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SESSION 1A — INTEGRATED WATER QUALITY MONITORING AND MANAGEMENT

Passive Sampling of Pathogens in Water

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Effective microbial monitoring in water systems is critical for protecting public health. Passive sampling provides a unique opportunity to representatively sample waters in remote and difficult to reach locations. This groundbreaking study presents the first successful attempt to quantitatively back-calculate microbial concentrations from passive samplers deployed in water systems, offering a practical alternative to expensive autosampler infrastructure. We compared three passive sampling materials against traditional composite autosamplers for detecting three pathogens. Field trials were conducted across multiple events in Melbourne, Australia, with deployment durations ranging from 6 to 96 hours. Results demonstrated distinct performance characteristics for different passive materials. Cotton-based samplers excelled at early pathogen detection during short deployments (6-48h), particularly under high turbidity conditions following rainfall peaks. Electronegative membranes showed superior performance for longer deployments (48-96h), achieving consistent linear uptake of CrAssphage with a quantifiable accumulation rate of 7.44 mL day^{-1}. Most significantly, we successfully back-calculated time-weighted average concentrations from passive samplers that aligned closely with autosampler measurements. Agreement improved substantially with deployment duration. This research addresses critical infrastructure challenges facing Canadian municipalities by providing a scalable, cost-effective monitoring solution. Passive samplers require no power, minimal maintenance, and can be deployed in remote locations where traditional autosamplers are impractical. The methodology enables enhanced microbial risk assessment for stormwater reuse applications while supporting evidence-based methods. The findings have immediate applications for Canadian water professionals managing water systems, particularly in northern climates where equipment maintenance and power access are challenges.

Integrated Surveillance of Antimicrobial Resistance Genes Across One Health Reservoirs: Surface Water, Municipal and Hospital Wastewater, And Farm Animal Manures

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The rise in antimicrobial resistance (AMR) poses a significant global health threat to human, animal, and the environment. Addressing AMR requires a One Health approach recognizing their interconnectedness. The goal of the program is to develop a sensitive, cost-effective, accessible and informative surveillance technology of antimicrobial resistance genes (ARGs) capable of identifying similar sequence variants in different One Health reservoirs. The technology relies on sequencing PCR amplicons. Field studies followed two sampling designs. First, samples of municipal wastewater and manures from chicken, swine, and cattle were obtained from across Canada and the sequence variants of 13 ARGs were compared. Second, sample types were extended to include hospital wastewater, surface water, and retail meat. These samples will be obtained from a single sentinel region of the federally-coordinated FoodNet program located in Montérégie inscribed in the Richelieu and Yamaska watersheds. Sample collection will continue for two years. They will be analyzed for the variants of approximately 100 clinically relevant ARGs after a PCR survey of 384 genes. Cross-Canada samples revealed 4 distributions of sequence variants. (1) Variants found in all reservoirs included all beta-lactamases (blaOXA, blaKPC, blaTEM, blaLCR, blaCTX), ereA (macrolide resistance), and multidrug efflux pumps (mdtH resistance to fluoroquinolone, mdtG resistance to phosphonates). (2) Variants of two ARGs were segregated between wastewater and the animal manures (mefA for macrolide resistance, qnrB for fluoroquinolone resistance). (3) The tetracycline ARG (tetM, tetW) variants appeared segregated between chicken and swine on one side and cattle and municipal wastewater on the other side. (4) Finally, the same variants of lnuC (lincosamide resistance) were found in chicken and swine manures, and wastewater, but they were different in cattle manure. Thus, it appears that the type of resistance may influence the variants distribution, and hence the observed connectivity between reservoirs. Future work will involve incorporating the variant distribution information with the integrated risk assessment model for AMR (iAM.AMR) in development by PHAC to provide new information for mitigation to policy makers.

An Ontology-Driven Multi-Agent Framework for Decentralized Water Management

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Introduction Water stress—driven by climate change, population growth, and aging infrastructure—is pushing a shift toward decentralized water solutions. Decision support systems are vital for optimizing water management, yet face challenges from data fragmentation and limited interoperability. This study presents a semantic modelling architecture that unifies heterogeneous data into a structured knowledge graph to support scalable, integrated decision-making. Methodology At its core, the architecture uses an RDF-based ontology to semantically represent decentralized water systems, integrating domain-specific concepts with top-level ontologies. The ontology is extensible, enabling cross-domain scalability. Data are mapped into RDF triples to build a dynamic knowledge graph, which agents can query, update, and reason over in response to user inputs or new data. A multi-agent system interacts with this graph: • Query Agent handles SPARQL queries and triggers computations when data are missing. • Mass Balance Agent simulates water flows and tank dynamics. • RO Agent models reverse osmosis processes. • Optimization Agent balances cost, efficiency, and sustainability. • Weather Agent integrates localized data using geospatial metadata from the Open-Meteo API. • Mapping and Update Agents convert household-level data into RDF triples and keep the graph updated. Results and Discussion This setup enables static queries (e.g., tank capacity) and dynamic ones (e.g., water levels), where agents initiate simulations, compute missing data and refresh the graph. In one scenario, the system optimizes a household setup by minimizing energy use, rainwater refills, and tank costs. Decision variables include tank size and greywater reuse, with or without MBR treatment. The Optimization Agent identifies balanced solutions based on user goals. Future Work Ongoing development aims to scale this framework to the city level, integrating decentralized and centralized systems.

Assessing Coastal Urban Water Metabolism Based on the Water Mass Balance Framework Across Periods

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Due to the combined effects of population growth, urbanization, and climate change, resource shortages in coastal areas have led to increasing environmental, ecological, social, and economic problems. It cannot be ignored that the status of water resources in many coastal cities has become increasingly fragile. In a changing climate, the amount and intensity of rainfall have continued to decline, resulting in some coastal regions experiencing severe drought. Simultaneously, the water supply situation has further deteriorated because the water storage capacity of local dams cannot meet the rapidly growing needs of citizens and industries in coastal areas. As coastal cities face water resource challenges, in order to have a clearer understanding of the current status of urban water resources, water managers and planners need first to integrate all water flows into an integrated system. At the same time, exploring the natural water cycle and the possibilities for efficient water use in coastal areas requires quantifying the performance of the entire water system. This study established a water–energy nexus in special circumstances by comparing water-related electricity consumption and energy emissions before and after a drought period to analyze and determine the correlation between the two types of flows. A water balance model and a water metabolism assessment framework are applied to demonstrate the performance of Cape Town's water system over four different periods. The findings of this study can help reveal the role of water-sensitive interventions during critical periods in achieving water performance targets, such as increasing precipitation use efficiency, diversifying alternative water sources, and improving the health of urban water metabolism, as well as managing increasingly stressed urban water systems in coastal cities under climate change.

Maintenance Matters: Effects on Rainwater Harvesting Systems Performance and Water Quality

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The broader adoption of rainwater harvesting systems in Canada will not be possible without extensive research to support the integration of this emerging technology into codes of practice and to validate the existing criteria for design and maintenance requirements. In this study, three residential systems equipped with 5-micron filters were investigated. The filters were replaced nine months after installation, and the storage tank was emptied and cleaned following one year of water quality monitoring. Reductions of 36%, 16.6%, and 70% were observed in turbidity, heterotrophic plate count, and dissolved organic carbon, respectively. The sediments that had accumulated in the tank underwent both quantitative and qualitative analysis. The identification of composite elements, including quartz and albite, along with the measured sediment mass, provided further insight into site-specific factors (e.g., storage tank placement, catchment surface characteristics) and their impact on the system's performance. Water samples collected from residential systems were compared with those from large building systems in terms of metal content. The average sodium concentration in residential samples was 1.3 mg/L, whereas samples from large buildings showed significantly higher levels, averaging 25.5 mg/L. Systems maintaining free chlorine concentrations within the range recommended by the Canadian National Standard for Rainwater Harvesting Systems (CSA B805-18/ICC 805-2018; 0.5–2 mg/L) generally exhibited lower heterotrophic bacterial counts, with no detection of total coliforms or Escherichia coli in 100 ml of sample. However, the elevated sodium levels observed in these systems may correspond to the use of sodium-based disinfectants, such as sodium hypochlorite. Continuous monitoring of the tank's water level and the flow rate to the end-use points within the building is being conducted to evaluate the influence of hydraulic retention time on key water quality parameters.

SESSION 1B — ADVANCES IN BIOLOGICAL WASTEWATER TREATMENT

Improving Denitrification Process in a Wastewater Treatment Plant by Using Methanol Produced In-Situ from Greenhouse Gas

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Connor Lynch-Staunton Wastewater treatment plants (WWTPs) are increasingly recognized as significant contributors to greenhouse gas (GHG) emissions worldwide. These emissions? mainly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)? are produced during biological aerobic and anaerobic treatment processes. Activated sludge processes, particularly those involving aerobic respiration and nitrification-denitrification cycles, contribute to the production of CO_2 and N_2O due to microbial metabolism. Insufficient carbon availability during denitrification often results in incomplete nitrate reduction, leading to increased emissions of N_2O. The denitrification process is upgrading by addition of carbon under the form of methanol. Methanol is increasingly being used as a supplemental carbon source in denitrification processes. When recycled into the treatment system, methanol increases nitrogen removal efficiency and reduces N_2O accumulation caused by carbon limitation, as reported in previous studies. To decrease the costs of purchasing methanol, production of methanol from biogas generated at WWTP was suggested. Thus, a novel electrochemical technology has been developed, which captures both CO_2 and CH_4 and converts them into methanol. Using wastewater effluent as an electrolyte, the device operates at ambient temperature and pressure without catalyst. The system has been designed for low energy consumption, requiring only about 0.06 kWh per run. Different types of diffusers and electrolyte volumes were tested to increase CO_2 transfer and overall efficiency. The resulting products were analyzed using gas chromatography (GC). To adjust the converter to a variety of ventilation systems, the tests were done for emissions containing from 2% to 25% of CO_2. Tests were conducted in HVAC lab at Concordia University. The results showed that biogas with all CO_2 concentrations tested in lab give positive results. Generated methanol can be returned to the denitrification process, improving nitrate conversion to nitrogen gas. The innovation of the system lies not only in capturing greenhouse gases produced by WWTP but also in converting them into a valuable product in accordance with the principles of the circular economy. It can be applied equally for wastewater treatment plants as well as building ventilation systems, petroleum industry, cement production plants, etc.

Shock Strategies for Nitrite Oxidising Bacteria (NOB) Suppression in Membrane Aerated Biofilm Reactors (MABR) to Enhance Partial Nitrification-Anammox (PN/A) Performance

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Partial nitrification-anammox (PN/A) is a cost-effective and energy-efficient nitrogen removal process. The efficiency and stability of PN/A process are often challenged due to the activity of NOB. Effective control of NOB is more challenging under mainstream conditions as compared with side-stream centrate treatment, mainly due to lower temperature and NH4+-N concentration of mainstream wastewater. This study examines multiple shock strategies for NOB suppression under mainstream conditions, namely low pHs (<5.0), high pHs (>9.0), combinations of low pHs with free nitrous acid (FNA), and combinations of high pH and free ammonia (FA). Four MABR pilots were used for this study, while the shock strategies were applied and repeated intermittently when stable complete nitrification was observed in the pilots. Each shock treatment was maintained for 20 hours, followed by a 24-hour batch operation, after which the reactor was transitioned into continuous operation. Similarly, two side-stream MABR pilots were also subjected to high FA in combination with high pH to evaluate the suppression of NOB. Nitrogen species (NH_4^+-N, NO_2^--N, NO_3^--N) were monitored to determine the changes in AOB and NOB activities. Following conclusions were made from this study: (1) low pH shock had better NOB suppression compared to high pH shock; (2) comparing with the low pH shock, high FA exposure combined with high pH achieve a better NOB suppression with less nitrate generation rate; (3) combination of high FA and high pH, when applied repeatedly in side-stream MABR pilots, were effective in achieving NOB suppression. The strategies applied in this study demonstrated that selective suppression of NOB in MABR systems can be achieved effectively.

Anaerobic Fermentation of TWAS: Effects of Physical, Chemical, Biological and Thermal Pretreatments on Solubilization Efficiency

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Anaerobic digestion (AD) is a widely applied biological process for stabilizing waste-activated sludge (WAS), offering the added advantage of renewable energy recovery through biogas production. In the digestion of complex, particulate, or lignocellulosic organic matter such as sewage sludge, the fermentation stage constitutes the initial and rate-limiting step. Recent studies have investigated the integration of fermentation as a standalone stage within AD systems, however, a slow fermentation rate limits the biodegradability of sludge. This study aims to address this limitation by investigating various pretreatment strategies to enhance the solubilization of organic matter before methanogenesis. This study evaluated the impact of various pretreatments on the fermentation phase of AD using thickened WAS (TWAS). Feedstocks were subjected to hydrothermal pretreatment (HTP; 70 °C, 90 °C, and 170 °C), ultrasonication (US; 3000, 5000, and 10000 Kj/kg TS), and alkaline or acidic conditioning, as well as YDRO biological dosing (5%, 10%, 15%). Batch fermentation tests were conducted for 80 h under mesophilic anaerobic conditions, with monitoring of solids composition, pH, soluble chemical oxygen demand (SCOD), ammonia nitrogen (NH_3–N), soluble phosphorus (SP), alkalinity, and volatile fatty acids (VFAs). The Extracellular Polymeric Substances (EPS) were extracted from each of the raw and pretreated feedstocks upon the termination of the fermentation. The samples were analyzed for Proteins and Polysaccharides in each of the soluble (SEPS), loosely bound (LB-EPS), and tightly bound (TB-EPS) EPS. Feedstock pretreatments markedly altered physicochemical properties. HTP (70–170 °C) significantly increased SCOD (9 – 18 g/L) with HTP 70 reaching 2665 mg/L as CH_3COOH VFA, and enhanced SP release (up to 1002 mg/L SP). Ultrasonication produced moderate SCOD gains (4 – 9 g/L) but high soluble phosphorus and elevated ammonia. Although YDRO treatments yielded the highest TCOD (58-71 g/L) they had the lowest soluble results among the measured parameters. Acid treatment (pH 4.9) maximized SP (1006 mg/L) yet inhibited VFAs (44 mg/L CH_3COOH) and showed lowest alkalinity (422 mg/L $CaCO_3$). Overall, thermal pretreatments, especially HTP 70 and HTP 170, were most effective for enhancing soluble fractions and VFA production. These were also consistent with EPS results with protein (502 µg/mL for HTP170) and polysaccharides (236-462 µg/mL) samples having a high SEPS immediately when added to the feedstock. The alkaline chemical pretreatment showed notability high SEPS levels which is correlated with a high pH breaking down cell walls immediately. After fermentation HTP 70 and 170 continued to show strong performance, with HTP 170 achieving the highest VFA concentration

(2642.5 mg/L CH_3COOH), both paired with elevated SCOD (6.5–6.9 g/L). Ultrasonication produced moderate to high VFAs (1976.7 – 2223.3 mg/L) and SCOD levels of up to 6.3 g/L, with US 5000 yielding the best VFAs production. YDRO 15% yielded VFAs comparable to thermal treatments (2633.3 mg/L) despite the lowest alkalinity. Acid treatment maintained the highest SP (831.7 mg/L) but the lowest VFAs production (1745.0 mg/L), while alkaline treatment preserved the highest alkalinity (800 mg/L) with moderate VFAs (2040.0 mg/L). EPS results showed that YDRO had no proteins present (0 mg/L) indicating that proteins were broken down. The thermal pretreatments continued to show high release of soluble matter and breakdown of EPS during the fermentation process showing that proteins and polysaccharides were used up during fermentation. Base pretreatment samples showed considerably low EPS concentrations at termination, showing again that the high pH and chemicals breaks down EPS over time. Overall, results demonstrate that targeted pretreatments substantially improve organic matter solubilization and VFA yields during fermentation, with high-temperature treatments showing the greatest potential for enhancing AD fermentation and acidogenesis. This study provides valuable insights into optimizing the pre-methanogenic phase of AD, with implications for improving startup performance, fermentation-driven resource recovery, and overall process stability in sludge management systems.

Enhancing Methane Production from Thickened Waste-Activated Sludge: A Comprehensive Comparison of Pretreatment Methods

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Anaerobic digestion (AD) is a sustainable approach to reducing volume and recovering value from thickened waste-activated sludge (TWAS) by generating energy from the breakdown of the organic material by anaerobic microorganisms. This is a comprehensive study directly comparing the AD performance of a range of pretreatment methods including chemical, thermal, mechanical, and bioaugmentation. Biochemical methane potential (BMP) tests were conducted on TWAS to measure and compare the performance of eleven pretreatment conditions: ultrasonication (US) at 3000 kJ/kg TS, 5000 kJ/kg TS, and 10000 kJ/kg TS, hydrothermal pretreatment (HTP) at 70°C, 90°C, and 170°C, bioaugmentation technology using the Ydro Process® at doses of 5%, 10%, and 15%, chemical pretreatment with acid (1 M HCl to pH of 4), and chemical pretreatment with base (1 M NaOH to pH of 10). Raw TWAS was used as the control. This experiment was performed in triplicates under mesophilic conditions. Results indicate that TWAS pretreated with the Ydro Process® at a 15% dose generated the highest cumulative methane yield at 286 mL CH4/g COD added and the highest biodegradability at 71%. Similarly, the Ydro Process® at a 10% dose resulted in the same biodegradability of 71% and a cumulative methane yield of 284 mL CH4/g COD added. The third highest performance was TWAS subjected to chemical pretreatment with acid, resulting in a cumulative methane yield of 266 mL CH4/g COD added and a biodegradability of 67%. This study also investigates the foaming potential of each pretreatment condition to evaluate which condition results in the least foaming. In digesters, foaming can lead to issues like pipe clogging. For TWAS pretreated with the Ydro Process® at all doses, maximum foam height during foam tests was under 100 mm and foaming propensity under 85 mm/g TS, indicating minimal foaming effects. These findings suggest that bioaugmentation of TWAS using the Ydro Process® offers a cost-effective pretreatment method to enhance AD performance while also mitigating digester foaming.

Wastewater Surveillance of Antimicrobial Resistance: A One Health Approach

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Antimicrobial resistance (AMR) poses a growing threat to human, animal, and environmental health. Excessive and inappropriate use of antimicrobial agents represent the primary catalysts for AMR, allowing resistant organisms to develop and spread. Currently, AMR surveillance mainly occurs through human testing in healthcare settings, with significantly less surveillance of spread among entire communities as well as environmental and animal reservoirs. Wastewater AMR surveillance enables population-level monitoring by quantifying genetic targets in wastewater samples. This research aims to examine the presence and distribution of AMR in wastewater while investigating relationships with existing clinical data and pharmaceutical use patterns in collaboration with local public health authorities. Utilizing a One Health perspective, we will consider the interconnections between humans, animals, and the environment. Retrospective samples from two wastewater treatment plants serving the population in Kingston, Ontario, will be screened for antibiotic resistance genes via quantitative PCR (qPCR). Spatiotemporal relationships between wastewater AMR signals, community infection rates and prescription data, and local/regional hydrometeorology will be explored via correlational analyses and geographic information system (GIS) approaches. Initial qPCR analyses of samples from 2022 exhibit medium to high abundances of AMR genes coding for resistance to antibiotic classes including beta-lactams, macrolides, and sulfonamides. Of four carbapenemase-producing Enterobacteriaceae (CPE) genes screened for, blaKPC was detected consistently throughout the year, while blaNDM displayed cyclical fluctuations. Abundance of all four genes increased in the fall. The wastewater trends were similar to those of reported CPE-related illnesses, suggesting a potential association between wastewater and local human health. Future work will expand the time scale of this data for comparison with additional clinical and environmental data. By assessing wastewater analysis as a complementary tool to current AMR surveillance efforts, this work will inform future monitoring for AMR, contributing to the overall management of AMR both locally and globally.

SESSION 1C — MICROPLASTIC BEHAVIOR AND REMOVAL

Microplastic Release and Morphological Changes of Reusable Face Masks under Various Conditions

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People are paying more attention to personal protection, leading to a significant increase in the use of masks in daily life. Although masks play a vital role in protecting human health, their environmental footprint remains significant. In particular, masks may contribute to environmental pollution during both use and disposal. This study simulated the use and disposal of masks made with the ëncore® patented technology (Frëtt Solutions etrëma® masks) in natural environment in a laboratory setting and conducted a systematic evaluation of the properties and environmental behavior of reusable masks. Comparative experiments with disposable masks have shown that etrëma masks not only have more stable fabrics but also contribute less to microplastic pollution in aquatic environments. Even after 100 washing cycles, the surface fabric of etrëma masks showed no significant damage, while the inner fabric exhibited minor pilling but no breakage. After 10 days of UV exposure, no surface damage was observed. Although disposable masks also performed well in UV protection, their surface fabric showed significant damage and pilling after only a few washes. These results suggest that, from an environmental perspective, etrëma masks represent a more sustainable alternative to disposable masks.

Evaluating Granular Activated Carbon (GAC) and Biochar for Microplastic Filtration in Drinking Water: Role of Flow Regime, Particle Size, and Organic Matter

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Microplastics (MPs), particles ≤5 mm in size, pose a significant global environmental threat due to their widespread presence in aquatic ecosystems and potential harm to wildlife and human health. The limitations of current water treatment processes have led to the detection of MPs in tap water, highlighting the urgent need for innovative removal strategies. This study systematically evaluates the removal efficiency of two filtration media, granular activated carbon (GAC) and biochar, using a controlled separation-column setup. Experiments are conducted under three hydraulic loading rates (5, 10, and 15 m/h) and for three size classes of fluorescent polyethylene microbeads (10–45, 53–63, and 130–150 µm) representing high-escape MPs in water treatment systems. To reflect realistic environmental challenges, media are tested in both virgin condition and after pre-saturation with humic acid, simulating the influence of natural organic matter on filtration performance. MP quantification was performed via filtration through 0.4 µm filters, drying, and counting via ImageJ software. Removal efficiency (RE, %) is calculated from initial (C_0) and final (C_1) MP concentrations, and RE is plotted for 600 bed volumes (BV), equal to ~6 hours test continuously, to compare performance across media and MP sizes. The initial results reveal that both media maintain high RE (>85%) for MPs > 53 µm at HLR 10 m/h up to approximately 500 BVs, with a rapid breakthrough for GAC after. Pre-saturation with humic acid significantly decreases media performance, with exhausted GAC exhibiting severe RE reductions and instability, leading to a negative RE for small MPs at 60 BV. Exhausted biochar, however, retains relatively robust removal for larger MPs, showing superior resilience to organic matter compared to GAC, underscoring its suitability under realistic environmental conditions. Thus, while both media show strong potential for large MP removal, additional design considerations or media modifications are required to enhance removal of smaller, high-escape particles under prolonged filtration conditions.

Microplastics in Freshwater Food Chains: Priority List Based on Identification of Oxidative Stress Response Characteristic

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Exogenous exposure to high concentrations of microplastics (MPs) cause oxidative damage to freshwater food chains (FFCs). Thus, the patterns and mechanisms of oxidative stress responses (OSRs) induced by MPs in FFC organisms were investigated using theoretical simulation methods. Results showed an increasing (reduced) OSR was found in lower trophic levels (higher trophic levels). Besides, polycarbonate (polyvinyl chloride) causes the most (least) significant OSRs in FFC organisms, respectively. The impacts of MP additives were also analyzed using the full factorial experimental design, revealing flame retardants significantly influence oxidative stress variability. A constructive solution of "restriction-control-focus" is proposed for different types of MPs by the coefficient of variation-corrected CRITIC and the nested mean classification method. The mechanism analysis revealed a positive correlation between protein secondary structure orderliness and OSRs. Proteins in organisms that contain a high proportion of hydrophobic non-polar amino acids are more likely to bind to MP and enhance OSRs. This is the first study assessing the OSR patterns and ecological risks of MPs and their additives in FFCs with a proposed priority list, providing theoretical support for risk assessments and management strategies in freshwater environments.

Innovative Nanobubble Disruption of Microplastic-Associated Biofilms in a Simulated Drinking Water Reactor

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Polystyrene (PS) microplastics are widely detected in drinking water systems, where their hydrophobic surfaces promote bacterial colonization and robust biofilm formation. These biofilms increase the risk of contaminant adsorption, disinfectant resistance, and potential microbial regrowth. In this study, we investigated the effectiveness of air nanobubbles (NBs) as a non-chemical approach for removing biofilms from conditioned bofilm-PS surfaces and explored the mechanistic pathways of disruption. The study used a pilot-scale system to replicate hydraulic conditions, consisting of approximately 10 m of ¾ inch PVC piping with fittings (couplings, unions, valves, elbows) to create realistic flow dynamics. A pump circulated water from a 4-inch PVC reservoir, with a flow meter monitoring flow rates throughout. This setup simulated biofilm formation and microplastic behavior in DWDSs under controlled conditions. Biofilms were conditioned on polystyrene (PS) microplastics to investigate detachment and suspension dynamics under nanobubble influence. Air-filled nanobubbles (<200 nm) were generated and applied to the system. Biofilm activity was quantified using adenosine triphosphate (ATP) assays, while morphological changes and viability were assessed using flow cytometry, and functional groups characterized via FTIR spectroscopy. Results showed that NB exposure for 5 hours led to a 78% reduction in ATP activity on PS microplastics compared to untreated controls, indicating substantial suppression of biofilm metabolism. Flow cytometry revealed a sharp decline in the viable cell population within the remainder zone—from 96% in untreated biofilms to just 9% after 5 hours of NB treatment—correlating with significant structural disruption and detachment. FTIR analysis supported these findings, with post-treatment spectra showing reduced absorbance in protein (Amide I & II, ~1650 and ~1540 cm^{-1}) and polysaccharide (~1000–1150 cm^{-1}) bands, indicating degradation of the extracellular polymeric substances (EPS) matrix. Data suggest that the nanobubble-mediated mechanism includes both oxidative stress and physical disruption of the biofilm matrix. The higher surface energy and aromatic nature of PS may initially promote stronger EPS and microbial adhesion compared to other microplastics such as polypropylene, however, prolonged NB exposure proved effective in significantly reducing biofilm mass. These results highlight the potential of air nanobubbles as a sustainable strategy to control biofilms populated with microplastics in drinking water pipes. Future research will further characterize the disruption mechanisms at play. It will focus on how nanobubbles influence biofilm structure, composition, and microbial activity under different hydrodynamic conditions, and assess their effectiveness in enhancing biofilm removal and reducing microbial viability.

Improving Removal of Microplastics and Nanoplastics in Wastewater Treatment Plants Under Challenging Environmental Conditions

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Microplastics have been widely observed in terrestrial and aquatic ecosystems. Wastewater and drinking water treatment plants are a major barrier to preventing the release of micro- and nanoplastics into ecosystems. Therefore, information on the efficiency of water treatment plants to remove micro- and nanoplastics is critical to alleviate their public health risks and environmental impacts. Additionally, the removal of micro- and nanoplastics in challenging conditions is poorly documented in the literature. In this study, the removal performance of both conventional and alternative coagulants for polyethylene microplastics, polystyrene nanoplastics, polyester fibers, and crumb rubber particles in cold water and various pH are systematically investigated. Results indicate moderate to high removal for micro-scale plastic particles across different coagulants and temperatures. Nanoplastic removal was significantly correlated with turbidity (indicator of total suspended solids). The removal performance by alum was relatively stable across different temperatures and decreased under pH 8.5. The performance of ferric sulfate was greatly compromised by low temperature and low pH, while the pre-polymerized coagulants (aluminum chlorohydrate, polyaluminum chloride) showed high removal for contaminants under different temperatures and pH. These findings provide practical guidance for optimizing chemically enhanced primary treatment in cold or chemically unstable wastewater treatment environments.

SESSION 1D — EMERGING TECHNOLOGIES FOR WATER TREATMENT

Experimental Evaluation of Salinity Gradient Energy Generation from Mine Water Using Pressure-Retarded Osmosis

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Mining industry consumes high volumes of water, posing challenges on limited water resources and producing contaminated effluent which is characterized by its high salinity, extreme pH, and high metal(loid)s and compounds sensitive to redox conditions that cannot be discharged into the environment without proper treatment. Integrating water recycling and energy recovery practices can significantly mitigate the water footprint of mining operations leading to more sustainable resource management. This study examines the potential of pressure retarded osmosis (PRO) integrated with membrane-based pretreatments to improve water quality for reuse and contribute to renewable energy generation. Two effluents from different processes of mining were employed involving effluent 1 impacted by explosive leaching and effluent 2 which is a tailing pond water. Water characterization showed that Effluent 1 had elevated concentration of Na^+, K^+, Ca^{2+}, Mg^2, Cl^-, NO_3^-, and SO_4^2 measured at 14306 mg/L, 751 mg/L, 1926 mg/L, 5336 mg/L, 172090 mg/L, 9720 mg/L, and 6512 mg/L, respectively. Moreover, chemical oxygen demand of 8100 mg/L and total organic carbon concentration of 10.2 mg/L, indicated its strong osmotic potential for energy recovery but also a significant risk of scaling and membrane fouling. On the other hand, effluent 2 had an acidic pH of 3.7 and contained trace metals such as Cu^{2+}, Zn^{2+}, and Fe^{3+}. Several pretreatment methods, including ultrafiltration, nanofiltration, and reverse osmosis, were applied to effluent 1 while effluent 2 underwent ultrafiltration with pH adjustment to improve compatibility of membrane. A bench-scale flat-plate PRO system with an effective membrane area of 34 cm^2 was tested using high-salinity brine produced from reverse osmosis treatment of effluent 1 as the draw solution along with pretreated effluent 2 with a total dissolved solids of 2000 mg/L as a feed solution. The system achieved a high-power density of 22 W/m^2 with a low reverse solute flux of 2 g/m^2 at $20^{\circ C}$ with an optimized draw to feed solution flow ratio of 1.2:1. The results represented high performance of the proposed integrated membrane-based pretreatment methods with PRO in producing high-quality permeate water suitable for reuse as well as harnessing salinity gradient from mining waters to generate renewable energy.

Ensuring Mineral Quality of The Water in a Sorbent-Based Atmospheric Water Harvesting Device

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Water scarcity is a global issue with serious implications for communities around the world, intensified by climate change. The 2018 water crisis in Cape Town, Quebec's 2020 water restrictions, and the latest water crisis in Catalonia, highlight the urgent need for sustainable water resource management. Alternatives such as Atmospheric Water Harvesting (AWH) are promising. However, challenges remain, including the mineralization of the harvested water; since this water lacks essential minerals concentration such as calcium or magnesium. Ensuring that water meets World Health Organization (WHO) mineral guidelines is crucial for health and taste aspects. There are conventional mineralization methods such as Calcite, Corosex™ or even mineralizing filters available on the market. However, this project proposes to explore a low-consumable mineralization strategy that leverages natural material such as local soils, rock, and sands, to enhance the mineral content of AWH water. Of the materials tested, Black Earth soil (0.03 g/mL) and Red beach sand from Prince Edward Island (0.25 g/mL) showed strong potential for improving hardness, reaching concentrations of 182 mg/L and 265 mg/L $CaCO_3$, respectively. Fast ion release kinetics were observed, with saturation reached within 15 minutes. Overall, this approach contributes to the development of decentralized, low-consumable systems for providing not only accessible but also quality and mineral water by using readily available materials. It also reinforces the potential of AWH technologies as a promising solution for water-stressed communities.

A Diffusivity-Driven Approach to Lithium Separation using Shock Electrodialysis

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Lithium is a critical component of modern energy storage systems, enabling technologies from electric vehicles to grid-scale renewable energy storage. Rising demand has intensified reliance on primary extraction from hard-rock ores and brines which consume large amounts of water and energy and can cause severe environmental hazards. Recovery of lithium from secondary sources such as wastewater generated during battery recycling and certain industrial processes offers a more sustainable supply route although effective separation from other monovalent cations remains difficult due to their similar chemical properties. This study investigates shock electrodialysis (SED), which is an emerging ion-exchange membrane (IEM)-based technology for selective lithium recovery. SED exploits concentration polarization near IEMs, and in this study, we designed SED to enhance separation by employing inherent differences in ion diffusivity. Ions with lower diffusion coefficients, such as lithium, develop steeper concentration gradients in the boundary layer near IEMs creating an opportunity for its selective separation. A bench-scale SED reactor was constructed with two cation-exchange membranes (CEMs), forming a central separation compartment and two electrode compartments. The feed solution containing an equimolar mixture of Li^+ and K^+ was introduced from the bottom of the central compartment, and two effluents exited through separate outlets from the concentrating and diluting boundary layers. The applied voltage, flow rate and inter-IEM distance were systematically varied in the SED operation. The results confirmed preferential selection of Li^+ over K^+ for all experimental conditions. Model simulations on a ternary ion system (Li^+, K^+, and Cl^-) were used to explain how the membrane selectivity, electric current, and boundary layer thickness influence the selective separation. Both experimental and modelling results provided a foundation for developing SED into a scalable and energy-efficient separation method for lithium ions using its low diffusivity.

A Trimodal Tablet-Based Sensor System for Rapid, Equipment-Free Water Hardness Analysis

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We present a simple, portable, and instrument-free tablet-based system for point-of-use measurement of water hardness. The system uses two pullulan-encapsulated tablets: one containing Eriochrome Black T (EBT) with CAPS buffer and the other containing EDTA. Together, they enable a three-stage approach to hardness assessment. Dissolving the EBT tablet in a water sample produces an immediate color change for rapid qualitative screening. Dissolving both tablets simultaneously yields a reddish colorimetric signal that provides a semi-quantitative estimate of hardness. For precise quantification, an inverted microtitration is performed by gradually adding water to the dissolved tablets until a reddish endpoint appears, and the required volume is used to calculate hardness from a calibration curve. Results from real-world samples closely matched those from standard EDTA complexometric titration, with reduced interference from competing ions. The tablets remain stable for at least seven months and remove the need for glassware, instrumentation, or specialized training, offering a low-cost, user-friendly solution for water hardness monitoring at the point of use.

Assessment of the Impact of Point-of-Use Filters on Water Quality

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Water quality can be compromised by pipe degradation, scaling, biofilm formation, or aging infrastructure. Events like the Flint lead crisis (2014–2019), health violations affecting around 6% of U.S. water utilities in 2019, and a 30-year boil-water advisory in Canada's Neskantaga First Nation highlight ongoing challenges in maintaining water quality from treatment to tap. Sensory issues such as taste, odor, and color have driven the popularity of point-of-use (POU) devices that claim to remove contaminants and remineralize water, especially for reverse osmosis systems. Although many devices are reported as effective, concerns remain due to a notable lack of independent data verifying manufacturer claims, long-term effectiveness, potential microplastic release, bacterial growth during stagnation, sludge or algae formation, and their role as possible reservoirs for contaminants. This study evaluated commercially available POU filters claiming to remineralize and improve water quality. The devices were tested at a flow rate of 0.8 L/min using demineralized water, following NSF/ANSI 53–2024 guidelines. Chemical and microbiological quality of treated water was assessed over 5 to 6 weeks. Results showed minimal changes in ion concentrations, alkalinity, conductivity, and total dissolved solids (TDS), with only slight hardness increases not exceeding 15 mg $CaCO_3$/L. Elevated bacterial counts were found at the filter outlets; however, influent demineralized water already harboured an average of 3,800 CFU/mL, suggesting contamination cannot be attributed exclusively to the filters. The findings highlight a lack of scientific evidence supporting these filters' performance and support concerns that their promotion may rely more on marketing than efficacy, potentially leading to water quality deterioration rather than improvement.

SESSION 2A — ADVANCED TREATMENT OF EMERGING CONTAMINANTS

Comparative Evaluation of Microgranular, Granular, and Powdered Activated Carbons for PFAS Removal in Drinking Water Treatment

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Activated carbons (ACs) are widely used in water treatment and are commercially available in three forms: powdered AC (PAC), granular AC (GAC), and the less common microgranular AC (μGAC) which has a size between GAC and PAC. Each of these forms is tailored for specific applications. PAC is typically applied before coagulation, GAC is used in fixed-bed filters after filtration, and μGAC is newly introduced for application in fluidized bed reactors. This study compares three types of μGAC with the other forms of AC, all bitumen-based, for PFAS removal in batch tests under identical conditions. The tests were conducted in 1 L HDPE bottles using settled water from a drinking water treatment plant in Saint-Lambert, Quebec, spiked with 11 PFAS. AC doses ranged from 10 mg/L and 1000 mg/L. The bottles were mixed using a rotator for up to 15 days. Samples were filtered over 0.3 μm Glass fiber membranes and analyzed for UVA254, DOC, and PFAS concentrations. The five ACs were also characterized for their morphological, physical, and chemical properties. The results showed that the regenerated μGAC outperformed the other two μGACs in UVA254 reduction and DOC and PFAS removal [55%, 43%, and 69%, respectively]. However, PAC was the most performing for PFAS removal under the test conditions [72% average PFAS removal]. PAC had the lowest oxygen content, making it the most hydrophobic AC, which explains its higher PFAS removal efficiency via hydrophobic interactions. The results of the characteristics analyses and the batch experiments show that the differences between μGACs, and between μGACs and GAC, appear more related to the properties of the adsorbents rather than to the particle size differences between the μGACs and the GAC.

Risk Assessment of Horizontal Transfer of Antibiotic Resistance Genes Among Bacteria Under Environmental Exposure to Microplastics and Per/Polyfluoroalkyl Substances

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Microplastics (MPs) and per/polyfluoroalkyl substances (PFASs), as emerging pollutants widely present in aquatic environments, pose a significant threat to human health through the horizontal gene transfer (HGT) of antibiotic resistance genes (ARGs). Molecular dynamics simulations and machine learning can accurately capture the complex interactions between molecules. This study utilized them to identify the HGT risk between bacteria under MPs and PFASs stress. This study found that MPs and PFASs significantly increase the HGT risk between bacteria by 1.23 to 1.57 times and 1.26 to 1.59 times, respectively. Notably, long-chain PFASs and perfluoroalkyl carboxylic acids increased the HGT risk by 1.38 and 1.40 times, respectively. Additionally, MPs primarily increase the HGT risk by enhancing hydrogen bonding interaction between key proteins in the HGT pathway and “active codons”. The electronegativity and polarizability of PFASs critically influence the HGT risk, acting inversely and directly proportional, respectively. A significant synergistic effect on HGT risk was observed under the combined stress from PP-MPs and PFASs, with a synergy value of 27.6, markedly increasing the HGT risk. Further analysis revealed that the smaller the minimum distance between key proteins in the HGT pathway and “active codons”, the sharper the peak of the RDF curve, indicating a higher HGT risk. This study identifies the characteristics of HGT risks between bacteria in aquatic environments under the individual and combined stresses from MPs and PFASs at the molecular level. It provides a theoretical basis for mitigating ARG transfer and comprehensively assessing the health risks posed by these emerging pollutants.

Behavior of Perfluoroalkyl Substances (PFASs) in Sewage Sludge Under Electrokinetic Phenomena

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Perfluoroalkyl substances (PFASs), a group of highly persistent organic pollutants used extensively in industrial and consumer products, frequently accumulate in sewage sludge during wastewater treatment processes, posing long-term environmental and health risks. When PFAS-contaminated biosolids are applied to agricultural land, these compounds can migrate into soil, be taken up by crops, and ultimately enter the human food chain. Conventional treatment methods are often inadequate for their removal, especially from complex matrices such as sewage sludge. This study evaluated the response of two legacy PFASs, perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS), to electrokinetic treatment process in sludge medium. The electrokinetic (EK) process achieved around 75 and 79 % reduction in total concentrations of PFOA and PFOS, respectively in both solid and liquid phases of sludge. The remaining concentration of both compounds showed a high transport toward anode zone. PFOS demonstrated greater removal compared to PFOA especially from liquid phase. Residual PFASs exhibited preferential migration toward the anodic region. Notably, the remaining PFOS was predominantly retained in the solid fraction (>85%), compared to approximately 70% for PFOA, highlighting the stronger affinity of sulfonic acids for solid matrices relative to carboxylic acids. These results emphasize the influence of functional group chemistry on PFAS mobility under electric fields. This study demonstrates the impact of EK treatment potential mobilization of PFAS in sludge matrix as a potential approach for simultaneous PFASs remediation and upgrading the quality of waste activated sludge (WAS), with broader implications for reducing PFAS transfer from wastewater biosolids to agricultural systems and the human food supply.

Visible Light-Driven Photocatalytic Degradation of TCPP By Ppy-g-C_3N_4-MIL88B Photo-Catalyst with Z-scheme Heterojunction

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A novel visible-light-assisted photo-Fenton methodology is introduced for the efficient degradation of the persistent fire retardant TCPP, employing a green photocatalyst: PPy-g-C_3N_4-MIL88B. This engineered nanocomposite demonstrates a narrowed bandgap (reduced from 3.2 eV to 2.3 eV), enhanced charge transfer, improved stability, and significantly reduced iron leaching. Structural and optical properties of the synthesized photocatalyst were rigorously validated through HAADF-FE-SEM, TEM, FTIR, XRD, XPS, BET, PL, and UV-DRS analyses. When coupled with H_2O_2 and LED illumination, the PPy-g-C_3N_4-MIL88B catalyst achieved 99.29% degradation of TCPP under optimized conditions (59 min, 100 mg/L catalyst dosage, pH 5, airflow 15 L/min). Five degradation by-products were identified and monitored, all of which showed notable concentration reductions after only 20 minutes of treatment. Toxicity assays based on Pimephales promelas (fathead minnow) demonstrated a clear improvement in water safety post-treatment, with LC_{50} (96 h) values increasing from 7.24 mg/L (TCPP) to 19.12 mg/L and 58.23 mg/L for two major by-products. The experimental design and optimization process were conducted using response surface methodology (RSM) with central composite design (CCD), producing a reduced quartic model of high statistical significance ($p < 0.0001$). Finally, the catalyst's performance was validated using real water samples from several Canadian aquatic environments, where it achieved over 65% degradation efficiency for TCPP and other emerging contaminants. This study highlights the potential of PPy-g-C_3N_4-MIL88B as a sustainable and effective photocatalyst for treating contaminated natural waters and removing hazardous emerging pollutants, offering promising applications in environmental remediation and improving water quality.

Synthetic Accessibility Evaluation of Environmentally Friendly Paes Substitutes by Machine Learning

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Phthalates (PAEs) are important plasticizers that can be released into the environment during their production and use, causing significant impacts on aquatic environments and organisms. To mitigate the environmental hazards of PAEs, this study aims to identify molecular substitutes with high synthesizability and environmentally friendly, promoting the replacement of traditional PAEs plasticizers. Using the latest PU learning method, which addresses the issue of the absence of negative labels in samples, molecular descriptors are employed to characterize the structural features of molecules. A Bagging PU Classifier semi-supervised model is built to study the synthesizability of theoretically designed PAEs alternative molecules. Three highly synthesizable, environmentally friendly PAEs alternative molecules (U5, U44, and U62) are identified. The accuracy of the model and the synthesizability of the molecules are validated using the kNN model and ADMETlab 2.0 software. Further, the SHAP method is used to analyze the synthesis mechanisms of PAEs alternative molecules, revealing that VE2_DzZ and maxHCsats are key parameters influencing the synthesizability of these molecules. It is also found that the ability of molecules to undergo substitution reactions and their molecular structure are closely related to their synthesizability. Thus, the density functional theory (DFT) method is employed to explore the substitution reaction capabilities of the molecules, indicating that all three PAEs substitutes are prone to substitution reactions. Moreover, a 3D-QSAR model is developed to establish a quantitative structure-activity relationship between molecular structure and synthesizability. The model results show that all three PAEs substitutes are synthesizable, and the three-dimensional potential maps demonstrate that factors such as steric fields, hydrophobic fields, hydrogen bond acceptor fields, hydrogen bond donor fields, and electrostatic fields all influence the synthesis of PAEs substitutes. To address the issue of the PU learning method's insensitivity to negative sample feature recognition near the classification threshold, a random forest-gradient boosting stacking model is further constructed, based on the Bagging PU Classifier predictions and molecular descriptor methods. This model aims to investigate the synthesizability of PAEs substitutes in more depth. Comparing the performance of random forest and gradient boosting models, using molecular fingerprints and descriptors as molecular features, reveals that molecular fingerprints are more advantageous in building machine learning models that establish relationships between molecular structure and properties. SHAP analysis of the important features of molecular fingerprints identifies that PAEs alternative molecules with substitution reactions occurring on single-side chains or benzene ring C atoms may exhibit higher synthesizability. To improve the model's prediction performance, a random forest-gradient boosting stacking model is developed, which successfully identifies two additional PAEs alternative molecules (U4 and U55) with higher synthesizability. This further reduces the number of unlabeled samples and enhances the predictive capability of the PAEs alternative synthesizability model, facilitating the identification of unknown PAEs substitutes' feasibility. In total, five PAEs alternative molecules with high synthesizability are identified, thereby minimizing the research costs for future PAEs alternative molecules. This work provides

theoretical guidance for the development of emerging pollutant substitutes and new materials, supports pollution control strategies from a "source control" perspective, and offers theoretical support for pollutant management and environmental hazard reduction.

The Characterization of Defected Hexagonal Boron Nitride and Its Photocatalytic Effect on PFAS Removal in Drinking Water

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Polyfluoroalkyl substances (PFAS), predominant in the manufacturing of industrial and consumer products are of growing concern, as they pose adverse health effects and have been identified in drinking water sources. PFAS contamination guidelines established by various global organizations are evolving rapidly. As a result, industries are under increasing pressure to adopt new, and potentially costly, technologies to comply with these regulations. Photocatalysis may prove to be a cost-effective PFAS destruction technology, as it can be operated at lower energies than current methods, and the catalyst can be recycled, improving material costs. Due to internal and/or edge defects present in hexagonal boron nitride (hBN), the defected material can be classified as photocatalytically active, absorbing UV-C light in the range used for water disinfection (~254 nm). Herein, we detail our efforts to further understand the defect structure properties and surface chemistry of hBN in relation to PFAS destruction. Liquid-phase exfoliation (LPE) is one method which can be employed to create hBN nanosheets with induced structural defects, varying on the solvent used. Using water as a solvent, changes in surface chemistry and electronic properties upon LPE were detected through infrared spectroscopy, x-ray photoelectron spectroscopy, diffuse-reflectance spectroscopy and transmission electron microscopy. The correlation between the surface defect structure of hBN and its photocatalytic ability towards PFAS degradation, using perfluorooctanoic acid (PFOA) as a probe contaminant, has been examined using liquid chromatography mass spectrometry. Future work is dedicated to examining possible changes in hBN structure following UV exposure and investigating potential degradation byproducts using high-resolution mass spectrometry. The outcome of this project will contribute to creating a new sustainable, cost-effective method to remove PFAS present in drinking water.

SESSION 2B — INNOVATIONS IN BIO-BASED WASTEWATER TREATMENT

Modification of Cellulose Fibers as A Method to Reduce Bridging Agent and Co-Agent Demand in Wastewater Coagulation-Flocculation

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Wastewater treatment is continuously seeking alternatives to conventional methods in coagulation-flocculation to better address the challenges posed by increasing water volumes and emerging contaminants. Recently, cellulose fiber super-bridging agents have demonstrated improved turbidity and contaminant removal efficiency, owing to their enhanced floc-forming capabilities when used in a multi-agent system alongside traditional coagulants and flocculants. Even so, the dosage required for natural-based alternatives to reach intended purification levels remains a major concern, an issue that is also relevant for cellulosic super-bridging agents.

The present research explores the modification of cellulose fibers to increase their surface area and enhance contaminant and co-agent interactions. To assess the impact of fiber modifications, jar tests are performed using modified fibers and pristine fibers with comparisons made against a conventional treatment system lacking fibers. The extent of fiber modification is systematically evaluated using the material modification index. Performance is further analyzed by varying both the concentration of fibers and that of co-agents in the treatment system, as well as examined in sludge dewatering. The modified fibers exhibit superior turbidity reduction over both pristine fibers and conventional treatment without fibers. Furthermore, they represent significant potential for reducing the required fiber dosage. This research highlights the impact of easy modification routes of fibers to enhance their performance and enable dosage reduction without compromising on efficiency.

Kinetic Study of Euglena gracilis Growth and Paramylon Accumulation with Amino Acid-based Nitrogen Sources

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Euglena gracilis is a microalga with flexible metabolism between cell growth and biopolymer accumulation, resulting in increasingly active studies for its potential in sustainable wastewater treatment due to its ability to absorb pollutants, remove excess nutrients, and produce valuable biopolymers, such as paramylon and wax esters. These biopolymers offer a sustainable alternative in various industrial applications, particularly in pharmaceuticals, bioplastics, and biofuel production. E. gracilis growth and biopolymer production are influenced by various cultivation conditions, such as the growth conditions (phototrophic, heterotrophic, or mixotrophic), nutrient sources, and nutrient availability. Thus, clear understanding of E. gracilis growth kinetics is essential for optimizing cultivation conditions and maximizing biopolymer yields. This study investigates the effect of amino acid supplementation as a nitrogen source on E. gracilis growth and paramylon synthesis under heterotrophic conditions. Batch reactors were used to cultivate E. gracilis with various nitrogen sources, including amino acids (i.e., glutamine, asparagine, glycine) and inorganic nitrogen (i.e., ammonium). Experimental results indicate that cultures containing amino acids are more effective than inorganic nitrogen, enhancing both growth and paramylon accumulation. Cultures supplemented with asparagine consistently yield high dry cell weight (DCW), specific growth rate (μ), and paramylon content, outperforming ammonium. The kinetic study of E. gracilis growth and paramylon accumulation with amino acid-based nitrogen sources provides valuable insights for more sustainable and efficient bioprocesses in wastewater treatment and industrial applications.

Anaerobic Biodegradability of Thermal Hydrolyzed Waste Activated Sludge and Food Waste

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In this study, the impact of thermal hydrolysis pretreatment (THP) on the mono- and co-digestion of thickened waste activated sludge (TWAS) and food waste (FW) was carried out at temperatures of 150, 170, 190, and 210 ˚C and volumetric ratios of 90:10, 70:30, and 50:50 in batch anaerobic tests. THP enhanced solubilization, reduced volatile suspended solids (VSS) and the particle size of TWAS as the temperature increased, showing optimal improvements at 170 ˚C. THP showed no significant impact on FW with only marginal improvements at 150 ˚C. Increasing the temperature beyond 170 ˚C for TWAS and 150 ˚C for FW deteriorated anaerobic biodegradability, forming refractory compounds. Co-digestion improved methane yields and kinetics as the contribution of FW increased. Co-digestion of thermally pretreated TWAS with FW improved the methane yields by 27% and kinetics by 29% at 170 ˚C with no synergism. Co-digestion of thermally pretreated FW with TWAS improved methane yields by 15% and kinetics by 25% at 150 ˚C, with improvements up to 21% in synergy. THP of the mixed feedstocks improved methane yields by 53% and kinetics by 92% at 170 ˚C, with improvements becoming less pronounced with the increase in the volume of FW and temperature.

Investigating the Efficiency of Immobilized Beads Using Sodium Alginate Compared to Self-Aggregated Granules in Algal Bacterial Granular Sludge

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Algal bacterial granular sludge (ABGS) is an integrated system of adding algae to aerobic granular sludge (AGS) to enhance the pollutant removals in wastewater treatment as an alternative to conventional activated sludge (CAS) systems. ABGS systems utilize aeration to form dense, self-aggregated microbial granules from mixed liquor suspended solids (MLSS). Through a symbiotic relationship, algae produce oxygen through photosynthesis for microbial bacteria's growth while simultaneously capturing the carbon dioxide released by bacteria. However, the process of making these self-aggregated granules can take weeks or months to form dense mature granules. Through the use of polymers like sodium alginate, the initial start of ABGS systems can be skipped by immobilizing the sludge into desired sized beads and adhere the algae to the surface of the beads. Self-aggregated granules were added in a Plexiglass column-type sequencing batch reactor (SBR) at a volume of 4.8 L while MLSS beads were immobilized with sodium alginate solution and hardened with a calcium carbonate solution overnight and then placed into a similar SBR column at a volume of 1.1 L. Both reactors had a volumetric exchange ratio (VER) of 50%, resulting in an 8-h hydraulic retention time (HRT). The operational cycle for both reactors lasted four hours and was repeated six times daily, with five sequential phases: influent addition, anaerobic reaction, aerobic reaction, settling, and effluent discharge. Air was introduced from the bottom through a fine air bubble diffuser using an air pump during aeration. Both reactors were fed a synthetic acetate-based wastewater containing the requirements for the growth of microorganisms. Algae species Scenedesmus obliquus was added with LED lights to create a light-to-dark ratio of 12 hours on/off, providing the environment for algal growth. Analysis was conducted weekly to examine the biomass characteristics of (MLSS), mixed liquor volatile suspended solids (MLVSS), and sludge volume index (SVI). System performance was assessed for chemical oxygen demand (COD), ammonia, phosphorus in both the influent and effluent, as well as the soluble organics, Nitrate, total suspended solids (TSS) and volatile suspended solids (VSS) in the effluent. Particle size distribution (PSD) and DNA samples were taken weekly from the reactor to examine the growth, size, and microbial dynamics. Weekly testing monitored protein and polysaccharide extracellular polymeric substance (EPS) secretions. This researched aimed to understand the efficiency of parameter removals with the use of immobilized beads when compared to self-aggregated granules and compare the adhesion of algae to granules verses immobilized beads.

Biofiltration combinée du phosphore et des nitrates des eaux usées à l'aide du procédé Techno-P à base de sous-produits de bois activés à l'hydroxyde de fer

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Afin de répondre aux exigences environnementales liées aux rejets de phosphore, une recherche menée chez Investissement Québec en collaboration avec l'Université Laval a permis de développer un procédé d'élimination du phosphore nommé Techno-P. Celui-ci repose sur des biofiltres remplis d'un milieu activé à base de sous-produits de bois imprégnés d'hydroxyde de fer. Toutefois, la présence de nitrates pourrait affecter négativement l'efficacité de ce procédé, en modifiant les conditions favorables à la dissolution réductive du fer. L'objectif de cette étude est d'évaluer les performances d'élimination simultanée du phosphore et des nitrates par le procédé Techno-P. Deux biofiltres (C1 et C2), d'un mètre de hauteur et 15 cm de diamètre, ont été alimentés pendant 461 jours avec une eau usée synthétique contenant du phosphore (5 puis 100 mg P-PO4/L) et, pour C2 uniquement, 20 mg N-NO3/L. Le biofiltre C1 sans nitrates sert de témoin. Le média usagé a été caractérisé par diffraction des rayons X (DRX), microscopie électronique à balayage (MEB) et spectroscopie EDX. Un suivi régulier des paramètres physico-chimiques (phosphore et nitrates) a été effectué à l'entrée et à la sortie des biofiltres. Les résultats montrent une excellente performance d'élimination du phosphore au cours des 412 premiers jours (≤ 0,3 mg P-PO4/L). Toutefois, la performance du biofiltre C2 se détériore par la suite, atteignant 21,6 mg P-PO4/L au jour 461. Cette baisse de performance s'accompagne d'une dénitrification atteignant 80% dans le biofiltre C2. Le pourcentage d'élimination global du phosphore est de 99,9 % pour C1 contre 98,2 % pour C2. Ces résultats mettent en évidence que les biofiltres à base de bois imprégnés d'hydroxyde de fer sont efficaces pour l'élimination du phosphore et des nitrates des eaux usées. L'analyse du média révèle la présence de précipité de strengite (FePO4·2H2O) dans les deux biofiltres, ainsi que la vivianite (Fe3(PO4)2·8H2O) dans le biofiltre C1 sans nitrates.

Biological Pretreatment of Manure for Enhancing Hydrolysis and Fermentation of Manure in Anaerobic Digestion

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The biological pretreatment of manure has emerged as a promising strategy to enhance the efficiency of anaerobic digestion. Manure is typically rich in lignocellulosic materials and other recalcitrant organic compounds that limit microbial accessibility and slow down the hydrolysis step, which is often the rate-limiting stage of digestion. Biological pretreatment, by employing selected microorganisms and enzymatic processes facilitates the partial degradation of complex organic matter prior to digestion. This improves substrate availability, accelerates microbial activity, and increases methane yield. In addition to enhancing biogas production, biological pretreatment may also contribute to more stable process performance, reduced retention times, and improved nutrient recovery, making it an attractive and sustainable option for optimizing the anaerobic digestion of manure. This research aimed to investigate the influence of a novel bioaugmentation method using YDRO on manure hydrolysis and fermentation. Various dosages of YDRO were applied to determine the optimal level for enhancing the process. Manure samples were collected from a dairy farm in Caledon, Ontario, and the inoculum was obtained from the Ashbridges Bay Wastewater Treatment Plant in Toronto, Ontario. Manure slurry was prepared by homogenization and pretreated for 6 hours with five varying doses of activated YDRO. The doses applied were 5, 10, 15, 20, 25, and 30 g of YDRO per liter of feedstock. Activation of YDRO was performed according to the manufacturer's standard procedure. The pretreated samples were subsequently fed into 500 mL batch reactors operated under mesophilic conditions. Each reactor with a working volume of 500 mL was prepared with inoculum (seed) and pretreated manure containing different YDRO dosages. The fermentation experiments were conducted over a period of 80 hours. Manure without pretreatment was used in control reactor. According to the results, bioaugmentation with YDRO enhanced VFA formation and acidification. The control (manure slurry without YDRO, mixed for 6 hours) showed the lowest values, while the highest VFA concentration was observed in samples pretreated with 5 g/L YDRO, reaching 1783 mg/L CH_3COOH, a 72% increase compared to the control reactors. Similarly, solubilization improved with YDRO bioaugmentation. Soluble COD increased with increasing YDRO dosage, with the maximum SCOD obtained at 5 g/L YDRO, corresponding to 7.5 g/L SCOD and a 59% increase compared to the control. Biological pretreatment of manure with YDRO enhanced hydrolysis and acidification during anaerobic digestion. This fermentation experiment was conducted in parallel with the BMP assay, which confirmed the overall improvement of the process achieved through the novel bioaugmentation method. For manure, the application of 30 g of YDRO per liter of feedstock resulted in the highest volatile fatty acid (VFA) formation and a marked increase in soluble COD. Additional findings, including the effects on methanogenic activity, will be presented in detail during the presentation.

SESSION 2C — AI AND MODELING IN WATER MANAGEMENT

Modélisation intégrée basée sur la dynamique des systèmes pour évaluer l'impact anthropogénique sur la qualité des lacs

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La dégradation de la qualité des lacs est un enjeu écologique universel. Plusieurs facteurs contribuent à ce phénomène, notamment l'urbanisation, les changements dans l'utilisation du territoire et les changements climatiques. La densification des systèmes septiques autour des lacs situés sur des bassins versants ruraux contribue significativement à l'exportation excessive de nutriments, accélérant la pollution des eaux comme celle au phosphore. Des conditions technologiques telles que la performance des systèmes septiques et les caractéristiques géologiques, couplées aux conditions démographiques des bassins versants, influencent la concentration de phosphore dans un lac. Au Québec, les systèmes septiques ne sont pas systématiquement inspectés dans toutes les municipalités, ni rigoureusement répertoriés de façon standardisée, ce qui limite la compréhension et la prise en compte de leur impact environnemental. Cette limitation est observée dans le manque de représentativité de l'impact des systèmes septiques dans la modélisation intégrée de la qualité des lacs actuelle. Ainsi, une approche de modélisation par scénarios basée sur la dynamique des systèmes a permis une analyse de sensibilité sur les variables ayant l'impact potentiel le plus important sur la concentration de phosphore. Parmi celles-ci s'inscrivent la capacité d'adsorption du sol dans lequel les systèmes sont installés, l'état de performance des systèmes, leur distance par rapport au lac, ainsi que la densité de population sur le bassin versant et le taux d'occupation des ménages. Les résultats démontrent qu'une croissance de la population, une occupation résidentielle accrue et un taux croissant de non-conformité des systèmes septiques peuvent causer une augmentation considérable de la concentration en phosphore du lac en Cœur, situé dans la municipalité de St-Hippolyte, bien au-delà des seuils gouvernementaux établis.

Artificial Intelligence in Anaerobic Digestion: A Review of Machine Learning Applications for Process Monitoring, Control, and Forecasting

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Anaerobic digestion (AD) is a vital biological process that converts organic waste into renewable energy and nutrient-rich biofertilizer. However, AD is hindered by process complexity due to fluctuations in operational conditions (e.g., temperature). Such complexities necessitate advanced modeling techniques, such as machine learning (ML) models, to better simulate the AD process under various operational conditions. Although there are some review studies that focused on the applicability of ML models in AD systems, most of them examined individual ML techniques, such as artificial neural network (ANN), or specific feedstock such as food waste. Thus, there is a lack of comprehensive reviews that investigate a variety of ML models with different feedstock, highlighting the dataset requirements for successful implementation of ML modeling. Therefore, the current review provides a comprehensive summary of the development of ML applications in the AD process in the last 15 years covering more than 100 articles, positioning this work as the most comprehensive and up-to-date review to diagnose the applicability of ML in AD systems. This study adopts four methodological lenses to systematically explore the topic including the nature of ML models (e.g., model types), dataset requirements (e.g., number of observations), model evaluation metrics (e.g., root-mean squared error (RMSE)), and the AD-related information (e.g., waste type). This review revealed important insights about the applicability of ML models in AD processes. For example, it was found that regression-based models have constituted the majority of modeling approaches employed in ML modeling (approximately 93%) while the remaining studies examined the classification models. Among the regression algorithms, the ANN emerged as the most frequently employed model in literature. This study can serve as an integrated reference for the application of ML models in AD systems, aiding in selecting the appropriate dataset requirements and ML modeling techniques for successful implementation of ML.

Deep Learning for Filamentous Cyanobacteria Identification Using Confocal Laser Scanning Microscopy

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Excessive growth of certain cyanobacteria species in freshwater or marine systems can lead to harmful algal blooms (HABs). HABs can produce toxic substances called cyanotoxins, such as microcystins, saxitoxins, anatoxins, nodularins, and cylindrospermopsins. As a result, identification of toxin-producing cyanobacteria in aquatic environments is essential for assessing water quality. A deep learning model, specifically a convolutional neural network (CNN), was used to classify 14 isolated filamentous cyanobacteria samples: Anabaena vigueri, Aphanizomenon flos-aquae, Calothrix spp., Cylindrospermopsis raciborskii, Geitlerinema splendidum, Lyngbya aestuarii, Oscillatoria tenuis C.Agardh ex Gomont 1892, Oscillatoria tenuis var. tergestina, Phormidium sp. HD798, Phormidium sp. YKN15-5, Plankthotrix agardhii/suspensa, Plankthotrix rubescens 19LV, Plankthotrix rubescens 5LV, and Pseudanabaena limnetica. Microscopic images were acquired using a confocal laser scanning microscope with 5 different channels (DAPI, FITC, TRITC, Cy5, and black and white). A CNN model was developed and trained on the obtained images. The model trained using only black and white images showed an accuracy of 58%. The low classification performance may be due to the similar physical features of the cyanobacteria species. When all 5 channel images were used to train the model, the accuracy increased to 96%, indicating the importance of fluorescence-based channels (DAPI, FITC, TRITC, and Cy5). Among the four fluorescence channels, TRITC was found to be the most important in the cyanobacteria classification while DAPI was the least important, based on the machine learning results. In conclusion, the excitation and emission wavelengths in microscopy play a critical role in image recognition and object classification by artificial intelligence models.

Integrating Landscape and Stormwater Management: A New Optimization Tool for the Sponge City Projects

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The development of Sponge City projects involves a complex multi-objective optimization process. Existing models often lack clarity in defining objectives, constraints, and decision variables, while their practical applicability remains limited. This study proposes a novel model that integrates three key objectives: minimizing project costs, maximizing the hydrological efficacy of sponge facilities, and improving landscape quality—the latter being systematically incorporated for the first time. The model employs three representative types of sponge facilities as decision variables and includes comprehensive constraints that reflect hydrological, engineering, economic, and planning requirements. Compared to conventional approaches, the proposed method reduces data demands and achieves efficient solution generation using the NSGA-II algorithm. Applied to a real-world campus renovation project in Beijing, the model produced a diverse set of Pareto-optimal solutions. For instance, under different objective priorities, the results show that project cost can be reduced by up to 45.8%, landscape quality can be improved by as much as 30.2%, and annual runoff pollution removal ratio can be enhanced by up to 22.99%, depending on the selected solution. This modeling approach offers a flexible and practical decision support tool for Sponge City project design, particularly relevant for cities in China and other developing regions undergoing rapid urbanization.

Multi-Parameter Optimization of Air Gap Membrane Distillation for Brine Desalination Using Artificial Neural Networks

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Air Gap Membrane Distillation (AGMD) is a promising desalination technology with significant potential for addressing global water scarcity. However, the interplay of operational parameters significantly impacts its performance, making optimization a challenging task. Thus, this study seeks to develop a predictive model to be used in optimizing the AGMD process for efficient brine desalination. To achieve this, Artificial Neural Networks (ANNs) were utilized to develop predictive models for AGMD desalination. The ANN model is trained and validated using experimental data while varying membrane pore size, feed salinity, feed flowrate and hot flow temperature to predict two critical performance metrics: permeate flux and specific thermal energy consumption (STEC). Different network architectures were tested through varying the numbers of neurons in the hidden layers and testing three different activation functions. The sigmoid activation function was found to be the most effective with 13 neurons resulting in a RMSE of 0.02. The model achieved an R^2 value of 98.64%, 98.84%, and 98.74% for the training, validation, and test datasets, respectively. While flux predictions yielded a higher R^2 value of 99.45% compared to STEC which achieved an R^2 value of 97.60%. Although other modeling approaches can also provide interpretable insights into the effect of different parameters, ANN models are more suitable for integration into real-time process control systems. Differential evolution is then applied using the ANN model to predict optimal performance metrics by assigning varying weights to flux and STEC, ranging from 0.2 to 0.8. This research establishes a scenario-based framework for optimizing AGMD in brine desalination under diverse priority settings offering practical guidance for different applications. By addressing the challenges of brine desalination through AGMD, this study provides an approach for reducing the environmental risks associated with brine disposal through enabling the efficient recovery of freshwater from brine.

Potential of Unmaintained Sensors for Continuous Monitoring of Aerated Lagoons

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Aerated lagoons are the most common type of wastewater treatment plant (WWTP) in Quebec, Canada, largely thanks to their low labour and operational costs, which make them well suited for small and decentralized communities. Despite these advantages, they face persistent challenges, including limited treatment capacity, high energy consumption, and insufficient nutrient removal, leading to non-compliance with effluent standards. Improving lagoon performance could benefit from advanced monitoring and control strategies; however, their adoption is limited in small facilities because conventional sensors demand frequent maintenance and regular operator presence. This study evaluates the use of unmaintained sensors for continuous monitoring of dissolved oxygen (DO) and pH in aerated lagoons. Results from a full-scale aerated lagoon in Portneuf, QC, show that, although unmaintained sensors provide less accurate measurement values than laboratory analyses of infrequent samples, they can effectively capture process dynamics and deliver useful operational insights. These findings highlight the potential of unmaintained sensors as a cost-effective, low-maintenance monitoring solution that can improve the sustainability of aerated lagoons.

SESSION 2D — WATER QUALITY AND ECOSYSTEM RESTORATION

Shallow Lake Phosphorus Attenuation Practices for Water Column and Sediment Using Geotextile Filtration

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Phosphorus, a nonrenewable resource and essential macronutrient for living organisms, has been a difficult issue for nations to deal with due to its increased concentration in surface waters. This phosphorus is/had been discharged on waterbodies uncontrollably and are accumulating in those causing recurring eutrophication occurrences. On this a cascade of aquatic ecosystem alterations occurs, characterized by the proliferation of algal and cyanobacterial communities over other species. Distinct remediation practices are being used, classified on sediment-oriented including sediment dredging and sediment capping with inert elements (i.e., lanthanum modified bentonite) or chemical addition (i.e., coagulants and pure oxygen), water column oriented: such as hypolimnetic water aeration oxygenation and biological methods: underlined are biomanipulation and macrophyte management. Therefore, there is a growing need for innovative, efficient, strategies to mitigate the impacts of P pollution on waterbodies. With this in mind, an emergent treatment method combination is being under investigation based on the use of geotextiles as filter media for eutrophic water and sediment. The objective is the attenuation suspended particles and particulate phosphorus attenuation. A laboratory study is evaluating the possibility of this filter media on reducing phosphorus concentration on resuspended sediments and an in-situ investigation is successfully reducing this in the water column. Thus, this paper aims to present information towards the in-lake phosphorus attenuation deployment from a lake system (water column and sediment) using eutrophic water geotextile filtration and air-induced sediment resuspension followed with geotextile bag filtration. A case study related to a Quebec mesotrophic lake (Lake Caron) water filtration and sediment resuspension, located in the Sainte-Anne-des-Lacs municipality, will be characterized, and investigated for remediation.

Phytoplankton Community Structure and Biovolume for Canadian Lake Trophic State Assessment

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Phytoplankton communities are a sensitive bioindicator of trophic status in freshwater ecosystems. Different algal groups exhibit distinct ecological optima, making their relative abundance a reliable proxy for ambient nutrient conditions. An abundance of Cyanobacteria is typically associated with eutrophic to hypertrophic waters, often driven by high nutrient levels, particularly phosphorus. Conversely, a diverse and balanced community with significant contributions from Bacillariophyta and Chlorophyta usually signifies mesotrophic conditions. The use of phytoplankton biomass to classify trophic states remains a foundational principle in aquatic ecology, particularly in natural ponds and lakes. While community composition is critical, quantifying algal biomass via biovolume provides a more accurate assessment than simple cell counts, as it accounts for large size discrepancies among species. In this study, four lakes in Sainte-Anne-des-Lacs, Quebec, were assessed in summer 2025 using Carson's index, Nygaard's phytoplankton ratios, and biovolume measurements. The aim of the research was to develop a method that integrates both ratio and volume indices of algal groups to provide a more balanced and informative assessment. The results showed that a high biovolume dominated by Cyanobacteria clearly indicated highly eutrophic lakes (Lake Caron and Lake Johanne). In contrast, a moderate biovolume with a balanced ratio of Bacillariophyta, Chlorophyta, and other groups was characteristic of mesotrophic lakes (Lake Schryer and Lake Canard), which were also closely associated with diverse macrophyte and zooplankton communities. This method is designed to be predictive of temporal trends and more diagnostic, as it enables analysis of nutrient pressures in both water and sediment. Furthermore, this approach provides a detailed and ecologically relevant assessment of lake health, offering valuable insights for water quality management and restoration efforts.

Quantifying Microbial Contamination and Hydraulic Dynamics in A Multifunctional Resilient Park

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Introduction: Resilient parks are increasingly being implemented as nature-based solutions to address urban challenges such as flooding and the urban heat island effect, both intensified by climate change. These multifunctional spaces serve as recreational areas in dry weather, and as stormwater management systems during rainfall, storing runoff, improving water quality, promoting infiltration, and contributing to groundwater recharge. While some studies have assessed the hydraulic performance or water quality improvements of such structures, there is a knowledge gap regarding residual microbial contamination and related public health risks following flood events. Method: This study addresses this gap by investigating a resilient park in Montréal, Québec, whose green infrastructure (GI) includes two vegetated depressions: one large and gently sloped, the other smaller but deeper, resembling an empty lake, with a total capacity of 627 m^3. From June to October 2025, GI soil, water, and passive samplers are being collected during both dry and rain events. Samples are analyzed for E. coli, total coliforms, and parameters including water level, soil moisture, temperature, pH, and water conductivity, pH, and total suspended solids. Preliminary results: Fecal contamination was detected in drainage water, with total coliforms reaching 70.000 CFU/mL and E. coli up to 2.000 CFU/100 mL – possible sources include small animals. Conductivity ranged from 190–280 µS/cm; pH remained around 7 ± 0.5. Microbial concentrations followed a "first flush" pattern, indicating particle mobilization during initial flow. Water levels in the drainage system are largely influenced by the recreational water jets. Visual analysis shows greater turbidity at the input than at the output branch, likely due to particle deposition. Next steps: Ongoing work will expand the assessment to detection of nontuberculous mycobacteria (NTM) and viruses, and evaluation of aerosolized particles.

Characterization of Source Water Quality in Nunavik (Northern Quebec)

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Drinking water in the fourteen communities of Nunavik (a region in northern Quebec, found above the 55th parallel) is often only treated by UV disinfection, followed by chlorination. This means that the quality of treated water provided to consumers is influenced by the variability of water quality within the source. However, in Nunavik, surface water quality data is extremely limited due to both exemptions from regulatory monitoring for the local water plant operators and limited scientific publications on the subject. It is therefore vital to better understand variations in surface water quality in order to ensure treatment efficiency, especially because this northern region is particularly vulnerable to the effects of climate change. The aim of this research is to characterize the water quality of both current and potential additional water sources in Nunavik, and assess the quality of water which could be produced after treatment of potential additional sources. This presentation will highlight the analysis of source water quality data collected to date in the northern villages of Kangiqsualujjuaq, Salluit and Umiujaq (Nunavik, QC), showcasing the difference in source water quality between these small northern communities and larger communities in southern Quebec.

Evaluation of Encapsulated Capping Materials with Non-Woven Geotextiles for Phosphorus Attenuation in Lake Sediment Capping

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Phosphorus-enriched lakes represent one of the most pressing environmental challenges in recent years, significantly impacting aquatic ecosystems and water quality. Excess phosphorus often results from various factors, primarily linked to anthropogenic activities such as agricultural practices involving heavy fertilizer use, the discharge of domestic and industrial sewage, and stormwater runoff from urban areas. These inputs accelerate nutrient loading in lakes, creating conditions favorable for harmful algal and cyanobacterial blooms. Such blooms can deplete dissolved oxygen levels, degrade water quality, disrupt aquatic life, and severely reduce the aesthetic and recreational value of lakes. This study aims to explore the application of non-woven geotextile encapsulated with capping materials including lanthanum-modified bentonite, fine-grained granular ferric hydroxide, activated carbon, and organoclay — as a method for reducing phosphorus concentrations in both the water column and sediment of a mesotrophic lake. The research will use samples collected from Lake Caron, a shallow mesotrophic lake located in Sainte-Anne-des-Lacs, Quebec. Batch experiments have already been performed to determine the optimal dosage of each capping material. Preliminary findings indicate that granular ferric hydroxide achieved approximately 50% phosphorus removal efficiency, while lanthanum-modified bentonite reached about 30%. Granular ferric hydroxide, being a potential by-product of mining operations, offers an added advantage by promoting resource reuse, thus contributing to sustainable remediation practices. By integrating effective phosphorus control methods with sustainable material sourcing, this research seeks to provide a practical and environmentally responsible approach to restoring and protecting freshwater ecosystems.

Strategic Use of Rainwater Harvesting Systems in the Agricultural Field

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Rainwater harvesting systems (RWHS) are climate change adaptation measures to secure a supply of non-potable water. They can be particularly interesting in agriculture when considering the large water demand of producers and increased uncertainty surrounding future water availability. However, there is limited information and regulation on the proper design, operation, and maintenance of RWHS, leading to concerns about the harvested water quality and the associated health risks. The physical and microbiological quality of RWHS water can be impacted by atmospheric pollutants, collection surfaces, and storage that may render the harvested rainwater unsuitable for certain agricultural uses such as irrigation or washing. The study aims to evaluate the average water quality of RWHS in agriculture and the factors impacting this quality, to provide guidance for good practice with these systems and facilitate their adoption. Two agricultural sites in Quebec (Canada) were characterized and sampled three times during summer 2025. For each site, rainwater from the reservoir, at the point of use and drinking water were sampled. And for each sample, different water quality parameters were assessed: pH, alkalinity, turbidity, organic carbon, Legionella pneumophila, coliforms, Escherichia coli, heterotrophic plate count (HPC) and metals. The results confirm that rainwater pH (6.2-6.5) and alkalinity (1-2 mg $CaCO_3$/L) are much lower than underground water pH (7.5-8.8) and alkalinity (293-311 mg $CaCO_3$/L), therefore suggesting that rainwater could also be used to adjust the pH or hardness of other water sources, if necessary. Additionally, the preliminary analyses demonstrate aerobic heterotrophic bacteria concentrations exceeding 3e5 CFU/mL and the presence of E. coli in rainwater. These results are significantly higher than the values measured in the RWHS water of large buildings and confirm the importance of a thorough study of these systems in the agricultural field.

SESSION 3A — CLIMATE CHANGE AND WATER MANAGEMENT

Assessing Willingness to Pay for Solar Desalination Technologies as a Climate Change Adaptation: A Socioeconomic Study

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Climate change continues to exacerbate the global water crisis, spurring development of diverse strategies and technologies to ensure future freshwater supply. However, to date, many advanced water treatment technologies and innovative products remain confined to the laboratory, often with limited understanding of real public demand and interest. To address such a disconnection between research and societal needs, we present a socio-economic study, assessing the public interest in and support for the implementation of an innovative water treatment solution. In specific, we designed and conducted a survey in the rural area of Marocco, a developing country facing sever water stress, to investigate the people's willingness to pay (WTP) for a solar-powered, portable desalination devices. The survey was carried out in a rural area of Casablanca-Settet region, Marocco. We identified the WTP associating with the socio-economic profile while also assessing the residentials' subjective perception of water quality. These perceptions were then compared with objective measurements. The results show that the key factors influencing WTP include the education level, income, the presence of water supply issues, and experience with similar devices. Notably, residents' perceptions of poor water quality significantly increased their WTP (i.e., the average WTP rose from 1.68 k MAD to 6.26 k MAD). In addition, with the assistance of potential governmental subsidies (e.g., 71.63%), the average WTP increased to 17.29k MAD, higher than the estimated cost of the product (~15 k MAD). These results provide insight into the social profile impact and economic viability in employing renewable energy-based desalination solutions to alleviate the water crisis in the context of developing countries. In addition, these outcomes contribute to the evidence-based decision-making for allocating public resources toward sustainable water solutions in climate-vulnerable communities

Full-Scale Venturi Air Stripping for H_2S Removal from Landfill Leachate: Preliminary Results and Future Abatement

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Elevated hydrogen sulphide (H_2S) in landfill leachate presents significant operational and environmental challenges, including accelerated infrastructure corrosion, occupational health risks for staff and inhibitory effects on downstream leachate treatment. This study presents preliminary results from a novel, full-scale, venturi-based stripping system deployed at the Trail Road Landfill in Ottawa, Ontario, designed to reduce dissolved H_2S concentrations in leachate prior to hauling and off-site treatment at the City of Ottawa's main wastewater treatment facility. The venturi system utilizes high-velocity leachate flow to entrain and inject ambient air into the pumped stream, promoting transfer of H_2S from the liquid to gas phase. Performance is being assessed through water chemical analyses and continuous gas-phase monitoring via in-line sensors at critical process locations. The H_2S venturi stripping system was deployed in late 2024 and since then, total sulphide concentrations in the pumped leachate decreased by an average of 55.2% (range: 0% to 97.9%). The system achieved 63.5% removal of the strippable fraction (H_2S) of total sulphides (range: 7.2% to 97.8%), demonstrating effective performance under varying operational conditions. The next phase of the research project will focus on developing integrated on-site abatement technologies to capture and treat the stripped H_2S gas. Potential treatment approaches under consideration include biofiltration, activated media systems, and chemical oxidation processes.

More is less: On Changes in Snow Water Availability in Northern North America

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We introduce a new diagnostic measure of Snow Water Availability (SWA), which quantifies water stored in the snow-covered portion of a grid area. By integrating different datasets for snow depth, snow density, and snow cover fraction, we form four SWA estimates at the 25×25 km2 across the northern North America, i.e., Canada and Alaska, where snow water is a key to human and ecosystem livelihoods. We show that annual long-term mean of SWA during 2000–2020 was 996 ± 170 km³. While average SWA increased from 799 ± 121 km³ in 2000-2010 to 1208 ± 231 km³ in 2011-2020, significant declines in SWA (p-value ≤ 0.05) were observed in ~3% of the domain, mainly in snow-rich regions of North American Cordillera, headwaters to major rivers in western Canada. Continuations of these losses, alongside insignificant decreases in SWA across southern parts, can threaten water security across a quarter of Canada, where ~86% of its population reside. We discuss the climatic drivers of SWA changes and highlight its implications from both water quantity and water quality perspectives.

Leveraging Floating Photobioreactors for Marine Carbon Dioxide Reduction in the Context of Climate Change

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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, demonstrating high potential for marine carbon dioxide reduction (mCDR). While traditional aquaculture systems for facilitating microalgae biomass growth have been extensively studied, floating photobioreactors (PBRs) offer an innovative alternative. These systems can reduce competition for land by utilizing marginal areas, such as coastal or offshore zones, while simultaneously achieving mCDR. However, there is a lack of comprehensive research on the PBRs associated microalgae biomass yield potential, environmental impacts, and net carbon reduction, especially in specific areas such as the Canadian coastline. This review first summarizes the design of photobioreactors (PBRs) for aquatic applications. It then discusses the influence of natural environmental factors, such as light and salinity, on microalgae growth. The impact of water quality parameters, including organic pollutants and emerging contaminants like microplastics, is also evaluated. Finally, various physical, biological, and nanotechniques for enhancing the carbon capture capacity of microalgae in the context of climate change are discussed, concluding with recommendations for future research.

Best Management Practices under Climate Change: A Call for Better Observation and Modeling

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Best Management Practices (BMPs) are widely implemented in Canada and elsewhere to reduce nutrient transport from agricultural lands to downstream water bodies. However, will they be still efficient under climate change? We exemplify how BMPs will become inadequate across the Qu'Appelle River Basin, a large and agriculture-dominated watershed in Saskatchewan, Canada. Using an ensemble of the latest future climate projections under moderate and high radiative forcings, we evaluated BMP performance both in terms of nutrient removal and cost up to the end of 21st century. Although the cost of removal decreases in future, we show that on the one hand, future nutrient loads will surplus the capacity of BMPs; and on the other hand, the efficiency of BMP consistently declines. Together, this creates a condition that under some scenarios and even by utilizing all possible BMPs, it becomes impossible to maintain historical nutrient loads without adopting alternative BMPs. To better understand the response of BMPs to climate variability and change, we focus on wetlands, the most widely available nature-based BMPs in Canada. We explore the nutrient dynamics through a high frequency spatiotemporal monitoring in a terminal wetland in southern Quebec. Our findings highlight substantial intra- and interannual variability along with spatial variation in retention capacity. While as a whole, the monitored wetland acts as a sink of nutrient, different segments of the wetland can switch between being sink to sources, a dynamic that current wetland models do not account for. Among various climatic drivers, air temperature emerged as the most consistent and influential factor affecting nutrient retention. We call for more detailed monitoring and modeling to accurately capture dynamic behavior of BMPs, particularly wetlands under evolving environmental conditions.

Dynamic Modelling of Ion Exchange for A Smart and Resource-Efficient Operation

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Ion exchange (IX) is a key technology in resource recovery, demineralization, and fit-for-purpose water production due to its inherent ion-selective recovery properties. A major challenge in the optimization of the IX process is the accurate prediction of breakthrough and regeneration cycles, which would enable improved resin utilization and reduced chemical consumption. Ion breakthrough for complex effluents cannot be reliably estimated by simple mass balances due to the competition for exchange sites in the resin according to the different ion-resin affinities. Regeneration is therefore critical, directly influencing contaminant removal efficiency, operational costs, and environmental footprint. Regeneration efficacy depends on resin-specific and process-specific factors, including the specific type and concentration of the regenerant, the operating conditions, and the presence of fouling. The selection of suitable regenerants requires a balance between desorption efficiency and chemical use. In the context of PFAS treatment, regeneration is particularly problematic, with recent studies highlighting competitive adsorption and the influence of chain length, ionic strength, pH, and kinetic effects on the system performance. Furthermore, operational parameters, particularly temperature, flow rate, and contact time, can significantly influence ion desorption rates and capacity recovery, with the utilization of high-temperature regenerants increasing energy demands and salt-based systems complicating downstream management. Numerous transport and kinetic models have been developed to support optimization and minimize waste. Consequently, techno-economic assessments facilitate the identification of more sustainable formulations. In this work, we present a series of operational scenarios for IX treatment, showing that with a limited set of parameters and representative components, long-term cycle simulation can serve as a basis for monitoring performance to guide experimental design and process optimization.

SESSION 3B — ADVANCED WATER AND WASTEWATER TREATMENT

A Novel Electrochemical Converter for Integrated Biogas Valorization and Wastewater Pollutant Removal

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Wastewater treatment plants (WWTPs) are known sources of greenhouse gas (GHG) emissions such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and nutrient pollutants (e.g. nitrate, phosphate, sulphate) that degrade water quality. These dual environmental challenges require integrated solutions that can mitigate GHG emissions while enhancing effluent quality through pollutant removal. The main aim of this study was to develop a novel electrochemical device for converting biogas to valuable fuel and products while simultaneously lowering GHG emissions and removing unwanted contaminants (from wastewater effluent). A key innovative aspect was to explore the use of effluent from a local municipal WWTP as the electrolyte in the electrochemical system. The system was a batch electrochemical reactor (volume: 1250 cm³) with copper and lead electrodes. Experiments were performed using both tap water and real WWTP effluent as electrolytes and GHGS, including N_2O as the gas input. Tests explored optimal conditions regarding the cathodic potential, flow rate, distance between electrodes, and potential duration of input. Concentrations of pollutants - nitrate, nitrite, phosphate, sulphate, and ammonium - were quantified by analytical Ion Chromatography (IC), and solid by-products created during the electrochemical reaction were characterised where possible by Scanning Electron Microscopy (SEM) and Energy-Dispersive X-ray Spectroscopy (EDS). The developed electrochemical convertor exhibited excellent pollutant removal effectiveness under optimal conditions. Using tap water as the electrolyte, there was 69% nitrate removal and 86% phosphate removal. With real WWTP effluent as the electrolyte, pollutant removal was significantly improved, achieving 98% phosphate removal, 88% nitrate removal, and 79% sulphate removal within 30 minutes. The major pollutant removal mechanisms identified were phosphate removal via precipitation of struvite ($MgNH_4PO_4 \cdot 6H_2O$)—identified by SEM - EDS with magnesium (60%), nitrogen (16%) and phosphorus (32%) found in the precipitate. Struvite precipitation occurred after 10 minutes of operation, at a pH of 8.8, and is relevant as a fertiliser product. Nitrate removal occurred via electrochemical reduction at the cathode. Sulphate removal was identified due to the oxidation of copper, creating copper (II) sulphate ($CuSO_4$), which is relevant as a therapeutic product (fungicides, aquaculture). Another compound that was present as a by-product was copper (II) hydroxide ($Cu(OH)_2$), produced because of the oxidation process of the copper electrode. The optimal removal efficiency was obtained at 10 cm between electrodes, after which performance was substantially impaired at 12.5 cm (primarily due to an overall lower electrical

current). The removal efficiencies of N_2O, phosphate and nitrate further improved (compared with a 10-minute gas input duration) by raising the gas input duration from 10 to 30 minutes, particularly during the first 20 minutes of operation. In summary, the developed electrochemical device provided a successful and integrated method for removing pollutants of concern from wastewater effluent. Consequently, this approach provides the opportunity to enhance effluent quality and conserve water resources.

Impact of Chemical and Microbial Iron Oxidation on Standing Column Well Performance: A Case Study in Montreal

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Standing column wells (SCWs) are environmentally friendly alternatives to conventional heating and cooling systems, using groundwater's natural heat for thermal exchange. However, their long-term performance and maintenance costs depend on both thermal efficiency and water quality. A 500 m-deep SCW on Louvain Avenue, Montreal, QC, showed high thermal potential but elevated iron concentrations. The latter can be problematic if Fe^{2+} is oxidized to insoluble Fe^{3+}—either chemically in the presence of oxygen or biologically by iron-oxidizing bacteria (IOB) such as Gallionella—as it forms deposits and biofilms on piping and surfaces, reducing heat transfer and hydraulic performance. To assess the risk, multiple sampling campaigns were performed over a two-year period and under varying conditions. The results revealed a strong tendency for iron oxide precipitation and IOB proliferation, particularly Gallionella. Additionally, in a 12-day recirculation test between the well and an external barrel, dissolved oxygen rose from 0.1 to 6.5 mg/L, Gallionella reached 8,000 CFU/mL, and Fe^{2+} dropped from 15.7 to 0.1 mg/L. To gain further insights into the process, additional laboratory tests were conducted. These tests showed that without a continuous Fe^{2+} supply, oxidation was mainly chemical, with no IOB detected. Biological activity occurred only in a sealed, low-oxygen (2 mg/L) setup, where a balance between chemical and microbial oxidation allowed Gallionella to reach 3,000 CFU/mL, indicating that even low oxygen can stimulate iron bacteria in the well. Despite these findings, the injection tube showed no oxidation or biofilm; however, the well was not continuously operated during the two-year period. In conclusion, both in situ and laboratory tests indicate that the well is highly vulnerable to iron oxidation. Any air entering the well or piping could trigger iron deposition and biofilm growth, reducing SCW efficiency and increasing maintenance costs.

Coupling Partial Nitrification and Anammox for Nitrogen Removal in Saline Mine Wastewater

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Mine wastewater is among the most challenging industrial effluents to treat. It often carries high concentrations of ammonium and salts, while offering little biodegradable carbon. These conditions restrict the activity of nitrifying and anammox bacteria, making conventional denitrification both costly and inefficient. To address this, we are exploring a low-energy alternative: coupling partial nitrification (PN) with anaerobic ammonium oxidation (anammox), and gradually adapting the system to tolerate salinity levels close to seawater. The setup consists of a 5-L W8-digestor type reactor for partial nitrification, operated under intermittent aeration (DO 0.4–0.6 mg/L) to encourage ammonia-oxidizing bacteria while suppressing nitrite-oxidizing bacteria. Effluent from this reactor feeds a 1-L anammox reactor running under strictly anoxic conditions. Both were seeded with sludge from Lake Caron, Quebec, and receive 150 mg/L ammonium chloride with nitrite at a 1.71:1 ratio. Since January 2024, cycle times have been reduced from 72 hours to just 4 hours, and salinity has been increased from 1,000 ppm to the current 5,000 ppm, with a target of 30,000 ppm. Operations are maintained at 28–30 °C and pH 7.5–8. Effluent analysis is done by using Ion Chromatography. So far, the process has remained stable at 5,000 ppm, consistently producing nitrite in PN and converting ammonium nitrite in the anammox stage. Under current conditions, the combined system is achieving an overall nitrogen removal efficiency of 65–70%. Work is ongoing to monitor performance and microbial adaptation as salinity approaches marine levels. By advancing PN–anammox for saline, low-carbon wastewaters without external carbon addition, this study aims to offer a practical, energy-efficient approach for nitrogen removal in mine-impacted waters and other high-salinity industrial effluents.

Optimizing Chemical Backwashing of Anthracite–Sand Filter Media from Laboratory Screening to Pilot-Scale Application

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Granular media filters are an essential part of drinking water treatment, yet their efficiency drops over time as layers of coagulant deposits, biofilms, and fine particles build up within the bed. Standard hydraulic backwashing removes some of this material but often leaves enough residue to restrict flow, shorten filter runs, and eventually require media replacement. In this work, we explored chemical cleaning to restore performance and extend the life of the filter bed. The laboratory phase began with anthracite and sand samples collected from a municipal filtration plant. Several cleaning agents were compared at the same concentration to determine which was most effective at removing accumulated solids and coagulant residues. The best-performing chemical from this screening was then tested at different concentrations to identify the optimal conditions for cleaning. Performance in both stages was evaluated through pH changes during washing, turbidity release, total solids removed, and surface analysis using scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDS). These optimized cleaning conditions are now being applied in a pilot-scale study at the Britannia Water Treatment Plant in Ottawa. Two identical filter columns are operated under matched flow rates and loading conditions, one using the chemical cleaning method developed in the laboratory phase and the other relying on hydraulic backwashing alone. The pilot measures headloss progression, filtration run duration, floc retention, and media condition after cleaning. Although results are still in progress, running both systems in parallel under the same conditions will allow for a direct comparison of performance. By moving from laboratory screening to real-world trials, this work aims to provide water utilities with a clear basis for deciding whether to integrate chemical cleaning into their backwash routines. The approach has the potential to improve filter efficiency, reduce maintenance costs, and extend the useful life of filtration media.

Treatment of High-Strength Liquid Waste Stream Using the Bioelectrochemically Enhanced Anaerobic Digestion Process

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High-strength waste streams contain elevated organic matter and soluble chemical oxygen demand (sCOD), requiring efficient treatment before disposal. Conventional aerobic systems are effective but costly due to high aeration demand and sludge generation. Anaerobic digestion (AD) is more economical but limited by moderate methane (CH_4) yields (~0.35 L/g $sCOD_{removed}$) and the need for elevated temperatures (35–45 °C). To overcome these limitations, bioelectrochemically enhanced anaerobic digestion (BEAD) integrates bioelectrochemical pathways to improve substrate degradation and CH_4 recovery. This study evaluated BEAD using food waste (FW) leachate as a model high-strength stream. Under ambient conditions (23–25 °C), BEAD and AD were compared across organic loading rates (OLRs) from 3–12 gsCOD/L/day. At lower OLRs (3–6), both systems performed similarly, but BEAD stabilized faster. At higher OLRs (7–12), BEAD achieved superior sCOD removal (94–88%) and CH_4 yields (0.30–0.35 L/gsCOD removed), compared with AD (91–81% and 0.28–0.23). BEAD sustained stability over the full OLR range (3–12), whereas AD was limited to 3–6. Temperature effects were also tested at a fixed 1.4 V. Thermophilic BEAD supported the highest OLR (14 gsCOD/L/day) and CH_4 yields (0.39–0.40 L/gsCOD removed), representing an 8–30% improvement over mesophilic (0.33–0.37) and psychrophilic (0.31–0.33) conditions. Microbial analysis showed enrichment of hydrogen-producing butyrate oxidizers and exoelectrogens, suggesting co-existence of conventional and exoelectrogenic CH_4 pathways. Enhanced thermophilic performance was linked to stronger syntrophic interactions between acetogens and hydrogenotrophic methanogens, aided by FW leachate and conductive biorings facilitating direct interspecies electron transfer (DIET). Overall, thermophilic BEAD supports higher OLRs, improves energy recovery, and lowers costs, highlighting its potential as a robust technology for treating high-strength organic waste.

Design and Testing of a Phosphorus Removal Structure for Mitigating Phosphorus Losses from Intensively Cultivated Organic Soils

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Excess phosphorus (P) export from intensive vegetable production on the organic (muck) soils of Holland Marsh, Ontario, is one of the contributors to elevated P concentrations in Lake Simcoe and the lake's chronic algal blooms. Edge-of-field (EOF) technologies such as wetlands, phosphorus removal structures (PRSs), and filter strips have shown promise on mineral soils, but their performance on muck soils remains largely unknown. This study evaluates a PRS filled with activated alumina (AA), a high-capacity P sorbent material, for treating subsurface drainage from a 2.4 ha vegetable producing field in the Holland Marsh. A PRS (0.91 m wide × 3.05 m long × 0.61 m high) was installed, and subsurface tile drainage effluent is discharged through the PRS. Influent and effluent are collected by automated ISCO samplers and analyzed for dissolved reactive P (DRP) and total P. Hydraulic residence time and flow volume are continuously monitored. Guided by the USDA P-Trap design tool, the PRS is expected to treat ~66245 hectoliter of tile effluent annually and achieve a 42% DRP reduction over its first three years. Over the next three years, we will (i) quantify PRS P-removal rates across variable flow and temperature regimes, (ii) determine sorbent longevity and regeneration needs, and (iii) upscale field-scale results via mass-balance modeling to estimate watershed-wide load reductions attainable through strategic PRS deployment across the Holland Marsh drainage area. This study provides one of the first assessments of AA-based PRSs on organic soils and offers evidence to guide scalable P-mitigation strategies in intensive crop production systems, contributing toward the Lake Simcoe Protection Plan target of reducing overall P load to 44 t yr $^{-1}$.

SESSION 3C — EMERGING CONTAMINANTS IN AQUATIC ENVIRONMENTS

Important Factors Governing Source Emissions and Aquatic Loadings of Chemical Additives Used in Vehicle Tires: Insights from Environmental Monitoring and Computational Modeling for Urban Environment

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Vehicle tires contain chemicals like N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD) and when released and transformed into 6PPDQ, harmful effect can occur to aquatic life. Despite of intensive studies on this group of chemicals with high environmental concern, there are questions related to their source emissions and aquatic loadings yet to be answered. While environmental emissions from tire wear chemicals is an obvious emission pathway, it is unclear how chemicals from the particles move to the environment and whether diffusive emission to the air and then atmospheric deposition play a role to govern the source-receptor relationship. Furthermore, it is unclear about the time scale from the chemical entering the urban environment to loading into aquatic environment. These questions are important otherwise there would be a gap to link chemical uses and the targeted aquatic ecotoxic effect. Through monitoring and modeling of a suite of chemical additives in vehicle tires, we explored the emission processes from vehicle tire and fate processes linked to urban aquatic environment. We found that the residence time of emitted tire chemicals in non-aquatic urban environment can be at a time scale of months before reaching the aquatic environment depending on climate factors. Diffusive emissions are often overlooked but important for certain tire chemicals especially at the tire operating temperatures. Because the time scale for the tire chemicals to reach aquatic environment, environmental transformations are important and transformation products should be monitored in order to establish a mass balance. Through nontargeted screening of well-known tire chemicals and environmental samples directly receiving emissions, we noted some important transformation products that should be considered when conducting water monitoring. A general risk assessment suggest transformation products of some tire chemicals could contribute higher risk.

Rapid Detection of Antibiotic Resistance in Escherichia coli in the Presence of Ampicillin and Carbapenem Using Advanced Quantitative Culture Methods.

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The WHO is predicting a surge in illnesses related to antibiotic-resistant bacteria (ARB), highlighting the need for surveillance of ARB in environmental samples including municipal wastewater. In this study, the aim is to develop and validate cost-effective methods using the Colilert-18/Quantitray MPN method and TECTA system to enable rapid and routine monitoring of ARB in wastewater, providing the total number of resistant coliform and E. coli bacteria along with the number of non-resistant coliform and E. coli bacteria. Utilizing the Quantitray method, water samples from wastewater treatment plants in Kingston were tested with and without ampicillin added to the culture medium at concentrations up to 10 µg/mL, and meropenem, imipenem and ertapenem at concentrations up to 1 µg/mL. After culture at 37 ºC for 18 hours, comparison of results indicated that 20% of E. coli in the sample were resistant to ampicillin while 0.03% were resistant to the carbapenems. Building on these findings, additional experiments are underway to determine the presence of carbapenem-resistant genes using DNA extraction and PCR methods. These tests aim to confirm the genetic basis of resistance. Kirby-Bauer and microdilution tests will further characterize the bacteria present, enabling a comprehensive understanding of resistance profiles. The TECTA system has been shown to distinguish between resistant and non-resistant strains with automated detection and detection times below 12 hours, and development of quantitative assays for resistant bacteria are underway. Demonstrating the feasibility and effectiveness of these methods in routine monitoring of ARB will enable rapid and low-cost surveillance in wastewater and environmental waters.

Degradation of Xanthate vs Two Alternative Flotation Collectors in Aqueous Solutions

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Desulfurization is a widely applied method for processing sulfidic ores, producing a concentrate of sulfides with economic value and geochemically stable tailings through flotation. The process uses xanthates as the collectors most extensively used. While very performant in the flotation process, xanthates are also linked to the aquatic toxicity of the effluents generated due to the thiosalts created as by-products during their degradation. Recent research attempted the use alternative collectors to optimize flotation performance, including compounds from the mercaptobenzothiazole (MBT) and dithiophosphate (DTP) groups. The degradation pathways of these collectors in aqueous solutions and the nature of the products generated, particularly in the absence of minerals, remain barely documented yet. In this study, the degradation of xanthate alongside two alternative collectors: AERO 407 (MBT+DTP) and AERO 3477 (DTP only) was investigated. Tests were conducted under control conditions, with and without hydrogen peroxide (H_2O_2), and at pH levels of uncontrolled, 2, 4, 7, and 10. Degradation was monitored using UV-VIS spectroscopy along with the measurement of sulfates, sulfides, and dissolved organic carbon (DOC) concentrations. The results indicate that, under unmodified, neutral, and alkaline conditions, the degradation of collectors is generally slow. Accelerated xanthate degradation was observed in the presence of H_2O_2 and under acidic pH, with CS2 as the dominant degradation pathway. AERO 407 exhibited a similar pattern, as evidenced by the disappearance of MBT bands under H_2O_2 treatment and acidic conditions. In contrast, AERO 3477 remained stable under all tested conditions, displaying distinct behavior: the addition of H_2O_2 resulted in more intense absorption with a slight spectral shift, producing a broader and higher band. The highest concentrations of sulfate and sulfides were observed during the degradation of AERO 3477, reaching approximately 150 mg/L and 200 mg/L, respectively. On the contrary, the highest COD value of 136 mg/L was found during the decomposition of AERO 407 in the presence of H_2O_2. These findings provide new insights into the kinetics of collector decomposition, the role of pH and oxidizing agents, as well as the contribution of flotation reagents to thiosel generation in mining effluents. Keywords: Xanthate, MBT, DTP, Decomposition, Thiosels, Flotation

Assessing the Risk of Emerging Contaminants in Canadian Waters with the HydroFATE Contaminant Fate Model

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Emerging contaminants in Canadian waterbodies pose significant risks to both the environment and human health. While comprehensive monitoring is essential, resource constraints often hinder the feasibility of widespread assessments. Existing models for evaluating contamination risks generally require specialized technical expertise and substantial computing power, limiting their accessibility for stakeholders involved in water management. To address these challenges, we introduce HydroFATE, a global contaminant fate model designed as an accessible tool for screening chemical contamination risks in surface waters associated with human consumption. HydroFATE enables stakeholders, including those in the chemical and pharmaceutical industries, wastewater treatment facilities, health authorities, policymakers, and environmental consultants, to efficiently prioritize monitoring and regulatory compliance efforts. Although plans are in place to develop a more user-friendly interface, HydroFATE's current framework already allows for scientifically robust and rapid assessments, making it a valuable resource for informed decision-making. Initial applications of the model have demonstrated its effectiveness in identifying antibiotic pollution, with peer-reviewed studies highlighting its capabilities. Ongoing efforts to expand HydroFATE to cover a broader range of contaminants will further enhance its utility across Canada. By fostering collaboration with government agencies, non-profit organizations, and industry stakeholders, we aim to encourage the widespread adoption of HydroFATE. This initiative will support evidence-based policy development, ultimately contributing to the preservation and improvement of Canada's water quality and ecosystem health.

Acting Against Growing Presence of Pharmaceuticals in Water Resources – A Global Problem

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Medical science has advanced in the last decades, permitting the curing of several diseases. However, the excessive use of pharmaceuticals increases their content in sewage. Naproxen and ketoprofen can be found in untreated wastewater at quantities as high as hundreds of thousands of ng/L. Furthermore, ibuprofen has been found in treated wastewater at levels greater than 20,000 ng/L in Poland. Generally, common sewage treatment methods are unable to remove pharmaceutical compounds. Since surface water serves as a receptor of wastewater treatment (WWTP) effluents, they are the major source of pollutants (including pharmaceuticals) in water resources. As such, the presence of pharmaceutical compounds in the source of water is a global problem. For example, the concentrations of sulfamethoxazole (SMX) in St Lawrence, downstream of WWTP in the Montreal area, have been measured at around 210 ng/L. The water quality monitoring of the Vistula, the main river in Poland, demonstrated the concentration of antibiotics (azithromycin, clarithromycin, ceftazidime, and erythromycin) higher than 1000 ng/L, while sulfamethoxazole reached peak concentrations of 1770 ng/L. The use of psychotropic drugs such as antidepressants (Venlafaxine) and anxiolytics has been increased in recent years; similarly, the application of synthetic hormones (e.g. 17α-ethinylestradiol, EE2). They can be found in St. Lawrence at the level of 740ng/L and 3ng/L, respectively. Pharmaceuticals, besides saving many lives, have a devastating impact on aquatic life and subsequently on human population. Antibiotics such as ciprofloxacin and sulfamethoxazole (SMX) exert selective pressure on native microbial communities, promoting the proliferation of resistant bacterial strains. This also facilitates the horizontal gene transfer of antibiotic resistance genes (ARGs) between environmental bacteria and potential human pathogens. They affect the behavior of aquatic invertebrates and vertebrates even at low concentrations if they are present in surface waters. Documented impacts include altered feeding behaviors, impaired predator avoidance, disrupted migratory patterns, and changes in social interactions. Chronic exposure may lead to long-term ecosystem imbalances, weakening resilience to environmental stressors and increasing the vulnerability of aquatic habitats to invasive species or further contamination. Sediment accumulation of antibiotics further extends their ecological impact, exposing benthic organisms and altering benthic-pelagic coupling. Collectively, these effects contribute to the degradation of aquatic ecosystem health and function. These compounds can also disrupt microbial-mediated processes such as nitrification and denitrification, reduce species richness, impair biofilm formation, and interfere with algal growth and photosynthesis, ultimately affecting oxygen production and food web dynamics. Subsequently, additional operation units dedicated to polishing effluents with respect to micropollutants such as pharmaceutics might be implemented at the WWTP to protect water resources. One of the affordable methods might be a filtration-adsorption system. The proposed system consists of biochar produced on-site from sludge generated at a WWTP and pyrolysis on an industrial scale. A series of tests with a filtration-adsorption column, filled with various granular biochar sizes, demonstrated an efficient removal of SMX by 88-95% and PCM (Paracetamol) by 95-95% within a few hours.

Comparaison de l'élimination de plus de 300 Contaminants d'Intérêt Émergent (CIE) dans 25 stations de récupération des ressources en eau (StaRRE) québécoises

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Des études ont montré la propagation mondiale des CIE dans les eaux de surface, dégradant ainsi leur qualité. Les traitements conventionnels ne parviennent souvent pas à éliminer suffisamment les CIE. Un traitement plus avancé, par exemple l'ozonation ou l'adsorption sur charbon actif, peut éliminer de nombreux CIE, mais ces traitements sont coûteux à mettre en œuvre et à utiliser. La recherche sur les contaminants d'intérêt émergent s'inscrit parfaitement dans l'amélioration de la qualité de l'eau, en particulier de la qualité des eaux de surface et des questions de santé publique et environnementale. Ce projet a pour but de dresser un portrait de la présence des CIE dans les eaux usées du Québec. Puis d'évaluer les performances des StaRRE échantillonnées en mettant en évidence les paramètres influençant l'élimination des CIE via des méthodes de partitionnement de données (« clustering »), dans un but global d'amélioration de la gestion des CIE au Québec. Avec la collaboration du MELCCFP, des prélèvements sont effectués depuis 2022 et se poursuivront jusqu'en 2026 dans 42 StaRRE représentant 80 % des rejets totaux des eaux usées du Québec. Les StaRRE étudiées utilisent quatre technologies: boues activées, étangs aérés, biofiltres et traitements physico-chimiques. Les prélèvements sont réalisés 4 fois en effluent et 2 fois en affluent par StaRRE sur une année, couvrant ainsi les quatre saisons. Des analyses de plus de 300 CIE sont effectuées dans des laboratoires accrédités: produits pharmaceutiques, SPFA, BPC, dioxines, PBDE, métaux, etc. De plus des paramètres conventionnels sont mesurés: pH, température, azote, phosphore, MES et DCO. Les métadonnées des StaRRE et les propriétés des CIE sont utilisées pour l'analyse détaillée des résultats en vue d'une meilleure compréhension de la situation. La première étape a permis de mettre en avant les substances prioritaires et de comparer l'efficacité des quatre technologies échantillonnées en termes d'élimination des CIE, suggérant que deux des technologies sont plus efficaces. L'effet de la saison et la différence en performance selon les familles de CIE ont été observés clairement.

SESSION 3D — INNOVATIVE WATER TREATMENT TECHNOLOGIES

Synergistic Nitrogen Fate Control via Integrated Biofilm Management and In-Situ Sludge Settling in a Novel Hybrid Airlift Bioreactor for Water Quality Enhancement

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Excessive nitrogen discharge from industrial wastewater accelerates eutrophication, posing critical risks to aquatic ecosystems in nutrient-sensitive watersheds. Conventional multi-stage biological nitrogen removal (BNR) systems typically require separate reactors, large footprints, and long hydraulic retention times (HRTs), while struggling with biomass washout and incomplete integration of nitrification, anammox, and denitrification pathways. This study introduces a patent-pending Hybrid Airlift Bioreactor (HALBR), a compact vertical-loop configuration that integrates in-situ sludge settling and biofilm attachment surfaces within a single unit. The reactor incorporates four functional zones: (i) an anaerobic upflow riser for hydrolysis and partial denitrification, (ii) an anoxic mixing zone to facilitate nitrite/nitrate reduction, (iii) an oxic downcomer with controlled aeration for partial nitrification and nitritation, and (iv) a clarification zone for selective sludge retention. The in-situ settling compartment maintains extended sludge retention times (SRTs), selectively enriching slow-growing autotrophic populations, while the downcomer-attached biofilm establishes stratified aerobic and anoxic microenvironments. This dual biomass mechanism enhances nitrogen removal efficiency, eliminates the need for secondary clarification, and significantly reduces energy demand. When treating high-strength wastewater, the HALBR achieved >96% total nitrogen removal (effluent TN < 8 mg/L), a 40% reduction in aeration requirements, 72% lower sludge production, and stable operation at nitrogen loading rates up to 1.2 kg N/m^3/day. The integrated biofilm/settling approach directly converted >90% of influent nitrogen to N_2 gas, producing consistently low-turbidity effluent (<5 NTU). This compact, energy-efficient configuration provides a robust and scalable solution for meeting stringent nitrogen discharge limits in wastewater treatment plants across Eastern Canada, where both environmental protection and operational cost-efficiency are critical.

Aluminum Nanoparticle Enhanced TiO_2 Photocatalysis of Organic Pollutants under Solar Irradiation

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Providing safe drinking water is increasingly challenging due to limited clean water supplies and inadequate treatment infrastructure in rural regions. Solar-driven processes offer a low-energy, sustainable route for water purification, but their adoption is limited by cost and scalability. Here, we report an optimized aluminum/titanium dioxide (Al/ TiO_2) plasmon-photocatalytic heterostructure designed to enhance sunlight-driven photocatalysis by tuning aluminum nanoparticle (Al-NP) size. Al-NPs were synthesized via a bottom-up, organic solvent-based Schlenk line method and coupled with P25 TiO_2. Unlike top-down approaches, this solution-based method provides scalability, high yield, crystallinity, and plasmonic quality. Cysteine (Cys) ligands stabilize the heterostructure in water, preventing aggregation and ensuring consistent photocatalytic activity. Compared to P25 TiO_2, the Cys-stabilized Al/ TiO_2 system achieved a 60% improvement in organic micropollutant degradation under sunlight. Al-NP size was tuned using density gradient centrifugation, enabling study of size-dependent plasmonic effects. The heterostructure was characterized by UV–Vis diffuse reflectance spectroscopy, TEM, dynamic light scattering, and positron annihilation lifetime spectroscopy. Tested on real lake water samples, the material demonstrated effective sunlight-driven purification. This study establishes a scalable, ligand-stabilized route for Al/ TiO_2 heterostructures with tunable plasmonic properties, offering a cost-effective strategy for decentralized water treatment in resource-limited settings.

Performance of Electrokinetic Systems for Oil and Grease Removal in Produced Water

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Produced Water (PW) from oil and gas operations contains a complex mixture of oil, suspended solids, dissolved salts, as well as organic and inorganic contaminants, making its treatment both technically and environmentally challenging. Conventional treatment methods often struggle to remove stable emulsions and finely dispersed oil droplets, especially when grease is present. Among emerging treatment methods, electrokinetic (EK) techniques—particularly electrocoagulation, electroflotation, and electrophoresis—have shown significant promise in effectively removing oil and grease from produced water. These processes operate by applying a low-voltage direct current across the stainless-steel electrodes, inducing chemical reactions that generate coagulants in situ and facilitate the destabilization, aggregation, and separation of emulsified oil droplets. Electrokinetic treatment offers several advantages over conventional methods, including reduced chemical usage, lower sludge production, and effectiveness against stable emulsions. However, factors such as salinity, electrode material, voltage, current density, and pH critically influence performance. Results showed that oil removal efficiency remained high (up to 99%) even at low voltages, with faster removal occurring in high-salinity PW due to greater ionic mobility. Notably, 91% oil removal was achieved in just 18 minutes in high-salinity PW, indicating that ion concentration significantly influenced removal kinetics. Additionally, pH was found to play a crucial role in treatment performance Since optimal removal occurred under moderately acidic to neutral conditions (pH 5.5–8), which promoted the formation of metal hydroxide flocs, enhanced electrooxidation of organic matter, and prevented electrode passivation. This study found effects of voltage, salinity, and pH to created favorable conditions for destabilizing oil emulsions, floc formation, and flotation of oil droplets. The results demonstrate that the EK reactor provides an efficient, low-chemical, and scalable solution for treating oil- and grease-laden Produced Water. Keywords: Electrokinetic System, Oil and Grease, Removal, Produced Water

Protecting Groundwater Quality from Petroleum Pollution Using Eggshell–Clay Adsorptive Barriers

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Accidental petroleum spills are a critical source of water pollution, as hydrocarbons infiltrate soils and leach into aquifers, threatening groundwater quality and ecosystem health. This study evaluates an eco-engineered barrier system made from chicken eggshell waste combined with clay to prevent the downward migration of petroleum contaminants. Laboratory experiments investigated the adsorption capacity under varying eggshell structures (ground vs. crushed) and clay fractions (1–5 g) at different contact times (30–150 minutes). Results demonstrated that eggshell–clay composites achieved high pollutant removal efficiency, with crushed eggshells paired with 5 g of clay removing up to 91% of toluene, while a 3:2 clay-to-eggshell ratio achieved ~86% removal in just 60 minutes. Multivariate statistical analyses confirmed the significant effects of eggshell morphology, clay content, and exposure time, while Langmuir isotherm modelling ($R^2 > 0.99$) validated the adsorption mechanism. By transforming food waste into low-cost, natural liners, this method offers a sustainable and scalable approach to mitigate petroleum hydrocarbon pollution, safeguard groundwater quality, and protect dependent ecosystems and human health. Keywords: aquifer contamination prevention, water quality, petroleum hydrocarbon spills, eggshell–clay barriers, adsorption, sustainable remediation

Cryopurification for Water Treatment: From Lab to Pilot-Scale Testing in Yukon, Canada

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The current project focuses on water purification in cold climates using a nature-driven approach, known as freeze concentration technology, or cryopurification. It takes advantage of the Arctic and Subarctic natural conditions rather than fighting against them. The approach was first tested for mine-impacted water (Faro Mine, Yukon) treatment at the lab-scale at Western University. It followed by the pilot-scale testing in Whitehorse, Yukon during winter 2025. The main objective was to decrease elevated zinc concentration in Faro Mine water close to the effluent quality standard. Based on the interim results obtained, contaminant removal can reach up to 90–95% from the Faro Mine water under optimal conditions using one cryopurification cycle. The main parameters that influence the process of cryopurification and could increase the purity of the ice were freezing temperature and the direction of ice front propagation. According to the results, using multiple cycles of cryopurification may enhance the removal of contaminants from both the contaminated water and the post-cryopurification brine solution. The up-to-date findings suggest that the approach could be scaled up and be a sustainable, green water treatment solution at the contaminated mine sites in the North.

Experiential Learning through Optimization of Jar Tests with Coagulation and Flocculation

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'Jar Tests' are a common laboratory procedure utilized on site in plant applications as well as in college and university level water treatment courses. Jar Tests provide students and operators an opportunity to visualize the coagulation and flocculation process and, in practical applications, improve the water treatment process. In this project, we examined a current lab procedure for coagulation and flocculation with a goal to maximize the visual impacts of the procedure, merged with theory to improve student knowledge and understanding of the process. Various factors influence coagulation and flocculation, including the coagulant used and its dosage, which is based on solution pH. However, the process of coagulation can drop pH by consuming alkalinity, meaning a solution may need some addition of a form of alkalinity, like soda ash. A final consideration is the mixing speed, by ensuring adequate dispersion of the coagulant during coagulation and the sufficient growth of floc during flocculation. Through testing two coagulants, alum and ferric chloride, under a variety of these conditions and monitoring the turbidity and pH, the best and worst combinations of factors were identified, with the best results having low turbidity. Overall, the best results occurred at optimal coagulant doses for the solution's initial pH when approximately double the stoichiometrically required alkalinity was added, taking turbidity from >200 NTU to around 1 NTU. For purposes of updating the lab procedure, by ensuring two jars have desirable results and two jars have undesirable results, students will be able to quantifiably and qualitatively understand the importance of coagulation and flocculation and its factors.

POSTER

Occurrence of Microplastics in a Wastewater Treatment Plant in the Greater Montreal Area

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Microplastics are prevalent in the environment, and wastewater treatment plants are suspected to be a significant contributor to their presence. This study investigated the occurrence of microplastics in a wastewater treatment plant (WWTP) located in the Greater Montreal Area. Wastewater samples were collected during the winter of 2025 and pretreated to remove substances or materials that may hinder the accurate detection of microplastics. Organic matter was digested sequentially using sodium hypochlorite and hydrogen peroxide, cellulose was removed with cupriethylenediamine, and sand was separated via density separation using zinc chloride. The resulting residues were then examined for the presence of microplastics. Microplastic analysis was carried out using PerkinElmer Spotlight 400 Fourier-transform infrared microspectroscopy (FTIR) and Keyence VHX700 optical microscope (magnification 20x). Six types of microplastics, including polyethene terephthalate (PET), polystyrene (PS), polypropylene (PP), polyacrylamide (PAM), polyvinylstearate (PVS), and polyurethane (PUR), were detected, with sizes ranging from 71 to 2176 µm. In terms of shape and colour, fibres and a white or clear colour were dominant. These findings confirm the presence of microplastics in the WWTP studied. Moreover, the work employed pretreatment protocols, specifically cellulose removal, that facilitated the accurate detection of microplastics, demonstrating a robust methodology for monitoring microplastics in complex wastewater matrices.

Corner Turbulence in Open Channels: Implications for Sediment Mixing and Water Quality

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Turbulent flows in open channels are inherently three-dimensional, with complex secondary currents developing in corner regions where the sidewall meets the bed. These corner-induced vortices—typically two counter-rotating cells per corner—are driven by turbulence anisotropy and have significant implications for velocity distribution, sediment transport, and mixing processes that influence water quality. This literature review synthesizes experimental and computational studies spanning laboratory to field scales (Re = Re = 10^3 to 10^{6+}), with geometries ranging from sharp rectangular to smooth trapezoidal sections. Laser Doppler Velocimetry (LDV), Particle Image Velocimetry (PIV), and Acoustic Doppler techniques consistently reveal that flow in narrow channels (aspect ratio < 5) is dominated by strong corner vortices and the velocity-dip phenomenon, while wider channels exhibit more localized corner effects. Advanced simulations—including RANS with Reynolds Stress Models, LES, and DNS—have captured these secondary flows with increasing fidelity, especially under varying wall slopes, corner rounding, and structural obstructions such as baffles. Emerging machine learning (ML) methods show strong potential to supplement traditional turbulence models, enabling rapid prediction of velocity profiles and secondary circulation strength from limited data or geometric parameters. Despite decades of study, gaps remain in understanding high-Re field-scale behavior and the dynamic interaction of corner turbulence with sediment, vegetation, and pollutant dispersion. This review highlights the importance of resolving corner-region dynamics for accurate modeling of flow structure and water quality outcomes, and identifies future opportunities at the intersection of hydraulics and data-driven modeling.

Removal of Antibiotics from Hospital Wastewater Using Synergistic Effects of Mxene and TiO2 in a Binary Heterostructured Membrane

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Pharmaceutical contaminants in hospital wastewater pose a critical environmental challenge, with current limitations in conventional membrane technologies for their removal. This work explores the development of a novel binary heterostructured membrane combining polyvinylidene fluoride (PVDF) with TiO_2-modified MXene nanosheets (TiO_2@MXene) for enhanced antibiotic rejection. The multi-layered TiO_2@MXene composite, fabricated via vacuum-assisted filtration, exhibited enhanced hydrophilicity (water contact angle of 19.5°) and permeability (293 $L.m^{-2}.h^{-1}.bar^{-1}$). The TiO_2 nanoparticles introduced photocatalytic activity and contributed to sieving and adsorption mechanisms. The fabricated membrane achieved removal rates of 87.8% for tetracycline and 60.7% for meropenem in single-solute feed tests, operating optimally at neutral pH conditions matching those of hospital wastewater effluents. Mixed antibiotic solutions and spiked hospital wastewater samples were also tested to study the effect of possible matrix effects. Notably, the removal rate for tetracycline remained high with 77.4% in mixed antibiotic solutions and 70.1% in spiked wastewater despite the increased complexity of the feed, demonstrating the membrane's sustained performance under realistic conditions. These findings highlight the synergistic effects of MXene's layered structure and TiO_2's photocatalytic performance in enhancing the membrane's selectivity and degradation performance. The developed membrane therefore presents a promising approach for mitigating pharmaceutical contamination in hospital wastewater treatment.

Addressing Long-Term Durability Challenges of TiO_2-Based Photocatalysts for Sustainable Textile Wastewater Treatment Applications

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Persistent organic dyes in textile effluents pose significant environmental and health risks worldwide. Conventional treatment methods often fail to fully degrade these pollutants, driving interest in advanced oxidation processes (AOPs), especially TiO_2-based photocatalysis. However, the long-term durability of TiO_2 photocatalysts under industrial conditions remains a major challenge limiting their large-scale application. This study evaluates the durability of the commercial TiO_2 photocatalyst P25 under simulated textile wastewater treatment conditions over a 28-day period, replicating key parameters such as pH, flow pattern, temperature, and light intensity. Exhausted catalyst samples are periodically collected, dried, and stored. Short-term photocatalytic tests under UV-B irradiation identify the most deteriorated specimens. Sample selection is validated through Dynamic Light Scattering (DLS), Zeta Potential Measurement (ZPM), and Ultraviolet-Visible Diffuse Reflectance Spectroscopy (UV-Vis DRS). In the next phase, selected samples will undergo further characterization using X-ray Diffraction (XRD), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray Spectroscopy (EDS), and Brunauer-Emmett-Teller (BET) surface area analysis to reveal irreversible structural and surface changes responsible for photocatalytic activity loss. These insights are expected to support the development of more resilient TiO_2 photocatalysts, advancing practical and sustainable solutions for textile wastewater treatment and ultimately contributing to improved global water quality management.

Impact of Iron & Manganese on PFAS Removal using Ion Exchange Resins

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Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals used in everyday products like non-stick coatings, textiles, and firefighting foams. Due to their excellent thermal and chemical stability, they persist in the environment and contaminate food and drinking water sources, potentially causing cancer, cardiovascular disease and endocrine disruption. Consequently, many countries have tightened their regulations on PFAS levels in drinking water. To remove PFAS from contaminated groundwater, anion exchange resins (AERs) are often selected due to their simple contactor configuration. However, their performance may be compromised by readily co-occurring groundwater constituents such as iron and manganese. The present research investigated the impact of iron and manganese on the performance of AERs for PFAS removal from groundwater. Lab-scale short-bed adsorber tests were conducted using water spiked with PFAS and dissolved or particulate forms of iron and manganese. Furthermore, to evaluate the influence of metal–organic matter complexes, experiments were performed both in the absence and presence of natural organic matter (Suwannee River NOM). The impact was assessed through PFAS breakthrough curves, pressure loss across the column, and metal ion uptake. Tracer tests and interrupted column tests were also performed to better understand the underlying mechanisms responsible for these impacts. Initial results indicated that iron, particularly soluble form (Fe(II)), caused significant fouling and reduced resin performance, leading to earlier PFAS breakthrough across all chain lengths. The impact was especially pronounced for longer-chain PFAS and for perfluoro sulfonic acids (PFSAs). In contrast, dissolved manganese (Mn(II)) had a lesser effect and largely passed through the resin without accumulating in the column. These findings highlight the importance of the pre-treatment for iron and manganese to maintain AER effectiveness in PFAS removal.

Analysis of Filter Materials for Phosphorus Reduction from Agricultural Drainage Effluent

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Phosphorus (P) from agricultural drainage systems is a major contributor to water bodies, causing excessive aquatic plant growth, algal blooms leading to eutrophication. To reduce the amount of P, researchers have been exploring various approaches, including plant-based materials, industrial bi-products, whose P removal performance varies with the change of numerous bio-environmental factors. This analysis emphasized key factors such as inflow and material pH, initial P concentration, and adsorption versus precipitation capacity. Adsorptive materials such as steel slag, nano-engineered particles, ceramsite (Zn/Zr), and Fe-based media generally achieve higher and faster P removal than precipitation-based materials. Lab experiments showed higher P-removal efficiencies than field experiments often reaching 99%. Industrial by-products specifically steel slag demonstrated strong performance across wide pH and temperature ranges, while materials like ferric hydroxide granules (CFH) and iron-coated sand (ICS) offer both high efficiency and recyclability. Performance can be reduced by high alkalinity, larger grain sizes, and low inflow P concentrations.

Predicting Clean-in-Place Performance in Full-Scale Membrane-Based Water Treatment Plants

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Membrane fouling poses a significant challenge in the development of membrane technology by reducing membrane permeability and, consequently, the rate of water production in treatment plants. Periodic membrane cleaning is therefore essential, and optimizing the cleaning schedule is critical for efficient operation because there is a tradeoff in determining the membrane cleaning frequency. Prediction models can link the operation parameters to the membrane cleaning performance and, therefore, enable the membrane cleaning schedule optimization. Among different membrane cleaning methods, including air scrub, chemically enhanced backwash (CEB), and clean-in-place (CIP), CIP is the most thorough cleaning method with the longest duration and highest dosage of chemicals. It plays an important role in foulant removal, but there is a lack of studies on CIP performance prediction. This paper aims to develop machine learning (ML) models to predict CIP effectiveness, measured by the specific flux (SF) after CIP and the recovery factor, using data from five full-scale water treatment plants. The ML models with five decision-tree-ensembled algorithms were trained on operation parameters from over 800 CIP cycles, extracted from the time-series datasets in the recent five years. These models had similar and satisfactory performances in predicting the CIP effectiveness, with the testing R2 of 0.62 - 0.69 for the SF after CIP and the testing R2 of 0.52 - 0.56 for the recovery factor. The backward input feature selection was conducted to explore the important factors that impact the CIP effectiveness. The results of such feature importance analysis showed that the SF and transmembrane pressure (TMP) before the CIP event were important for CIP effectiveness predictions, suggesting that the maintenance of SF by CEB and air scrub before the current CIP is important to improve the CIP performance.

A Methodological Approach for a Comparative Life Cycle Assessment of Phosphorus Adsorption Materials to Treat Drainage Runoff

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Phosphorus (P) remains a major pollutant in agricultural cropping systems. Research is being conducted on methods of P reduction in agriculture. Edge of field treatment systems using sorption material are being investigated however, little is known about the environmental impacts of various sorption materials. A Life Cycle Analysis (LCA) and an investigation of end-of-life options (EOLs) for these systems, once the sorption materials become saturated, are required to fully understand the impacts of future installations. The objective of the LCA is to analyze and compare the environmental impacts of some promising P sorption materials in order to provide recommendations for their large-scale implementation. The scope of the analysis will be gate-to-grave from the acquisition of the sorption material to its fate at the chosen EOLs. Experimental modelling will be performed to support the LCA analyses and for providing LCA input data. Assessment categories include climate change, water use, eutrophication, eco-toxicity, and cost.

Integrating Passive Sampling and Transcriptomic Bioassays to Enhance Water Quality Monitoring

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Monitoring water quality in Canada traditionally relies on collecting water samples and quantifying targeted contaminants using analytical chemistry. This approach provides valuable long-term trend data for known chemicals, but does not readily detect unknown contaminants. It also does not provide information on the bioavailability of contaminants and how they could impact aquatic organisms. To address this data gap, we are developing monitoring approaches that combine passive sampling with transcriptomic-based bioassays in larval fish and established fish cell lines. Polar Organic Chemical Integrative Samplers (POCIS) were deployed for one month in June 2025 in freshwater rivers within the St. Lawrence watershed and subsequently extracted. Extracts were analyzed for a select set of 8 pesticides and 9 pharmaceutical and personal care products using targeted gas chromatography-mass spectrometry (GC/MS). Extracts were then tested exposing cultured rainbow trout (Oncorhynchus mykiss) gill cells (RTgill-W1) or larvae to a dilution series of each extract. Survival and transcriptomic responses were assessed. For each extract, we calculated an in vitro effect concentration 50% (EC50) and an in vivo lethal concentration 50% (LC50). Ongoing work will derive transcriptomic points of departure (tPODs) for each extract dilution series. The tPOD represents a benchmark dose where a concerted transcriptomic response is first detected. We hypothesize that tPODs will reveal further insights into disrupted biological pathways that align with certain chemical profiles. These findings demonstrate the potential for integrating passive sampling and transcriptomic bioassays to provide a more comprehensive picture of water quality, including evaluating the toxicity of complex contaminant mixtures and unknown toxicants.

FEEM Spectroscopy as a Rapid Screening Tool for Sewage Contamination: Correlation with Viral and Bacterial Indicators

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Untreated sewage contamination of surface waters poses significant public health risks through microbial pollution and subsequent recreational waterborne illness (RWI). The United States recorded 7.15 million RWI cases in 2014, resulting in approximately 6,600 preventable deaths attributable to inadequate monitoring. Current surveillance of recreational waters depends on faecal indicator bacteria (FIB), polymerase chain reaction (PCR), or a combination of the two. FIB provides a non-specific proxy for pathogens by detecting bacteria like E. coli and enterococci but is time-intensive and fails to assess viral pathogen risks. Conversely, PCR is a highly specific molecular technique targeting distinct genetic sequences, but its use is costly and requires skilled personnel. This study investigates Fluorescence Excitation Emission Matrix (FEEM) spectroscopy as a rapid, low-cost approach for recreational water surveillance. FEEM characterizes fluorescent dissolved organic matter signatures, including tryptophan-like and humic-like fluorescence associated with sewage contamination, potentially offering real-time assessment capabilities. This proof-of-concept study compared FEEM spectroscopy with culture-based FIB enumeration and digital PCR quantification of human-associated microbial source tracking markers (HF183, CrAssphage) and enteric viruses (HAdV, NoV, EV) across serial dilutions of raw wastewater (n=8 sampling events, Montréal, Canada). Parallel factor analysis (PARAFAC) decomposed FEEM data into interpretable components, while simple linear regression evaluated associations between fluorescence parameters and pathogen concentrations. This study represents the first direct comparison of FEEM spectroscopy and digital PCR for wastewater characterization. Results demonstrate the potential of FEEM as a complementary screening tool for waterborne pathogen monitoring, contributing to the development of rapid assessment methods for recreational water management.

Self-Sustained Energy in Remotely Located Toilets

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In the Northern regions of Canada, year-round freezing temperatures and permafrost prevent the use of centralized sewage collection and treatment systems which rely heavily on a pipe network. Instead, many remote settlements make use of honey buckets, which are plastic pails that serve as toilets. The waste collected in these honey buckets, including human urine and feces, is disposed of in open lagoons or even directly into lakes, rivers and other water bodies. Without access to more advanced wastewater treatment technologies, this practice places many Northern communities at risk of water-borne disease due to possible sewage spills or contamination of drinking water. This presentation proposes anaerobic digestion as both a decentralized solution to sewage treatment and as a source of renewable energy. Collected sewage in remote location undergoes anaerobic processes. Synthetic human waste has demonstrated methane yields up to 0.66L CH_4 per gram of volatile solids at ambient temperatures after a freeze-thaw cycle indicating that the deployment of such systems to subarctic environments is feasible when coupled with a source of heat such as a solar thermal collector. Biogas can thus be used to fuel generators and provide a source of electricity and heat while the digested waste may be safely disposed of. Methane generated by anaerobic digestion may be electrochemically converted to methanol, producing a fuel for direct methanol fuel cells. Subsequently, energy produced can be used in-situ, e.g. for toilet lighting. Such a solution is applicable to Northern communities as well as other remotely located communities. Simultaneously, these communities will benefit from the on-site production of methane, a source of renewable energy capable of lowering their consumption of fossil fuels, their greenhouse gas emissions and their expenditures related to the purchase and transportation of fuel.

Interactions in Combined Fouling, Their Impact on Salinity Treatment Performance and Membrane Cleaning Strategies in Reverse vs Forward Osmosis

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With rising global water scarcity, reverse osmosis (RO) and forward osmosis (FO) processes are increasingly used to treat high-salinity waters such as seawater and saline mine drainage. These waters contain mixtures of colloids and fine suspended particles, including dissolved organic matter (e.g., humic substances, proteins, and polysaccharides), inorganic ions (e.g., Na^+, K^+, Ca^{2+}, Mg^{2+}, and SO_4^{2-}), and, in the case of seawater, biological species (microorganisms and algal products). Their filtration leads to fouling phenomena that alter membrane properties, reduce salt rejection and permeate flux, and increase the need for frequent cleaning and operating costs (chemical consumption and early membrane replacement). Fouling is generally classified either reversible, where cleaning protocols restore flux but increase the specific cleaning frequency and cleaning chemical intensity, or irreversible where flux recovery falls below acceptable thresholds, leading to membrane disposal. The molecular interactions governing these compounds interactions with each other and with the membrane surface remain insufficiently understood, limiting the ability to predict fouling layer morphology, flux decline, and the reversibility of filtration performance after cleaning. Therefore, this study aims the integration of current knowledge and identification of research gaps on the interactions in RO vs. FO systems, the evaluation of their consequences for filtration performance, and critical assessment of the effectiveness of existing cleaning protocols in restoring reversible fouling. Feedwaters represent complex matrices of biotic and abiotic contaminants that interact both in the bulk and at the membrane interface (foulant-foulant and foulant-membrane interactions), driven by shared physicochemical properties of water (charge, ionic valency, and functional groups of foulants). The interfacial microenvironment (surface charge, roughness, and concentration polarization) still alters the contributions of key forces (electrostatics, divalent-cation bridging, hydrophobic interactions, and hydrogen bonding during fouling). As a result, deposition at the membrane interface is a multi-component-dependent process that differs from solution behavior, leading to complex performance outcomes (synergistic, inhibitory, or additive) that are not predictable from single-component studies. To analyze these interactions, various sets of experimental and modeling tools have been applied. Atomic Force Microscopy (AFM), Quartz Crystal Microbalance with Dissipation (QCM-D), X-ray Photoelectron Spectroscopy (XPS) and X-ray Absorption Near Edge Structure (XANES) are used to identify adhesion/cohesion forces, surface attachment, and local coordination, while theoretical and computational approaches including extended DLVO theory (XDLVO), molecular dynamics simulations (MDS), and density functional theory (DFT) provide estimates of interaction energies between foulants and membranes. These approaches link molecular-scale mechanisms with RO and FO filtration performance. Operationally, membrane fouling is managed through a two-tiered strategy: (i) prevention, via selective pretreatment and surface modification to reduce foulant adhesion; and (ii) mitigation, through hydraulic/chemical cleaning (rinsing, backwashing, and osmotic backwashing). Selection is guided by foulant class (organic, biofilm, inorganic scaling, mixed) and by process (RO vs FO). Performance is assessed with standardized metrics (flux recovery, specific cleaning frequency, and cleaning chemical intensity). Overall, a mechanistic understanding of foulant-foulant and foulant-membrane interactions is therefore key to lowering operating costs and extending membrane lifetimes. Applying this understanding will enhance process optimization while minimizing water use and reducing waste generation.

Effects of Biochar and Vegetation on Leachate Quality from Bioretention Systems

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Cities are susceptible to urban flooding due to the increasing impervious surfaces. Stormwater contains various contaminants, which are detrimental to the surrounding ecosystems. Bioretention systems have been increasingly used in cities to tackle these problems. However, current bioretention substrates, primarily comprising of sand and compost, have showed limited contaminant removal capacity. Biochar, a carbon-rich material produced by the pyrolysis of biomass, is suggested as a potential substrate additive for bioretention systems. Post-processing biochar may further enhance biochar physicochemical properties while reducing biochar phytotoxicity. The objective of this research is to investigate the effects of post-processed biochar and vegetation on the leachate water quality, including pH, turbidity, total suspended solids (TSS), conductivity, and total dissolved solids (TDS), from bioretention systems. In this experiment, glass columns were filled with either pure substrate, substrate with unprocessed biochar, or substrate with biochar that has undergone post-pyrolysis thermal air oxidation (hereinafter: treated biochar). One seedling of Rudbeckia hirta was planted in the columns of vegetated treatment, and the rest remained non-vegetated. Weekly irrigation with synthetic stormwater was conducted to evaluate leachate pH, turbidity, and conductivity from the bioretention systems. Additionally, the columns were irrigated with synthetic stormwater spiked with 4.5mg/L of micro- and nano-plastics monthly to evaluate the TSS and TDS. During the irrigation events, leachate from the vegetated columns had lower conductivity and pH compared to non-vegetated columns. Columns amended with treated biochar produced leachate with higher pH than those containing pure substrate or unprocessed biochar. We also revealed that leachate TDS and conductivity declined with increasing plant total leaf area. These results suggest that treated biochar and vegetation can improve some water quality parameters in bioretention systems, potentially mitigating the negative effects of urban stormwater on the ecosystems.

Floods and Green Infrastructure: How Much Phosphorus Could be Lost in Community Gardens and Stormwater Management Ponds?

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Urban water systems face increasing nutrient pressures, as impervious surfaces and engineered drainage disrupt natural infiltration, concentrate stormwater flows, and enhance nutrient mobilization. These altered pathways accelerate both the timing and magnitude of nutrient delivery to receiving waters, degrading aquatic ecosystems and threatening drinking water. Green infrastructure, such as stormwater management ponds (SWMPs) and urban agriculture (UA), can mitigate flooding by increasing perviousness and temporary storage. Some systems, like SWMPs, are designed primarily for stormwater control, while others, such as UA, provide these benefits as co-benefits. Determining whether they function as nutrient sinks or sources requires quantifying phosphorus inflows, outflows, and storage, as these stocks and fluxes define the material that could be mobilized under changing hydrological conditions. This research uses a spatially explicit substance flow analysis to quantify phosphorus dynamics in London, Ontario. The city-wide analysis quantifies intentional phosphorus flows and stocks in UA and SWMP systems. Preliminary results for SWMPs show an average loading of 130 kgP/yr into ponds and 1,407 kgP/yr removed via sediment management. Across UA sites, 390 kgP/yr is added via soil amendments, while only 68 kgP/yr is removed via crop harvest, leaving residual phosphorus to accumulate in soils or be lost from sites. Mean sediment stocks are 619 kgP/ha in SWMPs and 77 kgP/ha in UA soils. Mapping revealed that 87% of ponds and 39% of gardens in floodplains may be vulnerable to phosphorus export during extreme events. In the next phase, the InVEST Nutrient Delivery Ratio model will assess how much of these phosphorus stocks are at risk of hydrosphere loss. This research identifies where phosphorus stocks and flows concentrate and how their location relative to floodplains influences export vulnerability.

Characterization of the Quality of Natural Sources of Water in A Northern Village of Nunavik

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The consumption of untreated natural sources of water is a common practice among a part of the population in some northern villages in Nunavik (North of Québec). This practice is partly due to the low trust in the quality of drinking water distributed by the community's water treatment plant. Frequent boil water advisories, even if the majority are only preventive, have an impact on the population's trust in the quality of the water served at home. However, the consumption of water from natural sources is not without risk and could be a cause of waterborne diseases. In recent years, health problems (diarrhea) have been reported to the Nunavik Regional Board of Health and Social Services (NRBHSS). The population attributes these health problems to the quality of the treated water. However, it is difficult to define the origin, knowing that the consumption of natural sources could expose the population to these problems. As part of my research, I participated in multiple sampling campaigns, in summer 2024 and 2025 as well as in spring 2025, with the goal of characterizing the water quality of treated water and natural sources of water consumed by the population in Nunavik. The specific objectives of my research are to evaluate and compare the quality of these waters using genomic analysis (amplicon sequence analysis of 16S rRNA, 18S rRNA and ITS region and PCR genotyping of selected waterborne pathogens), microbiological analysis (bacterial count of total coliforms, Escherichia coli, Enterococci, Pseudomonas aeruginosa and others) and physicochemical quality (pH, conductivity, turbidity, temperature, dissolved oxygen, total organic carbon, UV absorbance at 254nm, metals). During this presentation, I will specifically compare water quality of two untreated natural sources of water used by a part of the population as freshwater and compare them with water quality from treated water.

Characterization of Microbial Water Quality in Nunavik Home Tanks and Influence of Cleaning Strategies

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Nunavik is a remote region in the north of the province of Quebec, with a drinking water supply system different from that found in major Canadian cities like Montreal. Drinking water is distributed by trucks and stored in home storage tanks due partly to presence of permafrost. These tanks are professionally cleaned every two years, and little is known about the quality of the water stored in them. The lack of information on this subject has led to public health authorities questioning the safety of this water. The objective of this project is to gather more information on the quality of stored water and evaluate the efficiency of the cleaning procedure. During summer 2024, a sampling campaign was carried out in one northern village in Nunavik. A broad portrait of the quality of drinking water stored in home tanks was obtained by monitoring various physicochemical, microbiological and genomic parameters. Microbial species including pathogens and regulated ones were analysed such as E. Coli, Enterococcus, Pseudomonas Aeruginosa and total coliforms. Overall, 74 tanks were sampled with a variety of characteristics analysed for each. The tanks were sampled before and after the cleaning process to evaluate the efficiency of it. A second more targeted campaign was carried out in summer 2025, to evaluate the temporal variability of the quality of water stored in home tanks, one year after their cleaning. The data collected from both campaigns is detailed here to give a portrait of the quality of drinking water stored in home tanks from 2024 to 2025, with a focus on microbiological quality.

Assessment of direct injection in LC-QTOF-MS for the suspect or non-targeted screening of emerging contaminants in different types of water

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Assessment of direct injection in LC-QTOF-MS for the suspect or non-targeted screening of emerging contaminants in different types of water Rheina Hawabhay 1, Jingyun Zheng 1, Lan Liu 1, Jessica Head2, Morgan Solliec3, Karine Lalonde3, Stéphane Bayen1* 1 Department of Food Science and Agricultural Chemistry, McGill University. 2 Department of Natural Resource Sciences, McGill University. 3 Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs The chemical diversity of various aquatic systems is both intriguing and concerning. Samples extracted from rivers, oceans or creeks, inherently require broader analytical approaches notably for contaminants of emerging concern (CECs). Given the complexity and unpredictability of aquatic systems' chemical composition, suspect or non-targeted screening (SNTS) of water bodies can reveal valuable insights on the occurrence of CECs. In recent years, separation techniques coupled with high resolution mass spectrometry (HRMS) have become a central approach for the comprehensive analysis of CECs, their metabolites and transformation products. However, to date, only a limited number of suspect or non-targeted studies have investigated the presence of CECs in aquatic systems. Therefore, in this study, a method based on direct injection for water followed by LC-Q-TOF-MS analysis for the SNTS of contaminants in different types of natural and drinking waters was assessed. Method performances were evaluated for a range of analytes, including pesticides, pharmaceuticals, personal care products, and plastic-related chemicals in river water, tap water, ultrapure water and bottled water, with emphasis on limits of identification using different data treatment pipelines. Traces of residues were detected in samples collected in 2025, and MS/MS data was further mined. Overall, this study demonstrated the potential of high-resolution LC-Q-TOF-MS for the combined targeted and non-targeted analyses of trace contaminants in natural and bottled waters covering a wide range of physicochemical properties.

Numerical Simulation of Microplastic Fate and Transport in the St. Lawrence River Using the 2D Horizontal Modeling Approach

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Microplastics (MPs) are emerging contaminants that threaten aquatic ecosystems by accumulating in water bodies and affecting water quality, sediment dynamics, and aquatic organisms. The St. Lawrence River (Quebec, Canada), a vital waterway linking the Great Lakes to the Atlantic Ocean, plays a key role in regional ecology and commerce, and MP contamination poses risks to water quality, biodiversity, and fisheries, highlighting the need for effective pollution management. This study applies a two-dimensional (2D) horizontal hydrodynamic and transport model (MIKE 21) to simulate the fate and transport of MPs in a section of the St. Lawrence River near Montreal. The hydrodynamic model is developed based on depth-averaged shallow water equations, incorporating the Navier-Stokes equations for flow dynamics and advection-dispersion equations to track MP movement. The transport model integrates key environmental factors, including flow velocity, turbulence, particle size distribution, and settling velocities, to accurately simulate MP dispersion and accumulation. Model simulations were conducted by using field-measured hydrodynamic parameters, such as water depth, flow velocity, and discharge rates, combined with MP concentration data obtained from water and sediment sampling. The model outputs were validated against observed data to ensure accuracy in predicting MP accumulation zones and dispersion patterns. The findings contribute to a deeper understanding of MP behavior in freshwater systems and provide critical insights for pollution mitigation strategies. This study underscores the importance of numerical modeling in assessing MP contamination and informing management approaches to protect this vital water resource. Keywords: Microplastics, MIKE 21, fate and transport, hydrodynamic modeling, St. Lawrence River, aquatic pollution