFHxS (0.03 - 23.7 µg/kg), PFNA (0.02 - 13.4 µg/kg) and PFOA (0.05 - 6.8 µg/kg), being the predominant PFAS. The ∑14 PFAS detected in soils from chicken-feeding areas ranged from 3.3 - 10.5 µg/kg and 2.1 - 19.1 µg/kg in eggs. This confirmed that the chickens are exposed to PFAS from the surrounding soils and other sources through their diet and foraging. Generally, the detection of elevated levels of PFNA, PFUnDA, and PFTrDA suggests an industrial input from the production of Surflon® at the Pierre-Bénite site. A significant negative correlation (p-value < 0.001) was observed between PFAS concentrations across the zones and their distance from the chemical industry. The variability in PFAS distribution may be influenced by wind direction, which has likely transported airborne PFAS from its source near the industrial complex and extending towards other parts.

Keywords

PFAS, Chemical industries, Soil, Chicken eggs, Ambient deposition

Key findings on the spatial distribution of a diverse range of PFAS in the St. Lawrence River and major tributaries

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This comprehensive investigation characterized the occurrence of 77 cationic, zwitterionic, and anionic per- and polyfluoroalkyl substances (PFAS) across collected surface water samples from 232 sites along the approximately 700 km St. Lawrence River and its tributaries, creeks, and lakes in Quebec between 2018 and 2021. Analyte detection was performed using a UHPLC-high resolution Q-Exactive Orbitrap mass spectrometer. While total PFAS concentrations exhibited a slight difference across the St. Lawrence River's main stream (with an average Σ77PFAS of 12 ng/L), tributary levels showed significant variability. This variability was strongly influenced by localized point sources, with some hotspots, such as those near airports, reaching concentrations as high as 3600 ng/L. Although zwitterionic and cationic PFAS were often non-detectable, high concentrations (e.g., up to 570 ng/L for 5:1:2 FTB) were observed in tributaries impacted mainly by aqueous film-forming foam (AFFF) usage. Kohonen mapping further identified common PFAS signatures across sites, providing insight into their distribution patterns. The concentrations of legacy PFAS like PFOS and PFOA in the St. Lawrence River generally align with current Canadian and USEPA guidelines for surface water. Exceedances were, however, found when more Stricker thresholds were applied.

Keywords

PFAS, Emerging contaminants, Surface water, St. Lawrence River, Canada

Session 2 - (Special Session) Ocean Frontier Institute: Safety, Sustainability, and Climate Action in Oceans Environments

/Keynote Speaker/ Dr. Kris Poduska and Dr. Paul Snelgrove

The Ocean Frontier Institute at Memorial University: A Proposed Centre to Unite Ocean Research on Safety, Sustainability, and Climate Action in Oceans Environments

Kris Poduska[1], Paul Snelgrove[1]

[1]Memorial University

The Ocean Frontier Institute (OFI) is a partnership formed to coordinate ocean research and increase collaboration focused on the North Atlantic Ocean. With Dalhousie University as the lead academic institution, and Memorial University as the main founding partner, OFI has built trans-Atlantic international partnerships and delivered research outcomes that have segued from an initial focus on safe and sustainable oceans to a current focus on three jointly-developed research pillars: Net-Zero (Climate, a core focus of Transforming Climate Action (TCA)), as well as Biodiversity, and Bioresources (Fisheries and Aquaculture, a core focus of Safe and Sustainable Development of the Ocean Frontier (SSDOF)). As a primary goal, OFI aims to sustain the historic relationship established by Dalhousie and Memorial by serving as an umbrella organization for academic-led interdisciplinary ocean research in Atlantic Canada and beyond. At Memorial University, OFI aims to continue to catalyze new and champion ongoing coordinated research and training programs broadly related to oceans, linking diverse members of the Memorial community across departments and faculties with each other and with other institutions that advance understanding and sustainable use of the North Atlantic.

The IceShark - an Innovative Method of Capturing Plankton under the Ice

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Seasonal sea ice plays a crucial role in shaping coastal ecosystem dynamics throughout the circumpolar region. Of particular interest to oceanographers is the ice-ocean interface which functions as a multidimensional habitat, supporting both Sympagic algae and pelagic phytoplankton in the under-ice surface waters (UISW). These organisms vary both spatially and temporally, dependant often on nutrients availability and light attenuation associated with the sea ice. In turn these primary producer support and sustain zooplankton populations, forming the foundation of the marine food web. However, climate driven shifts in sea ice extent, duration, and thickness are expected to disrupt plankton communities both through spatial and temporal scales, potentially triggering cascading effects across higher trophic levels. Despite these ramifications, research focusing on plankton dynamics at the ice-ocean interface is limited, largely due to restrictions associated with access and isolation of under ice surface waters, as well as difficulties in undertaking work in subzero conditions. In addressing this gap, our study introduces a novel sampling methodology, using a newly designed apparatus, dubbed the IceShark. Here we discuss the development of the IceShark and evaluate its initial performance during pilot deployments along a Fjord system in Nunatsiavut.

Keywords

Climate change, Plankton, Sea ice, Food web, Nunatsiavut, Methodology

Assessing Structural Differences in a Key Marine Calcifier in the Northwest Atlantic

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We show preliminary lab-based studies that lay the groundwork necessary to characterize the effects of ocean climate variability on the mineralogical and structural/morphological integrity of rhodoliths. These free living, photosynthesizing nodules of coralline red algae are important marine calcifiers and carbonate sediment producers in the Northwest Atlantic. Rhodolith beds are key biodiversity hotspots that are vulnerable to physical forcing by the increasing severity and frequency of wind and wave storms [1]. They are particularly vulnerable to ongoing ocean acidification and intensification of wave storms because they: 1) possess a Mg-containing calcium carbonate skeleton that is reported to be more soluble than pure calcium carbonate; and 2) grow very slowly (typically < 0.5 mm/year) [2]. These characteristics may compromise their ability to compensate for tissue loss to increased dissolution and abrasion in a changing ocean climate [2]. We show complementary data from optical microscopy, scanning electron microscopy, energy dispersive X-ray analysis, infrared spectroscopy, and X-ray diffraction that allow us to assess mineral composition of "dead" (inner, non-photosynthetic) parts [3]. We hypothesize that mineralogical and microstructural differences could alter fracturing and abrasion rates of rhodoliths (which occur from shallow subtidal to depths >150 m). If dissolution is extensive, this could influence ocean carbon budget calculations. Our work could provide unique information for management and conservation strategies for benthic rhodolith-based ecosystems along coastal NL and beyond.

[1] Bélanger D, Gagnon P. (2023). Spatiotemporal variability in subarctic Lithothamnion glaciale rhodolith bed structural complexity and macrofaunal diversity. Diversity. 15: 774-794.

[2] Teed L, Bélanger D, Gagnon P, Edinger E (2020). Calcium carbonate (CaCO3) production of a subpolar rhodolith bed: Methods of estimation, effect of bioturbators, and global comparisons. Estuarine, Coastal and Shelf Science. 242: 106822.

[3] Breen, JJ (2025). Characterizing the Carbonate Mineral Content of Rhodoliths in the Northwest Atlantic. BSc(Honours) thesis: Memorial University of Newfoundland.

Keywords

Ocean, Sustainability, Calcium carbonate, X-ray diffraction, Infrared spectroscopy, Electron microscopy

Wave Climate Change Assessment over Newfoundland's East Coast: Methodology and Projections

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Climate change is accelerating, posing numerous challenges along coastal areas such as erosion and flooding. Among several mechanisms contributing to these challenges, changes in wave regimes play a key role in shaping coastal risks, making their assessment critical for adaptation and mitigation efforts. Newfoundland, with its unique geographic location being directly exposed to the North Atlantic Ocean, faces multiple climate change-related challenges and is the focus of this study. This study explores the future changes in wave conditions using a cold coupling approach, where near-surface wind fields from the WRF model simulations drive the MIKE21-SW spectral wave model under the Representative Concentration Pathway (RCP) 8.5 emission scenario, which represents the high greenhouse gas emissions trajectory.

To assess changes in wave conditions, a 42-year wave modeling framework was developed, covering both historical and future periods for comparative analysis. Offshore wave boundary conditions, including wave height, period, and direction, were derived from CSIRO's WWIII simulations, which incorporated multiple GCMs, and relative sea-level projections from the IPCC Assessment Report were used. The regional model was downscaled to high-resolution subdomains utilizing bathymetric data from the GEBCO dataset with ~450 m resolution to accurately represent seafloor topography.

Projected changes in wave climate for the late-century period (2060 - 2080) indicate a general reduction in average significant wave height (~0.1 m) along Newfoundland's southern waters, while northern areas experience an increase of ~0.2 m, with the most pronounced rise occurring offshore in the north. The east coast of the Avalon Peninsula shows minimal change in mean wave height. However, despite relatively minor shifts in average conditions, extreme wave heights increase significantly across much of the region, particularly in northern waters. Offshore east of the Avalon Peninsula, a key region for future studies, experiences a notable rise of approximately 3 meters in extreme wave events.

Keywords

Climate change, Extreme waves, Numerical modeling, WRF, MIKE21-SW

Sinking vs. Suspended: How Phaeocystis Blooms Shape Particle Composition in the Labrador Sea

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Sinking particles are crucial for transporting photosynthetically fixed carbon from the surface to the deep ocean through the biological carbon pump. Composition and morphology can influence the relationship between particle size and sinking velocity despite the common assumption that size alone determines sinking speed. In this study, we present direct observations of the biogeochemical composition and morphology of suspended and sinking particles collected below the euphotic zone with a Marine Snow Catcher during the decline of a large Phaeocystis pouchetii bloom in the Labrador Sea (May-June 2022).

Our findings show that suspended particles consistently had a higher ratio of Transparent exopolymeric particles to particulate organic carbon (TEP/POC) than sinking particles, except at greater depths (>300m), where ratios were similar. In contrast, the ratio of Coomassie stainable particles to POC(CSP/POC) was higher in sinking particles during the late stages of the Phaeocystis bloom. However, the contribution of CSP/POC was low and variable between fractions during the decline of the bloom and non-bloom conditions. Sinking particles were slightly larger and more compact, while suspended particles were more porous and exhibited greater variability in size and morphology across depths and bloom stages.

Factor Analysis of Mixed Data indicates that the bloom stage was the primary driver of particle variability, with the first two dimensions explaining 42% of the total variance. Significant contributions also came from the ratios of BSi/POC, CSP/POC, and particle porosity.

Sinking and suspended particles were distinctly separated along Dimension 3, which had a high loading of TEP/POC. These results highlight the significant impact of the bloom stage on particle composition and sinking characteristics, offering insights into how increased Phaeocystis bloom frequency may affect carbon fluxes in the Labrador Sea.

Keywords

Particle composition, suspended, sinking, biological carbon pump, Phaeocystis bloom, Climate-driven bloom shifts.

Session 3 - Emerging Contaminants (2)

/Keynote Speaker/ Dr. Feiyue Wang

Cryospheric Chemistry: Biogeochemical Processes in the Earth's Cryosphere

Feiyue Wang[1]

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Most chemical reactions in aqueous solution slow down as temperature decreases. Once the solution is frozen, however, certain reactions are known to proceed very differently from their aqueous counterparts, some being dramatically accelerated in rate while others yielding unexpected products. Although the mechanisms of these "cryoreactions" remain poorly known, their importance in stratospheric and tropospheric processes has been long recognized. Evidence is mounting that the Earth's cryosphere (e.g., snow, glacier ice, river/lake ice, sea ice, permafrost, and their adjacent boundary layers) is also much more biogeochemically active than previously thought, affecting not only the storage and transport of chemicals, but also their chemical transformation, bioavailability, and biological effects. In this presentation, I will provide a synopsis of recent progress in the understanding of cryoreactions and cryospheric chemistry, and their implications for the regional and global cycling of carbon and contaminants in a changing climate.

Keywords

Cryosphere, cold regions, carbon dioxide, mercury, oil spills, microplastics

Microplastics in Ice: Transformation, and Environmental Implications in Cold Regions

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Ice plays a crucial role in temporarily storing and transporting microplastics (MPs) in aquatic environments, particularly in cold regions. As ice forms, MPs suspended in the water column can become trapped within its structure, leading to their sequestration and potential long-range transport by drifting ice floes. However, as temperatures fluctuate, these stored MPs can be reintroduced into the environment upon ice melting. The freezing process itself also alters the physical properties of MPs, influencing their fate and behaviour once released back into the water.

This study examines the impact of freezing on MPs, particularly in freshwater systems. The results indicate that the physical compression exerted during ice formation induces MP aggregation, leading to an increase in particle size. Upon melting, these larger aggregates exhibit modified buoyancy characteristics, which in turn accelerate their rising or settling velocity in the water column. Furthermore, freezing conditions can cause surface wetting changes that enhance the dispersion of hydrophobic MPs, potentially affecting their interactions with other environmental particles and organisms.

Salinity also plays a key role in modifying the freezing-induced transformations of MPs. In saline water, the formation of a brine network within the ice structure reduces the compressive effects of freezing on trapped MPs. This mitigates the extent of aggregation and alters their subsequent dispersion patterns once released. Given that MPs in cold environments are subjected to repeated freezing and thawing cycles, understanding these processes is essential for assessing their long-term environmental impact.

This research highlights the need for further investigation into the interactions between MPs, ice dynamics, and environmental factors such as salinity. The findings provide valuable insights into how MPs behave in cold regions, with implications for pollution monitoring, ecosystem health, and mitigation strategies.

Keyword

microplastics, cold regions, freezing

Impact of Plastic Additives on Microplastic Aging During Ozonation

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Microplastics (MPs) are a growing environmental concern due to their widespread presence. While water and wastewater treatment plants can capture larger MPs, smaller particles often evade removal processes, entering drinking water systems and aquatic environments, posing risks to ecosystems and human health. MPs undergo aging processes that lead to physicochemical changes and the leaching of dissolved organic matter (DOM), which can further influence their environmental behavior. Ozonation, a widely used disinfection step in water and wastewater treatment, has the potential to accelerate MP aging. Commercial plastics typically contain additives, such as antioxidants, plasticizers, and flame retardants. These additives may alter MP aging mechanisms, affecting MP surface morphology, fragmentation patterns, size distribution, adsorption characteristics, DOM leaching, and the release of nanoplastics (NPs). Such changes can significantly influence the transport, fate, and ecological toxicity of MPs in environmental systems. While existing research has primarily focused on the effects of environmental conditions and plastic types on MP aging, the impact of additives, particularly during ozonation, has received limited attention.

This study investigates the role of plastic additives in MP aging during ozonation by comparing polyethylene (PE) and polylactic acid (PLA) with and without additives (PE+/PE- and PLA+/PLA-). Results showed that additive-containing MPs (PE+ and PLA+) exhibit significantly enhanced aging compared to their additive-free counterparts (PE- and PLA-), characterized by increased DOM leaching and NP release. Additives catalyzed radical generation under ozone exposure, accelerating polymer oxidation and fragmentation. Two-dimensional infrared correlation spectroscopy further reveals distinct bond cleavage sequences between additive-containing and additive-free MPs, highlighting the critical influence of additives on MP aging mechanisms during ozonation. The research outputs would provide scientific insights into MP aging behavior in water/wastewater treatment systems and offer new perspectives for optimizing treatment operations and addressing ecological risks.

Keywords

microplastics, nano plastics, plastic additives, ozonation, aging

Evaluating Microplastic Contamination in Wastewater and River Systems

Katarzyna Jaszczyszyn[1, 2], Edyta Kiedrzyńska[1, 3], Marcin Kiedrzyński[4]

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The world is currently facing what is known as the triple planetary crisis, which encompasses three key and interconnected issues: climate change, pollution, and biodiversity loss. Human activity is the primary driver of this crisis, with plastic pollution posing a particularly serious problem. Plastic materials are ubiquitous, and their demand continues to rise. Inadequate wastewater treatment and unsustainable waste management result in plastic being released into the environment, including water bodies.

This study presents key findings from an analysis of microplastics (MPs) contamination in the Pilica River catchment (central Poland) and the Vistula River system, including its tributaries that leads to the Baltic Sea. FTIR imaging spectroscopy was employed to characterize MPs in collected samples, revealing the ubiquitous presence of plastic fragments in various shapes and colors. Spectroscopic analysis identified several groups of polymers, with significant amounts of polyethylene, polypropylene, their copolymers, and synthetic rubber particles. These findings strongly suggest that the MPs have an anthropogenic origin. To enhance understanding of MPs transport dynamics and identify their sources, monitoring at the catchment scale is essential. This knowledge will enable more effective management and regulatory development, which are crucial for mitigating the impact of MPs on these ecosystems.

The research was funded by the National Science Centre, Poland (Project No. 2021/43/B/ST10/01076, acronym: FARMIKRO) project manager: prof. Edyta Kiedrzyńska, ERCE PAS

Keywords

microplastics, environmental analysis, FTIR imaging spectroscopy, catchment scale

Session 4 - Water Resources & Quality Management (1)

/Keynote Speaker/ Dr. Manuel J. Rodriguez

Teaching and research on water resources protection in vulnerable communities: The field learning experience in Colombia with Canadian graduate students

Manuel J. Rodriguez[1]

[1]Université Laval

This presentation will highlight the design and implementation of a teaching-research training conducted in Colombia, South America, about the challenges of water access and protection in vulnerable communities in the Andean region. This is a field learning experience that focuses on the challenges and approaches to managing water and sanitation services in a land-use planning context in vulnerable regions and communities, with limited resources and/or where socio-economically disadvantaged populations live. The field learning experience covers the complete water resource cycle including the supply of drinking water (from its origin at the source to its point of consumption by the citizen) and the management of liquid discharges (human exposure, decontamination, receiving environment and effluent recovery). Particular attention is paid to the links (Nexus) between water resource management and the land (the watershed). The field component focuses on research visits in communities of many sizes, located in varied climates and altitudes (from 250 m to 4200 m) in the tropical region of the Andes Mountain range (Paramo and glacier mountain systems, and associated valleys and plains). Considerable attention is paid to the local impacts of global and climate change on these communities. The talk will illustrate the experience acquired from 2022 to 2025 within the partnership of Université Laval (Quebec), University of Victoria (British-Columbia) and Universidad Cooperativa de Colombia (UCC).

Implementing Wastewater Surveillance for COVID 19: Insights from Newfoundland and Labrador's Integrated Public Health Approach

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The COVID-19 pandemic accelerated the need for innovative public health surveillance methods, with wastewater-based epidemiology emerging as a critical complementary tool. For the first time, by utilizing viruses detected in community sewage, environmental surveillance has been closely integrated with public health research nationwide in Canada. This study details the design, implementation, and evaluation of a province-wide wastewater surveillance program in Newfoundland and Labrador. Employing both composite and passive sampling methods, the program monitored SARS-CoV-2 RNA at 27 locations across 23 communities, covering nearly 51% of the provincial population. Samples were processed using RT-PCR at the National Microbiology Laboratory (NML), with additional assays performed to track emerging variants. The integration of data through PowerBI dashboards and ESRI mapping tools enabled early outbreak detection (often 3-7 days ahead of clinical surges) and facilitated the timely introduction of public health interventions when necessary. The surveillance system demonstrated high sensitivity, detecting community prevalence as low as 0.01%, while also revealing challenges related to sampling logistics, laboratory turnaround times, and data harmonization. Overall, our findings underscore the value of wastewater surveillance as a robust adjunct to traditional epidemiological methods and provide a framework for its expansion to monitor other public health threats, including influenza, RSV, and monkeypox, offering critical insights for proactive disease monitoring in both pandemic and post-pandemic contexts.

Keywords

COVID-19, wastewater surveillance, environmental monitoring, passive sampling, public health surveillance, Newfoundland and Labrador

From Threats to Solutions: A Decision-Making Methodology for Protecting Drinking Water Sources in Québec, Canada

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Since 2004, the Canadian Council of Ministers of the Environment (CCME) promotes the multi-barrier approach to provide safe drinking water to the population. The first barrier is drinking water source protection (DWSP). In Québec, the Water Withdrawal and Protection Regulation (WWPR), implemented in 2014, requires all municipalities serving over 500 people to conduct a vulnerability analysis of their drinking water source. These analyses identify threats within the catchment area of a drinking water intake. With climate change intensifying extreme weather events, altering hydrological cycles, and increasing contamination risks, proactive source protection planning is more critical than ever to ensure the resilience and sustainability of drinking water supplies. While municipalities are encouraged to develop Drinking Water Source Protection Plans (DWSPPs) to mitigate these threats, no standardized methodology exists for selecting appropriate protection measures. To address this gap, this research develops a structured methodology for selecting protection measures tailored to the specific threats identified in vulnerability analyses. By categorizing threats from vulnerability reports and reviewing protection measures through literature and stakeholders consultations, a refined decision-making approach was developed. More than 350 threats and close to 250 protection measures were studied and reviewed. The methodology was then validated through an application for a medium-to-large municipality in the province of Québec. Ultimately, watershed organizations were key players in the elaboration of the decision-making methodology, since in many cases they were mandated by municipalities to draw up protection plans. The various participatory processes for drawing up protection plans were therefore also studied in this project. As a result, this research provides a structured approach to help entities in charge of DWSPP to make context-adapted decisions on drinking water source protection.

Keywords

drinking water source protection, decision-making methodology, vulnerability analysis, protection measures, watershed management, Québec

Quantifying Uncertainty in Urban Hydrological Models and Exploring AI-based Prediction: A Case Study in the Saanich Area

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Hydrological models rely on spatial data inputs that inherently contain uncertainties that can affect the accuracy of model predictions. First, this study uses real data from the Saanich area to quantify uncertainty in hydrological model inputs using a new fuzzy-entropy based approach to quantifying uncertainties in the spatially distributed slope, land use, and soil data. These three types of spatial data are critical to estimating peak flowrates and volumes in watersheds for most deterministic hydrological models. We develop histogram-based membership functions for spatial data and integrated fuzzy Shannon entropy using a fuzzy inferencing system to compute the normalized watershed fuzzy Shannon entropy along hydrological flow paths. The results indicate that as the spatial scale increases, the uncertainty in spatial data gradually increases, impacting hydrological model outputs such as peak flow and total volume. Furthermore, model uncertainty is not only derived from input data but can also arise from the computational model process, potentially introducing errors and additional uncertainties. Future research can extend fuzzy analysis methods to quantify uncertainties within model processes and track the propagation, thereby optimizing model structures and improving the reliability of simulation results. This would provide more robust decision-making support for water resource management and urban planning. Additionally, this study explores the feasibility of applying Large Language Models (LLMs) in hydrological prediction. Not surprisingly, the results show that LLMs perform poorly when fine turned on limited data but can achieve performance comparable to traditional hydrological models (PCSWMM) when trained on larger datasets.

Keywords

hydrological model inputs, Shannon entropy, spatially distributed fuzzy entropy, scale effects peak flows, total volumes, fuzzy logic

Session 5 - Emerging Contaminants (3)

/Keynote Speaker/ Dr. Caterina Valeo

Remediation of Heavy Metals, Microplastics and Other Emerging Contaminants from Nature-Based Infrastructure

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This work explores the potential for vegetated stormwater infrastructure (treed bioretention cells with structural soil) for remediating heavy metals and emerging pollutants in stormwater. Low Impact Development (LID) technologies, such as rain gardens (bioretention cells) and permeable pavements are a type of nature-based stormwater infrastructure that treat polluted urban stormwater both in terms of water quantity and quality. There is significant body of long-term research on the performance of bioretention cells and permeable pavements for removing a variety of regulated (total suspended solids), and unregulated but conventional (non-emerging) contaminants, with varying success. More and more vegetated structures are moving toward using large woody vegetation such as trees, amended soil blends to improve water quality performance, or structural soil for added structural support under vehicle and pedestrian loads. Structural soil is a mix of 80% aggregate and only 20% organic media blended using a binder. There is very little research into the role of structural in bioretention cell performance. This research reviews the literature and presents insights into how treed bioretention cells with structural soil can eliminate emerging contaminants such as microplastics, PFAS, PAHs and 6ppd-quinone, and to draw inferences on the role of structural soil vs vegetation for eliminating these contaminants. In addition, this talk will present the results of an investigation into the water quality remediation performance of in a treed bioretention cell built with structural soil and subject to car wash wastewater (CWW) loading. CWW is known to contain heavy metals and PAHs and is likely to contain emerging contaminants picked up in vehicle operation. The study and methodology are grounded in a nature-based approach tailored for water treatment particularly suited to remote, rural, and underserved areas, found in developing regions of India and Malaysia. Car wash wastewater contains numerous The research explored tree health and evaluated the performance of the designed treatment field in removing contaminants from CWW. Regarding heavy metal content, the trees did uptake heavy metals from the root system, which successfully migrated to the leaves. But heavy metal concentrations varied between different trees and leaf positions, with some metals exhibiting higher concentrations in the bottom leaves and others showing higher concentrations in the top leaves. The concentrations of heavy metals in the leaves were also influenced by seasonal variations and leaf turnover.

Keywords

emerging contaminants, stormwater, structural soil, treed rain gardens, bioretention cells, heavy metals, carwash wastewater

Machine Learning-Enhanced SR-FTIR Imaging Reveals Molecular Disruptions from Face Mask and PBDE Co-Contamination in Marine Ecosystems

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The accumulation of disposable face masks in marine environments presents a growing concern, not only as plastic debris but also as carriers of persistent organic pollutants. Their interactions between the masks with co-existing contaminants such as 2,2′,4,4′-tetrabromodiphenyl ether (BDE-47) and their biological consequences in marine ecosystems remain poorly understood. In this study, we employ machine learning-assisted synchrotron-based Fourier Transform Infrared (SR-FTIR) imaging to investigate the biochemical disruptions induced by mask-PBDE co-contamination. By integrating supervised learning with high-resolution spectral imaging, we identify species-specific alterations in photosynthetic efficiency, lipid organization, and protein structures in marine microalgae. These cellular disruptions contribute to a 58% decline in microalgal biomass, ultimately reducing oceanic CO_2 sequestration by 5.2 gigatons over 10 years. Our findings highlight how machine learning enhances SR-FTIR imaging analysis, enabling a deeper understanding of contaminant interactions at the molecular level and reinforcing the need for advanced analytical approaches in environmental risk assessments.

Keywords

Disposable face mask, PBDEs, Co-contamination, Machine learning, Synchrotron FTIR imaging, Toxicity

To Explore Distribution, Diffusion Regularity and Influencing Factors of Antibiotic Resistance Genes in the Water Transfer Chaint from Luanhe River to Tianjin Based on Metagenomics

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Yuqiao Reservoir is an important drinking water source for Tianjin. As the source of the "Water Diversion Project from Luanhe River to Tianjin", there are more than one hundred kinds of antibiotic resistance genes (ARGs) contamination in Panjiakou and Daheiting Reservoirs. However, the level of ARGs in the upstream water transfer chain of Yuqiao Reservoir (Lin River, Sha River, Li River) has not been studied yet. It is necessary to characterize the dynamic mechanism of ARGs in this basin to gain a deeper understanding of water ecosystem security. In this study, metagenomic methods were used to investigate the distribution characteristics of ARGs and mobile genetic elements (MGEs) in the surface water of the Water Transfer Chaint from Luanhe River to Tianjin during different periods, and combined with the correlation mechanisms among microbial community structure and environmental factors. The result shows that the water transfer chain of the Luan River to Tianjin contains 19 types of ARGs with 1161 subtypes. The main types of ARGs are Multidrug, MLSB(Macrolide-Lincosamide-Streptogramin B) and Tetracycline, with macB and tetA58 being the dominant ARGs. Major types of MGEs are integration/excision(IE) and replication/recombination/repair (RRR) are predominant. Compared to the flood period, there is a significant positive correlation between ARGs and MGEs during the dry period. Correlation analysis indicates that temperature, dissolved oxygen, and nitrate show significant correlation with various ARGs ($p < 0.05$). The abundance of ARGs is more easily affected by multiple environmental factors, but the composition of ARGs show correlation only with total phosphorus and dissolved total phosphorus. Proteobacteria is the most dominant phylum, and several dominant microbial genera, such as Acidovorax and Rhodoferax, also show significant correlation with ARGs, especially during the dry period. The co-occurrence network analysis reveals the most significant co-occurrence relationship between ARGs and MGEs, and some microbial genera related to nutrient elements and photosynthesis also show co-occurrence relationships with major ARGs. This project aims to profoundly understand the biogeochemical cycle mechanisms of ARGs in the upstream water transfer chain of the reservoir, and it can provide a scientific basis for decision-making to control the transmission of resistance genes within the regional basin.

Keywords

Water Transfer Chaint from Luanhe River to Tianjin, ARGs; MGEs; Metagenomics, Bacterial community, Environmental factors

Transport of Microplastic and Antibiotic Co-contaminants in Tidal Zones

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Microplastics (MPs) and antibiotics (ATs) are emerging contaminants with recognized negative effects on marine ecosystems. MPs can adsorb and transport ATs, posing combined toxic effects to marine organisms. Despite growing concerns, research remains limited on the MP-AT co-contaminants in tidal zones, which are home to numerous aquatic species and represent a particularly susceptible ecosystem. This study used polyethylene (PE) MPs and tetracycline (TC) to investigate the influence under various conditions, including sediment sizes, tidal cycles, and MP sizes, on the transport of MP-AT co-contaminants in tidal zones using a tidal cycle simulation system, which was designed to replicate the tidal dynamics and provide insights into the movement and behavior of contaminants. It was observed that MP-AT co-contaminants in tidal sediments exist in three distinct transport states. Smaller MP-AT co-contaminants (State 1) pass through sand pores and are widely distributed in the upper sediment layers, whereas larger MP-AT co-contaminants (State 2) concentrate in layers 1-5 due to size limitations. Agglomerated MP-AT co-contaminants (State 3), unable to pass through sand pores, accumulate at the bottom. Tidal cycles enhance MP-AT co-contaminant retention, while sand size (125-212 μm) limitedly affects their distribution. MP size played a crucial role, with larger MPs settling in layers 1-5 and smaller MPs remaining more dispersed. These findings emphasize the importance of MP size in affecting contaminant transport in tidal environments. Results from this research will contribute to the development of transport models and help predict the long-term environmental impact of MP-AT co-contaminants.

Keywords

Microplastics, Antibiotics, Agglomerates, Transport, Tidal zone

What Drives High Concentrations, Low Diversity and Patchy Distribution of Microplastic in a Marine Bay?

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In the summer of 2021, concentrations of microplastic 300 - 5000 µm ranged from 0.11 to 0.67 particles m-3 in the surface waters of Placentia Bay, Newfoundland. Transparent polypropylene (PP) fibers dominated by far, contributing 47% to total MP inventories, whereas transparent polyethylene (PE) fragments contributed 11%, blue PP fibers 6%, and white PE fragments 3%. The remaining 33% of microplastic particles consisted of a variety of fragments and fibers of different polymer compositions and colors, each individual group contributing < 3%. The clear dominance of transparent PP fibers, and the size frequency distribution of fibers, suggest a distinct input event of transparent PP fibers, overlaying the background microplastic signature. A back of the envelope estimate suggests that this signal is consistent with the accidental release of disposable medical facemasks during the COVID pandemic.

Keywords

Microplastic, Medical Facemask, Marine, Placentia Bay Newfoundland

Session 6 - Water Resources & Quality Management (2)

/Keynote Speaker/ Dr. Xiangliang Pan

Challenges and Solutions for Monitoring Nanoplastic in Complex Environmental Media

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Micro-/nano-plastics are emerging contaminants with global concern. However, research on pollution, behavior and ecological and environmental risks of nanoplastics are still greatly challenged by the analysis methodology. The challenges are from separation and enrichment of nanoplastic from environmental media, removal of non-plastic natural organic nanoparticles, as well as strong interferences and optical diffraction limit in identification of nanoparticle polymers by vibrant spectroscopy. Herein, we developed a methodology overcoming these limits for effective pretreatment, efficient and precise identification and quantification of nanoplastic in environmental media.

Keywords

Microplastic, Nanoplastic, Pretreatment, Identification, Methodology

How Drinking Water Systems Can Adapt to Climate Change From Source to Tap?

Manuel J. Rodriguez[1], Sonja Behmel[2], Ianis Delpla[3], Cynthia Compaoré[1]

[1]Université Laval, [2]Watershed Monitoring, [3]EHESP

Extreme events like floods, droughts, water scarcity, heat waves, wildfires, extreme cold, are some consequences of climate changes aggravating challenges associated with drinking water supply. Concerning water quality, rising temperatures and variations of precipitations patterns associated with climate changes may have significant consequences on drinking water systems (DWSs). Drinking water quality depends on the source water quality and the processes used in treatment plants. Source water quality is highly threatened by climate changes. For example, heavy rainfall is known to increase natural organic matter (NOM) and microbiological pollution in raw waters. Also, increased temperatures and concentrations of NOM may impact treatment efficiency. The consequences are a lower removal of NOM, reduction of the efficiency of physico-chemical treatment, higher disinfectant demand, higher formation of disinfection by-products (DBPs), and increasing risks for microbiological contamination.

The scientific literature indicates that, despite the interesting potential of DSSs for protecting water quality, few practitioners use them. The question here is to understand, with the collaboration of practitioners, the reasons for this low use of DSSs and how to encourage greater use of these tools. The objective of this research is to assess the interest and capacity to use DSSs for adaptation to climate change consequences on source water quality, treatment plant operations and water quality management in the distribution network. To this end, about thirty municipality participants volunteered for serious games that were designed to assess the use of DSSs for climate change adaptation concerning water quality protection.

The serious games were organized in the form of hypothetical scenarios, in which participants were presented with two to three fictitious but realistic scenarios, along with a series of questions they answered as the scenarios unfolded. Each scenario presented one climate hazard that could be intensified (in frequency or intensity), according to the literature. For each scenario, a DSS was presented (with its strengths and weaknesses) to allow adaptation to the climatic hazard of the scenario. The hazards and DSSs were selected considering participants and the municipalities they represented. At the end of the presentation of each scenario, a discussion was held with the participants around the questions of a discussion guide. This discussion covered both the use of DSSs for and the evaluation of serious games for promoting the use of DSSs

It was possible to identify human and social challenges linked to the use of DSSs for DWS adaptation to climate change, water quality protection and certain challenges like financial limitations, lack of regulatory obligations and lack of workforce. Results suggest the rising-up of awareness concerning the need for preventive adaptation based on an informed decision support process and better cooperation between drinking water management stakeholders. Serious games like those used in this study, could be an effective way for raising awareness on the aggravated risks to water quality posed by climate change and they can be helpful to promote the use of DSSs for drinking water systems adaptation to climate change.

Keywords

Water quality, Drinking systems, Climate change, Adaptation, Serious game

Degradation Mechanism of Typical Non-steroidal Anti-inflammatory Drugs in Water by a Novel UV/Monochloramine Advanced Oxidation Process

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UV-activated chloramine advanced oxidation process has potential application value in the degradation of organic micropollutants. In order to investigate the removal performance of non-steroidal anti-infammatory drugs in water by ultraviolet/monochloramine (UV/NH2Cl) system, the degradation of nabumetone (NMT) by UV photolysis, NH2Cl oxidation and UV/NH2Cl was compared. The influence of various factors on the degradation of NMT by UV/NH2Cl was investigated. The degradation pathways of NMT were investigated and the toxicity changes were predicted by combining the quantum chemical calculation and the detection results of UPLC-HRMS. Finally, the generation of disinfection by-products was analyzed. The results show that: (1) The degradation of NMT in UV/NH2Cl system conformed to the pseudo-first-order reaction kinetics equation. When the initial concentration of NMT was 5 μmol/L, and the dosage of NH2Cl was 50 μmol/L, the degradation efficiency of NMT could reach 88.81% after 150 s of reaction at normal temperature. (2) Increasing the dose of NH2Cl could promote the degradation of NMT, and there was no significant change in the degradation rate of NMT in the range of pH 5.5-8.5. The addition of Cl-, HCO3-, and natural organic matter inhibited the degradation of NMT. (3) A total of 10 degradation products were identified based on UPLC-HRMS, and the degradation process of NMT mainly involved hydroxylation, nitrosation and demethylation. The TEST software predicted that the acute and developmental toxicity of the degradation products were higher than that of the NMT. (4) UV/NH2Cl promoted the generation of disinfection byproducts during the degradation of NMT. The results of this study show that UV/NH2Cl advanced oxidation process has good degradation efficiency for NMT in water, and its degradation products may have higher acute and developmental toxicity, which needs further investigation.

Keywords

Ultraviolet/monochloramine (UV/NH2Cl); Nabumetone (NMT); Kinetics; Degradation pathways; Disinfection byproducts

Decision Support Tools for Drinking Water Production from Source to Treatment

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Drinking water quality and production can be affected during or after rainfall events in watersheds that alter surface raw water quality. Two key parameters - raw water particles and Natural Organic Matter (NOM), are particularly impacted. Time lags occur between rainfall events and the measurement of turbidity (particles) and UV absorbance (UV254, representing NOM) at water intakes. These delays prevent timely adjustments in the Drinking Water Treatment Plant (DWTP), potentially leading to suboptimal coagulation, reduced treatment efficiency, and public health risks.

This study explores two decision support tools (DSTs) based on machine learning models: (a) predicting raw water quality (turbidity and UV254) using rainfall and river flow time series and (b) testing virtually coagulant doses for NOM removal using historical DWTP performance data. These tools were developed in a watershed-DWTP system in Quebec, Canada. Results indicate that machine learning models provide effective support for DSTs in drinking water production. The developed DSTs could enhance Weather-Event-Water-Treatment Early Warning Systems (WEWT-EWS). Several questions arise: What is the optimal prediction horizon for raw water models? Should DWTP performance models be based on real, simulated, or hybrid data?

Future research should focus on extending prediction horizons using AI-based tools and integrating upstream water intake data into hydrology-water quality models. Additionally, efforts should be made to refine the quantity, quality, and density of data in DWTP performance models.

Keywords

Drinking water quality, Decision support tools, Drinking water production, Machine learning models

Improving Access to Safe Water in Palafitic Communities in Colombia

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Access to safe water, sanitation and hygiene (WASH) services remains a global health challenge, especially in vulnerable communities. In Colombia, less than 20% of population has adequate sanitation services, with large disparities between urban and rural areas. This problem is particularly acute in the Palafitos communities of the Colombian Caribbean region, such as Palafito of Buenavista, where, despite living on the water, the inhabitants do not have safe access to WASH services.

Colombia has unique geographical and environmental characteristics. Its location, very close to the equator, allows for a variety of mountainous, tropical and desert climates. Water sources generally come from the high mountains of the Cordillera of the Andes, which are the drinking water supply for many communities.

This is the case for the main river in the country, the Magdalena River, which rises at an altitude of almost 4,000 m in the mountains and flows into the Caribbean Sea, It is affected by numerous anthropogenic pressures, with major pollutant discharges, combined with haphazard and poorly controlled land use. The populations living in the palafittic villages have to fetch their water in the delta of the Magdalena River, close to its mouth in the Caribbean Sea.

This project seeks to improve access to drinking water in the Palafito of Buenavista through three main lines of action:

1. Assessment of current access to WASH services

The current situation of access to drinking water in Buenavista is being analyzed through:

· The observation of water collection and distribution sources.

· Assessment of water quality from source to household use, identifying physical, chemical and microbiological contaminants.

· Household surveys to understand water consumption and use habits, as well as hygiene and sanitation practices.

· Water samples will be collected at different points in the community (water source, transport, and storage in homes and community spaces) to measure parameters such as pH, turbidity, residual chlorine and microbiological contamination.

· A risk evaluation associated with water consumption and use, by combining survey results and water quality results.

2. Evaluation of a water treatment system

A water treatment device developed by Colombian university partners will be tested and adapted to local source water conditions. This system will be implemented in a school or childcare center. The device will be monitored for one year to evaluate its effectiveness. Tests will be previously conducted in laboratories at Université Laval to improve the device performance and adaptation.

3. Technology transfer and water quality monitoring.

Local leaders and students will be trained in water quality monitoring methods, using accessible and low-cost analytical tools to measure contaminants in water. This will improve local capacity to monitor and respond to water quality issues.

The presentation will also present results obtained during field campaigns collected in 2024 and 2025 in the Palafito of Buenavista. Results show a high contaminant charge in the water consumption points of the community, evidencing the need for improvement of population access to safe water and development of strategies to reduce exposure to microbiological and chemical contaminants.

Keywords

Vulnerable communities, Access to safe drinking water, Palafitos, Drinking water

Session 7 - (Special Session) Oilfield Water and Wastewater Treatment – Focusing on Emerging Contaminants and Resource Development

Utilizing petroleum coke for the treatment of hydraulic fracturing flowback and produced water

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Responsible hydraulic fracturing is important to the future of Canada's oil and gas sector. Hydraulic fracturing operations consume significant amount of water. The flowback and produced water during operation contain toxic chemicals and is stored on-site. Alberta Energy Regulator (AER) records hundreds of surface spills of flowback and produced water annually. Nevertheless, to promote water reuse and reduce cost during hydraulic fracturing operations, industries use fit-for-purpose water treatment methods to treat the flowback and produced water targeting suspended solids and dissolved solids. In addition, the recent interest in the lithium content in the hydraulic fracturing flowback and produced water has spurred direct lithium extraction technology development across Canada. However, most of these technologies will require certain degree of organic removal.

Given the high cost of traditional water treatment technologies, developing low-cost alternatives for flowback and produced water reuse would be beneficial. In this study, we evaluated water treatment methods by utilizing waste materials (i.e., petroleum cokes) from oil sands industry for hydraulic fracturing flowback and produced water treatment by employing an in-house coke activation method. Flowback and produced water samples from different well locations in the Western Canadian Sedimentary Basin were analyzed and compared using a suite of analytical techniques and statistical methods. Emerging contaminants were identified by high resolution mass spectrometry using non-targeted analysis method. The organic removal efficiency of different coke products was compared. The results show that the surface area of coke is the main factor influencing its adsorption capacity for dissolved organics. This study demonstrated the promising potential of utilizing petroleum coke for treating flowback and produced water.

Keywords

Flowback and produced water, Water treatment, Petroleum coke, Emerging contaminants

Efficiency of Solar-Driven Tin Oxide for Treatment of Real Oil Sands Process Water

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The Canadian oil sands industry, primarily located in northern Alberta, contains some of the largest oil deposits on the planet. Bitumen recovery from these deposits using surface mining requires about 3-4 barrels of freshwater for each barrel of bitumen [1-2]. This extraction process results in the generation of large volumes of oil sands process water (OSPW), which contains a variety of organic and inorganic contaminants, including naphthenic acids (NAs). NAs are one of the primary contributors to the toxicity of OSPW, posing potential risks to human health and various organisms [1-2]. Their low biodegradability and complex structure make their removal difficult with conventional treatment methods, necessitating advanced treatments [3]. Advanced oxidation processes (AOPs) involve innovative approaches for treating OSPW, with the potential for on-site application. Studies have confirmed the efficacy of AOPs in OSPW treatment, demonstrating the ability to mineralize organic contaminants without generating secondary pollution. Among various AOPs, some methods, like UV/H2O2, require UV light and chemical additions, leading to increased costs and environmental impact. Recently, solar-driven catalysis has emerged as an eco-friendly alternative, focusing on the development of catalysts activated by solar light [4-6]. The effectiveness of tin oxide (SnO2) under simulated solar light was studied to treat real OSPW. The findings showed that this process has a high potential for eliminating fluorophore organic contaminants and classical NAs (O2-NAs) from OSPW, achieving over 90% degradation of O2-NAs in 8 hours of simulated solar irradiation. In contrast, treating OSPW under the same irradiation time without SnO2 resulted in negligible photodegradation of O2-NAs, suggesting that these compounds are highly resistant to solar radiation alone. Finally, electron paramagnetic resonance measurements confirmed the primary role of hydroxyl radicals in degrading fluorophore organic contaminants and O2-NAs by the solar/SnO2 process. These results highlight the potential of SnO2-based photocatalysis in removing classical NAs and other organic compounds from real OSPW.

Keywords

Solar-Driven Photocatalysis, Oil Sands Process Water, Fluorophore Organic Contaminants, Toxicity Analysis

Physicochemical and Behavioral Changes of Oil during Weathering Processes in Freshwater Wetland Mesocosms

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Oil spills in freshwater environments can have more severe impacts on the environment and humans than in marine environments due to limited water movement, prolonged oil residence, and the high sensitivity of freshwater ecosystems. Spilled oil will undergo weathering processes, such as evaporation, photooxidation, and degradation, that alter its physicochemical properties and toxicity. Oil weathering involves changes in density, viscosity, surface/interfacial tension, and chemical composition, which affect the transport and fate of oil in the environment. While most studies have focused on oil weathering in ocean environments, the behaviors of weathered oil are different in freshwater due to smaller physicochemical gaps between oil and water, such as density and surface tension. To address knowledge gaps regarding oil photo-transformation, physiochemical changes, and their transport in freshwater environments, particularly under winter conditions, this study simulates the evaporation and photo-oxidation of oil in freshwater wetland environments using outdoor mesocosm tanks (183 x 121 x 76 cm). The changes in chemical composition, oxidation intermediates, density, viscosity, and surface/interfacial tension of oil are monitored. Furthermore, the changes in dissolution, dispersion, and emulsion of weathered oil are evaluated in the mesocosm tanks. The findings would improve the prediction of oil behavior in freshwater wetlands by considering various oil weathering processes and their effects on oil properties.

Keywords

Oil Weathering, Great Lakes, Freshwater Wetland, Physicochemical Property, Transport And Fate

Remediation Technologies and Case Studies for Refined Oil Contaminated Sites

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With the advancement of industrialization, the issue of petroleum-contaminated soil and groundwater has become increasingly severe, with refined oil leakage emerging as a particularly significant concern. Refined oil, including gasoline, diesel, and lubricants, are key products derived from crude oil processing. Leakage of these products may occur during production, transportation, storage, and other stages. Due to their unique physicochemical properties and migration behavior, refined oil leaks pose a serious threat to soil and groundwater systems, leading to potential contamination. In recent years, increasingly stringent national policies and regulations have raised the bar for the management and protection of soil and groundwater environments, as well as the control of pollution risks. Soil contamination surveys have revealed that long-operating petroleum and petrochemical enterprises are particularly vulnerable to pollution or high pollution risks, primarily due to pipeline leaks, compromised impermeable layers, or other deficiencies. Preventing further contamination spread and mitigating impacts on surrounding environments are now urgent tasks and critical demands for enterprises. The key to controlling soil and groundwater pollution risks within target limits lies in the selection of appropriate remediation technologies tailored to site-specific conditions.

The Research Institute of Safety & Environment Technology (RISE) has prioritized the remediation and control of soil and groundwater pollution in the petroleum and petrochemical industry. We have developed a suite of advanced products, technologies, and equipment, including rapid investigation and simulation assessment, continuous permeable reactive barriers, mild chemical oxidation, multi-phase extraction, and stratified injection. Our expertise encompasses the entire process of soil and groundwater pollution investigation, assessment, risk control, and remediation, providing comprehensive technical research and service capabilities. These solutions have been successfully applied at numerous sites contaminated by refined oil leaks, demonstrating their effectiveness in addressing complex environmental challenges.

Keywords

Refined Oil Leakage and Contaminants, Environment Protection Remediation Technologies and Case, Soil-Groundwater Remediation and Risk Control, Petroleum and Petrochemical Enterprises

Nanocomposite of Eugenol/Poly Siloxane/Graphene Oxide as an Efficient Anticorrosion and Anti-Biofouling Additive for Marine Epoxy Coatings

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A novel nanocomposite, Eu-PMHS-GO, was synthesized through a Pt-catalyzed hydrosilylation of polymethylhydrosiloxane (PMHS) with eugenol (Eu), followed by esterifcation with graphene oxide(GO). A marine epoxy resin was then modifed with Eu-PMHS-GO as a dual-function additive for enhanced anticorrosion and anti-biofouling properties. Our studies demonstrated that Eu-PMHS-GO signifcantly improved the hydrophobicity and mechanical strength of the epoxy coatings, with optimal performance observed at 0.001 wt% additive loading. The modifed coatings exhibited superior corrosion resistance, maintaining high water repellency and impedance values even after 30 days of immersion in seawater. Additionally, the incorporation of Eu-PMHS-GO inhibited the adhesion of marine microorganisms, including the diatom Phaeodactylum tricornutum and two bacterial strains, Bacillus subtilis and Synechococcus sp. At low additive loadings (0.001-0.05 wt%), the epoxy coatings showed high anti-algal and anti-bacterial adhesion efficiencies. However, at higher loadings (> 0.1 wt%), the performance decreased sharply, which is attributed to increased aggregation of Eu-PMHS-GO in the epoxy coating layer. This comprehensive study demonstrates the applicability of Eu-PMHS-GO as an efficient, multifunctional additive in marine coating technology.

Keywords

Graphene, Graphene Oxide, Eugenol, Polymethylhydrosiloxane, Additives and Anticorrosion

Session 8 - Water and Wastewater Treatment (1)

/Keynote Speaker/ Dr. Huining Xiao

Functional-Modified Cellulose as Environmentally Friendly Materials to Address Environmental Concerns

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As the most abundant natural polymer on earth, cellulose has attracted tremendous interests due to its biodegradable features and great potential for various applications. Over the past decade, we have developed several approaches to render cellulose-based materials multi-functional to address environment concerns. Among them, cellulose-based adsorbents or hydrogels towards the removal of contaminants are particularly appealing. Moreover, smart or responsive carriers originating from cellulose were created for the controlled release of agrochemicals and soil remediation afterwards. Presented herein will mainly cover those areas while such functional materials represent the trend of utilizing environmentally friendly materials to address environmental issues.

Application of Biocarbon Materials in Wastewater Treatment

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Hydrothermal carbonization is an efficient way to convert biomass waste to biocarbon materials named hydrochar. Hydrochar typically possesses unique characteristics like abundant surface functional groups such as carboxyl, carbonyl, and hydroxyl groups; high carbon content; a well-developed porous structure; and high stability and adsorption ability. Such intrinsic physical and chemical properties make it a valuable biocarbon material for various applications across fields, such as agriculture, environmental remediation, sensing, catalysis, and innovative construction materials. This work focuses on the application of hydrochar in wastewater treatment. Highly efficient nanocomposite materials TiO2/hydrochar were innovatively synthesized and tested in photocatalytic degradation of organic pollutants such as organochlorinated pollutants, dye, and antibiotics. The synergistic effect of TiO2 and hydrochar led to 97%, 92%, and 98% of photocatalytic degradation of pentachlorophenol (PCP), sulfamethoxazole (SMX), and methylene (MB) respectively. The enhanced photocatalytic activity is due to the synergistic effect between HC and TiO2 nanoparticles, including improved interfacial charge transfer kinetics between TiO2 and hydrochar, high anatase content of TiO2, better surface area, better light absorption of nanocomposites, and rapid transfer of photogenerated $e{-}s$, inhibiting the e- and h+ recombination process. The photoreaction mechanism is that TiO2 nanoparticles initiate the photo-redox reactions, and mesoporous HC accumulates the adsorption of MB dye on the interface of TiO2 and HC and accelerates the charge separation

Keywords

Biomass, Biochar, Photocatalysis, Wastewater

A Systematic Review of Ammonia Removal via Simultaneous Nitrification and Denitrification in Membrane Aerated Biofilm Reactor Systems

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The counter-diffusional biofilm structure of membrane aerated biofilm reactors (MABR) facilitates strata formation, which can support multiple pollutant removal pathways, such as simultaneous nitrification and denitrification (SND). Several operational factors that influence ammonia removal via SND have been documented. However, the inconsistency in literature makes it challenging to identify the most important factors that influence ammonia removal via the SND pathway. The work focused on extensive literature review and statistical evaluation of varying operational factors that affect ammonia removal in MABR via SND.

Principal component analysis (PCA) was performed on 51 data points using Minitab software to explore and visualize the datasets. The results indicated that the first three components had eigenvalues higher than 1, and these three components accounted for 71.1% of the variation in the dataset. PC1 accounted for 36% of the total variation, and the factors that correlated most with PC1 included HRT (0.521), temperature (0.402), influent ammonia concentration (0.369), and air pressure (0.315). PC1 positively correlated with all four factors and thus, an increase in these factors increases the value of PC1. Additionally, the first four PC explained almost 82% of the variation in the dataset, of which PC1 contributed the biggest portion. Hence, the most important factors that influenced ammonia removal efficiency via SND in the selected papers could be among these four factors.

Since PCA results could not exactly conclude the most important factor influencing ammonia removal efficiency via SND in MABR systems, CART®Regression predictive analysis was performed to determine the most important factor among the eight evaluated factors regarding ammonia removal efficiency via SND. CART® Regression analysis was performed on 49 datasets after removing more outliers identified in PCA. According to CART®Regression analysis, pH and membrane surface area were the most and least important factors respectively, which influenced ammonia removal efficiency via SND in MABR systems. Influent ammonia concentration was 54.3% as important as pH, while the rest of the predictor variables were below 50% as important as pH. The pH and influent ammonia concentration are very important factors for ammonia removal via SND in MABR systems. Knowing the most important factors that influence ammonia removal via SND is a fundamental step in optimizing these factors. These factors provide a springboard for further research and serve as key considerations for engineers in system design, reactor feasibility assessment, and effective management of MABR systems performing SND.

Keywords

Ammonia Removal, Membrane Aerated Biofilm Reactor (MABR), Simultaneous Nitrification/Denitrification, Wastewater Treatment

Aerobic Granular Sludge: A Resilient Solution for Extreme Ethylene Glycol Shock in Wastewater Treatment

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De-icing fluid is widely used to prevent ice formation and remove snow from aircraft, roadways, and other critical surfaces. Ethylene glycol (EG), a major component of de-icing fluid, can enter water networks, potentially leading to environmental contamination. Consequently, ingestion of EG-contaminated water can lead to metabolic acidosis and acute kidney failure due to its metabolization in the liver into harmful compounds, such as glycolic acid and oxalate. Therefore, an adequate treatment strategy is needed to control the flux of EG into water systems. Conventional biological processes find it challenging to endure the shock loading of EG. EG increases influent COD, disrupting the carbon-to-nitrogen (C/N) ratio and hampering microbial activity. Hence, advanced biological processes are needed to handle such harsh operating conditions. Aerobic granular sludge (AGS) is a promising alternative to conventional activated sludge owing to its unique physicochemical characteristics. AGS is a self-aggregated microbial consortium that forms 3D-structured granules. These granules can remove organic matter and nitrogen simultaneously, owing to the presence of various redox microenvironments. They are also more resilient to shock loading because of their dense structure and stratified microbial communities that enable efficient adaptation to fluctuating environmental conditions. Herein, this study investigates the impact of EG on AGS characteristics and treatment performance under EG concentrations ranging from 120 mg/L to 2,000 mg/L. The AGS system achieved nearly complete simultaneous nitrification-denitrification (SND) at EG concentrations above 800 mg/L, with COD removal consistently exceeding 90%. Changes in the granule size distribution and mixed liquid suspended solids (MLSS) revealed gradual granule disintegration at EG concentrations above 1,200 mg/L. However, they still maintained great treatment performance despite fragmentation. Stable COD and nitrogen removals at a very high C/N ratio (> 60) demonstrate the AGS potential for the treatment of EG-contaminated wastewater, making it a reliable candidate for large-scale applications.

Keywords

Aerobic granular sludge, Carbon-to-nitrogen (C/N) ratio, Resilient microbial communities, Feast/famine conditions, Granule stability, Shock loading

Session 9 - (Special Session) Strengthening Emergency Response Measures for Hazardous and Noxious Substance Spills in Aquatic Ecosystems

/Keynote Speaker/ Dr. James Brydie

Hazardous and Noxious Substances (HNS): Evolving Research Trends, Priorities, and Opportunities

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With the increasing global transportation of chemicals, alternative fuels and plastics, the risk of an accidental release of one or more Hazardous and Noxious Substances (HNS) also increases; typically from ship-sourced spills, road, rail and via pipeline leakage. Unlike conventional oil spills, it is widely recognized that the significant differences in physical and chemical composition of HNS may result in more complex spill scenarios and associated environmental impacts. For example, HNS may float, evaporate, sink, dissolve, or a combination of these, leading to challenges in spill detection, identification, response strategies, environmental impact, and recovery. This presentation will summarize the range of HNS being transported in Canadian and European waters, some of the key challenges faced by spill responders and where scientific research may provide support. Current approaches used to detect and monitor spill behaviour will be discussed along with supporting research and knowledge gaps.

The physical and chemical characterization of HNS needed to better understand their environmental behaviour, along with bench-, pilot-, and field-scale spill simulations, calls for important operational, and health and safety information to be gathered and summarized for spill responders. More broadly, these data also support improved contaminant modelling and simulations, the appropriate choice of sensors for spill surveillance, viable options for post-spill recovery, and regulation and policy development. Research opportunities exist in the areas of spill detection, rapid characterization of complex HNS mixtures, testing and use of various sensors and sensor platforms, and increased application of artificial intelligence to interpret and communicate complex data during a spill incident.

Fate and Biodegradation of Wood Oil in Cold Marine Environments: Mechanistic Insights and Ecotoxicity Evaluation

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The demand for biomass pyrolysis oil (i.e. wood oil) is increasing as a result of global carbon neutrality efforts. Anticipated climate-related increases in northern Atlantic and Arctic shipping activity elevate the risk of wood oil spills in these vulnerable marine ecosystems. After marine oil spill response options like dispersant application, biodegradation is considered to be the ultimate mitigation option. However, the biodegradation behaviour of wood oil in the northern Atlantic Ocean and associated eco-toxicity risks remain poorly understood. In this study, we assessed the biodegradation of fresh, weathered, and chemically dispersed wood oil under simulated northern Atlantic Ocean temperatures (i.e. 4 and 20°C) by comparing it with conventional Alaska North Slope (ANS) crude oil using two types of oil-degrading bacteria (e.g., alkane-degrading Alcanivorax. sp and aromatic-degrading Exiguobacterium. sp.). The removal of representative oil components (e.g. for crude oil: alkane and aromatics; for wood oil: phenol and aldehyde), the formation of suspended oil-mineral aggregates, and biodegradation-induced ecotoxicity were comprehensively explored. In contrast to the degradation of n-alkanes and PAHs present in ANS crude oil, the phenolic and aldehyde constituents dominant in wood oil were highly biodegraded via decarboxylation and ring-opening pathways. Alcanivorax. sp and Exiguobacterium. sp exhibited comparable wood oil degradation pathways. During biodegradation, the microbial assimilation of hydrophobic ANS increased dissolved oil bioavailability, increasing oil concentration in the water phase. For wood oil, large quantity dissolved oil constituents could be easily biodegraded. Biodegradation of wood oil enriched the lignin in suspended aggregates, potentially affecting marine snow formation. Additionally, compared with fresh wood oil, the weathering pretreatment of wood oil enhanced microbial assimilation. Marine algae were subjected to additional toxic substances like alcohols during dispersant addition. The toxicity was elevated under low temperature due to decreased biodegradation rate, posing potential risks to the health of northern Indigenous communities and the fragile Arctic ecosystem. This study provides essential, but previously unreported evidence which improves our understanding of wood oil behaviour in northern Atlantic Ocean environments to support marine biofuel spill response strategies and associated risk management.

Keywords

Biodegradation, Wood oil, Crude oil, Marine environment, Oil-Particle Aggregates, Ecotoxicity

Assessing the Fragmentation Processes of Microplastic Nurdles in Water under UV Irradiation and Simulated Solar Spectrum

Md Hosnay Mobarok[1], Qin Xin[1]

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Microplastic (MP) nurdles, also known as pre-production plastic pellets, are among the most widely transported materials via ocean shipping. Classified as hazardous and noxious substances, they pose risks to both human health and the environment. An estimated 400,000 tonnes of nurdles enter aquatic ecosystems annually, primarily due to accidental spills during transportation. Understanding the degradation processes of spilled MP nurdles under natural weathering conditions is of significant scientific and regulatory interest. In this study, we investigated the weathering of four widely used MP nurdle types - polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyethylene terephthalate (PET) - in both fresh and saline water under UV and simulated solar irradiation for five months. The samples were exposed to light for five days per week, followed by rotary agitation for two days per week. Biweekly water samples were analyzed to assess the size and morphology of released secondary microplastics (sMPs) and nanoplastics (NPs) using scanning electron microscopy (SEM) and dynamic light scattering (DLS). Chemical characterization of sMPs and NPs was conducted via Fourier-transform infrared (FTIR) spectroscopy. This study enhances our understanding of plastic degradation mechanisms and contributes to environmental risk assessment and plastic pollution management.

Keywords

Hazardous and Noxious Substance, Microplastics, Nurdles, Weathering

Biodegradation of Pyrolysis Oils in Canadian Ocean Waters is Driven by Temperature

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Biofuels derived from renewable sources, such as pyrolysis oils, offer a promising alternative to petroleum-based fuels as they are produced from renewable sources (i.e., vegetable oil or animal fat) thus reducing dependence on petroleum oils. While some studies indicate that certain commercially available biofuels can rapidly biodegrade in water, these oils are still classified as Hazardous and Noxious Substances (HNS) due to their potential negative effects on marine life when spilled into the sea. Understanding the various behaviours and bioavailability of HNS in aquatic environments enhances spill response preparedness and helps minimize the environmental impact when spill incidents occur.

This study explores the biodegradation of pyrolysis oils by native microbes in Canadian marine waters, utilizing a comparative approach to assess pyrolysis oil biodegradation through incubation experiments. Unlike the commonly used univariate analyses for microbial and chemical data, this multivariate approach integrates both microbial responses to oils and changes in the organic quality of water. This method allows for assessing how various factors, including temperature, microbial origin, ocean water characteristics, and oil type, influence the biodegradation of these oils.

The objectives were to identify correlations between oil degradation and microbial responses at different time points and uncover patterns of chemical and/or microbial changes in oil-affected water. Advanced statistical tools were used to analyze microbiological and chemical datasets, allowing for comparisons across multiple variables.

Pyrolysis oils (100 µL) from two suppliers, referred to as Bio-oil and Wood oil, were introduced into 200 mL of water collected from three regions of Canada, including the Atlantic, Pacific, and Arctic Oceans. This enabled the assessment and evaluation of the biodegradation capabilities of indigenous microbial communities in water from these various regions. Laboratory-scale experiments were conducted under mixing conditions (200 rpm) at temperatures of 4°C and 15°C for 21 days to assess the influence of temperature (among other factors) on microbial activity in different Canadian marine environments.

Overall biodegradation rates were assessed by comparing the organic carbon content of water at different intervals at three hours post-spill (T3) with the organic content of water on Days 7, 14, and 21. The microbial community's response to these oils at the same sampling points was analyzed using 16S rRNA gene sequencing to identify the specific microbial groups involved in the biodegradation process.

The results showed low biodegradation rates (3% to 20%) of pyrolysis oils at 4°C, while almost complete biodegradation (88% to 97%) was observed at 15°C. Microbial community analysis revealed a significant contribution from members of Proteobacteria in the biodegradation of pyrolysis oils across the East Coast, Pacific Ocean, and Arctic Ocean waters.

Our findings indicate that, of the factors studied, temperature had the greatest influence on oil biodegradation rates, rather than the location of microbial sampling. Furthermore, the activity of specific microbial taxa at low temperatures highlighted the potential role of low-abundant taxa in oil biodegradation in marine environments. This study supports the forecasting of pyrolysis oil loss and biodegradation potential under these specific temperatures and environmental conditions.

Keywords

Hazardous and Noxious Substances, Pyrolysis Oils, Canadian Ocean Waters, Regions, Temperature, Microbial Response

Fate and Ecotoxicity of Bio-Derived Oils after One-week of Weathering in Salt Water: A Mesoscale Study

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The global demand for Hazardous and Noxious Substances (HNS), such as plastics, chemicals, and bio-derived oils, continues to rise, increasing their transport and potential for accidental spills. Advancements in bio-feedstocks and process technologies have led to an increasing variety of commercially transported bio-derived oils, each with distinct properties. However, knowledge gaps remain regarding their environmental fate, behaviour, and ecological impact when accidentally released into aquatic environments.

To support HNS emergency response, remediation and recovery efforts, one-week meso-scale tank tests were conducted to simulate the weathering processes of bio-derived oils in near-shore saltwater environments. This work examines how the chemical and physical properties of three bio-derived oils—canola oil, biodiesel, and wood oil, affect their short-term fate and behaviour in seawater. The results showed that canola oil and biodiesel remained afloat and weathered in a similar way to conventional petroleum diesel. Wood oil, derived from biomass pyrolysis, rapidly dispersed and dissolved under wave action. The high solubility of pyrolysis-derived compounds such as glycolaldehyde, acetic acid, and acetol led to elevated dissolved organic content and significant changes in water chemistry. An analysis of oil mass distribution across environmental compartments (e.g., sediment, water) was conducted. Furthermore, Microtox assays and 10-minute echinoderm (Strongylocentrotus purpuratus) fertilization tests revealed that waters exposed to weathered wood oil and biodiesel remained toxic at the end of the one-week test, posing an ongoing hazard to aquatic ecosystems.

Keywords

bio-derived oil, pyrolysis oil, spill behaviour, meso-scale tests,water; toxicity

Session 10 - Water and Wastewater Treatment (2)

Optimizing Pressure-Retarded Osmosis for Energy Generation Using High-Salinity Mine Water

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The increasing demand for renewable energy sources has led to an upsurge in the exploration of sustainable energy technologies. Pressure-retarded osmosis (PRO) is a membrane-based process that harnesses energy from salinity gradients. In the context of mining operations, mine water presents both an environmental challenge and an opportunity for resource recovery. This study investigates the application of PRO for energy generation using actual gold mine wastewater, with emphasis on pretreatment strategies. Two effluents were used in the system including Effluent 1, water impacted by explosive leaching process, and Effluent 2, originating from a tailings pond. The system utilizes reverse osmosis-treated Effluent 1 as the draw solution, producing high-salinity brine, and pretreated Effluent 2 as the feed solution, with a total dissolved solids concentration of 2000 mg/L and an acidic pH of 3.7. The PRO system was configured as a bench-scale flat-plate unit and tested using commercial membranes. Water characterization revealed that Effluent 1 was dominated by Na^+ (14306 mg/L), K^+ (751 mg/L), Ca^{2+} (1926 mg/L), Mg^{2+} (5336 mg/L), Cl^- (172090 mg/L) NO_3^-(9720 mg/L), and SO_4^2 (6512 mg/L), with high chemical oxygen demand of 8100 mg/L and total organic carbon concentration of 10.2 mg/L, indicating a promising potential for energy recovery but also a significant risk of fouling and scaling. Effluent 2 contained trace metals such as Cu^{2+}, Zn^{2+}, and Fe^{3+}. Multiple pretreatment methods, including ultrafiltration, nanofiltration, and reverse osmosis, were evaluated. pH adjustment was also employed to neutralize the acidic feed solution and enhance membrane compatibility. Experiments conducted at 20°C yielded a power density of 22 W/m² and a water flux of 17 L/m²·h. Reverse solute flux remained below 2 g/m²·h due to the use of membrane-based pretreatments and an optimized draw to feed solution flow ratio of 1.2:1. This study presents a robust PRO framework tailored to mining environments and contributes to the integration of membrane-based resource recovery and renewable energy generation in industrial wastewater management, thereby supporting circular economy practices in the mining sector.

Keywords

Pressure-retarded osmosis (PRO); Mine water; Reverse osmosis brine; Membrane fouling; Power density; Membrane-based pretreatment

Crab shell-based Adsorbent for Phosphorous Removal from Wastewater

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Crab processing by-product, including shells and residual meat, is typically landfilled or disposed of at sea. This not only represents an environmental burden to the ecosystem, but also a financial burden to the processors. The by-product can be processed via hydrothermal carbonization (HTC) to produce a hydrochar and liquid product with potential value-added products. HTC has the advantage of being able to treat a "wet" biomass, eliminating costly drying steps typical of other processes and is relatively fast compared to biological processes. The focus of this work is the hydrochar, investigating its use as biosorbent to remove phosphorous from wastewaters. The hydrochar loading was varied from 5-30 g/L and initial phosphorous concentrations from 0.2-48 mmol/L (20-4600 mg/L phosphate). The crab hydrochar showed excellent removal of phosphate (63% at 4600 ppm and complete removal at lower levels) and a maximum adsorption capacity of 139 mg/g.

Keywords

crab shell, hydrochar, wastewater treatment, phosphorous

Reactivation of Preserved Fungal Biomass: Unlocking Its Potential for Wastewater Treatment Under Low-Temperature Conditions

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Fungi are promising for wastewater treatment because of their robust enzymatic activity and adaptability. Proper preservation and reusability of fungal biomass are crucial for its practical application and commercial potential. Herein, this study examines the reactivation and performance of fungal biomass preserved under three conditions, dried at 21°C, frozen at -15°C, and frozen at -80°C, compared to the non-preserved control. Additionally, its ability to treat synthetic wastewater under lower temperatures (15°C, 10°C, and 6°C) is evaluated.

Four laboratory-scale reactors, operated at a 48-hour hydraulic retention time (HRT), were monitored over 15 days for chemical oxygen demand (COD), ammonium nitrogen (NH_4-N), and nitrate nitrogen (NO_3-N) removal. Biomass concentration, settleability, and oxygen concentration at different depths within fungal granules were also assessed using microsensors.

The results indicated that while the dry-preserved biomass required a brief adaptation period, it ultimately achieved high COD (93.12%) and NH_4--N removal rates (approximately 100%), comparable to the control (93.97% COD and approximately 100% NH_4-N). In contrast, fungi -80°C - preservation initially resulted in lower removal and had challenges in maintaining consistent NH_4-N performance over time. The -15°C-preservation method exhibited generally stable removal rates, particularly for NO_3-N. Fluctuations observed across all reactors suggest potential microbial community shifting, particularly involving denitrifying bacteria, which may have been influenced differently by each preservation condition. DNA analysis will be conducted to further investigate the microbial community composition within the fungal reactors to confirm the presence of nitrogen cycle-related microbes and their potential role in nitrogen removal.

Ongoing experiments are assessing the enzymatic activity and pollutant removal efficiency of preserved fungal biomass under low temperatures. These findings offer insights into the feasibility of fungal-based wastewater treatment in cold environments.

Keywords

Reusability, Preserved Fungal Biomass, Wastewater Treatment, Low-Temperature Treatment, Preservation Methods, COD Removal, NO_3-N Removal, NH_4-N Removal, Settleability, Oxygen Distribution, Microsensor Measurements

A Comprehensive Review of Switchable Biomaterials for Wastewater Treatment: Innovations and Progress

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The advancement of switchable biomaterials presents new opportunities for sustainable wastewater treatment by enhancing pollutant removal efficiency and material reusability. This review highlights the key properties and constraints of various stimuli-responsive biomaterials, including chitosan, polylactic acid (PLA), cellulose, biochar, rubber, resin, and natural fibers, focusing on their adsorption capacities, structural integrity, and practical feasibility. Widely utilized in dye separation and oil-water purification, cellulose-based materials exhibit adsorption capacities between 10 and 52 g/g, but it is necessary to improve mechanical strength for long-term performance. Heteroatom-enriched biochar, with its high porosity and surface areas surpassing 500 m2/g, achieves over 90% heavy metal removal, although variability in raw material sources affects consistency. Surface-modified rubber, resin, and fiber materials perform well in oil-water separation (>90%) due to their tunable wettability and self-cleaning capabilities. While low-energy regeneration strategies, such as CO2 bubbling and pH-mediated desorption, have enhanced reusability, further refinement of synthesis approaches remains crucial to achieve industrial scalability. Future developments should focus on hybrid material innovations, energy-efficient manufacturing, and integration into existing treatment facilities to enhance both environmental sustainability and operational efficiency.

Keywords

Switchable biomaterials, stimulus-responsive properties, material recycling, wastewater treatment

Chemical Inhibition of Methane Emissions from Oil Sands Tailings Ponds

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The Alberta oil sands represent the third largest proven reserve of crude oil in the world. One method of producing this oil is by mining, which produces tailings ponds holding water, fine minerals, bitumen and residual solvents. Naturally existing bacteria consume organic compounds in the tailings ponds resulting in the emission of greenhouse gas (GHG) such as CO2 and CH4. It is estimated that CH4 emissions from tailings ponds accounted for 45% of the total CH4 emissions from oil sands facilities. Given that CH4 is about 25 to 30 times more potent as a greenhouse gas than CO2, reducing CH4 emission from tailings ponds would have a rapid and significant effect on atmospheric warming potential from a mining operation.

In this study, laboratory scale bottle tests simulating oil sands tailing pond environments were set up and methane production from these bottle tests was monitored. Selected cost-effective chemical treatments were applied to the bottle tests to inhibit methane production. Over 1-year period, methane concentrations were dramatically reduced only after 1 chemical application. We found that under different amendment regimens, methanogenic populations can be suppressed, demonstrating that functionally similar disturbances in natural systems may result in distinct responses of the microbial populations involved. The inter-relationships among different parameters, such as methane, soluble organics in water, residual bitumen content in tailings, and microbial community, were investigated before and after the methanogenesis inhibition treatments. It is hoped that these cost-effective chemical treatments can be applied at a larger scale in the oil sands industry in the near future.

Keywords

GHG, Oil Sands Tailings Ponds, Methanogenesis, Chemical Treatment

Natural Flocculant-Enhanced Electrocoagulation for Efficient Pretreatment in Brackish Water Membrane Desalination

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Electrocoagulation (EC) is an electrochemical water treatment technology that electrically generates coagulants through released cations (Al3+, Fe 2+ or Fe3+) from sacrificial electrodes, without chemical additives. Thus, it has been considered as a promising, environmentally friendly pretreatment technique to remove the hardness and natural organic matter (NOM) in brackish water. However, EC alone often produces fine colloidal particles that may not settle efficiently, typically necessitating post-treatment such as membrane filtration, which increases both economic and energy costs for water treatment.

To address this limitation, in this study, Opuntia ficus-indica (prickly pear cactus) juice was investigated as a natural flocculant to enhance solid-liquid separation. Rich in mucilage, a biopolymer with negative charge due to the carboxyl group -COOH and long chains, cactus presents strong coagulation and adsorption properties, promoting ion adsorption and colloid aggregation, improving sedimentation and filtration efficiency. The results show that with aluminium electrode under a current of 1.75 A for 25 minutes (electrode distance, 2cm), adding 3 ppm cactus leads to ~95% turbidity reduction, significantly enhances the solid-liquid separation. The NOM and hardness removal is ~80% and 66% respectively, comparable to the EC followed with a filtration treatment (filter size: 0.45 µm).

The XPS and SEM were used to characterize the element composition and morphology of the sludge, and the result reveals the coexistence of precipitated hardness ions (i.e., Mg and Ca) with the sacrificial electrode (Al). We also evaluated the surface charge and the size of the flocculant, confirming that a small quantity (3 ppm) of cactus does not significantly impact the charge of the colloid (2.8±7.8 mV to 0.6±2.1 mV), while it significantly enhances the particle size (3.0±0.2 µm to 27.4±9.2 µm), enhancing the liquid-sludge separation. Additionally, barely Al^{3+} is detected in the treated water with the atomic absorption spectroscopy (AAS), ensuring that this method compliances with regulatory standards. By integrating Opuntia ficus-indica as a sustainable coagulant aid, this study shows that adding natural flocculant can replace the post-treatment (i.e., filtration) in EC-based water treatment, reducing energy consumption. This approach offers an effective, environmentally friendly, and cost-effective alternative for brackish water treatment.

Keywords

electrocoagulation, natural flocculant, brackish water, pre-treatment, reduce membrane fouling,

Session 11 - Oil Spill Response

/Keynote Speaker/ Dr. Kenneth Lee

Canada's Multi-Partner Research Initiative (MPRI): Advancing the Development and Application of Oil Spill Mitigation Technologies

Kenneth Lee[1]

[1]Kenneth Lee Research Inc.

While there is an international shift towards the development of clean renewable energy; the production of petroleum hydrocarbons within Canada will remain a key industry for decades to come due to socio-economic factors and global energy demand. To minimize the environmental consequences of oil spills in the aquatic environment, MPRI under Canada's Oceans Protection Plan (OPP) has funded a national/international collaborative research effort to:

1) Develop new oil spill response strategies, and

2) Enhance the level of science-based decision-making in oil spill preparedness and response operations.

This presentation will provide insights on the selection of research priorities by various agencies and an overview of ongoing research in the following subject areas:

· Fate, behaviour, and transport of oil (e.g., understanding natural attenuation, oil droplet formation, oil-particle aggregate formation, and oil emulsification to improve our capability to predict oil fate, transport, and behaviour)

· Development of alternative response measures (e.g., next-generation spill treating agents including shoreline washing agents, dispersants, and additives to enhance in-situ burning)

· Advances in oil detection and monitoring (e.g., development of oil sensors and unmanned surface/subsurface vehicles for oil spill response monitoring)

· Biological effects of oil (e.g., understanding long-term ecological effects at the population and community levels, development of predictive models to support oil spill preparedness, response operations and damage assessments)

· Enhanced methods to recover oil (e.g., advances in booms and skimmers, oil adsorbant/absorbant and oil decanting technologies) `

Application of science deliverables to support planning and decision-making (e.g., development of decision support tools to provide science-based information on the feasibility and viability of shoreline oil spill countermeasures)

Development and Evaluation of Bio-Based Dispersants for Oil Spill Response Across Different Salinity Conditions

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Oil spills pose significant environmental challenges due to their long-lasting impact on ecosystems, necessitating continuous improvements in spill response methods. Chemical dispersants are widely used to break down oil slicks by reducing interfacial tension and enhancing biodegradation. However, most commercial formulations are optimized for oceanic salinity levels, leading to reduced effectiveness in lower-salinity environments such as estuaries. As a more sustainable alternative, bio-based dispersants, particularly those incorporating biosurfactants, have attracted increasing attention with a high potential in low salinity levels. Yet, limited research has investigated their optimal formulation, underlying interaction mechanisms, and performance across diverse environmental conditions. This study aims to address these gaps by developing next-generation dispersants through the integration of biosurfactants (i.e., rhamnolipid and surfactin) with a chemical surfactant (i.e., polyoxyethylene sorbitan monooleate, polyoxyethylenesorbitan trioleate, sorbitan monooleate, sorbitan monolaurate, or dioctyl sulfosuccinate sodium), and evaluating their performance under varying salinity levels, mixing energies, and temperatures. The results demonstrated that bio-based dispersants adapted well to diverse environmental conditions, addressing challenges in dynamic aquatic ecosystems. Comparative assessment with commercial dispersants, including Corexit 9500A, and toxicity evaluation using algae highlighted their environmental compatibility. Molecular dynamics simulation provided mechanistic insights into the interactions between dispersant components and revealed how salinity influences dispersant efficiency by altering van der Waals and electrostatic interactions at the oil/water interface. These findings enhance the understanding of bio-based dispersants and support the development of environmentally friendly and effective oil spill mitigation strategies for sensitive aquatic environments.

Keywords

Dispersant, biosurfactant, chemical surfactant, estuarine environments, molecular dynamics simulation.

Pilot-scale Test of a Foam-Based Filtration System for Treatment of Decanted Water in Oil Spill Responses

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The long-term ecological impacts of an oil spill are closely dependent on the time oil remains at the spill site prior to removal. Mechanical skimming is the primary method used for recovering emulsified oil in marine spill settings, however the concentration of oil in the collected mixture can be as low as 20%. This results in inefficient usage of the onboard storage capacity of the response vessels, requiring more frequent trips to discharge the tanks at shore. While releasing this decanted water back to the spill site would improve overall oil recovery time, the concentration of emulsified oil within the water typically exceeds the 15ppm threshold specified in the MARPOL ANNEX 1 standard for safe release.

This work focuses on the development of a foam-based oil filtration system capable of removing emulsified oil droplets from decanted water prior to release back into the marine environment. A pilot-scale system was designed and constructed to a 1:10 scale of the storage capacity required for a large-scale oil spill response. This system consists of a network of 6 pressure vessels, each containing a custom-designed 50L polyurethane foam filter cartridge. The pressure vessels were designed to facilitate rapid cartridge replacement, utilizing camlock fittings and tri-clamp seals. The filter cartridges were configured in a radial configuration with an inside-out flow direction to ensure collected oil is deposited on the cartridge interior for clean and efficient replacement. The modular system design enables scalability to a multi-stage unit adaptable to the requirements of Tier-2 and Tier-3 oil spill response vessels.

The filtration unit was tested at the OHMSETT research facility in New Jersey, with both medium-crude oil (HOOPS) and diesel-based emulsions. In each test, oil was spilled into a wave tank and collected using disk skimmers. The collected mixture was allowed to gravity-separate for 30 minutes to generate decanted water representative of real-world spill conditions. The resulting influent was pumped through the system at flow rates of up to 5m3/h with initial influent concentrations of 200-352ppm. The results showed maximum outlet concentrations of up to 3.0ppm and 5.7ppm for HOOPS and diesel respectively, corresponding to removal efficiencies of >98%. With 1/3 of the cartridges in use, the system produced effluent below the target concentration threshold continuously over a 3-hour test until the supply of influent was depleted. The pressure drop across the system remained below 25 PSI at the maximum tested flow rate, indicating that the cartridges could be sized to meet the flow rates required for a full-scale system.

These results demonstrate the capability of this system for filtering decanted water at removal efficiencies sufficient to meet MARPOL standards for safe release. The low-pressure drop across the filtration media at high flow rates indicates that this system could be feasibly scaled to meet the throughput demands of a large-scale oil spill response.

Keywords

oil spill; decanted water; oil filtration; polyurethane foam; environmental remediation

Onboard Decanted Water Treatment in Oil Spill Response Using Polyurethane Foam as Filtration Media

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Oil spills pose a major environmental threat, releasing hydrocarbons into marine ecosystems and causing prolonged toxicity. One of the primary response methods is mechanical recovery using skimmers, which collect an oil-water mixture from the surface. This mixture, typically containing 20-80% water, is then pumped into temporary storage tanks on response vessels, where gravity separation occurs. After 30-60 minutes of settling, the water portion is decanted from the bottom. While discharging this decanted water would free up tank space for further recovery, it often contains an oil concentration that exceeds the international discharge standard set by MARPOL (<15 ppm). In Canada, the rule is even stricter—no contaminated water discharge is allowed. As a result, decanted water must be transported back to shore for treatment. This creates a major bottleneck: when storage tanks fill up, recovery operations have to pause, resulting in oil spreading further and inducing toxicity to water.

To solve this issue, we developed engineered polyester and polyether foams as onboard filtration media for decanted water treatment. Lab tests were first conducted to optimize foam formulations. A custom azelate polyester polyol foam emerged as the top performer, removing 99% of the oil. A polyether foam, slightly less effective at 95% removal, was also included for its ease of manufacturing. Following lab-scale verification, field tests were conducted at the Ohmsett Oil Spill Response Research facility, the North America's largest wave tank. Both foams were housed in custom cartridge filters (60 L of foam each) and integrated into a 1/10 scaled onboard filtration system. To simulate real spill conditions, a drum skimmer collected an oil-water mixture, which was stored, decanted for 30 minutes, and processed through the foam filtration system at 5 m^3/hr. Both foams achieved over 98.5% oil removal, reducing influent concentrations from over 200 ppm to final effluent levels of 2.3 ppm (polyester) and 3 ppm (polyether). The polyester foam further reduced marine diesel-contaminated water from 352 ppm to 5.7 ppm.

All treated effluent met international discharge standards (<15 ppm). Beyond efficiency, the foams proved highly practical for real-world use. They absorbed 1.5-2 g of oil per gram of foam, ensuring long-lasting performance. With just two cartridges (120 L of foam) running at one-third capacity, about 5 m^3 of decanted water was treated in three hours without saturation. At full scale, the system could operate continuously for an entire responder shift before needing a cartridge replacement, making it highly efficient and field-ready. Overall, these findings demonstrate that engineered polyester and polyether foams offer a scalable, easy-to-use solution for onboard decanted water treatment, ensuring MARPOL compliance. Future research will focus on refining full-scale implementation and evaluating long-term durability in diverse spill scenarios.

Keywords

Oil spill response, Decanted water treatment, Wastewater treatment, Filtration, Adsorbent, Polyurethane foam

Advancing Porous Materials with High Efficiency and Reusability Towards Practical Decanted Water Treatment

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This study explores developing and applying advanced porous materials, specifically Polyurethane Foam (PUF) and Hyper-Crosslinked Polymer (HCP), for efficient and reusable oil/water separation. The research focuses on integrating HCP into PUF to enhance oil adsorption capacity and mechanical robustness. Experimental results demonstrate that HCP-incorporated PUF exhibits superior oil-water separation efficiency, particularly at lower oil concentrations.

Adsorption isotherms and kinetics were modelled, revealing that HCP foam achieves higher adsorption capacities and efficiencies. Optimisation studies suggest that a two-stage adsorption unit significantly improves oil removal efficiency, achieving up to 99% oil removal. The findings highlight the potential of these materials for practical applications in decanted water treatment, addressing challenges such as decanting separated water directly to the ocean or rivers.

Keywords

Porous material, HCP, PU, oil water seperation

Session 12 - (Special Session) Future-ready Biological Water Resource Recovery Technologies in the Context of Climate Change

/Keynote Speaker/ Dr. Martha Dagnew

Strategies to Achieve Dynamic Resilience in Wastewater Treatment

Martha Dagnew[1]

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Wastewater treatment plants (WWTPs) have been integral to protecting source waters by intercepting contaminants such as nitrogen, phosphorus, pathogens, and organic carbon. Over the past 150 years, WWTP development has significantly improved public health, reduced mortality, and minimized environmental pollution. However, these systems now face multiple challenges, including urbanization, population growth, aging infrastructure, and increasingly stringent regulations. New stressors, such as climate change, amplify existing challenges by introducing extreme weather events like heavy rainfall, storms, droughts, and extreme temperatures. These conditions increase wastewater flow variability, alter composition and constituent fractions, shift operating conditions (e.g., temperature), lead to more unauthorized discharges, and cause frequent power and equipment failures. Such dynamic stressors threaten the stability and performance of wastewater systems; however, their full extent and impact remain unclear. Historically, biological WW treatment processes were designed to handle average loads, which has left them unprepared for these dynamic stressors. In cases of extreme events, many plants fail or resort to bypassing biological treatment and discharging untreated or partially treated wastewater into nearby water bodies to prevent biomass washout, leading to significant environmental and public health risks. For instance, in 2023, over 5.4 billion litres of partially treated sewage were bypassed into Ontario waterways from Toronto WWTPs following storm events. Similar contamination events have been reported globally, resulting from dynamic stressors, emphasizing the urgent need for resilient wastewater systems. This presentation will discuss existing WWTP strategies to handle extreme weather events.

Harnessing the Power of Machine Learning for Water and Wastewater Treatment Modeling

Zoe Li[1]

[1]McMaster University

This talk will provide an overview of past and ongoing research conducted by Dr. Zoe Li's research group in water and wastewater treatment modeling. Dr. Li's research focuses on environmental risk analysis and management, where she introduces new uncertainty quantification methods for water and environmental modeling and develops robust optimization tools to support risk analysis and management. With a focus on the integration of machine learning techniques in solving water and wastewater challenges, Dr. Li will present several applications in wastewater influent forecasting and membrane fouling prediction.

Coupling Bioengineering with Water Valorization: Towards Creating Closed-loop Water Systems

Guneet Kaur[1]

[1]University of Guelph

Water and wastewater streams emerging from rural and urban activities such as agriculture and dairy farm operations, food processing industries, household consumption etc. are nutrient rich and can be valorized to high-value bioproducts and bioenergy. Recovery of nutrients from water and wastewater streams from and their use as feedstock in bioengineered processes not only provides a route to treat these wastewater streams but also generate value. Additionally, the replacement of cost-intensive pure nutrients by such wastewater-derived feedstock could improve the economic feasibility of bioprocesses. Using examples from microbial fermentation and anaerobic digestion, this talk will illustrate the role of effective water resource valorization for environmental sustainability and mitigation of climate change. The challenges in water resource recovery and process optimization from feedstock composition, strain selection and development, process design, to economic and environmental sustainability assessment will be discussed. Overall, this talk will present bioprocess design solutions that could contribute towards the (i) development of cost-competitive, wastewater biorefinery-based production processes, and (ii) creation of a value chain based on efficient management system for water by-product or residual streams, thereby increasing the efficiency and sustainability of biomanufacturing.

Keywords

Bioengineered systems, Microbial cell factories, Agri-processing water, Digestate, Rhamnolipid biosurfactants, Life Cycle Assessment

Reimagining Biosolids Management Through the Lens of the Circular Economy

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[1]University of Regina

Wastewater treatment plants (WWTPs) produce significant amounts of sludge as a byproduct during treatment. This sludge management creates not only logistical hurdles but also a considerable financial challenge, with handling and disposal costs making up about 40 - 60% of total operating expenses at WWTPs. When properly treated, this sludge is converted into biosolids, often used in agriculture as fertilizers because of their rich nutrient content. Nonetheless, emerging pollutants, particularly per- and polyfluoroalkyl substances (PFAS) and microplastics, in biosolids have triggered environmental and health apprehensions. PFAS, known as "forever chemicals," remain in the environment and can accumulate in soil and water, potentially entering the food chain. Likewise, microplastics can harm soil ecosystems and threaten plant and animal life. These issues demand a reassessment of existing biosolids management practices. Adopting a circular economy approach offers a method to convert biosolids from waste into a valuable resource while mitigating risks. Innovative treatment technologies like pyrolysis and advanced thermal processing can minimize or eliminate contaminants, transforming biosolids into biochar or other safe, reusable materials. Furthermore, enforcing stringent monitoring and regulatory measures can assure the safe use of biosolids in agriculture. This presentation will examine the economic and environmental issues surrounding biosolids management, underscore the risks from contaminants such as PFAS and microplastics, and investigate sustainable, circular strategies for converting biosolids into safe, valuable resources.

Wastewater Biorefinery: Transitioning Wastewater Treatment Plants to Water Resource Recovery Facilities

Oliver Iorhemen[1]

[1]University of Northern British Columbia

With the emergence of the wastewater biorefinery concept, wastewater treatment plants are now viewed and envisioned as water resource recovery facilities inserted into circular cities to achieve sustainability. The aerobic granular sludge (AGS) biotechnology has particularly gained increased interest in this regard due to its compact nature, reduced energy consumption, enhanced settleability, low sludge yield, enhanced treatment performance, and potential for resource recovery. Research is already at an advanced stage on the recovery of phosphorus, alginate-like exopolysaccharides, and polyhydroxyalkanoates from AGS wastewater treatment systems. Exploring the possibility of more biopolymer recovery from AGS systems, this talk will provide an overview of past and ongoing research conducted by Dr. Iorhemen's research group at the University of Northern British Columbia on the recovery of two versatile biopolymers - xanthan and curdlan - from waste aerobic granules. The focus will be on successful AGS bioreactor operation for granule stability and high pollutant removal, factors affecting the biosynthesis of curdlan and xanthan in the aerobic granule matrix, and recovery protocols for these biopolymers from waste aerobic granules.

Keywords

Aerobic granular sludge, Curdlan, Xanthan, Wastewater biorefinery, Wastewater treatment plant, Water resource recovery facilities

Decoding Granule Dynamics: Does Granule Size Hold The Key for Low-Strength Municipal Wastewater Treatment?

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Municipal wastewater treatment plants (WWTPs) face increasing pressure to deliver high-quality effluent while minimizing energy use and footprint. A promising solution lies in aerobic granular sludge (AGS) - compact, biofilm-structured aggregates whose formation dynamics are influenced heavily by granule size. AGS systems, characterized by dense microbial biofilm granules, offer enhanced settling, biomass retention, and nutrient removal in compact reactors. Dr. Hamza and group investigate whether granule size could be the pivotal parameter in optimizing AGS treatment for low-strength municipal wastewater. The talk explores whether tuning granule size can unlock optimized treatment performance for low-strength municipal wastewater. Drawing on recent experimental findings in Dr. Rania Hamza's lab, it has been demonstrated that medium-sized granules (100-500 μm) offer a critical balance: dense enough for effective substrate diffusion and microbial stratification, but small enough to avoid diffusion limitations that hinder interior activity. Dr. Hamza's ongoing projects, including work on side-stream treatment and PFAS exposure, further show that controlled granule cultivation can balance removal efficiencies with energy and resource recovery goals relevant to low pollutant loading contexts. This talk will highlight how granule size metrics can inform reactor control strategies, cycle design, and scale-up decisions that move AGS from niche applications towards mainstream municipal wastewater treatment.

Keywords

Aerobic granular sludge, Extracellular polymeric substances (EPS), Granule size, Low-strength wastewater, Mass transfer, Wastewater treatment plant

Session 13 - (Special Session) Plastics in the Environment: Sources, Transport, Fate, and Effects

/Keynote Speaker/ Dr. Uta Passow

The Formation of Marine Oil Snow and the Consequences for Marine Ecosystems

Uta Passow[1]

[1]Memorial University

The Deepwater Horizon oil spill in the Gulf of Mexico (GoM) in 2010, triggered a ten-year intense research effort with the goal "to improve societies ability to understand, respond to and mitigate the impacts of petroleum pollution". The ongoing Canadian Multi-Partner Research Initiative builds on this acquired expertise "to advance science-based decision making in oil spill response operations by improving our knowledge of oil spill response and remediation strategies". One of the key insights gained was that even oils less dense than seawater may sink to the deep ocean in association with marine snow. Finding a significant amount of the spilled oil at the deep ocean floor was unexpected and changed oil spill response planning. Transport of oil to the deep ocean has multiple consequences for deep ecosystems and the respective organisms. In the GoM for example, deep sea corals were heavily impacted by the deposition or marine oil snow.

Microplastic and Oil Interactions: What We Know and What Remains Unknown

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Over 700 million liters of oil enter oceans annually through spills during oil extraction, transportation, and consumption, posing threats to marine ecosystems, including the deaths of sea turtles and dolphins. Chemical dispersants are commonly used to treat oil spills by breaking oil into droplets for biodegradation. Their efficiency is influenced by factors like seawater salinity and suspended particles. Microplastics (MPs), resulting from continuous plastic waste dumping, are a growing concern, with an estimated 24.4 trillion particles in the upper oceans. Their increasing presence in oil-polluted oceans introduces uncertainty regarding dispersant efficiency, as they may reduce dispersant performance and exacerbate ecological risks. Despite the significance of this issue, the interactions among MPs, oil, and dispersants have been largely overlooked. Our team has conducted comprehensive investigations into these interactions and identified a novel agglomerate: MP-oil-dispersant agglomerates (MODAs). These agglomerates are distinct from traditional oil-natural particle aggregates in both properties and behavior and may have more profound impacts on marine ecosystems. We found that MPs reduce dispersant effectiveness by forming MODAs, highlighting MP impacts on oil spill treatments. To better understand MODAs, we established a comprehensive framework on their formation, transport, and fate in marine environments. An AI-aided model was combined with a traditional model to predict MODA downward transport. While progress has been made, some critical questions remain: What are the ecological impacts of MODAs? How widespread and persistent are they? And how urgently should they be integrated into oil spill response strategies? These knowledge gaps will be discussed in this study, aiming to bridge current understanding and future research needs in MP and oil interactions.

Keywords

Microplastic, Oil spill, Transport and fate, Agglomerate, Marine environment

The Impact of Plastic Pollution on the Functioning of the Biological Carbon Pump

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Plastic pollution is ubiquitous in the environment, and has infiltrated marine ecosystems. Plastic particles < 5 mm in diameter are referred to as microplastics, and interact with marine biota and the marine carbon cycle. Specifically, microplastics have the potential to become incorporated into marine aggregates, alter their properties, and consequently impact the functioning of the biological carbon pump. The biological carbon pump is an important component of the global carbon cycle, and plays a role in regulating the Earth's climate. While interactions between microplastics and the carbon pump have been hypothesized, evidence is lacking. To fill this major knowledge gap, we will conduct laboratory experiments using roller tanks that simulate the formation of marine aggregates in cold ocean environments and the incorporation of microplastics into these aggregates. We hypothesize that the incorporation of 300-500 μm polyethylene and polyvinyl chloride fragments will significantly alter the size, number, and settling velocity of aggregates, as well as the particulate organic carbon content of aggregates formed from the marine diatom, Thalassiosira gravida. Two treatments will include diatom culture with the respective microplastic polymers, and a treatment with only diatom culture and no microplastics added will act as a control. Tanks will be rolled for 24-48 hours until aggregates form. Upon collection of all aggregates, we will measure their lengths and widths using ImageJ software, calculate their settling velocities, and determine their particulate organic carbon content using an elemental analyzer. We will test for significant differences between the control and the microplastic treatments using a one-way ANOVA test and then potentially follow up with a post-hoc Tukey HSD test.

Keywords

Microplastics, Plastic pollution, Biological carbon pump, Marine carbon cycle, Phytoplankton, Climate change

Raman-based Detection of Microplastics: the need for more accessible and reproducible protocols

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Microplastics present a threat to environmental health, which includes human health and health of other organisms. Detection _and identification_ of microplastics is key for both remediation and prevention. The more detailed the identification, the more likely one can find the source.

There are a number of groups working on microplastics detection, with a growing number focused on Raman-based detection. Two challenges faced by many are having a robust and accessible protocol for non-specialists, and having a consistent means to analyze data to allow for comparisons between labs. In partnership with collaborators who do field work with microplastics and who have focused on more traditional analysis such as manual counting and categorization by shape and colour, we are analyzing their samples in parallel using Raman microscopy. In this way we are developing more consistent and transferrable metrics as well as testing Raman-based protocols with non-specialists.

In this presentation we will share our progress in identifying the impacts of sample processing on microplastics identification and characterization. We will also present our lastest methodology to work with less-processed field samples.

Keywords

Microplastics, Raman, Microscopy

Why Biofouling Cannot Contribute to the Vertical Transport of Small Microplastic

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To explain the presence of buoyant microplastics like polyethylene and polypropylene in the deep-sea, the vertical transport by biofouling is one of the most referred mechanisms. Biofouling is thought to increase the density of microplastic particles to the point that they sink, but this has mostly been shown on microplastic particles of 1 mm or larger. Most microplastics in the ocean are smaller than 100 µm due to continuous fragmentation and microplastic particle abundance increases drastically with decreasing size. For a small buoyant microplastic particle to reach the deep-sea in a reasonable time, its excess density, the density difference between the particle and surrounding water, has to increase to the point that it can sink at around 10 m per day or faster. The composition of the biofilm and therefore its density as well as the thickness of the biofilm are important factors to gain the needed excess density. However, a biofilm matrix of only extracellular polymeric substances and bacteria has a lower density than seawater, in contrast to a biofilm including diatoms or large organisms like mussels or barnacles. And most marine biofilms seem to have a thickness of <15 µm on large surfaces. We argue that a small microplastic particle cannot host a biofilm community heavy and thick enough to induce an excess density large enough to enable rapid sinking or even sinking at all. Therefore, biofouling cannot be an efficient vertical transport mechanism for small microplastic.

Keywords

Microplastic, Biofouling, Biofilm, Density change, Sinking velocity, Vertical transport

Session 14 - Water and Wastewater Treatment (3)

Nanobubble-inspired Emerging Technologies and Emerging Contaminant Removal for Sustainable Environmental Remediation

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Environmental remediation entails developing innovative materials and advanced technologies to remove persistent pollutants and restore contaminated environments. Two key challenges in this field are the development of novel materials and the effective removal of stubborn contaminants such as per- and polyfluoroalkyl substances (PFAS). Our research tackles both by pursuing sustainable strategies for modifying activated carbon (AC) for onsite remediation and exploring alternative methods for PFAS removal evaluating.

For materials advancement, we employ ozone nanobubble cavitation to enhance AC performance. The process involves exposing AC to controlled interactions with ozone nanobubbles under optimized conditions, followed by a post-treatment stabilization step. The unique attributes of nanobubbles—prolonged reactivity and high mass transfer—enable precise microstructural modifications, while ozone oxidation introduces functional groups that synergistically boost both adsorption kinetics and capacity.

In parallel, for alternative methods for PFAS removal evaluation, we are investigating the use of naturally abundant materials as affordable, sustainable options for PFAS removal. Specifically, we utilize synthetic dyes as proxy contaminants to model PFAS adsorption and desorption behavior, thereby reducing reliance on direct handling of hazardous PFAS. Given that PFAS measurements via liquid chromatography-tandem mass spectrometry (LC-MS/MS) are costly and resource-intensive, the use of dye analogs—analyzed rapidly through spectrophotometric techniques—offers a scalable and cost-effective alternative for real-time monitoring and enhanced adsorption assessments.

This eco-friendly, streamlined approach represents a significant advancement over traditional AC modification methods. By rapidly assessing PFAS sorption behavior without direct exposure to toxic chemicals, our method enhances environmental safety and operational efficiency. As global efforts to address chemical contamination and build climate resilience intensify, innovative solutions like ours are vital for protecting soil and groudwater resources and safeguarding public health for future generations.

Keywords

PFAS, Activated Carbon, Nanobubble Cavitation, Dye Surrogates, Environmental Remediation

Microfluidic Confinement Technology for Enhanced Tetracycline Degradation

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Water pollution remains a critical environmental challenge, with recalcitrant organic contaminants such as antibiotics posing significant threats to ecosystems and public health. Tetracycline (TC), a widely used antibiotic, exhibits high environmental persistence due to its complex chemical structure, limiting the efficiency of conventional treatment methods such as adsorption and biodegradation. Even at trace concentrations, TC residues can contribute to the spread of antibiotic resistance, exacerbating environmental and health risks.

Advanced Oxidation Processes (AOPs), particularly photocatalytic systems (e.g., TiO_2/UV), have emerged as promising solutions for the degradation of persistent contaminants. However, conventional photocatalytic systems face challenges such as mass transfer limitations, radical diffusion losses, and inefficient light utilization, which hinder their practical applications. To address these challenges, confined photocatalytic systems have been developed to enhance the reactivity of oxidation systems by restricting the reaction space. Current confinement strategies include nanomaterial confinement, microdroplet confinement, membrane-based confinement, and microfluidic confinement. Among these, microfluidic reactor confinement has demonstrated significant advantages in practical engineering applications due to its continuous flow processing capability, precise control over the microfluidic environment, and potential scalability.

This study applied microfluidic confinement technology to the efficient degradation of tetracycline (TC). Comparative experiments and theoretical calculations demonstrated that the degradation rate constant of TC in the confined system was 25 times higher than that in the non-confined system, with a mineralization rate 30 times greater. These findings highlighted the potential of microfluidic photocatalytic systems for high-efficiency and scalable water treatment applications, providing new insights into optimizing confined advanced oxidation processes (AOPs) for practical implementation.

Keywords

Nanoconfinement, Advanced Oxidation Processes, Microreactor, Water Treatment

The Recovery of Xanthan from Aerobic Granular Sludge Wastewater Treatment Systems

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The aerobic granular sludge (AGS) biotechnology presents a promising avenue for recovering high-value products, including phosphorus, alginate-like exopolysaccharides, polyhydroxyalkanoates, and tryptophan. Xanthan, a versatile biopolymer with applications in various industries has been identified within the aerobic granule matrix. Given the high production costs and specialized laboratory requirements for conventional xanthan synthesis, the biosynthesis of xanthan in AGS-based wastewater treatment systems offers an economically viable and sustainable alternative. This study aimed to optimize key operational parameters—organic loading rate (OLR), chemical oxygen demand to nitrogen (COD/N) ratio, and feeding strategy—to enhance xanthan production within AGS bioreactors while maintaining wastewater treatment efficiency. The impact of these parameters on xanthan biosynthesis, substrate utilization, and granule stability was systematically evaluated through nine experimental runs, designed using the Taguchi fractional factorial design.

The results revealed that xanthan production was significantly influenced by OLR and COD/N ratio, while the feeding strategy had a negligible effect. A low COD/N ratio of 10 combined with a high OLR (≥2.0 kg COD/) yielded the highest xanthan production, peaking at approximately 45 mg xanthan/g biomass. Conversely, conditions with low OLR (0.8 kg COD/) and high COD/N ratios (≥30) severely hindered xanthan synthesis due to nutrient imbalances and substrate limitations. The dominance of OLR as the most influential factor was statistically confirmed through regression analysis, which demonstrated a strong model fit (F-value = 35.09, P-value = 0.001), underscoring the robustness of the findings. The study's insights contribute to the optimization of AGS-based wastewater treatment systems for efficient xanthan recovery, aligning with circular economy principles by transforming waste streams into high-value bioproducts. This research paves the way for further exploration into large-scale applications of AGS technology for biopolymer synthesis, offering an environmentally and economically sustainable alternative for xanthan production.

Keywords

Aerobic Granular Sludge, Biological Wastewater Treatment, Optimization, Xanthan, Wastewater Biorefinery

Retrofitting a CAS to an MBR in Municipal WWTPs to Address Water Reuse, Resource Recovery and Climate-change Induced Shock-loads: A Simulation-based Resilience & Sustainability Assessment Using Actual Plant Data

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The conventional activated sludge (CAS) system is the most common biological treatment method in municipal wastewater treatment plants (WWTPs) across Canada. Recent extreme weather events — including floods, heavy rains, and significant snowfalls — have led to extreme fluctuations (both overloading and starvation shocks) of hydraulic, organic, pathogen, particulate, and inorganic loadings in these plants. Records from the City of London, Ontario, reveal that the city has struggled with these stressors and resulting shock loads, necessitating bypass operations (350,973 m³ in 2024 and 802,052 m³ in 2023) to meet effluent and emission standards. In contrast, the Oxford PCP, the city's sole Membrane Bioreactor (MBR) plant retrofitted in 2008, tripling the treatment capacity on half the footprint, has avoided bypasses almost entirely over the past decade, demonstrating its excellent resilience. Meanwhile, Greenway PCP, the largest plant in the city, faced the highest volumes of bypasses, totaling 113,477 m³ in 2024 and 478,939 m³ in 2023. This study utilizes the SUMO-4N simulation model to analyze how influent characteristics, process parameters, and system configurations affect the resilience of CAS vs. MBR, as well as to assess the pros and cons of each system, including a cost-benefit analysis of retrofitting CAS to MBR. The MBR system enables water reuse, a crucial advantage during the climate crisis, while demonstrating greater resilience to transient stresses from influents during extreme events, despite concerns about greenhouse gas (GHG) emissions. Our simulation results indicate that retrofitting CAS to MBR systems - both with chemical phosphorus removal using $FeCl_3$ - results in a 17% increase in CO_2 emissions, while N_2O emissions decrease by 36%. Incorporating Enhanced Biological Phosphorus Removal (EBPR) into the MBR system not only offers material savings but also reduces greenhouse gases. The contact pre-anoxic configuration outperforms the underflow pre-anoxic configuration, achieving 11% CO_2 and 36% N_2O reductions compared to 12% CO_2 and 20% N_2O, respectively. Moreover, phosphorus bound to iron in CAS sludge is less bioavailable for fertilizer applications than phosphorus from EBPR sludge. These findings, in correlation with influent and process conditions, including F/M, ORP, VFA, active biomass composition, etc., in the bioreactor, are analyzed alongside experimental research findings and actual plant data to understand the system's mechanistic performance better. However, characterizing the static and dynamic resilience of biological wastewater treatment systems is a challenging endeavor within the scientific community. There is an urgent need to establish a practical methodology for assessing the resilience challenges typically faced by wastewater treatment plants (WWTPs) and evaluating the resilience performance of process intensification or new technological advancements designed to address extreme events. This case study illustrates a promising framework aimed at addressing these issues.

Keywords

Conventional Activated Sludge (CAS), Membrane Bioreactor (MBR), Enhanced Biological Phosphorus Removal (EBPR), GHG emissions, Water Reuse, Static & Dynamic Resilience, Sustainability, SUMO-4N Simulation

Session 15 - Waste Management and Environmental Remediation

/Keynote Speaker/ Dr. Vijaya Raghavan

Integrated Hydroponic-Plant Microbial Fuel Cell for Exudate Treatment and Sustainable Lettuce Cultivation

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This study tested whether microbial fuel cell (MFC) treatment has influence on closed-loop hydroponic system for lettuce cultivation. To assess the effectiveness of water treatment for exudate removal, a deep-water hydroponic system for lettuce cultivation was integrated with an H-PMFC (hydroponic-plant microbial fuel cell). The hydroponic solution was continuously circulated through the cultivation system and MFC in a closed-loop operation, without water changes during the entire experimental period, to treat organic compounds. The performance of H-PMFC was compared with a Positive Control (PC), where the hydroponic solution was replaced every two weeks; a Negative Control (NC), where the solution remained unchanged and untreated; and an MFC group, which has no plants. The results indicated that in the H-PMFC setup, leaf and root production was comparable to the PC setup, whereas the NC setup yielded less biomass. Lettuce plants in both the H-PMFC and PC groups exhibited significantly larger growth dimensions compared to those in the NC group. Additionally, electricity generation in the H-PMFC setup was substantially higher than in the MFC group. Therefore, the H-PMFC system demonstrates significant potential for effectively treating exudates from hydroponic plants.

Keywords

Hydroponic Lettuce Plants, Microbial Fuel Cell, Root Exudates, Green Agriculture, Water Recycling

Evaluation of the Use of an Air Bubble Curtain as a Supplemental Environmental Control During Remediation

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Background/Objectives. The air bubble curtain (ABC) bench scale study evaluated the use of ABC technology as a supplemental environmental control during implementation of sediment remediation activities. Bench scale study objectives included:

· Assessing the effectiveness of ABC technology as an in-water physical barrier to control suspended sediment (i.e., turbidity), non-aqueous phase liquid (NAPL), surface sheens, and dissolved phase contaminants in stationary and flowing water conditions.

· Obtaining data from bench scale testing to develop and validate a 3D computational fluid dynamics (CFD) model to predict ABC flow patterns and effectiveness at field scale.

· Evaluating monitoring techniques to assess effectiveness of ABCs at bench and field scales.

Approach/Activities. Bench scale testing was conducted in two phases of increasing scale and complexity.

· Phase 1 included testing in stationary water conditions in an 3000-liter tank.

- Optimal ABC configurations were evaluated using different bubble tube configurations, spacing, air flow rates, bubble sizes, and rising velocities.

· Phase 2 included testing in flowing water conditions (i.e., current) in a 27,000-liter temporary flume tank.

- Based on Phase 1 testing, the Phase 2 tank size, current conditions, and CFD modeling, the ABC configuration was further evaluated and revised in Phase 2 using three straight ABCs placed perpendicular to current flow and spaced at 3-meters apart with the air flow rates determined in Phase 1.

· Each testing phase evaluated the performance of the ABC system and modified the ABC system configuration for optimal performance.

· Monitoring techniques included use of turbidity sensors; visual assessments using video recording, color reactive fabrics, polyethylene samplers, and other observations; and dissolved phase sampling.

Results/Lessons Learned. The ABC bench-scale testing and CFD modeling results and lessons learned will include discussion of:

· ABC effectiveness to control suspended solids (i.e., turbidity), sheens, NAPL, and dissolved phase contaminants in both stationary and flowing water conditions.

· The effectiveness of various monitoring techniques.

· CFD modeling results.

Field videos and modeling simulations will be used to support the presentation.

Keywords

Remediation, NAPL, Air Bubble Curtain

Kinetic Analysis and Process Optimization of Oily Sludge and Sawdust Co-Pyrolysis for Waste Reduction and Energy Recovery

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The co-pyrolysis of oily sludge and sawdust is a promising strategy for converting waste into value-added energy products while reducing environmental impact. This study investigates the pyrolysis kinetics, product distribution, and char formation mechanism to enhance energy recovery and optimize waste utilization. Thermogravimetric analysis (TGA) was conducted to examine the thermal decomposition behavior of sludge, sawdust, and their blends. Kinetic parameters were determined using model-free methods, revealing that co-pyrolysis resulted in a higher activation energy compared to separate pyrolysis, suggesting complex interactions between organic and inorganic components. Product distribution analysis, including pyrolysis oil, pyrolysis gas, and char, showed an increased char yield of co-pyrolysis compared with pyrolysis, potentially due to the influence of mineral matter. These findings provide new insights into the reaction mechanisms governing co-pyrolysis and contribute to the optimization of waste-to-energy technologies, offering a sustainable solution for waste management.

Keywords

Oily Sludge, Pyrolysis Process, Kinetic Analysis, Thermal Characteristics

Scaling Up CO_2 Capture: Adsorption Performance of WoodBased Biochar from Pyrolysis for Flue Gas Applications

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[1]Ph.D Student, [2]Professor, [3]Researcher

This study aims to capture carbon with porous solid (biochar) from pyrolysis of forestry residue biomass from stack gases. Wood residues are currently stockpiled, representing an atmospheric carbon source via degradation. Conversion to biochar turns a heterogeneous carbon source into a more homogeneous carbon sink/sequestration. Biochar's large surface area, porosity, and chemical functionality make it a potential CO_2 adsorbent for use in capturing carbon from stack gases (at power plants, chemical plants, etc.)

We have demonstrated in previous work, on a small scale (0.5 g of adsorbent) adsorption system using 100% CO_2, wood biochar showed adsorption capacities equivalent to other fixed bed adsorbents. In this presentation the focus is on demonstrating the capacity of fast pyrolysis, wood-based biochar for concentrations of CO_2 from 5-20% (flue gas concentrations) in a larger scale system (5 g of adsorbent). Experiments were conducted with adsorbent mass and gas concentrations to analyze impact on breakthrough time and bed capacity. The results showed biochar can effectively adsorb CO_2 over a wide concentration range, with promising adsorption performance for flue gas treatment.

Keywords

Biochar, Flue Gas Mixtures, Bed Capacity, Adsorption

Precision Fermentation Platform for Upcycling of Agri-Food Bioresources to Valuable Bioproducts

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Recovery of nutrients from agri-food by-product streams and their use as feedstock in biotechnological processes is an environmentally benign and socially responsible way to treat the organic residues appearing from agri-food industry. Additionally, the replacement of cost-intensive pure nutrients by such residues could improve the economic feasibility of bioprocesses. In this talk, I will use the examples of high value bioproduction using precision fermentation platform to illustrate the role of effective resource valorization for environmental sustainability and mitigation of climate change. The precision fermentation platform comprises the optimization of the entire process chain from feedstock optimization, strain selection and development, process design, downstream processing, to sustainability assessment. Its effective design for the bioproduction of rhamnolipid biosurfactants and fungal biomaterials as single-use plastic alternatives will be presented. The importance of process intensification through the design and implementation of advanced and high-cell density fed-batch, and continuous bioreactor designs to achieve industry relevant product yields and productivities in bioprocesses will be highlighted. I will also discuss the sustainability of bioprocesses from a techno-economic and life cycle perspective. Overall, this talk will present the bioprocess design solutions that could contribute towards the (i) development of cost-competitive, biorefinery-based production processes, and (ii) creation of a value chain for agri-food industry based on environment-friendly and efficient management system for by-product or residual streams, thereby increasing the efficiency and sustainability of agri-food sector.

Keywords

Process Design, Microbial Cell Factories, Rhamnolipid Biosurfactants, Fungal Mycelium Materials, Waste Valorization

Session 16 - Environmental Sustainability, Human Health and Ecotoxicology

/Keynote Speaker/ Dr. Arja Rautio

Sustainable Solutions for Community Health in the Arctic

Arja Rautio[1]

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There are around seven million inhabitants in the Arctic, and about one million of these are Indigenous. Most of the Arctic populations live in settlements of more than 5000 people (Jungsberg et al., 2019). Arctic environment is in big change due to climate warming, and permafrost thaw, which have big impacts on the everyday life of 5 million inhabitants living in permafrost regions. Understanding and estimating those effects are vital for policymaking and adaptation actions. The other challenges for health of human and wild-life populations are food and water safety and security, biological invasive species, worldwide circulation of anthropogenic contaminants and existing and new infectious diseases. The most vulnerable are Indigenous peoples, whose diets comprise a large proportion of traditional terrestrial and marine foodstuffs (AMAP, 2021).

The growing awareness of the usefulness of the One Health paradigm to improve the ability of Arctic residents, public health agencies, and wildlife resource managers to address existing environmental threats and recognize emerging ones at an early stage. Warming climate and permafrost thaw may influence both contaminant exposure and the spread of zoonotic infectious diseases. Migration from smaller to larger communities and urban centres, is a growing trend in the circumpolar North, and may be accompanied by changes in exposure to pollution.

Populations living in the Arctic are exposed to both long-ranged pollution from the southern part of the globe, but also pollution from local sources. In the recent research projects, such as Nunataryuk (https://nunataryuk.org) and ILLUQ (https://illuq.eu), have focused on local contaminated sites and solid waste in the regions of thawing permafrost in the Arctic Canada and Greenland. The ArcSolution project (https://arcsolution.no) focuses on finding solutions in waste management and sewage. Heavy metals, persistent organic pollutants (POPs) and radioactive substances have long ecological half-lives in the Arctic. Local and Indigenous communities are searching for solutions, and transdisciplinary work with combining different knowledges could be useful in this work (Gartler et al, 2025).

Concentrations of most POPs and metals are declining in Arctic regions where time trend data exist (AMAP, 2021). However, climate change and new chemicals may change the exposure situation of Arctic populations and wildlife. Epidemiological human disease models are needed, as well as new approaches to integrate existing and future monitoring data. All this needs multi- and transdisciplinary research, including lifetime contaminant accumulation, lifetime exposure to zoonotic pathogens, and health consequences for wildlife and human consumers.

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Keywords

Climate Change, Permafrost Thaw, Pollution, Arctic Countries, One Health

Oil Uptake via Marine Snow: Effects on Blue Mussels (Mytilus sp.)

Verena Kalter[1], Benjamin de Jourdan[2], Nasima Chorfa[3], Feiyue Wang[4], David Schneider[1], Uta Passow[1]

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Accidental oil spills into the ocean can lead to downward transport and settling of oil onto the seafloor as part of marine snow, as seen during the Deepwater Horizon incident in 2010 in the Gulf of Mexico. The arctic and subarctic regions may favor conditions leading to this benthic oil deposition, prompting questions about the potential impacts on benthic communities. This study investigated the effects of oil-contaminated marine snow uptake on the blue mussel (Mytilus sp.). We exposed mussels for four days to 1) oil-contaminated marine snow (MOS treatment), or to 2) chemically-enhanced water-accommodated fraction (CEWAF) of oil plus unaggregated food particles (CEWAF treatment). Both oil treatments received the same nominal concentration of oil and food. Two controls were included: 1) Clean seawater plus unaggregated food (agg-free control) and 2) clean seawater plus marine snow (marine snow control). After the exposure, mussels were allowed to recover for ten days under clean, running seawater. Samples were taken right before and after the exposure period, and after the recovery phase for the following endpoints: distribution (partitioning) of oil compounds between seawater and MOS, and between seawater and mussel tissue; DNA damage (assessed via the comet assay); clearance rate; and condition index [tissue dry weight (g) divided by shell length (mm)]. Some discernable patterns were found in the partitioning of oil compounds between seawater and MOS. However, these patterns did not translate to any sig- nificant differences in the partitioning of oil compounds into mussel tissue between the two oil treatments. DNA damage did not exceed background levels (10% tail DNA or less; to be expected in healthy, viable cells) at any sampling time point, but significantly higher DNA damage was observed in CEWAF-T compared to MOS-T mussels after the recovery phase. After the exposure, a significant difference emerged in the clearance rate be- tween the CEWAF treatment and the agg-free control, but not between the MOS treatment and the marine snow control. All mussels except those from the CEWAF treatment exhibited an increased condition index after the exposure time. Together, these results suggest that aggregates could moderate the effects of oil exposure on blue mussels, possibly by providing better, more concentrated nutrition than unaggregated food particles.

Keywords

Mossfa, Oil, Mussels, Ecotoxicology, Newfoundland

An Integrated Model for Wastewater-Based Epidemiological Surveillance Utilizing Deep Learning Techniques

Tingyi Wei[1], Hongjing Wu[2], Deneen Spracklin[2], Xudong Ye[3], Qiao Kang[4], Baiyu Zhang[1], Bing Chen[1]

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Recent public health challenges have highlighted limitations in conventional clinical surveillance and underscored the need for innovative public health monitoring strategies. This study presents an integrated model for wastewater-based epidemiological surveillance that leverages deep learning techniques—specifically, artificial neural networks and long short-term memory networks—to analyze viral concentration data. These samples, primarily collected from wastewater treatment plants in communities with large populations, form the foundation for our analysis. When combined with water quality, environmental, and socio-economic parameters, these data further improve the performance of our forecasting model by fully leveraging our advanced AI tools. The model is organized into four key modules: Data Integration and Preprocessing, Statistical and Temporal Analysis, Predictive Modeling, and Decision Support. A preliminary model has been developed, and preliminary results demonstrate promising predictive performance; the model effectively captures temporal trends in wastewater viral loads and its predictions closely align with observed epidemiological data. The model was trained on over 2000 data points collected over a three-year period, achieving a mean prediction error ranging from 10% to 25% among different sites. These outcomes demonstrate that the integrated model improves forecasting accuracy relative to traditional methods and provides a scalable, adaptable tool for proactive public health response. By translating model outputs into actionable insights that drive early-warning systems and optimize decision-making, this approach delivers a transformative solution for infectious disease surveillance and environmental health management.

Keywords

Wastewater Surveillance, Machine Learning, Predictive Modeling, COVID-19, Public Health Preparedness

Time-Tension Line Cutters: A Possible Tool to Mitigate Whale Entanglements in Deep Water Fisheries

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Entanglement in vertical lines of fixed gear fisheries is one of the most concerning threats to the critically endangered North Atlantic Right Whale (NARW) (Eubalaena glacialis). Low breaking-strength (LBS) components are a promising mitigation effort in some fisheries; however, previous research has shown that they may pose a risk of gear loss and harvester safety in deeper fisheries due to unexpected breakage. Time-tension line cutters (TTLCs) offer a possible solution. The novel technology could replace LBS components in deep water fisheries, to allow for safer gear retrieval for harvesters. Once inserted onto vertical buoy lines, the TTLC will not cut the line unless a specified tension is sustained for a certain amount of time, longer than it would take for harvesters to haul in their gear. Alternatively, if the tension is maintained for the set amount of time, such as an entangled whale, the device will cut the rope to hopefully free the whale or at least reduce the amount of attached gear. Building upon previous research, this study explores three questions: (1) Do factory provided TTLC units require a "work in" period? (2) Does the amount of tension affect the time to cut? Finally, (3) does water temperature affect the time to cut? Controlled laboratory experiments were conducted at the Fisheries and Marine Institute of Memorial University in St. John's, NL, from October to December 2024. The time to cut of ten TTLC units was tested across multiple tensions and temperatures using a tensile test machine. Preliminary results indicate that some units do require a "work in" period, although this is not the case for all units. The time to cut appears dependent on tension, with increasing tension reducing the time to cut. Finally, the time to cut appears dependent on water temperature, with decreasing temperature increasing the time to cut. Using empirical data, survival analyses will be used to assess the impact of these factors on the TTLC's performance. This research fills significant knowledge gaps of TTLCs and brings forth important considerations for their functioning under various conditions. The results may provide valuable guidance to developers in the enhancement or modification of TTLCs to ensure ease of use, harvester safety, and effective conservation outcomes. The results will also inform best practices of TTLC deployment in deep water fisheries to ensure the safety of harvesters and optimize the mitigation of NARW entanglement.

Keywords

North Atlantic Right Whales, Entanglements, Time-tension line cutter, Deep water fisheries, Conservation

Occupational Health and Safety Challenges among Community Search and Rescue Responders in Nunavik and Nunavut

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This study explores the occupational health and safety (OHS) challenges faced by community Search and Rescue (SAR) responders in Nunavut and Nunavik, focusing on the interplay between job demands, job resources, and the unique environmental, operational, and social factors impacting their work. As the frontline of emergency response in remote Arctic regions - often operating without formal backup during missing person incidents or in response to distress notifications - these responders face mounting operational and psychological pressures during SAR missions, driven by climate change, increased subsistence activities, and expanding Arctic travel. Despite the critical nature of their role, their health and safety needs remain significantly underexplored in existing research. To address this gap, the study applies the Job Demands-Resources (JD-R) model and draws on qualitative data gathered through a roundtable discussion involving 42 participants, including community SAR responders, policymakers, and academics.

The thematic analysis identified extreme weather and geographic conditions, resource limitations, high-stress decision-making, limited support, and the critical incident stress that stems from responders searching for friends, family, and neighbours as significant job demands, leading to physical injuries, psychological strain, and burnout. Resource gaps, such as limited medical support, inadequate personal protective equipment (PPE), and insufficient weather and ice monitoring systems, further exacerbate these challenges.

The findings underscore that job resources - such as mentorship, advanced training, Inuit Qaujimajatuqangit (traditional Inuit knowledge), specialized equipment, access to critical incident stress management, and technological tools like Smart-Ice and two-way satellite communication devices - are not merely supportive but foundational to mitigating occupational risks, enhancing responder resilience, and contributing to the overall effectiveness and sustainability of SAR operations in the Arctic. Resilience is fostered by addressing mental health needs, providing timely stress management support, encouraging peer mentorship, integrating Inuit knowledge systems, and building adaptive capacity through culturally relevant training and community-based knowledge sharing.

The study also highlights how occupational health is impacted by climate change, which increases the unpredictability of weather and ice conditions, and the need for integrating climate data into SAR planning. Furthermore, systemic barriers, including inconsistent insurance coverage and financial strain on responders, necessitate policy reforms at both the provincial and federal levels. Based on the findings, we offer the following recommendations: optimize resources by providing SAR teams with reliable, climate-appropriate transportation, real-time ice and weather monitoring tools, well-maintained personal protective equipment (PPE), and formalized pre-mission hazard assessment protocols; and strengthen OHS frameworks by establishing clear, community-specific standard operating procedures (SOPs) for injury reporting, training access, and responder

insurance coverage. By addressing these challenges, community-based SAR organizations may help promote safer, more effective operations in Nunavut and Nunavik, supporting responder well-being and contributing to the resilience of Arctic communities.

Keywords

Arctic search and rescue (SAR), Occupational health and safety (OHS), Job demands, Job resources, Climate change, Environmental monitoring

Session 17 - Environmental Monitoring, Modeling and Decision Making

/Keynote Speaker/ Dr. Dongxiao Wang

Integrating High-Precision Monitoring for Marine Conservation in the Pearl River Estuary

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Human activities and natural dynamic processes play a crucial role in shaping the ecological environment of estuarine and coastal zones. The Pearl River Estuary Marine Ecological Environment Field Observation and Research Station, from the School of Marine Sciences at Sun Yat-sen University, has been conducting systematic marine ecological monitoring and conservation research, yielding a series of significant scientific achievements.

First, the station has leveraged high-precision instruments, including underwater gliders, large-scale mooring observation systems, ocean environmental buoys, and drifting buoys, to conduct long-term observations in the Pearl River Estuary and northern South China Sea. In the waters of Qiao Island, an acoustic monitoring buoy has been newly deployed, successfully recording the acoustic signals of Chinese white dolphins, providing crucial data for studies on their ecological behavior. Additionally, a self-contained hydrophone and CTD device have been installed on the Hong Kong-Zhuhai-Macao Bridge observation platform to monitor the activity patterns of Chinese white dolphins in freshwater plume front regions. Furthermore, shore-based sea temperature sensors and CTD devices have been deployed at Wailingding Island and Wanshan Island to assess the impact of extreme weather events, such as typhoons, on ocean temperature structures.

In terms of ecological monitoring, a coral reef survey in the Gabonese Archipelago has revealed the impacts of marine heatwaves and typhoons on coral bleaching, quantifying coral coverage, bleaching rates, and mortality rates across different regions. The bleaching phenomenon induced by elevated temperatures was particularly pronounced, with bleaching rates reaching up to 37.9% in some areas. Additionally, the station has conducted multiple comprehensive observations in the frontal region of the Pearl River Estuary using the FerryBox system, unmanned surface vehicles, and moored devices, elucidating the impact of freshwater transport on coastal ecosystems and addressing research gaps in estuarine dynamic processes and material transport mechanisms.

Keywords

Marine Conservation, Observations, Monitoring, Pearl River Estuary

Coupled OpenFOAM-Yade Modeling of Near-Bed Turbulence and Sediment Transport over Roughness Elements in a 2D Flume

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This study investigates near-bed turbulent flow and sediment transport over rough surfaces in a 2D flume. OpenFOAM is used to solve the RANS equations for fluid flow with the k-ω SST turbulence closure, while Yade models sediment motion using the Discrete Element Method (DEM). Three roughness types are examined: d-type, k-type, and intermediate. The influence of these roughness patterns on flow separation, turbulence, and shear stress is compared. The simulations show that k-type roughness produces higher turbulence and shear stress near the bed, which increases sediment movement. Intermediate roughness exhibits mixed behavior. The results match experimental data well. This study demonstrates that a coupled RANS-DEM model can predict sediment transport processes.

Keywords

Near-bed turbulence, Sediment transport, RANS modeling, DEM, Roughness elements, OpenFOAM

Smart Waste Operation and Management for the Food Waste Management in NL Industrial-Commercial-Institutional Sectors

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Food waste constitutes a major portion of municipal solid waste (MSW) produced by the Industrial, Commercial, and Institutional (ICI) sectors in Newfoundland and Labrador (NL). NL had one of the country's highest waste disposal levels per capita, more than 155,000 tons of organic waste are generated each year. Proper management of this waste stream would be crucial for minimizing environmental effects, improving resource utilization, and supporting sustainability efforts. However, composting facilities have not been involved in the current MSW management system in NL. This research focused on designing an integrated MSW management framework with composting system to enhance the efficiency of food waste collection. An interval mixed-integer programming model was developed for this purpose and the corresponding environmental impacts were evaluated by using life cycle analysis. The research compared both MSW management with and without considering composting of food waste within ICI sectors over a 30-year period. Efficiency and effectiveness of different strategies were analyzed, cost of various scenarios was obtained, and the environmental impact of all situations was identified, providing insights into long-term sustainable waste management planning. By aiming to minimize the overall system cost while meeting food waste management needs and reducing environmental impacts, the proposed framework can support the city who manages MSW and separate food waste in making informed decisions.

Keywords

Food waste, Smart waste operation and management, Life cycle analysis, Waste management, System optimization.

Floating Photobioreactors Facilitated Microalgae Biomass Generation for Marine Carbon Dioxide Reduction: A Literature Review

Zheng Wang[1], Baiyu Zhang[1]

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Microalgae have attracted great interest as a renewable biomass source due to their short growth cycles and wide range of byproduct applications, and have shown a high potential for marine carbon dioxide reduction (mCDR). While traditional aquaculture systems for facilitating the microalgae biomass growth have been extensively studied, floating photobioreactors (PBRs) offer an innovative alternative that can reduce competition for land by utilizing marginal areas such as coastal or offshore areas, meanwhile achieving the mCDR. However, there is a lack of overall research on the PBRs associated microalgae biomass yield potential, environmental impacts, and net carbon reduction, especially in specific areas such as the Canadian coastline. In this study, we summarized various methods for quantifying biomass generation, including collecting experimental data from PBRs at different scales and determining microalgal growth dynamics through empirical models and machine learning. The use of visualization tools such as GIS to quantify the spatial distribution of biomass production was also discussed. Subsequent carbon footprint analysis often uses a life cycle assessment (LCA) approach to comprehensively evaluate the microalgae biomass generation systems, covering all stages from cultivation to biomass conversion. The analysis shows that the microalgae biomass generation systems have significant net carbon benefits.

Keywords

Floating photobioreactors, Biomass generation, Carbon dioxide reduction

Prediction of Membrane Cleaning Performance using Data Analytics

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[1]McMaster University

The prediction of membrane cleaning performance is of great importance for the design and operation of membranes in water and wastewater treatment. Accurate predictions of membrane fouling enable the development of more efficient and effective cleaning strategies, which are essential for maintaining the optimal performance and minimizing the operation costs of membrane systems. In this study, we employed a series of data analytics techniques to predict the effectiveness of various cleaning approaches, including Enhanced Flux Maintenance and Clean-In-Place.

The results demonstrated the satisfactory performance of advanced data analytics and machine learning methods in predicting the effectiveness of different cleaning strategies. The application of the proposed prediction methods also provided valuable insights into the factors influencing cleaning performance, allowing for the optimization of cleaning protocols. This work not only highlights the potential of data-driven approaches in membrane cleaning but also lays a foundation for the integration of predictive models into membrane design and operational strategies.By incorporating these advanced predictive models, water treatment facilities can achieve improved cleaning efficiency, reduced downtime, and extended membrane lifespan. Ultimately, this research paves the way for more sustainable and cost-effective water treatment processes, contributing to better resource management and environmental protection.

Keywords

Membrane cleaning, Membrane fouling, Enhanced flux maintenance, Clean-in-place, Data analytics, Machine learning

Session 18 - Climate Change Modeling and Impact Assessment

/Keynote Speaker/ Dr. Haseen Khan

Climate Change and Its Impact in Coastal Areas of Newfoundland and Labrador

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Newfoundland and Labrador is often called the "Rock", but that does not mean it is invulnerable to hazards such as coastal flooding, erosion, sea level rise, hurricanes and even tsunamis. The historical pattern of settlement in this province was largely driven by the fishing industry with small settlements spread out along the coastline turning into permanent communities. Newfoundland and Labrador has over 500 coastal communities, over 24,000 structures (houses, businesses, sheds, fishing stages, etc.), over 300 small craft harbours, over 700 municipal wastewater outfalls, hundreds of kilometers of roads, and thousands of power poles, just to name some of the property and infrastructure all located within 60 m of the coastline of the province. Approximately 35,500 people in the province also reside within 60 m of the coastline. Coastal flooding in the province can be due to a combination of high tide, storm surge and waves. Approximately twenty percent of flood events in the province's flood event inventory are classified as coastal flooding. Hurricane Fiona, which struck the province in September 2022, demonstrated the vulnerability of coastal communities in Newfoundland and Labrador to coastal flooding hazards where one person died and over 100 homes were either destroyed or torn down after being deemed unsafe for habitation. With respect to climate change impacts by 2100 in parts of the province, sea level is expected to increase by 100 cm, projected future 1:100 storm surge is expected to exceed 4 m, and the projected future 1:100 storm wave heights are expected to exceed 10 m. This level of coastal flood risk poses a significant danger to many coastal communities in the province particularly to low lying areas and will require both mitigation and adaptation approaches. Parts of the province's coastline are also particularly sensitive to coastal erosion, with erosion rates at some beaches and cliffs higher than 45 cm per year. To combat the risk posed by such coastal hazards, more and more communities are having to build coastal protection infrastructure such as seawalls, sea dykes, jetties, breakwaters and revetments. Combating coastal hazards and establishing better management of coastal areas in Newfoundland and Labrador will not be easy and will require a combination of monitoring, land use planning, funding, physical and natural infrastructure, and policy decisions.

Keywords

climate change, coastal areas, Newfoundland and Labrador, coastal flood risk, best management

Assessing the Risks of Climate Change on Food Security on Prince Edward Island, Canada

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Food insecurity is defined as the inability to acquire or consume an adequate quality or quantity of food in socially acceptable ways or the uncertainty that one will be able to do so. A study in 2022 found that 16.9% of Canadians were living with food insecurity. However, the risks of food insecurity are not consistent among Canadians. Prince Edward Island (PEI) has shown the greatest increase in reported food insecurity among the provinces since 2018 (3-4% increase, 21.2% of families total). Additionally, the Intergovernmental Panel on Climate Change (IPCC) states that observed climate change is already impacting food security through increased temperatures, varied precipitation patterns, and more frequent extreme weather events. Moving forward, these impacts will also cause a wide range of health risks, including increased exposure to infectious diseases and malnutrition. To gain insights into how climate change and food security risks relate to one another, this presentation will describe a method for measuring the intersection of both the social and environmental risks to food security. The Centre for Disease Control and Prevention's (CDC's) social vulnerability index (SVI) will be analyzed to determine which of its factors are most indicative of food insecurity. Then, climate change risks will be evaluated based on current and predicted climate data in PEI. Preliminary results will be presented describing which PEI communities will be vulnerable to both food insecurity and climate change. These findings can inform policymakers attempting to meet current provincial goals for eliminating poverty and food insecurity in the province by 2035.

Keywords

Climate change, Food security, Food insecurity, Prince Edward Island, Canada

Microalgal Carbon Fixation under Contaminant Stress: Wastewater- and Natural Water-Based Photobioreactor Systems

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Amidst the escalating challenges of climate change and environmental pollution, the development of efficient and robust carbon sequestration technologies has emerged as a global priority. Microalgal photobioreactors (PBRs) present a promising dual-function approach by capturing CO_2 and treating wastewater, positioning them as a sustainable solution for facing the above-mentioned environmental challenges. This review critically examines the physiological mechanisms and operational performance of carbon fixation in PBRs using different substrate sources, with a comparative focus on wastewater-based and natural water-based systems. Key metabolic pathways, including Rubisco activity, carbon concentrating mechanisms (CCMs), and the modulatory role of extracellular polymeric substances (EPS), are examined under diverse natural and anthropogenic stressors. Wastewater-based PBRs, while nutrient-rich, are often characterized by high contaminant loads that induce oxidative stress, impair photosynthetic processes, and inhibit algal growth. In contrast, natural water-based PBRs, operating under lower contaminant loads, potentially offer enhanced system stability and carbon fixation performance. The review also explores the effects of complex pollutant interactions and evaluates critical performance indicators between the two systems. These insights contribute to advancing the development of deployment of microalgae-based technologies for carbon and pollutant mitigation, as well as the generation of high-value bioproducts.

Keywords

Carbon fixation, Wastewater-based PBRs, Natural water-based PBRs, Microalgae, Environmental pollutants

Real-World Performance of Battery Electric Buses in Cold Climates: Energy Consumption and Regenerative Braking Efficiency

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The transition to low-carbon public transportation is a key strategy in mitigating climate change, with battery electric buses (BEBs) playing an increasingly significant role in reducing greenhouse gas emissions. This study examines the operational performance, energy consumption, and regenerative braking efficiency of BEBs using a large dataset collected from Montreal's public transit network. The analysis highlights the substantial influence of seasonal and environmental factors on BEB energy efficiency. Energy consumption is highest in winter due to increased heating demand and adverse road conditions, while summer exhibits the lowest consumption, driven by reduced auxiliary loads and improved traffic conditions. Regenerative braking efficiency is most effective at mid-speed ranges and declines during winter, underscoring the role of temperature and operational factors in energy recovery.

The findings also emphasize the impact of auxiliary heating and cooling demands, particularly in extreme climates, where these systems significantly affect overall energy efficiency. Cost analysis reaffirms the economic advantages of BEBs over diesel and hybrid buses, although operational challenges related to range limitations and charging infrastructure remain. Optimizing BEB operations requires improvements in route planning, fleet scheduling, and driver training to enhance energy recovery and efficiency under varying climatic conditions.

By addressing limitations in previous studies, including smaller datasets and restricted environmental variability, this research provides insights into the complex interactions between climatic conditions, operational factors, and energy consumption in BEB fleets. These findings offer valuable guidance for policymakers, transit agencies, and urban planners seeking to improve BEB efficiency, reduce emissions, and support the broader adoption of sustainable public transportation systems in diverse climatic contexts.

Keywords

Battery electric buses, Energy consumption, Regenerative braking efficiency, Operational dynamics, Sustainable transportation systems, Real-world conditions

Calculation of Dimethyl Sulfide (DMS) Air-Sea Flux and Analysis of Its Contribution to the Regional Atmospheric Sulfur Cycle in the Northern South China Sea

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Dimethyl sulfide (DMS) is one of the most important volatile sulfur compounds in the ocean, playing a crucial role in global sulfur cycling and climate regulation. However, studies on DMS in marginal seas like the Northern South China Sea remain limited, especially regarding its spatiotemporal distribution and the relationships with environmental factors. In this study, the Kettle and Lana empirical models were used to estimate DMS concentrations in surface seawater and air-sea fluxes in the Northern South China Sea for 2012 and 2022. These estimates were further coupled with the COAWST model to simulate the spatiotemporal distribution of DMS in the atmosphere. The results indicated that DMS concentrations and air-sea fluxes in 2022 (concentration: 2.20 - 3.74 nmol/L; flux: 0.14 - 1.41 mol/km²/h) were generally lower than those in 2012 concentration: 2.40 - 3.80 nmol/L; flux: 0.14 - 1.54 mol/km²/h), indicating a decrease in DMS emissions over the decade. The study also revealed significant seasonal variations in DMS concentrations and air-sea fluxes, with highest seawater concentrations (~3.7 nmol/L) but lowest fluxes (0.14 mol/km²/h) in summer, and lowest concentrations (2.2 nmol/L) but highest fluxes in winter (1.5 mol/km²/h). These variations are mainly driven by phytoplankton biomass, light intensity, and mixed layer depth, with air-sea fluxes being significantly influenced by wind speed. The vertical distribution of DMS was highest in winter and lowest in summer, showing a positive correlation with seawater temperature and wind speed. The simulation results further demonstrate that marine DMS emissions contribute significantly to the formation of sulfur dioxide (SO_2) and sulfate aerosols in the atmosphere. This study innovatively quantifies the impact of DMS on the regional atmospheric sulfur cycle, providing essential data for the development of land-sea-atmosphere coupled sulfur cycle models and assessing regional climate effects, as well as offering scientific support for regional air quality management and marine atmospheric ecological security.

Keywords

Dimethyl Sulfide (DMS), Air-Sea Flux, COAWST Model, South China Sea

Session 19 - Climate Change Mitigation, Adaptation and Planning (1)

/Keynote Speaker/ Dr. Andrew Niblock

Adapting Water Supply Infrastructure to Climate Change

Andrew Niblock[1]

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Climate change poses significant risks to water supply infrastructure through increased variability in precipitation, rising temperatures, and more frequent extreme weather events. Drawing on the City of St. John's recent experience, this presentation examines how our utility is incorporating climate projections into asset management and upgrading aging infrastructure. Emphasis is placed on the approach used when analyzing the effects of climate change and the recommended results to ensure long-term water security.

Keywords

Utility planning, Climate change, Adaptation strategies

Enabling Resiliency in the Face of Climate Change

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SmartICE is an award-winning technological innovation for the North. SmartICE offers a suite of climate change adaptation tools that integrate Indigenous and local knowledge of ice with advanced data acquisition, remote monitoring and satellite mapping for ice travel safety. Our community-based services provide invaluable, data-driven insights into ice thickness and local ice travel conditions, in near real-time. Grounded in community engagement and working wth local governance structures, SmartICE co-designs and delivers trianing and monitoring activities in rural remote Indigenous communities.

First and foremost, SmartICE supports the needs of communities where we operate. Our source of strength is based on a combination of Indigenous and local knowledge, the latest science using advanced environmental monitoring solutions, and our commitment to economic and social development to support local cultures and livelihoods.

Our social enterprise business model is consistent with Inuit societal values, and commits to maximizing social impact and creating positive community change while collaboratively delivering ice information services with communities, for communities. SmartICE harnesses the vast potential of young Indigenous women and men to embrace science, technology, and Indigenous knowledge as a vehicle for sustainable employment, economic development, and well-being in their communities. SmartICE provides culturally contextualized training programs that are meaningful and effective in supporting northern community members to thrive and prosper.

The up-skilling support provided by SmartICE increases employability. Community members who are trained to operate our on-ice technology acquire technical skills that are broadly transferable. Hiring community operators is critical to ensuring that community members have confidence in SmartICE data, knowing that it was produced by combining Indigenous and local knowledge, and technology that is made in Inuit Nunangat, Yukon and Northern Territories.

In our suite of climate change adaptation tools we have a SmartQAMUTIK used for monitoring sea ice thickness, SmartBUOY is used for remotely monitoring sea and freshwater ice thickness, SmartPROFILER used for monitoring freshwater ice thickness and a variety of weekly and seasonal ice safety maps created by youth in 9 northern communities.

Community members use the data combined with Indigenous and local data collected to make informed decisions about ice travel.

Keywords

Climate change, Indigenous community, Community engagement, Adaptation, Remote sensing

Raft Foundation Feasibility for Cold Region Road in Northern Canada

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Road infrastructure is the primary transportation mode in Canada for both people and goods, while most of northern Canada is covered by permafrost layers. Thus, roads built in these regions have been constructed over the permafrost layers. However, permafrost is experiencing mega-scale degradation of seasonally frozen ground due to climate warming in Canadian northern regions, especially in Yukon, Northwest Territories, Nunavut, and Quebec. This poses significant threats, structural instability, uneven settling, thermal cracking, moisture damage, slope movements, and failure, to Canadian road infrastructure. Canada must invest in sustainable and climate-resilient infrastructure to safeguard its transportation networks and ensure long-term sustainability as climate effects escalate. Several solutions have been used to mitigate the influences of permafrost thawing on cold region roads globally. While these approaches have shown effectiveness, especially in remote areas, they face challenges such as high costs, environmental disruption, and limited adaptability under complex geological conditions. The main threats in remote communities are the lack of all-weather roads and seasonal roads instead of high-quality paved roads. Therefore, this paper proposes a novel raft foundation structure, between the subbase and subgrade of the road (fits both paved and unpaved roads), to mitigate the impacts of permafrost degradation on road infrastructure in northern regions of Canada. The Material Selection and Structural Layer Design concepts that address Canada's Cold Region Needs were discussed, and the potential outcomes of this project were also developed.

Keywords

Climate change, Permafrost degradation, Road infrastructure, Reinforcement layer, Raft foundation

A Critical Review of Carbon Emissions Trading in Ground Transportation: Policy, Research, and Future

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Ground transportation, encompassing road and rail sectors, significantly contributes to greenhouse gas (GHG) emissions. An emissions trading system (ETS) serves as a key environmental policy for regulating carbon emissions resulting from fossil fuel use in transportation. This study conducts a comprehensive literature review to assess the current state of ETS interventions in ground transportation, covering policy evaluation and comparison, scheme optimization and design, and targeted behavioral interventions. The findings indicate that existing upstream policies lack sufficient stringency and effectiveness, while downstream policy implementation remains limited. To address these gaps, this study proposes a downstream ground transportation emissions trading system (GTETS) that integrates the Internet of Things (IoT) and blockchain technology. Beyond road and rail emissions, the system also accounts for emissions-related activities of individuals and transportation companies, leveraging Web3-based technologies for enhanced monitoring, reporting, and verification.

Keywords

Transportation carbon pricing, Emissions trading system, Ground transportation emissions, Green logistics, Blockchain technology, Web 3.0

Reconstructing High-Temporal Wildfire Incidents from GOES Satellite Data

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[1]Stanford University

Recently, wildfire behaviour can evolve in minutes, yet most operational fire maps trail events by hours. We introduce an end-to-end, high-temporal pipeline that transforms raw GOES-16/17/18 Advanced Baseline Imager (ABI) Fire/Hot-Spot Characterization (FDCC) products into terrain-corrected, ~5-minute snapshots of fire activity across the U.S. Southwest. The principal obstacle for geostationary sensors is parallax—kilometre-scale displacements of hot-spot pixels caused by viewing the Earth's surface obliquely from 35,786 km altitude. We remove this bias by pairing 30 m-1 km USGS digital-elevation tiles with GOES projection metadata to derive, for every DEM cell, its exact ABI scan-angle coordinates. These pixel-map tables are generated once on an HPC cluster with MPI-tiled workloads and archived as chunked Zarr arrays. Orthorectifying millions of FDCC scenes then becomes a fast lookup: a fancy-index engine converts pre-computed angle tables into integer row/column indices, letting Dask pull only the required pixels. Benchmarks show a 40× speed-up—cutting wall-time to under three seconds per image—and >95 % memory savings relative to traditional per-file geometry computations. During January 2025, the system processed ~1.5 million scenes, producing a 5-minute time series of fire fronts ready for ignition detection, spread-rate analytics, and smoke-plume modelling. This open-source workflow demonstrates that once "too blurry" geostationary data can, when parallax is rectified at scale, provide near-real-time intelligence for wildfire situational awareness under a changing climate.

Keywords

Wildfire monitoring, GOES ABI, Parallax correction, Orthorectification, High-temporal fire mapping

The Use of Nature-based Infrastructure for Mitigating Coastal Erosion in Newfoundland

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[1]Memorial University

By 2100, the sea level in Newfoundland is projected to rise by 0.5 to 1 meter, which, combined with increased precipitation, will exacerbate vulnerability to coastal hazards. Coastal areas are high-energy, dynamic environments that are economically vital to the communities that live along them. Furthermore, it is important to protect coastal areas for their ecological and cultural value. In addition to artificial engineering structures for coastal protection, coastal wetlands and vegetation play a huge part in protecting and buffering against coastal hazards. Nature-based solutions for coastal protection are cost-effective, protect shorelines, benefit carbon sequestration, and restore habitats. Nature-based solutions have not been widely studied in Newfoundland, partly due to its unique coastal landscape, and our primary goal is to assess the potential use of such solutions on the island.

The objectives are to i) characterize vegetation-coastal characteristic associations to determine the best species-environment matching for Newfoundland's coasts, ii) conduct transplantation and species-suitability trials at a subset of coastal study sites, and iii) carry out an Extreme Value Analysis to suggest limits to planting in five Bays on the Avalon Peninsula. After identifying the terrestrial native plant species for the Avalon Peninsula and conducting salt stress trials on these species, we concentrate on our third objective. For our third objective, we analyzed data provided by the Province on residual water levels (storm surge) for the climate projections until 2100. We also compared these to historical data to provide a baseline for our study. The analysis provided us with water level residuals (m) values along the five locations of Ferryland, New Harbour, Gooseberry Cove, Topsail Beach and Salmon Cove. With this information, we suggest areas at higher risk of inundation and where it would be best suited for planting terrestrial vegetation, marine vegetation or hard engineering structures. We hope this information can be useful to communities in their plans of adaptation and mitigation efforts along coastal Newfoundland.

Keywords

Nature-based solutions, Climate change, Coastal erosion, Adaptation, Mitigation, Extreme value analysis

Session 20 - Climate Change Mitigation, Adaptation and Planning (2)

/Keynote Speaker/ Dr. Jan Borm

The Territory as Source of First Nations' Identities - Linking Nature, Culture and the Climate

Jan Borm[1]

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Indigenous territories are at the core of numerous contemporary issues, be they political, judicial or environmental, Daniel Chartier and Jan Borm note in the introduction to a forthcoming collective volume about comparative Indigeneity in the Americas (Presses de l'université du Québec à Montréal): Inuit, Innu, Atikamekw and Mapuche. These first nations have a vision of their territory that transcends conventional notions of ownership or stewardship of natural resources, conceiving of the links of culture, language and the environment as inseparable. As the Atikamekw playwright and academic Véronique Basile Hébert points out in the same volume, "Atikamekw culture and language are constructed by the territory and express the cosmogony of my people by its experience with the territory considered like the source of our cultural specificity, the source of our indigeneity, of our atikamekwicity". This holistic view entails that any deteriorated environment is a cause of suffering and a threat to the indigeneity attached to it. Deterioration of environmental conditions means a lower quality of life, thereby threatening cultural continuity, a key-factor for Indigenous societies to affirm their identity, to continue to recover from the many dramatics impacts of colonialism, and to develop new perspectives of personal and collective satisfaction as well as prosperity. This contribution will look at some recent Indigenous texts published both in French and English to illustrate the congenial link between nature and culture in Indigenous societies of the North, an absolutely essential aspect of their identity that law courts are slowly taking into consideration when it comes to territorial conflicts and Indigenous rights, as one notable example from Argentina goes to show.

Keywords

Arctic, Culture, Literature, Environment, Climate, Identity

Mineral Carbonation in Metalliferous Waste with High Alkalinity

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Mineral carbonation is a direct carbon sequestration technique trapping and storing inorganic carbon dioxide (CO2) as mineral carbonate precipitates. Alkaline materials offer a promising substrate for mineral carbonation, which mimics the natural weathering process of silicates to precipitate carbonates. These precipitates (i.e., calcite, dolomite, magnesite) are considered stable with low solubilities, and require high temperatures or acidic conditions to release inorganic carbon back into the geosphere. Two metalliferous wastes were previously considered feasible for mineral carbonation via preliminary testing. This work aims to optimize chemical carbonate precipitation to enhance carbon sequestration. Abiotic factors (CO2 concentration, timeframe, and moisture content) were altered and analyzed to establish optimal conditions for carbonate precipitation. The carbonate precipitates were qualified via fourier transform infrared spectroscopy (FTIR), x-ray diffraction (XRD), acid washing, and carbon content. The gaseous CO2 changes were quantified using gas chromatography. In comparison to mineral carbonation via CO2 influx, mineral carbonation is also analyzed by atmospheric CO2. The carbonate precipitated in metalliferous waste is enhanced at high CO2 influx with moisture content, which ultimately increased carbon sequestration. While increasing moisture content decreases CO2 in the headspace through mineral and solubility trapping, a moisture content below saturation is required to increase precipitated carbonates (i.e., mineral trapping/mineral carbonation). Further the impact of alkalinity on mineral carbonation was assessed by altering the initial pH with the use of buffers. This determined the role of alkaline mining waste as a substrate for carbon sequestration, all of which will allow projections of carbon offsetting at mining operations and their role in reducing global greenhouse gas emissions.

Keywords

Mineral carbonation, Carbon sequestration, Metalliferous waste, Carbon dioxide, Carbonates, alkaline

Harnessing Marine Microalgae for Carbon Capture and Biomass Production under Naphthalene and Bicarbonate Stress

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Marine microalgae are essential to the global carbon cycle, converting inorganic carbon into biomass through photosynthesis and supporting sustainable bioproduction. In natural seawater, atmospheric CO_2 enters the ocean and forms dissolved inorganic carbon (DIC), including bicarbonate (HCO_3^-), which serves as the primary carbon source for microalgae. Similarly, ocean alkalinity enhancement (OAE) increases seawater bicarbonate ion concentrations by adding alkaline materials—such as minerals—that raise alkalinity, thereby promoting greater inorganic carbon availability for microalgae and enhancing carbon sequestration. However, marine environments are increasingly exposed to pollutants such as polycyclic aromatic hydrocarbons (PAHs), commonly introduced through oil spills and runoff, with naphthalene as a representative compound. While many studies have explored the ecological effects of OAE, few have investigated how elevated bicarbonate concentration, especially under OAE conditions, interacts with PAHs to influence microalgal carbon flow and physiological responses. To address this gap, we cultured Dunaliella tertiolecta CCMP1320 under five $NaHCO_3$ concentrations (0.17, 0.5, 0.7, and 1 g/L) combined with 0.5 or 1 mg/L naphthalene over 15 days. To assess carbon flow, we measured carbon capture using Gas Chromatography-Thermal Conductivity Detector (GC-TCD), photosynthetic activity by tracking chlorophyll a and b, and downstream outcomes including biomass generation by testing OD680, protein content, flocculation, and morphology through SEM. Preliminary results indicate that D. tertiolecta exhibits strong carbon capture performance and physiological resilience under elevated bicarbonate conditions, even with naphthalene exposure. This suggests a synergistic potential of OAE and microalgal systems for carbon removal, even in pollutant-stressed environments. Our findings contribute to a more nuanced understanding of microalgal adaptability in enhanced alkalinity and contaminated conditions, supporting the development of integrated, nature-based solutions for marine carbon management.

Keywords

Marine algae, Polycyclic aromatic hydrocarbons, Carbon capture, Ocean Alkalinity Enhancement (OAE)

A Laboratory Investigation into Oil and Shoreline Sediment Interactions Under the Influence of Temperature

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Despite considerable efforts to prevent marine oil from reaching shorelines, extensive contamination is a persistent outcome of major oil spills, as exemplified by the Exxon Valdez (1989, ~2,000 km) and Deepwater Horizon (2010, ~1,700 km) incidents. In both cases, protracted shoreline response and environmental recovery operations dramatically exceeded the duration of active on-water efforts.

To better inform response and remediation strategies, it is critical to understand how oil interacts with shoreline sediments. This presentation explores the mechanisms influencing oil penetration and retention in coastal sediments through laboratory experiments encompassing 140 unique environmental conditions, each conducted in triplicate. Five uniform coarse-grained inorganic sediment classifications, ranging from coarse sand to medium pebble. Four test oils include three diluted bitumens (fresh, 24-hour weathered, 72-hour weathered) and one very low sulphur fuel oil (VLSFO). Experiments were conducted under seven temperature regimens: four uniform conditions (sediment and seawater at the same temperature) and three non-uniform conditions (sediment and water at different temperatures). By simulating realistic thermal and sedimentological conditions, this study provides valuable insight into oil behaviour within coastal sediments, with direct implications for improved spill modelling, response prioritization, and long-term environmental recovery.

Keywords

Oil in sediment interactions, Shoreline oiling, Oil trapping, Oil penetration, Oil retention

The Influence of Climate Change on North Atlantic Tropical Cyclone Genesis Regions

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Every year, coastal communities in the North Atlantic brace for the repeatedly devastating and traumatic effects of tropical cyclones. These storms cost nations billions of dollars in damage, catastrophic environmental loss, and loss of life. With the escalation of intense tropical cyclones forming earlier in the hurricane season and undergoing rapid intensification, it becomes critical to understand how climate change may influence the propensity of tropical cyclone formation in the genesis regions and their landfall variability. Using historical hurricane data from the International Best Track Archive for Climate Stewardship (IBTrACS), the Hurricane database (HURDAT2), reanalysis data from ERA5, and NOAA, we investigate the influence of five climate change indicators: sea surface temperature, ocean heat content, total column water vapour, the 26th-degree isotherm, and Clausius Clapeyron relationship over on the genesis regions of tropical cyclones in the North Atlantic. Statistical analysis and clustering machine learning methods are used to detect trends and test the statistical difference between the genesis regions and clusters of tropical cyclones over decadal and climatic periods. An improved understanding of how the genesis regions and landfall variabilities are evolving under the influence of climate change will inform disaster risk management professionals in nations, affording the opportunity to take adaptative measures in cases of increased risk of hurricane landfall.

Keywords

North Atlantic, Hurricane, Tropical cyclone, Climate change, Cyclogenesis

Poster Onsite Q&A Session

The Role of Wastewater Treatment Plants in Heavy Metal Pollution of Surface Waters: Evidence from the Pilica River, Poland

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Pollutants such as heavy metals, currently represent one of the greatest threats to the environment and aquatic ecosystems. The intensive development of industry and agriculture, rapidly progressing urbanization, and insufficiently effective wastewater treatment contribute to the increasing presence of toxic substances in the environment. These substances not only accumulate within ecosystems but also lead to the deterioration of the surface waters quality (Piwowarska & Kiedrzyńska, 2022; Piwowarska et al., 2024). Even a slight increase in heavy metal concentration can negatively impact individual organisms disrupt the food chain, and ultimately affect human health.

Taking the above into account, in order to meet the requirements of the Water Framework Directive (2000/60/EC of 23 October 2000), it is necessary not only to conduct environmental monitoring but also to identify substances included i.a. on the priority list contained in the Regulation of the Minister of Maritime Economy and Inland Navigation of 12 July 2019, and to eliminate or significantly reduce the transfer of heavy metals (e.g. cadmium, lead, nickel, mercury) to the environment.

The study aimed to assess the contribution of industrial facilities and municipal wastewater treatment plants to heavy metals discharge and to analyze the impact of wastewater treatment plants on water quality in the Pilica River catchment (central Poland). Seasonal monitoring conducted in 2022/2023 detected the presence of toxic heavy metals in almost all analysed samples (28 sites). The most frequently identified elements included arsenic, barium, tin, zinc, cobalt, copper, molybdenum, nickel, lead, mercury and chromium. The study results highlight the issue of heavy metal contamination in the aquatic environment. Due to the fact that there is still a lack of holistic studies covering entire river catchments, the studies conducted in the Pilica catchment are valuable material in terms of providing new knowledge on the impact of anthropogenic pollutants occurring in the river on its ecosystem and on the ecosystems of the Vistula and the Baltic Sea. Also, in order to permanently eliminate significant amounts of these compounds from the environment, it is necessary to develop effective methods in the field of Ecohydrological Biotechnology and Nature-Based Solutions (NBS) for the remediation of polluted waters and wastewater discharged into the environment. Because of effectiveness demonstrated by them, their use is in line with the current policy of the European Commission, the European Green Deal and the Baltic Sea Action Plan, aimed at improving the condition of surface waters.

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Keywords

Heavy metals, Pilica River, Pollution detection, Bioremediation

Detection of Microplastics in Seawater via AUV Sampling at Variable Flow Rates

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Plastics persistently infiltrate our oceans and break down into small pieces. When smaller than 5 mm, they are called microplastics (MPs). MP pollution can potentially harm ocean ecosystems. They are tiny and ubiquitous in the biosphere, even found within the bodies of animals. This characteristic significantly complicates their removal. Due to their difficult-to-degrade properties, they persist in the ocean environment. The porous structures make MPs prone to accumulating harmful bacteria and toxic chemicals, threatening marine life and ocean biomes over long timescales. Conventional methods, including the Fourier-transform infrared (FTIR) spectrophotometer system, Raman spectroscopy and Near-infrared (NIR) spectroscopy, are designed for laboratory environments for MP detection and are not suitable for use as in-situ real-time microplastic detectors on Autonomous Underwater Vehicles (AUVs). A research team at the University of Bayreuth proposed a rapid and robust method for detecting microplastics from environmental samples using Function Point Analysis based on a Fourier-Transform infrared (FTIR) spectroscopy system for the first time. However, it requires sample collection and preparation. Another team at the University of Hong Kong developed a method using a polarization camera to intelligently detect microplastics at flow rates ranging from 2 mL/min to 15 mL/min, demonstrating good performance. However, the flow rate is too slow for AUV use, and the samples are manually prepared rather than directly collected from the natural marine environment, underscoring the challenges that persist in practical applications. A few existing microplastic detector sensors can be used on AUVs to help researchers effectively monitor microplastics in the ocean. We are developing this methodology in the laboratory by employing machine learning algorithms and a polarization camera to detect MP mixed with seawater as it flows through a glass channel. The method features a compact design, making it a promising candidate to mount on a 5.5 m Explorer AUV. The AUV's cruising speed is 1.5 m/s. The study aims to align with this velocity as closely as possible to detect 0.5 mm - 5 mm microplastics mixed with seawater at adjustable flow rates from 0.07 to 6000 mL/min in the lab environment. In the meantime, the detection accuracy needs to be maintained, and the MP detector requires preparation for its forthcoming integration into the Explorer AUV. We also plan to collect MPs using the Explorer AUV with a trawl system, the "Babylegs" sampling setup motivated by researchers from Memorial University. The collection location is chosen near or in Holyrood Bay, Newfoundland, at constant pre-set depths. In our laboratory, we will reuse collected MPs to validate that the detection system inspired by previous research is capable of identifying targets from a real-world marine setting.

Keywords

Microplastic detection, Machine learning, Babyleg, AUV

A Review of QSAR Applications in Terpene Toxicity Analysis

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Terpenes are a large and diverse class of naturally occurring organic compounds widely found in plants, fungi, and some animals. Due to their broad distribution and structural diversity, terpenes exhibit a wide range of biological activities. Notably, their inherent toxicity has significant application value. For example, many terpenes are used as insecticides or antifungal agents in agriculture, medicine, and industry. As the utilization of terpenes continues to expand, a better understanding of their toxicological properties becomes increasingly important for both safety evaluation and application development. Quantitative Structure-Activity Relationship (QSAR) models offer a powerful computational approach to evaluate the toxicity of chemical substances based on their molecular structure. These models are particularly valuable in terpene toxicity studies, given the structural diversity and complex mechanisms of action exhibited by terpenes. In recent years, QSAR methods have been widely applied to assess various types of terpene toxicity, including acute aquatic toxicity, bacterial toxicity and insect toxicity. This study systematically summarized the current landscape of QSAR applications in terpene toxicity assessment. By comparing modeling approaches, molecular descriptors, and toxicity endpoints across studies, we identified common research paradigms and highlighted recurring structure-toxicity relationships. Furthermore, we examined how QSAR results relate to specific application contexts such as pesticide design and antimicrobial development, revealing underexplored areas such as chronic toxicity, mixture effects, and ecotoxicity. The findings of this review aim to serve as a reference framework for future QSAR studies in the field, guiding the development of more targeted, interpretable, and application-driven models for terpene toxicity analysis.

Keywords

QSAR, Terpene, Toxicity analysis, Insecticide

Exploring the Role of Regenerative Agriculture in Promoting the Sustainability of Local Food Systems: A Qualitative study in Newfoundland and Labrador.

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Abstract

Background: Regenerative agriculture has emerged as a sustainable approach to food production, emphasizing soil health, biodiversity, and ecological resilience. In Newfoundland and Labrador, where food security challenges persist due to geographical and climatic constraints, regenerative agriculture holds potential for strengthening local food systems.

Objective: This study explores the role of regenerative agriculture in promoting the sustainability of local food systems in Newfoundland and Labrador by examining the perspectives of key stakeholders, including farmers, community organizations and government officials.

Methods: A qualitative research design was employed through a one-on-one interview with stakeholders engaging in agriculture and food sustainability. Thematic analysis was conducted to identify key themes related to regenerative agricultural practices' benefits, challenges, and policy implications.

Results: Preliminary findings indicate the need for climate-resilient farming techniques, including season extension strategies and improved soil health practices, alongside better financial and policy support for farmers. The study also identifies the importance of education, supply chain management, and collaborative research to foster the growth of regenerative agriculture in Newfoundland and Labrador. Recommendations for overcoming barriers include enhancing soil regeneration practices, improving access to training and financial support, and strengthening local food systems through direct-to-consumer sales and institutional partnerships. Ultimately, the study underscores the potential of regenerative agriculture to enhance food security, mitigate climate change, and create economic opportunities for rural communities in Newfoundland and Labrador.

Keywords

Regenerative agriculture, Climate resilience, Soil health, Food sustainability, Local food systems, Newfoundland and Labrador.

Lifecycle-Based Strategies for Environmental Management in Petroleum and Petrochemical Industries

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Environmental risk management of contaminated sites in the petroleum and petrochemical industries is critical to safeguarding ecological security and sustainable development. This study proposes an innovative Integrated Contaminated Site Management (ICSM) framework, establishing a closed-loop lifecycle approach from contamination identification to long-term control. Upon contamination detection, high-precision site investigations are employed to delineate pollutant distribution and migration patterns. Multimedia risk assessments quantify human health and ecological risks, prioritizing remediation zones.

The remediation phase adopts a "zoned, graded, and synergistic" strategy, integrating physicochemical techniques (e.g., in-situ thermal desorption, chemical oxidation), bioremediation (microbial enhancement, phytoremediation), and hybrid technologies to target hydrocarbons and heavy metals. Post-remediation, a "monitoring-alert-response" system is established, leveraging big data analysis to track residual risks and prevent secondary contamination through regulatory measures (e.g., land-use restrictions, periodic audits). For sustainable post-management, a "prevention-control-governance" mechanism is emphasized. Petroleum and petrochemical industries are advised to conduct regular soil-groundwater monitoring, employ AI-driven predictive models for contamination rebound analysis, and implement adaptive control strategies. Remediated sites should be repurposed for low-sensitivity industrial or ecological use under green regeneration principles. By harmonizing technological innovation with institutional governance, such as embedding environmental accountability into corporate workflows, the ICSM framework drives the transformation of contaminated sites into low-risk, resource-efficient assets, offering a replicable paradigm for global low-carbon transitions in the petroleum and petrochemical sector.

Keywords

Integrated Contaminated Site Management (ICSM), Life cycle remediation, Risk assessment, Remediation technologies, Long-term governance

Study on Soil-Groundwater Contamination Remediation and Risk Control in Operating Petrochemical Plant

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Operational petrochemical facilities face persistent risks of soil and groundwater contamination due to the continuity of production activities. Critical pollution pathways include leaks from pipelines and processing units, failure of impermeable barriers in hazardous waste storage areas, and aging wastewater treatment systems. Under long-term dynamic production conditions, contaminants such as hydrocarbons, heavy metals, and organic compounds often accumulate covertly, migrating through soil pores into groundwater systems. This results in diffuse contamination plumes with poorly defined spatial boundaries and migration pathways, posing significant challenges to contamination prevention and control.

The remediation of such contamination is constrained by three primary challenges: (1) Hidden contamination identification: Traditional site investigations are hindered by dense infrastructure layouts and limited accessibility, reducing the resolution of contamination mapping; (2) Spatiotemporal conflicts between production and remediation: Conventional technologies (e.g., excavation, pump-and-treat) are incompatible with the demand for remediation without the production interruption; (3) Dynamic multi-phase pollutant migration: Interactions between soil and groundwater systems facilitate the formation of complex, heterogeneous contamination plumes, escalating risk management complexity. This paper highlights the urgent need for integrated solutions that merge advanced monitoring technologies (e.g., real-time sensor networks, three-dimensional (3D) contaminant modeling), in-situ remediation techniques (e.g., chemical oxidation, bioelectrochemical remediation), and adaptive management strategies. These innovations aim to establish a science-based framework for pollution control in operating petrochemical plant.

Keywords

Operational petrochemical facilities, Soil and groundwater contamination, Contamination identification, Remediation challenges, Multimedia migration, Integrated solutions

Pharmaceuticals, Microplastics, and Biogenic Compounds in River and Wastewater: Ecohydrological Catchment Monitoring and Photonic Sensor Technology

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Emerging pollutants in water and wastewater pose an increasing challenge for water resource management and environmental protection worldwide. The term 'emerging pollutants' refers to a broad range of chemical and microbiological substances that were previously unrecognized as threats to aquatic ecosystems or human health, or whose potential adverse effects have only recently been identified. This category includes pharmaceuticals (such as antibiotics and hormones), microplastics, and various pathogens, including antibiotic-resistant bacteria. Emerging pollutants originate from diverse sources, including households, industry, agriculture, and healthcare facilities, and can enter aquatic environments through multiple pathways, such as untreated or insufficiently treated wastewater, as well as urban and agricultural runoff. Due to their persistence, bioaccumulation potential, and toxicity, these contaminants pose a significant threat to aquatic ecosystem health and may have long-term consequences for biodiversity and human well-being. The development of an advanced, real-time water quality monitoring system is therefore crucial. In this context, the objective of this study was to:

1) Analyze of the role of wastewater treatment plants (WWTPs) in the emission of pharmaceutical and chemical pollutants, antibiotic-resistant bacteria, and microplastic particles into the waters of the Pilica River (central Poland). Ecohydrological studies were conducted in the Pilica River catchment (9,258 km², the largest left-bank tributary of the Vistula River), covering 17 municipal wastewater treatment plants of varying capacities (as part of the NCN-funded project, Poland, Acronym: Farmikro).

2) Develop of novel photonic probes for remote monitoring of parameters such as nitrate, nitrite, phosphate concentrations, and optionally ammonia and microplastics. The identification of signals emitted by various chemical compounds with characteristic absorption bands is expected to enable their differentiation with high probability (Research conducted within the NCBR-funded project, Poland, Acronym: FOSMO Water).

The studies revealed the presence of a wide range of pharmaceuticals, including antibiotics, as well as antibiotic-resistant bacteria (ARB) and microplastics, in both raw and treated wastewater. This contamination contributes to the pollution of the entire Pilica River system and increases ecotoxicity. The interdisciplinary nature of this study is essential for enhancing our understanding of aquatic ecosystem conditions and the spread of pollutants, including nitrogen and phosphorus compounds, for which photonic monitoring methods are being developed.

The research was conducted within the following projects funded by:

1/ The National Science Centre (NCN), Poland, as part of the Farmikro Project - 2021/43/B/ST10/01076;

2/ The National Centre for Research and Development (NCBR), Poland, as part of the FOSMO Water Project - HYDROSTRATEG1/000E/2022.

Keywords

Ecohydrological monitoring of the catchment area, Emerging pollutants, River, Wastewater treatment, Photonic sensors

Restaurant food waste reduction using nudge at customer level: An interventional study

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Food waste is a major global challenge with serious consequences for food security, the environment, and the economy. A significant portion of this waste happens at the consumer level, especially in restaurants, where portions, habits, and decision-making all play a role. This study explores how small behavioral nudges can help reduce food waste in a local restaurant in downtown St. John's, Newfoundland and Labrador, Canada. Over four weeks, we tested three different nudges—simple messages placed on table tent cards and menu stickers—to see how they influenced customer behavior. At the start, diners left an average of 37.2 grams of food per order. The first nudge brought that down by 47%, reducing waste to 19.7 grams. The next two nudges resulted in a 21.8% reduction from the baseline, with an average of 29.1 grams per order. Take-out box use also shifted, dropping from 14.4 boxes per 100 orders with Nudge 1 to just 3.4 boxes with Nudge 3. These results shows the power of simple, low-cost interventions to change behavior and reduce food waste in restaurant settings. The study adds to the growing research on food waste reduction and provides practical strategies for restaurant owners, policymakers, and sustainability advocates. Future research should examine how these nudges hold up over time, how customers perceive them, and how they could be scaled up to create a broader impact.

Keywords

Food Waste Reduction, Nudges, Restaurant Food Waste, Food Security, Customer Behavior

Carbon Dioxide Capture in Canada: Technologies, Policies, and Global Standing

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Carbon dioxide (CO_2) is the dominant anthropogenic greenhouse gas and a key driver of global climate change. With one of the highest per-capita emission rates among developed nations, Canada faces mounting pressure to decarbonize its economy while maintaining industrial competitiveness. In response, the federal government has adopted an ambitious net-zero emissions target by 2050, backed by national legislation and policy instruments.

Carbon capture, utilization, and storage (CCUS) has emerged as a cornerstone of Canada's climate strategy. It offers a viable pathway to reduce emissions from heavy industries and power generation. Canada's geological storage potential and supportive policy environment position the country as a serious global player in CCUS deployment. This poster summarizes Canada's CO_2 capture landscape, including major projects, policycontext, and global positioning. It identifies key strengths and challenges in scaling up CCUS to meet national climate goals.

Keywords

Carbon capture, CCUS, Canada, Climate policy, CO_2 storage, Net-zero emissions

Antidiabetic Drug Pollution in Water: An Urgent Emerging Threat and a Pathway Toward Biochar-Based Removal and Degradation

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This study explores the presence and treatment of antidiabetic drugs (metformin, vildagliptin, sitagliptin) in water. It analyzes the global market growth, widespread detection in water bodies, and the performance of existing adsorption technologies. The aim is to design a new method using modified biochar that can remove these drugs, regenerate for reuse, and safely degrade pollutants without creating harmful byproducts. Using pharmaceutical compounds in modern healthcare and daily lifestyle has introduced new contaminants into water globally. Over 160 different pharmaceutical pollutants have been detected in wastewater treatment plant effluents and other water bodies at concentrations of ng/l to µg/l. High persistence, low biodegradable nature, bioaccumulation, potential toxicity, and relative stability of these compounds made them much more difficult to remove from the environment. Some drugs remain active long after their expiry dates, with antibiotics detected in the environment, with 90% of their compounds remaining active 28-40 years after manufacturing. Among these pharmaceuticals, antidiabetic drugs are most commonly detected worldwide in wastewater and surface water. Studies from Canada have shown that 51% of water samples in Quebec and 50.7% in Ontario were contaminated with antidiabetic medications. According to WHO, 830 million people were living with diabetes globally in 2022, and the diabetes drug market (in USD billion) is expected to grow from 110.4 in 2023 to 205.3 by 2030. This exponential growth in the global market indicates that contamination could get worse. Currently, wastewater treatment plants are not designed to handle these drugs, and very limited research is being done regarding their effective removal and breakdown. Addressing the gap, our research focuses on developing chemically modified, regenerative adsorbents for removing anti-diabetic drugs from water and pathways for proper degradation.

Keywords

Anti-diabetic drug, Regenerative adsorbents, Degradation, Water treatment

New Analytical Methods in Water Quality Monitoring: From Microextraction to In-Situ Sensors

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Water is one of the most valuable environmental resources, and its quality is crucial for human health and ecosystem stability. Increasing urbanization, intensive agriculture, and the development of industry and pharmaceuticals contribute to water pollution, necessitating the implementation of effective water quality management strategies. Modern challenges in water protection arise from the growing presence of both so-called emerging contaminants (e.g., pharmaceuticals), which have only recently been identified as environmental and health hazards, and well-known, long-monitored pollutants such as inorganic ions, including ammonium, nitrate, nitrite, and phosphate. These contaminants can cause severe ecological consequences, such as eutrophication, changes in the biological composition of aquatic ecosystems, and health risks, for example, when consuming water contaminated with pharmaceuticals or excessive nitrate levels. Given the potential threats associated with these substances, the development of effective analytical methods enabling their precise measurement is of key importance.

For pharmaceuticals, high-performance liquid chromatography coupled with mass spectrometry (HPLC-MS/MS) is the gold standard in detection. Although most established analytical methods use solid-phase extraction (SPE) as a sample preparation step, recent years have seen growing interest in dispersive liquid-liquid microextraction (DLLE) techniques for pharmaceutical analysis in water. This trend stems from the need to develop more efficient, sensitive, and environmentally friendly sample preparation techniques in line with the principles of green chemistry. The advancement of these methods is crucial for monitoring water quality and assessing the environmental impact of pharmaceuticals.

Although colorimetric and spectroscopic techniques used for ion determination are highly sensitive, most laboratory approaches involve multiple steps that can be costly, labor-intensive, and unsuitable for direct fieldwork. Consequently, recent years have seen increasing attention to the development of continuous-monitoring sensors, which minimize sample disturbance and provide real-time data without the need for sample transportation to a laboratory. The advantage of such technology lies in its ability to enable rapid responses to regulatory exceedances, facilitating water quality management in reservoirs and wastewater treatment plants.

The work is dedicated to showcasing the development of new, alternative, and innovative methods for monitoring chemical water quality parameters within the framework of the FOSMO Water project. These methods utilize photonic probes that perform real-time measurements, significantly reducing analytical costs and measurement time.

Funding source: The National Centre for Research and Development (NCBR) as part of the FOSMO Water Project HYDROSTRATEG1/000E/2022.

Keywords

Monitoring, Environment, Microextraction, HPLC-MS/MS, Optical sensors

Exploring eDNA Metabarcoding as a Non-Invasive Monitoring Tool in Cold Oceans

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Climate change is warming the Subarctic and Arctic Oceans at a rate of 3-4 times the global average. This key driver of change urgently demands effective, cost-efficient, and non-invasive tools to monitor marine biodiversity in cold oceans, where harsh conditions can pose unique challenges. Environmental DNA (eDNA) metabarcoding, an increasingly popular sampling technique, offers a non-invasive approach based on the detection of trace DNA from water samples, followed by amplification and sequencing to determine species presence and overall biodiversity. Following development of a traits -based database, I will combine literature-based trophic information with eDNA evidence of species co-occurrence to create food webs for contrasting cold ocean ecosystems. Specifically, I will compare a suite of food web metrics between coastal fjords, continental shelf, deep-sea, and Arctic environments across the Labrador Sea and Baffin Bay to determine how marine regional biogeography shapes ecosystems in Canada's North.

Keywords

eDNA metabarcoding, Monitoring, Food webs, Biodiversity, Labrador Sea, Baffin Bay

Spatial and Temporal Variations of Heavy Metals and Probabilistic Health Risks in Underground Drinking Water Source in the Yellow River Basin

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The Yellow River Basin is an important water source in China, and heavy metal contamination in groundwater has achieved significant attention. This study analyzed the spatiotemporal variations, pollution levels, and sources of six heavy metals (Fe, Mn, As, Cu, Zn, Pb) in 152 underground drinking water sources in the Yellow River Basin from 2018 to 2022, and assessed human health risks，which provided a scientific basis for groundwater pollution management and health risk management. The results showed that the over-standard rates of Fe, Mn, As, Cl-, NH3-N and F- were 0.62%, 2.17%, 0.17%, 0.56%, 0.06%, 0.16% and 0.33%, respectively. The average concentrations of Fe and Mn generally decreased from upstream to downstream, As peaked in the midstream, while Cu, Zn, and Pb were highest downstream. Heavy Metal Pollution Index (HPI) indicated 91.89% and 4.20% of the monitored data were at low and moderate pollution levels, respectively. Principal component analysis shows that Fe, Mn and As in groundwater in the Yellow River Basin were mainly affected by natural factors, such as mineral oxidation and water-rock interaction, followed by human activities. Cu, Zn and Pb were mainly affected by human factors, such as industrial, transportation and agricultural activities. Correlation analysis showed that hydrochemical parameters NH4+-N and Cl- were associated with the migration and transformation of Mn, Fe and As. The health risk assessment results showed that heavy metals had no significant potential non-carcinogenic risk and carcinogenic risk to human body, but under extreme conditions, both the non-carcinogenic risk value (HQ) and carcinogenic risk value (CR) of As exceeded the standard values in different age groups, and As contributed more than 84% to total CR in 3 age groups. Therefore, it is recommended to improve the quality of underground drinking water sources by strengthening the source control measures and preventive measures, and strengthen the risk prevention and control of As to reduce the risk to human health.

Keywords

Yellow River Basin, Heavy metals, Groundwater, Correlation analysis, Probabilistic health risk, Source identification

A Numerical Modeling Approach to Simulate Pollutant Transport in Estuaries under Multi-Factor Influences

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With the increase in population and development in coastal areas, pollutants enter estuaries through rainwater runoff, industrial discharge, sewage treatment, and atmospheric deposition. These inputs have caused severe environmental pollution. Developing accurate numerical models can more help effectively understand and address pollution issues in estuaries. However, simulating pollution transport in estuaries requires consideration of multiple factors. These factors impact the stability and reliability of the model and may lead to inaccurate predictions and data distortion. This study aims to develop a comprehensive model to accurately explain and predict the migration and transport processes of pollutants in estuaries by combining hydrodynamic and water quality models. The two-dimensional fluid dynamics module is used to simulate free surface flow in estuaries and coastal areas. The water quality module is applied to simulate the dispersion and deposition of toxic substances and suspended particles and may also account for biochemical reactions. In addition, both models can be further refined by incorporating the influence of various factors (e.g., salinity, sediment characteristics, water quality parameters, meteorological factors, and physicochemical properties of pollutants), thereby improving their accuracy and applicability. This study adopts polycyclic aromatic hydrocarbons (PAHs), which are representative and environmentally persistent, as representative pollutants to validate the model's applicability in simulating the migration process of typical organic pollutants. According to preliminary results, PAHs tend to accumulate in sediments with weak hydrodynamic conditions, and sediment viscosity appears to affect their aggregation behavior. This model can enhance our understanding of how each factor influences pollutant migration. It supports better assessments and predictions of estuarine pollution and helps develop scientific and effective management strategies.

Keywords

Pollutant-transport, Hydrodynamic modeling, Water quality simulation, Estuary, Pollution risk

Forecasting and Management of Potato Late Blight

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Potato late blight (PLB), caused by the oomycete Phytophthora infestans, causes significant yield and quality losses for potato crops every year. Under optimal environmental conditions, the disease can spread rapidly and lead to catastrophic losses. Growers have used disease forecasting methods since the early 1900s to evaluate the likelihood of a disease outbreak occurring and progressing. Controlling PLB with fungicides is the most effective way to manage the disease; however, when weather conditions are unfavourable for disease development, fungicide treatments are less effective, resulting in unnecessary costs and environmental damage. Therefore, surveillance and disease forecasting are necessary for effective PLB management. This study evaluates different crop disease forecasting models for PLB control in Atlantic Canada and addresses the benefits and challenges associated with their implementation.

Keywords

Climate data, Disease forecasting, Phytophthora infestans, Potato late blight

Arsenic Distribution and Speciation in Multiphase Media in A Large Shallow Lake: The Influence of Eutrophication on Arsenic Cycling in Freshwater

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Arsenic distribution and speciation in multiphase media were analyzed from four Lake Taihu zones in summer, winter and spring to ascertain biogeochemical cycling and potential ecological risks in eutrophic lake systems. Generally, total arsenic concentrations in surface water, containing dominant inorganic arsenic species (arsenate and arsenite) and trace amounts of methylarsenicals (the sum of monomethylarsenic acid and dimethylarsenic acid), were higher in the eutrophic northern zones than in the mesotrophic southern zone. Surface sediment in the former contained more specifically-sorbed arsenic and amorphous iron (hydr)oxide-bound arsenic. In interstitial water, total arsenic concentrations showed an obvious increase during summer, especially in the northern zones, which is attributable to strong arsenic diffusion from sediments to the aqueous phase triggered by elevated pH levels induced by algal blooms and the reductive dissolution of amorphous iron (hydr)oxide. Accordingly, inorganic arsenic concentrations in interstitial- and even surface water increased significantly in the northern zones during summer and positively correlated to pH levels and free iron concentrations. An increase in dissolved organic carbon derived from algal degradation also promoted high arsenic concentrations in surface water. Furthermore, the relatively higher arsenite and methylated arsenic concentrations in phytoplankton in eutrophic zones were a response to much more vigorous arsenic biotransformation. In addition to phytoplankton metabolism, arsenic biotransformation was facilitated by high nitrogen levels and low phosphorus and arsenate ratios in surface water, favoring increased arsenite and methylarsenicals in eutrophic water during summer. Comparatively, lower arsenic concentrations were found in the aqueous phase and in phytoplankton during winter and spring. Of interest were the higher interstitial total arsenic and arsenite concentrations in spring compared to winter, a potential indicator of arsenic remobilization from sediments triggered by algae recruitment.

Keywords

Algal blooms, Arsenic species, Biotransformation, Mobilization

Unlocking the Value of Slaughterhouse Waste through Sustainable Hydrolysis for By-products Recovery

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Unlocking the Value of Slaughterhouse Waste through Sustainable Hydrolysis for By-product Recovery

Slaughterhouse waste (SHW) is a protein-rich byproduct with exceptional potential for methane generation via anaerobic digestion. However, in regions like Newfoundland and Labrador, this resource remains largely untapped due to its resistance to degradation and the high operational costs associated with conventional pretreatment, such as commercial enzymes, pH adjustment, or thermal input.

This study proposes an innovative and economically viable enzymatic hydrolysis approach utilizing proteolytic enzymes sourced from agro-industrial fruit waste, including kiwi, pineapple, and papaya. Unlike conventional techniques that often rely on commercial enzymes, pH regulation, or heat treatment, this method operates under ambient conditions, requiring no supplemental energy or chemical input. Cow blood was treated with varying proportions of fruit pulp and incubated. The extent of hydrolysis was assessed through multiple analytical techniques, including Ninhydrin and Bradford assays for amino acid and peptide quantification, volatile solids (VS) reduction for organic matter degradation efficiency, and FTIR spectroscopy for monitoring molecular-level structural changes. The results demonstrated a high degree of protein conversion into low-molecular-weight bioactive compounds, validating the process as a sustainable and low-cost alternative for waste valorization.

Importantly, this enzymatic pretreatment enhanced the subsequent methane yield in anaerobic digestion, significantly improving energy recovery from SHW. Based on reported biogas yields of 0.3-0.6 m³/kg total solids (TS) from cow blood and methane content of 60-65%, anaerobic digestion of this substrate presents a promising avenue for renewable energy production. Considering the energy potential of methane, this could translate to approximately 2.1-4.2 kWh of electricity per kg TS under optimal conversion conditions. Such energy recovery not only offsets the environmental burden of slaughterhouse waste but also contributes to decentralized, sustainable electricity generation within a circular bioeconomy model [1].

This research demonstrates a scalable and climate-conscious solution that integrates bioactive compound recovery with renewable energy production. The method aligns with circular economy principles and offers a practical model for sustainable SHW management in remote or off-grid regions.

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Keywords

Slaughterhouse waste, Enzymatic hydrolysis, Proteolytic enzymes, Actinidin, Bioactive peptides, Anaerobic digestion, Biogas production, Circular economy, Waste valorization, Newfoundland

A Novel Spectral Index for Detecting Large Plastic Accumulations Using Sentinel-2 Imagery

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Plastic waste is widespread in aquatic environments, from inland lakes to remote oceans. While satellite remote sensing provides a timely method for monitoring macroplastics, developing accurate detection approaches remains a challenge. This study introduces three new indices—chosen from ten band combinations based on hyperspectral measurements of water, wood, and plastic—and evaluates their ability to improve macroplastic detection. Using Random Forest models trained and tested on the Sentinel-2-based Marine Debris Archive (MARIDA) benchmark dataset (MBD), we find that Index-1 increases the F_1 score for plastics from 0.814 to 0.816, Index-3 boosts it to 0.823, and their combination achieves 0.827. Further testing with the Plastic Litter Projects (PLP) dataset supports these findings, as Index-1 raises the F_1 score from 0.667 to 0.684, and Index-3 increases it to 0.757. Overall, Index-1 and Index-3 significantly enhance the performance of Sentinel-2-based macroplastic detection models, demonstrating the effectiveness of the developed indices and their promising applicability in real-world environmental monitoring.

Keywords

Macroplastic, Sentinel-2, New index, Machine learning, Random Forest